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Norwegian Households' Willingness to Pay to Preserve a Global Public Good The Amazon Rainforest

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Abstract

The Amazon rainforest is the world's largest rainforest. Currently, at least 16 percent of the area has disappeared due to deforestation. Deforestation results in loss of ecosystem services and goods which provide local and distant households with benefits. Consequently, preservation of the Amazon rainforest has grown to become a global concern. Implementation of a preservation plan to preserve the Amazon rainforest depends on costs and benefits, which must be determined and weighted against each other. The respective benefits among distant beneficiaries are assumingly related to non-use values, which implies existence and bequest values. Through a contingent valuation survey with an internet panel of 300 randomly sampled Norwegian respondents, the study finds that Norwegian households are, on average, willing to pay between NOK 950 − 1100 as an annual national tax to secure the realization of an extensive preservation plan, which implies no further forest and species loss within 2050. Implicitly, the study provides clear evidence that distant beneficiaries are willing to pay to preserve the Amazon rainforest, where non-use values and carbon storage values are of great importance. Further, the study evaluates the reliability of utilizing three benefit transfer techniques, including the Delphi method, to determine mean WTP among Norwegian households to secure the realization of two preservation plans. Results indicate that estimates derived by utilizing the Delphi method as a benefit transfer technique are directly comparable to estimates derived by a population contingent valuation survey. On the other hand, utilizing unit transfer with income adjustment and function transfer as benefit transfer techniques do not provide directly comparable estimates. Thus, through low transfer errors and test results, the study provides evidence that the Delphi method is a reliable benefit transfer technique, which entails substantially less costs and time expenditures compared to population CV surveys.

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A.D.

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Abbreviations

BT benefit transfer

CV contingent valuation

EC environmental conservation

RP revealed preference

SP stated preference

TEV Total Economic Value

WTP willingness to pay

1. Introduction

The Amazon rainforest is the world's largest rainforest. As much as 40 percent of the total remaining amount of tropical forest today is represented by the Amazon rainforest (Andersen et al., 2002, p:1). The rainforest covers several South American countries such as Brazil, Colombia, Venezuela, Peru and Suriname. The total Amazonian area is about 5.5 million km^2 (Andersen et al., 2002, p:11), and 60 percent of the Amazon rainforest is located in Brazil (Nunes Kehl et al., 2015, p:1). Since the 1960's, deforestation of the Amazon rainforest has grown to become a major global concern (Uhl, 1987). Today, at least 16 percent of the Amazon rainforest has disappeared, but for now deforestation rates in the area are on a downward trend (Nunes Kehl et al., 2015; Malhi et al., 2008).

Andersen et al. (2002) identify several origins of deforestation in the Brazilian Amazon rainforest. The major contributor is the high growth in cattle ranching in the region, which previously has been heavily subsidized by the Brazilian government. It accounts for about 70 percent of deforestation of the Amazon rainforest (Malhi et al., 2008). The second major contributor is agricultural expansion and production. It contributes to 10 percent of forest clearing. Logging, mining, insecure property rights and road building are also important factors which lead to deforestation in the region.[1]

Deforestation of the Amazon rainforest promotes several environmental concerns and it results in loss of ecosystem services and goods (Foley et al., 2007). Carbon storage is an important global ecosystem service provided by tropical rainforests. Thus, removal of large forest areas, which is done by slash-and-burn techniques, induces less carbon storage and increased emissions (Verweij et al., 2009).[2] Further, deforestation results in loss of biodiversity and species. This is worrisome for both individuals located in and outside tropical rainforest regions, as 50 percent of the world's existing species are found here (Verweij et al., 2009). To reduce loss of ecosystem services provided by tropical rainforests, it is important to preserve such areas.

The study assesses how distant beneficiaries value avoidance of loss in forest and species by preserving the Amazon rainforest. The Amazon rainforest provides several ecosystem services, and values among distant beneficiaries of avoiding loss of forest and biodiversity are classified as benefits they obtain through cultural services. These are mainly non-use values individuals obtain from an ecosystem, such as its very existence. The thesis consists of five chapters. The first part describes background and existing literature on the topic, as well as problem statements. Secondly, relevant theory is examined in chapter 2. Chapter 3 describes methods applied in the thesis, while chapter 4 entails results. Lastly, discussions, a conclusion and a policy recommendation is provided in chapter 5.

[1] See Andersen et al. (2002, p:66-90) and Andersen and Reis (2015) for more information.

[2] Slash-and-burn is an agricultural method were farmers burn forest to cultivate land for farming. Intensive slash-and-burn make previous forest covers unable to recover (Tinker et al., 1996).

1.1 Background

Costanza et al. (1997) estimated that the total value of all ecosystem services provided by tropical forests is $3.8 trillion per year (Andersen et al., 2002, p:168). Values were determined by utilizing benefit transfer (BT) techniques, i.e. transferring valuation information from previous studies to value ecosystem services (Hanley et al., 2013, p:78). However, estimates and methods used were criticised, as the study transferred small-scale values to value global ecosystem services (Bockstael et al., 2000). The total value was revised by Costanza et al. (2014). Valuation transfers were improved and the revised current estimated value of all ecosystem services provided by tropical rainforests is $6.8 trillion per year (Costanza et al., 2014).

The Amazon rainforest is the world's largest rainforest, and the forest provides important local, regional and global ecosystem services. Therefore, the Amazon rainforest can be defined as a global public good (Navrud and Strand, 2016; Strand et al., 2017). It provides global benefits and ecosystem services in terms of carbon storage, biodiversity, recreational values and non-use values (Strand et al., 2017; Andersen et al., 2002, p:172). Such benefits can be defined as non-excludable, meaning the benefits are available for everyone. Further, they are non-rivalrous, meaning benefits obtained by one individual do not prevent other individuals of obtaining the same benefits. Therefore, it is reasonable to believe that distant beneficiaries are willing to pay to preserve the Amazon to secure current and future benefits.

Preservation of the Amazon rainforest has grown to become a global concern due to the rapid deforestation in the region since the 1960's. Should international policy-makers consider to implement a substantial preservation, then benefits and costs of alternative plans must be weighted against each other (Navrud and Strand, 2016). This is done by conducting a global benefit-cost analysis. The policy makers must value local, regional and global benefits which preservation of the Amazon rainforest entails. Additionally, the opportunity cost of increased preservation must de identified.

Carbon storage is a global benefit and an ecosystem service which the Amazon rainforest provides. Valuing carbon storage benefits of the Amazon can be done by the use of the social cost of carbon, i.e. the discounted cost (benefit) of a marginal increase (decrease) in carbon emissions (Greenstone et al., 2013; Strand et al., 2017). Additional benefits and ecosystem services, such as Amazonian timber and non-timber products, recreational values and biodiversity, can be monetized by market prices, revealed preference (RP) methods[3], i.e. observing households' consumption behaviour in markets associated with the Amazon rainforest (Segerson, 2017, p:21), and stated preference (SP) methods. SP methods, for instance contingent valuation (CV), elicit respondents' willingness to pay (WTP) for a quantity/quality change in an ecosystem service by conducting a survey with a constructed hypothetical market and policy-relevant scenarios

[3](RP) methods would typically be used to value recreational values of the Amazon rainforest (Navrud and Strand, 2016).

(Boyle, 2017, p:83). SP methods are the only methods applicable to determine non-use values (Johnston et al., 2017).

Few studies have determined non-use values among distant beneficiaries of the Amazon rainforest. Non-use values are divided into *existence* and *bequest values*. Overall, non-use values represent values of benefits individuals obtain by the existence of an ecosystem, that the good can be used by others and that the good is available for future generations (bequest values) (Pascual and Muradian, 2010, p:195). Such values are an important part of the global *Total Economic Value* of preserving the Amazon rainforest, i.e. the total value of a change in the quality or quantity of ecosystem services provided by the Amazon rainforest (Navrud and Strand, 2016). Existence of biodiversity, forest and tropical wildlife are examples of non-use values distant beneficiaries hold of preservation of the Amazon rainforest. Preservation avoids further biodiversity and forest loss (Morse-Jones et al., 2012).

Non-use values, in terms of WTP per household to preserve the Amazon rainforest, might be substantially lower than *direct* (sustainable consumptive benefits) and *indirect values* (non-consumptive benefits) for individuals located in the Amazon region. However, the number of distant beneficiaries is considerably larger. Their main benefits of preserving the Amazon rainforest are most likely non-use values (Navrud and Strand, 2016). Aggregate non-use values is therefore believed to be a decisive part of the global Total Economic Value of preserving the Amazon rainforest. These should be included if a benefit-cost analysis of preservation plans were to be conducted. (Andersen, 2015; Navrud and Strand, 2016). It is therefore both important and relevant to determine non-use values among distant beneficiaries of preserving the Amazon rainforest.

1.2 Existing Literature on the Topic

Carson (1998) addresses several philosophical and practical issues if one were to value a tropical rainforest by conducting a CV survey. It is important to define 'what' a tropical rainforest is and its function in the survey, so that each respondent has sufficient knowledge regarding the good of interest. One important function of a tropical rainforest is biodiversity, which implies that the term must be defined to the respondents in a common understandable manner (Carson, 1998). Further, Carson (1998) argues that one must determine 'where' the tropical rainforest of interest is located, 'when' a possible preservation program should be implemented and for how long, and who the respondents of interest are. As deforestation of the Amazon rainforest has been defined as a global concern, the population of all countries are of interest. This raises the issue of how to construct and translate a CV survey so that each population interprets the survey equally. Other important questions to consider are 'how' much of the defined forest will be preserved, and how it should be paid for (Carson, 1998).

Even though there are several practical and philosophical issues regarding valuation of a tropical rainforest, Kramer and Mercer (1997) conducted a CV study among U.S residents to determine their WTP to preserve tropical rainforests in general. Their study showed that U.S residents, on average, were willing to pay between $21 and $31 to preserve 5 percent of tropical rainforests in addition to what was already preserved at the time. This was a one-time voluntarily payment. Horton et al. (2003) conducted a CV study in the UK and Italy to determine households' WTP to impose preservation programs of parts of the Amazon rainforest. In the first program, 5 percent of the Brazilian Amazonia were to be preserved, with an average WTP per household of £30 as annual tax. The second program preserved 20 percent with an annual average WTP per household of £39.

Navrud and Strand (2016) conducted a Delphi CV survey for the World Bank to estimate WTP among households in European countries to preserve the Amazon rainforest. In general, the main objective of a Delphi study is to determine estimates based on experts' opinions on a specified subject, which has not yet been examined, through a survey (Sackman, 1974, p:4).[4] The study was extended by Strand et al. (2017) by including OECD countries and low-income, lower-middle income and upper-middle-income Asian countries. In total, 217 valuation experts were surveyed, while 48 valuation experts from different European countries were surveyed in the study by Navrud and Strand (2016). The main intention of the two Delphi studies was to determine non-use values which distant beneficiaries hold of preserving the Amazon rainforest.

The surveyed experts were introduced to two different costly preservation plans. Initially, 15 percent of the forest was already gone. In **Plan A**, there would be no further loss of forest, nor species, by 2050. Thus, 85 percent of the total area would be remained by 2050. **Plan B** implied some forest loss, such that 75 percent of the total area would be remained by 2050, and 7 percent species would be lost. The two preservation plans were compared to a reference scenario where 60 percent of the forest would remain by 2050 and 12 percent species would be lost (Navrud and Strand, 2016). Experts had to provide expected annual household mean and median WTP of their respective country for both plans, and for Europe as a whole (Navrud and Strand, 2016).[5] This was done in two rounds. In the first round the experts guessed mean and median values, and in the second round the experts could see each other's answers and adjust own answers. This is a standard procedure in a Delphi survey. The researchers then estimated the mean for each country and for Europe based on the experts' expected values in round 1 and round 2 for each plan (Navrud and Strand, 2016; Strand et al., 2017).

The European Delphi CV study finds that the expected mean WTP per household in Europe is €28, as annual tax, for the most extensive preservation plan. Three Norwegian experts were surveyed in the European Delphi CV study. The mean of the expected mean WTP of the three Norwegian environmental valuation experts is €65 per Norwegian household as an annual tax in round 1 (Navrud and Strand, 2016). In round 2, when they could adjust their answers, the mean of expected mean WTP of the Norwegian environmental valuation experts is $114.2 for the most extensive preservation plan (Strand

[4]Delphi method is explained in more depth in section 3.3

[5]The surveyed experts were provided a payment card of values ranging from €0 to €100.

et al., 2017). A general perception when conducting a Delphi survey is that estimates from later rounds are more accurate (Navrud and Strand, 2016). Implicitly, if a CV population survey were to be conducted in Norway, the Delphi study indicates that Norwegian households, on average, are willing to pay \$114.2 as an annual tax for preservation Plan A. For Plan B, the means of the expected mean WTP of the Norwegian environmental valuation experts are \$63 in round 1 and \$64 in round 2.[6]

The two Delphi studies are a part of a larger project by the World Bank called "Economic Valuation of Changes in Amazon Forest Area". After conducting the Delphi exercise in numerous countries and continents, their plan was to perform population surveys in some European countries, North America and Japan (Strand et al., 2017). So far, North America (USA and Canada) is the only place where such a population survey has been conducted.[7] It was found that North American households, on average, are willing to pay \$4.97 and \$3.19 annually for each percentage of potentially avoided forest and species loss, respectively (Siikämaki et al., ND). Marginal WTP estimates for avoiding forest and species loss were determined by conducting a choice experiment. The respondents were introduced to different preservation plans with varying attributes and asked to choose the option they prefer. The preservation plans presented to the respondents were not the same as the plans used in the Delphi studies.

1.3 Problem Statements & Hypotheses

The first problem statement of the thesis is to estimate non-use values which distant beneficiaries, implying Norwegian households, obtain by preservation of the Amazon rainforest. Non-use values amongst distant beneficiaries are mostly related to avoidance in loss of biodiversity and species, and avoiding further forest loss (Laurila-Pant et al., 2015; Kramer and Mercer, 1997; Horton et al., 2003). Valuation estimates are obtained by the use of the CV method. The data is collected by conducting a small-sample population panel survey of 300 respondents through Norstat. The data will be used to obtain estimates of the total and the mean WTP to preserve the Amazon rainforest among Norwegians households.

The surveyed respondents, representing their respective household, are presented with the two preservation programs, **Plan A** and **Plan B**. These are compared to a reference scenario with no policy intervention. Both preservation plans and the reference scenario differ slightly compared to scenarios defined in the Delphi studies. The **reference scenario** entails that the area of the Amazon rainforest will be reduced from 85 percent to 60 percent in 2050 and 24 percent of current species will be lost. **Plan A** implies no further forest and species loss within 2050, while **Plan B** implies 15 percent forest loss and 7 percent species loss compared to current levels within 2050. Thus, the study assumes

[6] My co-supervisor and co-author of the Delphi studies, professor Jon Strand, provided me with the mean WTP values of Plan B in round 1 and 2. These were not defined in the Delphi studies.

[7] The study was conducted by Siikämaki et al. (ND), but it has not been published yet.

that more species will be lost compared to the scenarios defined in the Delphi studies. It is important to note that 15 percent of the Amazon rainforest is already gone in all scenarios for both studies. Respondents are asked to specify their maximum WTP for each program on a payment card, which contains several payment values. The Payment vehicle for each program is a binding annual national tax (Strand et al., 2017). The first problem statement defined above allows us to formulate the two first research questions:

Research question 1: What is Norwegian households' willingness to pay to preserve the Amazon rainforest, considering Plan A?

Research question 2: What is Norwegian households' willingness to pay to preserve the Amazon rainforest, considering Plan B?

Research question one and two lead us to the second problem statement, namely to compare obtained results with estimates from previous studies. Implicitly, we will compare and discuss estimates obtained by the use of a population CV survey with estimates obtained by the use of a Delphi CV survey, for the same population. This makes it possible to evaluate the reliability of using a Delphi CV survey to determine non-use values among distant beneficiaries. Correspondingly, it makes it possible to evaluate the reliability of using the Delphi method as a BT technique. In the literature, the Delphi method has been applied as BT. Estimates derived in a Delphi study to value non-market goods rely on experts' previous experience and valuation information. For a further discussion, see Section 3.3. The comparative estimates are found in Navrud and Strand (2016) and Strand et al. (2017).

If estimates derived in a Delphi CV study are representative of estimates derived in a CV population study, then Delphi CV surveys can be used as a BT technique when population surveys are difficult to implement or time consuming and expensive. A global benefit-cost analysis requires a substantial amount of population surveys. The Delphi method might be an adequate BT technique for such analyses. This is perhaps the most interesting objective of the study, as it also is an objective of the World Bank project.[8] Further, we will compare obtained results with results from Siikämaki et al. (ND), which is referred to as the North American study. The reference scenario and the scope of the preservation plans are not the same. Thus, estimates might not be directly comparable. However, we can use the marginal WTP estimates for avoiding one percent forest and species loss from Siikämaki et al. (ND) to determine the means of WTP among North American households for our defined preservation plans. BT can then be used to determine the means of WTP among Norwegian households by adjusting for income and purchasing power. Further, the data set from the North American study will be utilized to estimate a logit-model. The model can be used to perform a function transfer as a BT technique to determine mean WTP to preserve the Amazon rainforest among Norwegian households,

[8]See Navrud and Strand (2016, p:3-4).

given the preservation plan defined in the North American survey.[9] Mean WTP is found by inserting mean values of independent variables obtained from the Norwegian sample into the logit-model. The second problem statement allows us to formulate research question three and four:

RQ.3: Is the mean WTP per hh/y of preserving the Amazon rainforest directly comparable conducting a population CV survey and a Delphi CV survey?

RQ.4: Is mean WTP per hh/y of preserving the Amazon rainforest, derived using international benefit transfer, directly comparable to mean WTP derived from a CV population survey?

Equivalence tests and t-tests will be used to evaluate equivalence or difference between mean WTP estimates derived using BT techniques and mean WTP estimates derived by estimations in the thesis. The hypothesis for RQ.3, H3.1, states that transferred values from the Delphi studies might be lower. The reference scenario in the Delphi studies entails less species loss. Additionally, experts were asked only to consider non-use values, which excludes regulating services such as carbon storage. This is probably more challenging for Norwegian households, as deforestation is often associated with climate concerns. Horton et al. (2003) find that several respondents consider indirect use-values, especially regulating services provided by the Amazon rainforest, when asked why they are willing to pay to preserve the Amazon rainforest. Furthermore, Siikämaki et al. (ND) find that some respondents consider the importance of carbon storage as a reason for possessing positive WTP.

For RQ.4, hypothesis 4.1 states that international transferred mean WTP estimates are believed to be higher. Surveyed households live closer to the Amazon rainforest than Norwegian households, and a greater share of North American households have potentially visited the Amazon rainforest and thus have higher WTP, for instance due to recreational and eco-tourism values. Additionally, the survey utilized in Siikämaki et al. (ND) indirectly referred to carbon storage as a benefit of preserving the Amazon rainforest. It is therefore believed that inclusion of carbon storage values yields higher WTP estimates.

As discussed above, it is reasonable to expect that some respondents have high WTP values to preserve the Amazon rainforest, as preservation results in less carbon emissions. To assess whether respondents consider that preservation results in less carbon emissions, one could ask whether this was considered after the elicitation question. This was done in the North American study. However, it can be a leading question. Respondents can state yes, as the question reminds them of the benefits of reduced emissions. If so, it is difficult to assess whether stated WTP values represent non-use values or carbon storage values. To evaluate whether respondents consider carbon storage, we decided not to mention carbon

[9] In the North American study, respondents were asked a dichotomous choice question to accept/reject a bid for a preservation plan, called Plan A, which entailed 10 percent forest loss and 8 percent species loss, compared 30 percent forest loss and 24 percent species loss if no plan were to be implemented.

in the survey, nor to ask if they considered reduced carbon emissions. After respondents stated their WTP, we asked an open question why they were willing to pay. Based on their responses, we coded five categories where climate/carbon storage is one of them. As a result, we are able to test if respondents who consider climate benefits have a different mean WTP compared to other positive WTP respondents. Further, we can also evaluate how carbon values affect WTP. The next research question can therefore be formulated as follows:

Research Question 5: Will carbon storage benefits be an important reason why respondents have positive WTP to preserve the Amazon rainforest?

Another concern to consider is that the Norwegian government, through the Amazon Fund, has been funding Brazil to reduce deforestation of the Amazon in order to reduce emissions, avoid biodiversity loss and protect the rights of indigenous individuals. In 2008 Norway and Brazil agreed that Norway would pay up to 1 billion US dollars by 2015 if Brazil significantly reduced deforestation of the Amazon rainforest over a ten-year period (Klima- og Miljødepartementet, 2017). Consequently, Norwegian households might feel that they have already paid to reduce deforestation of the Amazon rainforest through tax payments. Respondents might then state low or zero WTP. In order to assess whether this is a significant concern, we decided to ask respondents with zero WTP if the reason why they are not willing to pay is because the Norwegian government has already paid for mitigating deforestation of the Amazon rainforest. Furthermore, 1 billion US dollars over a ten-year period equals approximately a payment of $50 per Norwegian household per year over ten years (Strand et al., 2017).[10] We can transfer this value and test if the payment of $50 is a good proxy for Norwegian households means of WTP to preserve the Amazon rainforest for the two preservation plans. This leads us to the two next research questions:

Research Question 6: Will Norway's funding to Brazil to reduce deforestation in the Amazon rainforest be an important reason for protest zeroes among respondents?

Research Question 7: Is the Amazon Fund, which equals $50 per hh/y over ten years, comparable to Norwegian households mean WTP to preserve the Amazon rainforest for Plan A or B?

An important aspect of CV is to evaluate how socio-economic factors and preferences affect WTP among respondents (Johnston et al., 2017). In the survey, respondents are asked questions about their socio-economic characteristics related to income, education, age and gender. Additionally, questions regarding general preferences and preferences of the public good of interest are asked. It is important to include questions about socio-economic

[10] It is then assumed that Norway has 2 million households, which is a reasonable assumption.

factors and preference to evaluate if respondents understand the information provided in the survey, and to evaluate the validity of elicited values (Johnston et al., 2017). Therefore, we can formulate research question eight as follows:

Research Question 8: How can socio-economic factors and preferences explain WTP to preserve the Amazon rainforest among Norwegian households?

Table 1.1 addresses the main research questions and the hypotheses related to these.

Table 1.1: RQs & Hypotheses

RQ.1	**What is Norwegian households' willingness to pay to preserve the Amazon rainforest, considering Plan A?**	
H1.1	*What is Norwegian households' mean and total willingness to pay to preserve the Amazon rainforest, considering Plan A?*	
RQ.2	**What is Norwegian households' willingness to pay to preserve the Amazon rainforest, considering Plan B?**	
H2.1	*What is Norwegian households' mean and total willingness to pay to preserve the Amazon rainforest, considering Plan B?*	
RQ.3	**Is the mean WTP per hh/y of preserving the Amazon rainforest directly comparable conducting a population CV survey and a Delphi CV survey?**	
H3.1	*Carbon storage values and more species loss make mean WTP estimates of the population survey higher than the estimate obtained from the Delphi survey*	
RQ.4	**Is mean WTP per hh/y of preserving the Amazon rainforest, derived using benefit transfer, directly comparable to mean WTP derived from a CV population survey?**	
H4.1	*Higher carbon storage values among North American households make transferred mean WTP estimates higher in value*	
RQ.8	**How do socio-economic factors and preferences explain willingness to pay to preserve the Amazon rainforest among Norwegian households?**	
		Expected sign
H8.1	*Higher household income affects WTP positively*	+
H8.2	*Gender does not affect WTP*	0
H8.3	*Higher age affects WTP positively*	+/-
H8.4	*Higher education affects WTP positively*	+
H8.5	*Higher wanted public spending on tropical rainforest in South America positively affects WTP*	+
H8.6	*If respondents have visited or plan to visit the Amazon rainforest affects WTP positively*	+
H8.7	*If respondents find neither Plan A or Plan B as realistic affects WTP negatively*	-
H8.8	*Respondents who find environmental conservation somehow or very important affects WTP positively*	+
H8.9	*Being a member of an environmental organization affects WTP positively*	+

2. Theory

2.1 Welfare Economics

The overall objective of policymakers is to maximize social welfare. The overall societal welfare is represented by a social welfare function (SWF). The SWF represents utility of each member in the society (Pindyck and Rubinfeld, 2009, p:598). When the SWF is maximized then the society's resources are efficiently allocated. This is a situation economists refer to as *Pareto optimum*; it is not possible for any individual in the society to be better off without another individual being worse off (Singh, 2007, p:41-42).

The situation can be illustrated by the use of a production possibility frontier and an indifference curve, which represents the social welfare function.[11] We assume that the society produces two goods, a private good denoted as x and a public good denoted as q. Figure 2.1 illustrates the efficient allocation of the private and the public good. The optimal solution is defined where the slope of the indifference curve of the social welfare function equals the slope of the production possibility frontier (Mitchell and Carson, 1989, p:18). Implicitly, optimal production of the private and public good is x^* and q^*, respectively.

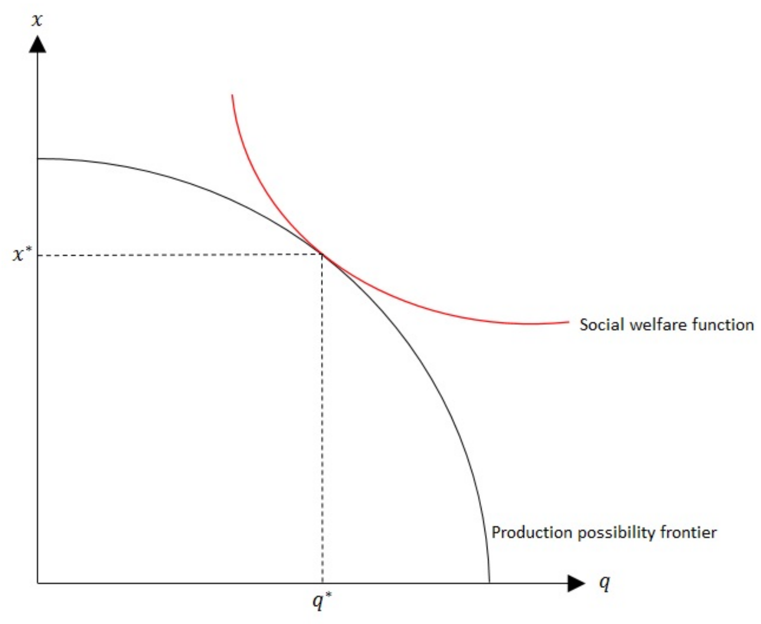

Figure 2.1: Maximized social welfare

It is not evident that we are located in the optimal solution. We could be located in a point below this solution. Then, there is room for *Pareto improvements*. A Pareto improvement is a situation where a policy makes some individuals better off while no one worse off

[11]The production possibility frontier illustrate all possible production combinations of the two goods. The indifference curve represents different combinations of the goods which yield equal societal welfare. (Fø rsund and Strø m, 2000, p:238)

(Mitchell and Carson, 1989, p:21). A Pareto improvement allocates societal resources more efficiently compared to status quo conditions. To assess whether there is room for a Pareto improvement, policy makers weight benefits and costs of policies which are considered to be implemented. The difference between benefits and costs of a policy is defined as net benefits. As long as the benefits of a potential policy are greater than the costs it entails, and there is room for compensation such that gainers can compensate losers, then the policy should be implemented. This criterion is referred to as the *Kaldor-Hicks criterion*, and one is then able to realise a Pareto improvement (Boardman et al., 2014, p:32).

In order to evaluate if the benefits of a policy are greater than the costs, a benefit-cost analysis is conducted (Mitchell and Carson, 1989, p:20). Boardman et al. (2014) identify nine steps when conducting a benefit-cost analysis. The overall evaluation of whether a policy or a set of policies should be implemented depends on the *net present value* (NPV). NPV is defined as the difference between present value of benefits and the present value of costs. $1/(1+r)^t$ is the discount factor and it determines how much we value future costs and benefits (Boardman et al., 2014, p:142).

$$\text{NPV} = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t} \tag{2.1}$$

If global policy-makers want to implement a plan to preserve the Amazon rainforest, then they need to utilize the theory of benefit-cost analyses into practice. They would conduct a global benefit-cost analysis of different specified preservation plans. Benefits and costs of the specified preservation plans must be identified. The preservation plan which provides the highest NPV should be implemented if, and only if, the NPV is positive and there is room for compensation.

2.1.1 Environmental Demand Theory & Welfare Measures

The only method to determine non-use values is by using stated-preference methods, where one approach is CV. Before clarifying further what the CV method is, it is convenient to explain the underlying theory of the method. We want to examine a household's demand for a given environmental good, namely the Amazon rainforest. In this section, consumer demand theory for environmental quality and welfare measures are used to determine welfare effects of increased preservation of the Amazon rainforest.[12] Respondents, which represent their household, are asked to state their WTP for two different preservation programs. Now, assume the following utility function (2.2) and budget constraint (2.3):

$$u(\boldsymbol{x}, Z, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.2}$$

$$Y \leq \boldsymbol{px} \tag{2.3}$$

We denote $\boldsymbol{x}$ as a vector of n private consumer goods, $\boldsymbol{x} = [x_1 ... x_n]$, Z as current quality level of the Amazon, $\boldsymbol{Q}$ as a vector of other public goods, $\boldsymbol{Q} = [Q_1 ... Q_n]$, and $\boldsymbol{T}$ as a

[12]References for this section is Kolstad and Braden (1991, p:17-31), Mitchell and Carson (1989, p:18-29) and Freeman et al. (2014, p:40-76).

vector of preferences to the household, $\boldsymbol{T} = [T_1...T_n]$. Y is denoted as household income to the respondent and $\boldsymbol{p}$ is a vector of n market prices, $\boldsymbol{p} = [p_1...p_n]$. Both increased consumption of $\boldsymbol{x}$ and improved quality of the Amazon rainforest provide the respondent with improved utility level. This indicates that:

$$\frac{\partial u}{\partial \boldsymbol{x}} > 0, \frac{\partial u}{\partial Z} > 0 \tag{2.4}$$

Respondent i can maximize utility subject to the budget constraint, yielding demand as a function of prices, quality level, other public goods, preferences and income, called Marshallian demand functions. We can then obtain the indirect utility function, which represents the maximum utility of respondent i, given prices, income, preferences, quality level and other public goods (Flores, 2017, p:29).

$$v(\boldsymbol{p}, Z, \boldsymbol{Q}, \boldsymbol{T}, Y) \tag{2.5}$$

Through duality, respondent i can minimize expenditures subject to attaining a given level of utility. This provides us with the Hicksian (compensated) demand functions (Braden & Kolstad, 1991:19). Favourably, Hicksian demand functions do not entail income effects of a price change, as expenditures vary so that the utility level remains at status quo level. Hicksian demand functions only entail substitution effects of a price change. Marshallian demand functions entail both substitution and income effects of a price change. Correspondingly, it is easier to measure welfare effects using the expenditure minimization theory when regarding public goods (Mitchell and Carson, 1989, p:23). Hicksian demand allows us to measure welfare effects in monetary terms holding utility at status quo level. Derivation of Hicksian demand functions is as following, where $u = U^1$ is status quo level of utility for respondent i.

$$\begin{aligned} \min_{\boldsymbol{x}} \quad & \boldsymbol{px} \\ \text{subject to} \quad & u(\boldsymbol{x}, Z, \boldsymbol{Q}, \boldsymbol{T}) - U^1 \geq 0 \end{aligned} \tag{2.6}$$

This gives us the Langrangian function:

$$L^* = -\boldsymbol{px} + \lambda[u(\boldsymbol{x}, Z, \boldsymbol{Q}, \boldsymbol{T}) - U^1] \tag{2.7}$$

The minimization problem provides us with the Hicksian demand function, which is a set of demand functions.

$$\boldsymbol{x}^* = \boldsymbol{h}(\boldsymbol{p}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.8}$$

The set of demands is a function of prices, status quo quality level of the Amazon rainforest, other public goods, preferences and status quo utility level. Substituting (2.8) into the objective function, (2.6), provides us with the expenditure function (Kolstad and Braden, 1991, p:19).

$$\boldsymbol{px} = \boldsymbol{ph}(\boldsymbol{p}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) = e(\boldsymbol{p}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) = Y^1 \tag{2.9}$$

The expenditure function can be used to measure the respondent's willingness to accept (WTA) compensation for an undesired quality change. The function (2.9) determines the minimum amount of income necessary for respondent i to obtain the status quo level of utility (U^1) with current quality level of the Amazon rainforest (Mitchell & Carson, 1989:26). We assume that the level of income necessary to obtain utility level U^1 is Y^1. Further, if preservation Plan A is not implemented then the quality of the Amazon rainforest declines from Z to Z^0, where $Z > Z^0$. The level of utility decreases to U^0, where $U^1 > U^0$. This gives us the following expenditure function: $e(\boldsymbol{p}, Z^0, U^0, \boldsymbol{Q}, \boldsymbol{T})$.

We want to measure the welfare effect if Plan A is not implemented, in other words, how much additional income respondent i demands in order to maintain status quo utility level U^1 after the quality decrease. Then, the new expenditure function is defined as:

$$e(\boldsymbol{p}, Z^0, U^1, \boldsymbol{Q}, \boldsymbol{T}) = Y^2 \tag{2.10}$$

We define Y^2 as the minimum income necessary for the respondent to obtain initial utility level, while Z decreases to Z^0 and vectors $\boldsymbol{p}, \boldsymbol{Q}$ and $\boldsymbol{T}$ are held constant. Intuitively, Y^2 must be higher than Y^1 in order to maintain initial utility level. This is due to the assumption in (2.4). The difference between the two expenditure functions, Equation (2.9) and (2.10), can be used to measure respondent i's welfare effect in monetary terms if Plan A is not implemented. The difference is referred to as *compensation surplus* (CS). The CS is respondent i's willingness to accept (WTA) compensation for the quality decrease, holding utility at status quo level (Mitchell and Carson, 1989, p:27).

$$\text{CS} = \text{WTA}_A = e(\boldsymbol{p}, Z^0, U^1, \boldsymbol{Q}, \boldsymbol{T}) - e(\boldsymbol{p}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) = Y^2 - Y^1 \tag{2.11}$$

The Hicksian welfare effect if Plan A is implemented can be measured by the use of *equivalence surplus* (ES). As already shown, if Plan A is not implemented, utility decreases to U^0. ES is the difference between two expenditure functions when utility is held constant at the new lower level (Freeman et al., 2014, p:54). This is what we refer to as WTP. WTP determines the necessary reduction in household income to obtain utility level U^0 if preservation Plan A is implemented.

$$\text{ES} = \text{WTP}_A = e(\boldsymbol{p}, Z^0, U^0, \boldsymbol{Q}, \boldsymbol{T}) - e(\boldsymbol{p}, Z, U^0, \boldsymbol{Q}, \boldsymbol{T}) = Y_1^1 - Y_2^2 \tag{2.12}$$

Intuitively, $Y_2^2 < Y_1^1$ because implementation of Plan A provides the respondent with increased utility. To maintain utility level U^0 then Y_2^2 must be less than Y_1^1. The decision of which measure to use depends on implied property rights of defined scenarios (Freeman et al., 2014, p:56). If respondents are asked about their WTP to maintain the current level of the Amazon rainforest, then the property rights are defined in the negative quality change. The respondents are not entitled to the current level available of the Amazon rainforest. They have to pay in order to maintain it. Thus, equivalence surplus should be used as a welfare measure (Freeman et al., 2014, p:56). However, if respondents have the right to the current level of the Amazon rainforest, implied property rights are defined in the status quo situation. Then, respondents should receive compensation if the current level is not maintained in order to retain the status quo utility level. In that case compensation surplus is the theoretically correct welfare measure to use, and a WTA compensation question should be asked (Freeman et al., 2014; Tol et al., 1999, p:56,p:68).

Whether households should be entitled the current level of the Amazon rainforest or not is a difficult question. The desired situation is that households maintain their initial utility level. Therefore, a WTA compensation question is theoretically more accurate to use. However, the implied property rights in the study are defined in the negative quality change. Therefore, a WTP question to avoid the quality/quantity decrease is framed.

WTP can also be expressed by using the indirect utility function, which is the inverse of the expenditure function. If one were to solve Equation (2.12) with respect to U^0, one obtains the indirect utility function where the utility level is a function of income and already defined attributes (Varian, 1992, p:103). In order to sustain the utility level after implementation of Plan A, a reduction in income is necessary which is the respondent's true WTP for Plan A.

$$U^0 = v(\boldsymbol{p}, Z^0, \boldsymbol{Q}, \boldsymbol{T}, Y_1^1) = v(\boldsymbol{p}, Z, \boldsymbol{Q}, \boldsymbol{T}, Y_1^1 - \text{WTP}_A) \tag{2.13}$$

2.2 Total Economic Value

2.2.1 Ecosystem services & Total Economic Value

Environmental goods and several ecosystem services are often referred to as non-market services. Non-market services are not traded in a market, but they still provide humans with benefits which can be monetized. Hence, they have non-market values (Hanley et al., 2013, p:4). Tropical rainforests, thus the Amazon rainforest, provide several ecosystem services. Ecosystem services can be defined as goods and services from an ecosystem which affect human well-being positively (Costanza et al., 1997; Elmqvist and Maltby, 2010, p:91). Mathematically, the value of ecosystem services is the present value (PV) of all benefits obtained by an ecosystem, such as the Amazon rainforest, from now until infinity. We denote B_t as the total benefits obtained by ecosystem services of the Amazon rainforest and e^{-rt} as the social discount factor (Elmqvist and Maltby, 2010, p:92). The PV of benefits obtained by ecosystem services of the Amazon rainforest is then:

$$\text{PV} = \int_0^\infty B_t e^{-rt} dt \tag{2.14}$$

The Millennium Ecosystems Assessment (2005) distinguishes between four broad groups of services: *supporting services*, *regulating services*, *provisioning services* and *cultural services*. Regulating services are benefits humans obtain by regulation of ecosystem services. Provision services are products which are obtained from the forest. The supportive services are necessary to produce other ecosystem services. Lastly, cultural services are defined as non-material benefits individuals obtain from the tropical forest (Millennium Ecosystems Assessment, 2005). Table 2.1 below depicts examples of ecosystem services provided by the Amazon rainforest defined in each of the four groups.

Table 2.1: Ecosystem Services of the Amazon Rainforest

Supporting services	Biodiversity[13]
	Water cycling[14]
Provisioning services	Timber
	Non-timber products
Regulating services	Climate regulation
	Fire protection[15]
	Carbon storage
Cultural services	Non-use values
	Recreation and eco-tourism
	Spirit and religion

Sources: Hanley et al. (2013, p:47), Millennium Ecosystems Assessment (2005) and Verweij et al. (2009)

Economists are interested in the total value of a change in one or several ecosystem services and biodiversity to determine benefits and costs associated with the change. This is measured by estimating the Total Economic Value (TEV). TEV determines the total value of a (marginal) change in the quality or quantity of ecosystem services and biodiversity (Pascual and Muradian, 2010, p:192). Preservation of the Amazon rainforest results in improved future quality of a large ecosystem, which provides several ecosystem services. To be able to conduct a benefit-cost analysis of preserving the Amazon rainforest, it is important to determine its TEV. TEV is divided into *use-values* and *non-use values* of ecosystem services and biodiversity. These are further divided into i) *direct use values*, ii) *indirect use values*, iii) *option values* and iv) *non-use values* (Pascual and Muradian, 2010, p:195). The TEV of an ecosystem service or an ecosystem is then defined as:

$$\text{TEV} = \text{direct use values} + \text{indirect use values} + \text{option values} + \text{non-use values} \quad (2.15)$$

Use values provide direct benefits to individuals and often have market prices. They consist of direct use values, indirect use values and option values (Pascual and Muradian, 2010, p:194). Direct use values are both consumptive and non-consumptive values obtained by ecosystem services of the Amazon rainforest. Typically, direct use values consist of benefits obtained by provisioning and cultural ecosystem services (Pascual and Muradian, 2010, p:197). Examples of consumptive direct use values are timber and non-timber products, which are provisioning services. Further, recreational activities can provide non-consumptive direct use values through wildlife tourism, hiking and photography (Kramer and Mercer, 1997). These are defined as cultural services.

Indirect use values are benefits provided by ecosystem services classified as regulating services (Pascual and Muradian, 2010, p:196). Fire protection and carbon storage are examples of regulating ecosystem services provided by the Amazon rainforest with indirect

[13] Biodiversity is important to secure ecosystem services of the Amazon rainforest as it affects other supporting services which ensure humans well-being (Millennium Ecosystems Assessment, 2005).

[14] Water cycle is a process which dissolves materials, both gasses and solid materials (Verweij et al., 2009).

[15] As the Amazon rainforest has a high level of humidity, the forest protects naturally against wild fire (Verweij et al., 2009).

use values (Andersen et al., 2002, p:172). Option values are the last use value TEV consists of. These are defined as the value of preserving ecosystem services and biodiversity for future use and information (Pascual and Muradian, 2010, p:196). Intuitively, option values of the Amazon rainforest are related to securing that biodiversity and provided ecosystem services can be used in the future (Andersen et al., 2002, p:169).

The second part of TEV is *non-use values*. Non-use values are related to benefits obtained by knowing that biodiversity and ecosystem services exist and that these can be used by others. Defined values consist of benefits from ecosystem services classified as cultural services (Verweij et al., 2009; Pascual and Muradian, 2010, p:197). Non-use values do not have market values (Pascual and Muradian, 2010, p:196). It is therefore necessary to use valuation techniques to determine their respective values. Non-use values consist of *bequest values* and *existence values*. Bequest values are values individuals obtain by knowing that biodiversity and ecosystem services exist for future generations. Existence values are obtained by knowing that biodiversity and ecosystem services exist (Pascual and Muradian, 2010, p:195). The global population can obtain benefits by knowing that parts of the Amazon rainforest are preserved both in terms of bequest values and existence values, making them, if located outside the Amazon region, distant beneficiaries of the Amazon rainforest (Navrud and Strand, 2016).

Table 2.2 identifies where different ecosystem services belong in the different components of the TEV of preserving the Amazon. However, distinguishing between the values of benefits defined in Table 2.2 is practically difficult (Andersen et al., 2002, p:169). For instance, biodiversity conservation have values which can be classified within several components of the TEV of preserving the Amazon rainforest. It has existence values as biodiversity conservation avoids species and forest loss. Biodiversity conservation also have direct use values in terms of eco-tourism, as conserving the biodiversity of the Amazon provides aesthetic values which tourists can enjoy (Andersen et al., 2002, p:169). Lastly, there are option values related to biodiversity conservation as it provides known and unknown scientific information for later use (Andersen et al., 2002, p:187).

Table 2.2: Ecosystem Services and the TEV of Preserving the Amazon Rainforest

Use Values			**Non-use Values**
Direct Use Values	**Indirect Use Values**	**Option Values**	**Existence Values**
Timber products	Fire protection	Save for future use	Forest
Non-timber products	Carbon storage	Save for future information	Species
Recreation			Bequest values
Ecotourism			

Sources: Ramachandra et al. (2011), Verweij et al. (2009), Pascual and Muradian (2010, p:195) and Andersen et al. (2002, p:169).

2.2.2 Theoretical framework of Total Economic Value

The following section provides a theoretical framework of Total Economic Value of the Amazon rainforest.[16] The theory is similar to section 2.1.1 A given individual minimizes expenditures subject to the given level of utility, U^1. We now define the individual's utility function and budget constraint as:

$$u(\boldsymbol{x}, Z, \boldsymbol{z_n}, \boldsymbol{z_u}, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.16}$$

$$Y \leq \boldsymbol{px} + \boldsymbol{p_n z_n} + \boldsymbol{p_u z_u} \tag{2.17}$$

Symbols $\boldsymbol{x}$, Z, $\boldsymbol{Q}$ and $\boldsymbol{T}$ are the same as in Section 2.1.1. However, we now define $\boldsymbol{z_n}$ and $\boldsymbol{z_u}$ as vectors of the individual's non-use and use services of the Amazon rainforest, respectively. Implicitly, $\boldsymbol{p_n}$ and $\boldsymbol{p_u}$ are vectors of prices of non-use and use services, respectively. Note that $\boldsymbol{p_n}$ is the shadow price of non-use services, implying the optimal price if there were a market for the non-use services (Randall, 1991, p:306).

$$\begin{aligned} &\min_{\boldsymbol{x},\boldsymbol{z_n},\boldsymbol{z_u}} \boldsymbol{px} + \boldsymbol{p_n z_n} + \boldsymbol{p_u z_u} \\ &\text{subject to} \qquad u(\boldsymbol{x}, Z, \boldsymbol{z_n}, \boldsymbol{z_u}, \boldsymbol{Q}, \boldsymbol{T}) - U^1 \geq 0 \end{aligned} \tag{2.18}$$

This gives us the Langrangian function:

$$L^* = -\left(\boldsymbol{px} + \boldsymbol{p_n z_n} + \boldsymbol{p_u z_u}\right) + \lambda[u(\boldsymbol{x}, Z, \boldsymbol{z_n}, \boldsymbol{z_u}, \boldsymbol{Q}, \boldsymbol{T}) - U^1] \tag{2.19}$$

The minimization problem provides us with the following sets of compensated demand functions:

$$\boldsymbol{x}^* = \boldsymbol{h_1}(\boldsymbol{p}, \boldsymbol{p_n}, \boldsymbol{p_u}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.20a}$$

$$\boldsymbol{z_n^*} = \boldsymbol{h_2}(\boldsymbol{p}, \boldsymbol{p_n}, \boldsymbol{p_u}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.20b}$$

$$\boldsymbol{z_u^*} = \boldsymbol{h_3}(\boldsymbol{p}, \boldsymbol{p_n}, \boldsymbol{p_u}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.20c}$$

Once again, we insert the demand functions into the objective function. For simplicity, we assume the vector $\boldsymbol{p}$ is exogenous. This gives us the following expenditure function:

$$e(\boldsymbol{p_n}, \boldsymbol{p_u}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.21}$$

We can use equation (2.21) to measure the total value of the Amazon rainforest for the given individual.

$$\text{TV} = e(\boldsymbol{p_n^*}, \boldsymbol{p_u^*}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) - e(\boldsymbol{p_n^0}, \boldsymbol{p_u^0}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.22}$$

The total value for the individual is defined as the difference between the two expenditure functions in equation (2.22). The first part consists of choke prices (p^*) and the last part consists of baseline prices (p^0). A choke price is defined as the highest possible price such that the demand for a good is equal to zero (Randall, 1991, p:306). Implicitly, choke prices

[16] Reference for this section is Randall (1991, p:303-321)

defined in Equation (2.22) make the individual's demand for use and non-use values of the Amazon rainforest equal to zero. The first part of Equation (2.22) defines the minimum income necessary with choke prices to sustain the status quo utility level. Baseline prices define current efficient prices. Thus, the last part of Equation (2.22) defines the minimum necessary income to sustain the same utility level with current prices. Intuitively, the expenditure function with choke prices must yield a higher minimum necessary income to sustain status quo utility as, in general, higher prices yield lower utility. Equation (2.22) can be decomposed into several parts:

$$\text{TV} = e(\boldsymbol{p_n^*}, \boldsymbol{p_u^*}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) - e(\boldsymbol{p_n^0}, \boldsymbol{p_u^*}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.23a}$$

$$+ e(\boldsymbol{p_n^0}, \boldsymbol{p_u^*}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) - e(\boldsymbol{p_n^0}, \boldsymbol{p_u^0}, Z, U^1, \boldsymbol{Q}, \boldsymbol{T}) \tag{2.23b}$$

The first line of Equation (2.23), (2.23a), defines the individual's non-use values. The second line, (2.23b), defines the individual's use-value of the Amazon rainforest (Randall, 1991, p:306). Considering Norwegian households, it is reasonable to believe that most benefits they obtain by the Amazon rainforest are related to carbon storage, recreational activities provided by eco-tourism and option values, which are defined in (2.23b), and non-use values in terms of existence and bequest values. These are defined in (2.23a). Few Norwegian households have assuminlgy visited or intend to visit the Amazon rainforest (Navrud and Strand, 2016). Correspondingly, recreational values and optional values are assumed to be small. The total value of preserving the Amazon rainforest among Norwegian households is therefore believed to consist of mostly non-use values and carbon storage values.

3. Method

3.1 Contingent Valuation Method

Contingent Valuation method is a stated-preference approach. SP approaches differ from RP approaches, as SPs elicit households' WTP or WTA compensation for a public good through surveys with constructed hypothetical markets and scenarios. RP methods obtain valuation information by observing consuming behaviour among households in markets for private goods associated with a public good (Pascual and Muradian, 2010, p:200).

CV can be used to both monetize use and non-use values of changes in public goods. A hypothetical market with policy-relevant scenarios is constructed. The CV survey is used to elicit households' welfare effects for a change in the quality or quantity of a public good. Conducting a CV survey involves several steps, where one usually follows the state of the art approach. Firstly, the public good of interest must be defined and a hypothetical market must be constructed with policy-relevant scenarios regarding changes in the quality or quantity of the public good. Different policies provide different scenarios in terms of the quality of the environmental good. The scenarios are compared to a reference level, where no policies are undertaken. Through data analyses, one can measure welfare effects among respondents by analysing their WTP for the stated scenarios (Johnston et al., 2017; Boyle, 2017, p:95). Importantly, the scenarios and the reference level must be credible and understandable to minimize response bias (Johnston et al., 2017).

Some decisions are important to regard when implementing a CV survey. Recommendations regarding the state of the art approach can be found in Johnston et al. (2017). Firstly, a relevant sample of the population of interest must be determined. The sample consists of respondents which are representative for the population. Importantly, choice of which survey mode to use must be decided. The NOAA Panel guidelines recommend to use personal interviews (Arrow et al., 1993). This is both expensive and time-consuming. Instead, it is now a common practice to collect data through web surveys (Johnston et al., 2017). However, unobserved characteristics of the respondents can result in selection bias (Johnston et al., 2017). Another concern related to web surveys is the representativeness of the sample. Parts of the population might not have access to internet or have poor computer skills, excluding them from the sample (Johnston et al., 2017).

Secondly, respondents must be informed of how to hypothetically pay for the policy scenarios. Correspondingly, a payment vehicle must be decided. The respondents can be asked to pay through increased local or national taxes or, alternatively, increased commodity prices related to the environmental good (Whitehead, 2006, p:72). It is recommended that the payment vehicle used is not voluntarily due to the well known free-rider problem of public goods (Johnston et al., 2017). Furthermore, it is important to decide which response format to use. The state of the art approach recommends single discrete binary choice questions when valuing public goods (Johnston et al., 2017).

Respondents are asked to either approve or disapprove if they are willing to pay a stated amount (NOK t) for a policy change (Boyle, 2017, p:102). This format is incentive compatible, i.e. respondents reveal their true information (Johnston et al., 2017; Boyle, 2017, p:105). However, the response format requires a large number of respondents as limited information of their WTP is provided by a single discrete choice question (Freeman et al., 2014, p:389).

An open-ended question is another alternative. Then, respondents are asked how much they are willing to pay directly (Boyle, 2017, p:102). It might be challenging for the respondents to answer a pure open-ended question. The situation and the questions are unfamiliar. This increases the possibility of zero-value responses (Johnston et al., 2017). An alternative is to use a payment card. The respondents are still asked an open-ended question. However, they are provided different values on a payment card, which they can choose their maximum WTP from. Then, a respondent's true WTP lies between the chosen amount and the next amount on the payment card (Whitehead, 2006, p:75). Favourably, it is easier for respondents to choose a value, and a smaller sample is needed. Conflictingly, the response format is not incentive compatible. Respondents can either have incentives to overstate or understate their true value (Boyle, 2017, p:105).

There are some general guidelines on the layout of a CV survey. Firstly, respondents are introduced to implications of the environmental good for then to be asked questions of their knowledge and preferences about the good of interest. (Freeman et al., 2014). These questions should be asked before the respondents state their WTP (Boyle, 2017, p:112). Secondly, respondents are introduced to the hypothetical policy-relevant scenarios and implementation of these policies. Additionally, information about the reference scenario is given so that respondents can compare policy scenarios with the reference level. Thirdly, questions about their WTP for the quality changes are asked, given the response format and policy scenarios (Freeman et al., 2014). Lastly, questions regarding socio-economic factors are asked at the end of the survey. Information regarding preferences and socio-economic factors among respondents helps to identify and understand characteristics, opinions and knowledge among the respondents, and how they affect elicitation and the validity of responses (Johnston et al., 2017).

Through implementation of the CV survey, data is obtained and collected in a data set. The data set is used to perform data analyses to determine mean WTP estimate of the sample size (n). The simplest way to denote mean WTP of the sample is (Boyle, 2017, p:113):

$$\overline{\mathrm{WTP}} = \frac{1}{n}\sum_{i=1}^{n}\mathrm{WTP}_i \tag{3.1}$$

The mean WTP can be used to estimate the total welfare effect of a defined policy scenario for the population of interest. This is defined as the total WTP (Boyle, 2017, p:117). Denoting N as the population size, estimated total WTP can be expressed as follows:

$$\widehat{\mathrm{WTP}}_{\mathrm{TOT}} = \overline{\mathrm{WTP}} \cdot N \tag{3.2}$$

There are some concerns using mean and total WTP as estimates to determine the population's mean and aggregate welfare effects. The estimated sample mean might not be sufficiently representative for the population. Consequently, estimated total WTP is inaccurate. An alternative is to weight sample characteristics equal to population characteristics, making estimated total WTP more representative (Boyle, 2017, p:117). Further, utilizing mean WTP as a welfare estimate is theoretically correct. However, WTP values among individuals depend on the respective individuals' income. Thus, individuals with high income will in theory have higher WTP values for environmental goods and services, and positive quality changes provide higher benefits for high-income individuals (Segerson, 2017, p:16). High WTP values often result in a right tailed distribution. An alternative is to use the median WTP. High WTP values will not put more weight on the median WTP as such outliers do on the mean WTP. Therefore, the median WTP can also be used as a welfare estimate (Cameron and Huppert, 1989).

Validity

The last step of conducting a CV study is to test and discuss the validity and the reliability of the study (Boyle, 2017, p:118). We distinguish between three main validity assessment frameworks, namely *content validity*, *criterion validity* and *construct validity*. Content validity is used to assess the survey and its questions, and the hypothetical market and the policy-relevant scenarios defined in the survey. Conducting a pilot study before implementation of the CV survey is helpful to assess the content validity of the study (Mitchell and Carson, 1989, p:192). The next validity framework, criterion validity, compares CV results with true market values (Mitchell and Carson, 1989, p:190). As non-use values do not have market values, criterion validity will not be emphasized in the study.

The third validity framework, construct validity, entails evaluating whether derived results of a CV study correspond to economic theory and results derived in similar existing studies. Two different parts construct validity can be defined (Mitchell and Carson, 1989, p:191). The first part is *convergent validity*, where one compares derived estimates with estimates from previous studies which have utilized alternative valuation methods. This form of validity is especially relevant in this study. The other part of construct validity is defined as *theoretical validity*, where one evaluates whether results correspond to economic theory, common sense and established practices (Boyle, 2017, p:119). For instance, it can be expected that respondents with high income value positive changes in environmental goods higher compared to low-income respondents (Bishop and Boyle, 2017, p:480). A relevant application to assess the construct validity is to perform a 'scope test'. A scope test implies testing if mean WTP for the extensive policy scenario is significantly higher than for the less extensive policy scenario (Boyle, 2017, p:120).

Advantages & Concerns of the Contingent Valuation Method

The main advantage of SP approaches is that they are the only approaches to estimate non-use values of public goods (Johnston et al., 2017). As there are few methods to estimate non-use values, CV has grown to become important. Additionally, the method is truly versatile. The CV method can be used to estimate both use and non-use values of a wide range of situations related to multiple different public goods (Hanley et al., 2013, p:62).

Arrow et al. (1993) and Mitchell and Carson (1989) identify several potential obstacles of the CV method. However, an underlying concern is the 'hypothetical market' bias. It is difficult to know if respondents overstate or understate their WTP value due to the hypothetically constructed situation (Hanley et al., 2013, p:287). Respondents might not take their budget constraint into account when stating their WTP for a program. Consequently, respondents state higher values compared to what they can afford. The stated WTP values do not reflect the respondents' actual WTP given the current situation. If the reference scenario involves several environmental concerns, respondents tend to overstate their true values (Arrow et al., 1993). Preservation of the Amazon rainforest contributes to prevent several environmental concerns, such as reduced carbon emissions. Thus, high WTP values can be expected, which do not only reflect non-use values.

It is important that the formulation of the reference and the policy scenarios are fully understandable for the respondents. If respondents misunderstand or misinterpret the survey, their stated WTP values are not reliable and thus not suited to be used as valuation estimates (Arrow et al., 1993; Johnston et al., 2017). Respondents can also have incentives to behave strategically in the survey (Mitchell and Carson, 1989, p:128). This is related to the free-rider problem of public goods. Consequently, a respondent might state a lower value than true WTP. The respondent expects others will pay more so that the public good will be sufficiently supplied (Mitchell and Carson, 1989; Haddad and Howarth, 2006; Hanley et al., 2013, p:128, p:133, p:62).

The 'warm glow' effect is another concern related to CV. A respondents might get a 'warm feeling' by stating a higher WTP value than the true value as the respondent feels she or he is hypothetically donating to a good cause. It is related to the feeling of social responsibility (Arrow et al., 1993; Wills, 1995, p:131). The last obstacle to address is referred to as the embedding problem. Respondents find it difficult to divide between scopes of different programs. This implies that respondents state quite similar WTP values for an extensive program and a less extensive program (Haddad and Howarth, 2006, p:133). Should the embedding problem occur in the study, then the difference in WTP estimates for Plan A and B is small although Plan B results in more species and forest loss.

WTP vs WTA

In Section 2.1.1, two different welfare measures were explained when examining the difference between two expenditure functions. Compensation surplus measures welfare effects by holding initial utility constant after a decrease in the quality of the environmental good. This reflects the households' WTA compensation for the quality decrease. Equivalence surplus measures the welfare effect by holding the new lower utility level constant after the quality decrease. Contrary to compensation surplus, equivalence surplus reflects households' WTP for implementation of preservation Plan A.

When conducting a CV study, one must decide which welfare measure to use. The choice determines whether to ask respondents of their WTP to avoid a quality decrease or their WTA compensation for a quality decrease of an environmental good. Which format to use depends on implied property rights in the scenarios. WTP is typically used when examining a quality improvement in an environmental good, while WTA is used when regarding the opposite (Flores, 2017, p:37). Thus, as we are examining a quality decrease, WTA is theoretically more accurate for this study. However, Arrow et al. (1993) recommend to use the WTP framework as this is more conservative, which implies that WTP values are generally lower in value (Pascual and Muradian, 2010; Mitchell and Carson, 1989, p:203, p:31).

One of the objectives in the thesis is to compare derived results with results from previous studies. In order to secure a high degree of comparability between this study and previous studies, it is necessary to choose the same framework as in the previous studies. The Delphi studies and the North American study utilized the WTP framework. It is therefore natural to choose the same framework, even though it perhaps is not theoretically correct. Thus, we assume that respondents are not entitled to have the current level of the Amazon rainforest available.

3.2 Econometric Methods

Econometric methods suitable to determine mean WTP depend on the choice of which response formate to use. The survey uses a payment card. Both parametric models and distribution-free econometric models can be used to determine mean WTP when a payment card is used as the response format (Haab and McConnell, 2002, p:126). This section explains three econometric models which will be utilized in the study.

3.2.1 Ordinary Least Square Regression

We can use a multiple linear regression model for cross-sectional data. The model uses ordinary least square (OLS) estimates, and is therefore referred to as OLS regression models (Wooldridge, 2013, p:854). The model can be defined as:

$$y_i = \boldsymbol{x_i}\boldsymbol{\beta} + u_i \tag{3.3}$$

$\boldsymbol{x}$ and $\boldsymbol{\beta}$ are vectors of response variables and coefficients explaining relationships between the dependent variable and response variables, respectively. Further, we denote y_i as respondent i's WTP, while u_i is observation i's error term (Wooldridge, 2013, p:27). From this equation we are interested in finding the expected value of y_i given response variables, $E(y_i|\boldsymbol{x}) = \boldsymbol{x}\boldsymbol{\beta}$. To obtain the best unbiased linear estimator (BLUE), the model needs to satisfy the following Gauss-Markov assumptions (Wooldridge, 2013, p:102):

MLR.1 The population model can be described as: $y = \boldsymbol{x}\boldsymbol{\beta} + u$

MLR.2 Random sampled data

MLR.3 No perfect linear relationship among independent variables

MLR.4 Error term has zero conditional mean, $\mathbb{E}(u|\boldsymbol{x}) = 0$

MLR.5 Homoskedasticity, $\text{Var}(u|\boldsymbol{x}) = \sigma^2$

Under MLR.1-MLR.4, the OLS estimators are unbiased, meaning that $\mathbb{E}(\hat{\boldsymbol{\beta}}) = \boldsymbol{\beta}$, and under MLR.1-MLR.5, the estimators are BLUE. In the model, y_i is assumed to be observable, meaning that we know the true WTP value for the respondents. However, with a payment card respondents' true WTP lies within an interval and is thus unobservable. An OLS regression does not consider that the expected value of y is uncertain, and can therefore yield biased estimates (Cameron and Huppert, 1989; Yang et al., 2012). Nevertheless, OLS can be used to provide baseline WTP estimates, but it is necessary to make assumptions regarding true WTP values of each respondent.

To simplify, we assume that respondents are provided with three payment choices. Firstly, respondents can choose $y_i = l$ as WTP. Then, WTP is assumed to be l and l is defined as the lowest value on the payment card, which is zero. Secondly, respondents can choose a payment value a_j. Then, the respondent's true WTP is assumed to lie in an interval between a_j and the next payment value a_{j+1}. However, the true value is unobservable for the econometrician. Thirdly, respondents can choose $y_i = k$, where k is a stated observed WTP value which is equal or higher than the highest payment value on the payment card. Thus, if a respondent chooses the last option, the respondent's true WTP is observable and equal to k. In the case where true WTP is unobserved in an interval, we can assume that the true WTP for a respondent is the midpoint of the chosen payment value and the next one (Cameron and Huppert, 1989; Yang et al., 2012).

3.2.2 Interval Regression

As the dependent variable is unobservable because it lies within an interval, we can use an interval regression model, which is a censored regression model. Contrary to OLS regression models, censored regression models use maximum likelihood estimators. The model can be defined as:

$$y_i^* = \boldsymbol{x_i}\boldsymbol{\beta} + \varepsilon_i, \quad \varepsilon_i|\boldsymbol{x_i} \sim N(0, \sigma) \tag{3.4}$$

The dependent variable, y_i^*, is the unobserved latent WTP variable, meaning the true WTP value of respondent i, while $\boldsymbol{x_i}$ and $\boldsymbol{\beta}$ have the same definition as in the OLS-model. The error term is assumed to be normally distributed with mean and standard deviation equal to 0 and σ, respectively (Cameron and Huppert, 1989). We are interested in determining $\mathbb{E}(y|\boldsymbol{x}) = \boldsymbol{x\beta}$. It is assumed that y^* is normally distributed (Wooldridge, 2013, p:597).

Still, we assume that respondents have three options on the payment card to choose from. i) $y_i^* = l$, ii) $a_j \leq y^* < a_{j+1}]$, and iii) $y_i^* = k$, which are the exact same options as used in the OLS model. The observed outcome of y can be defined as (StataCorp, ND):

$$y = \begin{cases} l & \text{if} \quad y^* = l \\ [a_j, a_{j+1}] & \text{if} \quad a_j \leq y^* < a_{j+1} \\ k & \text{if} \quad k = y^* \end{cases} \tag{3.5}$$

We have two dependent variables in an interval regression model, where the first is the lower bound and the second is the upper bound of the chosen payment value (StataCorp, ND). The probability that respondent i chooses payment a_j, so that true WTP lies between a_j and the next value on the payment card a_{j+1}, is:

$$\text{Prob}(y_i^* \subseteq (a_j, a_{j+1})) = \text{Prob}(a_j \leq y_i^* < a_{j+1}) = \text{Prob}(a_j \leq \boldsymbol{x}_i\boldsymbol{\beta} + \varepsilon_i < a_{j+1}) \tag{3.6}$$

The probability must be defined by a probability distribution. We denote $f(y_i^*; \boldsymbol{\theta})$ as the respective probability density function of y_i^* and $\boldsymbol{\theta}$ as a vector of unknown parameters. $F(y; \boldsymbol{\theta})$ is the corresponding cumulative distribution function. We can write the probability as (Lindsey, 1998):

$$\text{Prob}(y_i^* \subseteq (a_j, a_{j+1})) = \int_{a_j}^{a_j+1} f(\boldsymbol{y_i^*}; \boldsymbol{\theta}) dy_i^* = F(a_{j+1}; \boldsymbol{\theta}) - F(a_j; \boldsymbol{\theta}) \tag{3.7}$$

Asssuming normal distribution and denoting Φ as the standard normal cumulative distribution function, the probability can be written as (Cameron and Huppert, 1989):

$$\text{Prob}(y_i^* \subseteq (a_j, a_{j+1})) = \Phi\left(\frac{a_{j+1} - \boldsymbol{x}_i\boldsymbol{\beta}}{\sigma}\right) - \Phi\left(\frac{a_j - \boldsymbol{x}_i\boldsymbol{\beta}}{\sigma}\right) \tag{3.8}$$

Further, l and k are observable point data denoted as y. The probability of an observable point data is (Cameron and Trivedi, 2010, p:523):

$$\text{Prob}(y) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left\{-\frac{(y - \boldsymbol{x_i\beta})^2}{2\sigma^2}\right\} \tag{3.9}$$

The log likelihood function of n independent observations can be defined as (StataCorp, ND):

$$\ell(\beta, \sigma) = \sum_{i=1}^{n} \ln\left[\frac{1}{\sqrt{2\pi\sigma^2}} \exp\left\{-\frac{(y - \boldsymbol{x_i\beta})^2}{2\sigma^2}\right\} + \Phi\left(\frac{a_{j+1} - \boldsymbol{x_i\beta}}{\sigma}\right) - \Phi\left(\frac{a_j - \boldsymbol{x_i\beta}}{\sigma}\right)\right] \tag{3.10}$$

We can maximize the log likelihood function with respect to β and σ to obtain a maximum likelihood estimator for each parameter.

$$\text{argmax}_{\beta,\sigma} \sum_{i=1}^{n} \ell(\beta, \sigma) = \hat{\beta}, \hat{\sigma}$$

We are interested in determining the conditional and unconditional expectation of WTP, given chosen explanatory variables. The conditional expectation is defined as $\mathbb{E}(y|y > 0, \boldsymbol{x})$, which excludes zero responses. The unconditional expectation is of more interest as it includes zero responses, and it is defined as (Wooldridge, 2013, p:598):

$$\mathbb{E}(y|x) = \mathbb{E}(y|y > 0, \boldsymbol{x}) \cdot \text{P}(y > 0|\boldsymbol{x}) \tag{3.11}$$

3.2.3 Logistic Regression Model

Logistic regression is a binary response model. The logistic regression model has a similar underlying model as the interval regression model.

$$y_i^* = \boldsymbol{x_i \beta} + \varepsilon_i \tag{3.12}$$

We still have an unobservable latent dependent variable. However, now we assume that the observed dependent variable takes value 1 for respondents with positive WTP and value 0 for respondents with zero WTP. The observed depednent variable (y) can be defined as:

$$y = \begin{cases} 0 \quad if \quad y^* \leq 0 \\ 1 \quad if \quad y^* > 0 \end{cases} \tag{3.13}$$

The probability that the observed dependent variable takes value 1 given response variables is (Wooldridge, 2013, p:586):

$$\begin{aligned} \text{Prob}(y = 1|\boldsymbol{x}) =& \text{Prob}(y^* > 0|\boldsymbol{x}) = \text{Prob}(\boldsymbol{x\beta} + \varepsilon > 0|\boldsymbol{x}) \\ =& \text{Prob}(\varepsilon > -\boldsymbol{x\beta}|\boldsymbol{x}) = 1 - F(-\boldsymbol{x\beta}) = F(\boldsymbol{x\beta}) \end{aligned} \tag{3.14}$$

We can define $p = F(\boldsymbol{x\beta})$ as the probability that a respondent have positive WTP, while $1 - p = 1 - F(\boldsymbol{x\beta})$ is the probability that a respondent have zero WTP. It is necessary to make assumptions about the distribution of the error term, ε_i. We define F as the cumulative distribution function of the error term (Cameron & Trivedi, 2010:447). F can either be logistically distributed (logit model) or have a standard normal distribution (probit model) (Wooldridge, 2013, p:585). Assuming a logistically distributed error term, we denote the the probability of $F(\boldsymbol{x\beta})$ as $\pi(\boldsymbol{x\beta})$:

$$\pi(\boldsymbol{x\beta}) = \frac{e^{\boldsymbol{x\beta}}}{1 + e^{\boldsymbol{x\beta}}} \tag{3.15}$$

The logit model also uses maximum likelihood estimation. We can therefore determine the likelihood function. The probability distribution of "success" ($y = 1$) and "failure"

$(y = 0)$ for individual i can be described by a Bernoulli distribution, $p_i^{y_i} \cdot (1 - p_i)^{1-y_i}$, where $p_i = \pi(\boldsymbol{x\beta})$. Thus, the log likelihood function for the sample can be defined as (Cameron and Trivedi, 2010, p:447):

$$\ell(\boldsymbol{\beta}) = \sum_{i=1}^{n} [y_i \ln \pi(\boldsymbol{x\beta}) + (1 - y_i) \ln(1 - \pi(\boldsymbol{x\beta}))] \tag{3.16}$$

By maximizing this likelihood function, we obtain maximum likelihood estimators.

$$\text{argmax}_\beta \sum_{i=1}^{n} \ell(\beta) = \hat{\beta} \tag{3.17}$$

3.3 Benefit Transfer Techniques

One objective of the thesis is to compare results derived by Navrud and Strand (2016), where they used the Delphi method, with results from this study. In order to do so, we need to use *benefit transfer*. The fundamental purpose of BT is to transfer valuation information from study sites to new policy sites (Navrud, 2004, p:201). This section explains three BT techniques which are relevant for the study, namely *unit transfer*, *function transfer* and the *Delphi method* (Rosenberger and Loomis, 2017, p:431). *Meta-analysis* is another BT technique, but this will not be discussed and used in the thesis.

3.3.1 Unit Transfer

Unit transfer is defined as transferring values, for instance WTP estimates, from a study site to a policy site. One can use simple unit transfer by directly transferring estimates. Then, it is assumed that the marginal value provided by an environmental good is the same for an average individual for two different populations (Navrud and Ready, 2007, p:2).

We can use simple unit transfer from the two Delphi studies to compare mean WTP estimates derived in a Delphi CV study and a standard CV study. The population of interest in both studies is Norwegian households. However, the means of WTP among Norwegian households are given in Euro and US Dollar in the Delphi studies. We need to convert the initial stated values into NOK by using the purchasing power parity adjusted (PPP) exchange rate[17] at the time the Norwegian experts were surveyed, and adjust for inflation using the consumer price index (CPI).[18] Table 3.1 depicts initial expected mean WTP values among Norwegian households for Plan A and B in round 1 and round 2 from the Delphi studies. The table also depicts transferred mean and total WTP among Norwegian households for Plan A and B in round 1 and 2, adjusted for PPP and inflation. [19] Round 2 estimates will be of greater interest.

[17]Purchasing power party adjusted exchange rates make the price level equal in two different countries. Thus, the two countries have the same purchasing power when using PPP adjusted exchange rates (Kristófferson and Navrud, 2007, p:211). Information about PPP adjusted exchange rates can be found at OECD (ND).

[18]The Norwegian experts were surveyed in May/June 2012, so the PPP-adjusted exchange rate, EUR/NOK and US

Table 3.1: Simple Unit Values Transferred

Plan/Round	Initial Mean Value from Delphi Studies	Transferred Mean Value	Transferred Total Value
Plan A/Round 1	€65	NOK 500.18	NOK 1 188 913 355
Plan A/Round 2	$114.2	NOK 1166.1	NOK 2 771 809 653
Plan B/Round 1	$63	NOK 643.30	NOK 1 529 105 444
Plan B/Round 2	$64	NOK 653.61	NOK 1 553 612 015

Another objective of the thesis is to compare mean WTP estimates obtained from Siikämaki et al. (ND). We can also use unit transfer from this study. If an average North American household has equal preferences and wages as an average Norwegian household, then we only need to convert transferred values to a common currency, NOK. It is important to use the PPP-adjusted exchange rate as it equalizes the price levels between the two countries (Ready and Navrud, 2006). The indirect utility function, derived in Section 2.1.1, can be used illustrate the situation. We define P_t as the PPP-adjusted exchange rate (\$/NOK) at the time the North American respondents were surveyed. WTP_N and WTP_{NA} are defined as WTP among an average Norwegian household and an average North American household, respectively (Ready and Navrud, 2006).

$$v(\boldsymbol{p}, Z^A, \boldsymbol{Q}, \boldsymbol{T}, Y - \text{WTA}_N) = v(P_t\boldsymbol{p}, Z^A, \boldsymbol{Q}, \boldsymbol{T}, P_tY - P_t\text{WTA}_{NA}) \tag{3.18}$$

It might be unrealistic to assume that the mean WTP estimates of preserving the Amazon rainforest for North American households are the same as for Norwegian households. Income differences between the two populations will have an impact on the estimates. An alternative is to use unit transfer with income adjustment (Ready and Navrud, 2006; Navrud and Ready, 2007, p:2). We then adjust the estimate for difference in mean or median income of the two populations, where the mean/median household income in North America is converted to NOK by using the standard exchange rate (E_t). Further, it is necessary to determine the income elasticity of WTP (Ready and Navrud, 2006; Navrud and Ready, 2007, p:4).

$$\text{WTP}_N = P_t\text{WTP}_{NA} \cdot \left(\frac{Y_N}{E_tY_{NA}}\right)^\beta \tag{3.19}$$

Equation (3.19) calculates the transferred mean WTP among Norwegian households, (WTP_N), which equals the mean WTP estimate from the North American study, (WTP_{NA}), multiplied with the PPP-adjusted exchange rate and the median household income ratio ($\frac{Y_N}{Y_{NA}}$). The income ratio is powered by the income elasticity of WTP to preserve the Amazon rainforest, denoted as β (Navrud, 2004, p:202). We denote Y_N and Y_{NA} as the median income among Norwegian and North American households, respectively.

Dollar/NOK used is the average of 2012. Inflation is adjusted for by using CPI from May 2012 to Desember 2017.

[19]Total WTP is derived by multiplying transferred mean WTP with the amount of registered households in Norway, which in 2017 was 2 376 971 (SSB, 2017b).

North American households, on average, are willing to pay \$4.97 and \$3.19 for avoiding one percent loss in forest and species in the Amazon rainforest, respectively (Siikämaki et al., ND). If we multiply defined marginal WTP estimates with avoided percentage of forest and species loss related to Plan A and Plan B, then we obtain estimates of the means of WTP for the respective preservation plans among North American households. Thus, for Plan A North American households are, on average, willing to pay \$200 per year. For Plan B, North American households are willing to pay \$104 per year. We can then use unit transfer with income adjustment to determine the means of WTP among Norwegian households based on the marginal WTP estimates. Calculations can be found in Appendix II.

Table 3.2: Unit Transfer With Income Adjustment

Plan	**Income Elasticity of WTP**	**Transferred mean WTP among Norwegian households**	**Transferred total WTP among Norwegian households**
Plan A	$\beta = 1$	NOK 2187	NOK 5 198 435 577
Plan B	$\beta = 1$	NOK 1137	NOK 2 702 616 027
Plan A	$\beta = 0.5$	NOK 2125	NOK 5 051 063 375
Plan B	$\beta = 0.5$	NOK 1105	NOK 2 626 552 955

Note: Values are transferred from Siikämaki et al. (ND) and adjusted for PPP and CPI.

To evaluate the reliability of the transferred values we can estimate transfer errors. A transfer error is defined as the difference between transferred and estimated mean WTP in percentage, given by the following equation, where WTP_{BT} is the estimate derived using BT and WTP_{E} is the true estimated mean WTP (Kristófferson and Navrud, 2007, p:213):

$$\text{TE} = \frac{|\text{WTP}_{\text{BT}} - \text{WTP}_{\text{E}}|}{\text{WTP}_{\text{E}}}$$

For international BT studies, transfer errors are on average between 20 to 40 percent (Ready and Navrud, 2006).

T-test

To statistically evaluate whether the mean WTP estimates derived in this study are different to the estimates transferred from the comparable studies, we conduct t-tests. The null and alternative hypotheses can be stated as: H_0: $\hat{\mu_j} - \mu_0 = 0$ vs H_1: $\hat{\mu} - \mu_0 \neq 0$, where $\hat{\mu_j}$ is the estimated mean WTP derived in this study of plan j, while μ_0 is a transferred mean WTP defined in Table 3.1. The t-tests are two-sided. By rejecting H_0, we can conclude that the two estimates are different with α percent of committing a Type I error. If we fail to reject H_0, we risk β percent of committing a Type II error. The t-statistics used are denoted as:

$$t = \frac{\hat{\mu_j} - \mu_0}{s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad \text{or} \quad t = \frac{\bar{\mu_A} - \mu_0}{s/\sqrt{n}}$$

where s_p is the pooled sample standard deviation, n_1 is the sample size of this study and n_2 is the sample size from the study which we transfer values from. The t-statistic located to the left is a test of mean difference between two independent samples. To perform a valid test of mean difference between two independent samples, a few assumptions must be met. Normality and a common variance between the two independent samples are assumed (Rice, 2007, p:421). The one-sample t-statistic located to the right will be used to test for difference between mean WTP estimates and values of interest, such as values presented in Table 3.2. Additionally, the one-sample t-statistic will be used in a sensitivity analysis of the mean WTP for Plan A. H_0 is rejected if the absolute value of the t-statistic is greater than the critical value, $t_{1-\alpha}$.

Lastly, scope tests of mean difference between Plan A and Plan B will be performed by utilizing paired t-tests of dependent samples. The t-statistic is as follows:

$$t = \frac{\bar{D} - \mu_D}{S_{\bar{D}}}$$

where $\bar{D}$ and $S_{\bar{D}}$ is the average difference and the standard deviation of the difference, respectively (Rice, 2007, p:445-446). Sign tests of dependent samples will also be used to perform scope tests of median difference between Plan A and Plan B. As the t-test relies on normality, which might not hold, a sign test is a non-parametric alternative (Privitera, 2015, p:601).

Equivalence test - TOST

The t-tests described above is not consistent with environmental valuation theory as we want to prove equivalence between estimates, not difference (Kristófersson and Navrud, 2005). A problem with the t-test is that if we were to retain H_0, then we cannot conclude that the estimates are equal. An alternative test which has mostly been used in pharmaceutical research is equivalence tests, for instance a two one-sided test (TOST) (Kristófersson and Navrud, 2005). When conducting a TOST of equivalence, we define the null and alternative hypothesis as following, respectively:

$$\mathrm{H}_0 : D \leq -\Delta \text{ or } \mathrm{H}_0 : D \geq \Delta$$
$$\mathrm{H}_1 : -\Delta < D < \Delta$$

D denotes the difference between estimated mean WTP derived in this study and the transferred mean WTP, while Δ is an allowed bound of deviation which is defined as the allowed transfer error. Previous studies have allowed a transfer error of 20 percent (Kristófersson and Navrud, 2005; Lindhjem and Navrud, 2011). However, Kristófferson and Navrud (2007, p:215) recommend to use transfer errors of 20 and 40 percent.

H_0 states that the difference between the WTP estimates is greater than allowed transfer error, while H_1 states equivalence between the estimates when allowing a transfer error of Δ. Hence, if H_0 is rejected, we have equivalence between the estimates, given the allowed transfer error, without the risk of committing a Type II error. A TOST requires to conduct two one-sided t-tests with a defined allowed level of significance (α). The critical value is defined as $t_{1-\alpha}$ with N_1+N_2-2 degrees of freedom. The statistics are as following:

$$\mathrm{t} = \frac{D-\Delta}{s_p\sqrt{\frac{1}{\mathrm{n}_1}+\frac{1}{\mathrm{n}_2}}} \geq t_{1-\alpha}\ ,\ \mathrm{t} = \frac{\Delta-D}{s_p\sqrt{\frac{1}{\mathrm{n}_1}+\frac{1}{\mathrm{n}_2}}} \geq t_{1-\alpha}$$

Further, s_p is the pooled standard deviation of the mean WTP estimates (Kristófferson and Navrud, 2007, p:214). We can reject H_0 if the absolute value derived by both test statistics are greater than the critical value. If so, we have equivalence between the two mean WTP estimates, given an allowed transfer error (Lindhjem and Navrud, 2011). Note that due to a small sample size of the Delphi estimates, assumptions of such tests are not met with regard to normality and equal variances. Thus, test results from both t-tests and equivalence tests evolving the Delphi estimates might not be valid.

3.3.2 Function Transfer

In general, unit transfer does not take into account different characteristics and preferences between populations. It might be that the North American population has higher preferences of preserving the Amazon rainforest than the Norwegian population. Intuitively, by transferring mean WTP estimates from Siikämaki et al. (ND), the respective estimates might be overvalued even though one adjusts for income. Function transfer can be used by transferring a function from a study site to a policy site (Navrud and Ready, 2007, p:4). The function describes a relationship between the value estimate and characteristics of the good being valued and households characteristics (Rosenberger and Loomis, 2017, p:442). H_i is defined as household i's characteristics and G_j is characteristics of the environmental good (Navrud and Ready, 2007, p:4).

$$\mathrm{WTP}_{ij} = f(G_j, H_i) \tag{3.20}$$

If a researcher transfer a function from a previous study and collect a data set at a new policy site, the researcher can insert mean values obtained from the data from the policy site into the transferred function. Then, it is possible to estimate WTP at the policy site. The function consists of estimated parameters from the study site (Navrud, 2004, p:204).

A logit-model, utilizing the data set of Siikämaki et al. (ND), was estimated to determine mean WTP among Norwegian households. The transferred function was derived from a dichotomous choice question[20]. North American respondents were asked to accept/reject a bid of WTP for a preservation plan which entails avoiding 20 percent forest and 16 percent species loss compared to a reference scenario where forest and species will be lost by 30 and 24 percent within 2050, respectively. This preservation plan is similar to Plan B defined in this study, which entails 5 percent more forest loss and 1 percent less species loss. The transferred mean WTP among Norwegian households, an annual payment of NOK 5558 in December 2017 prices, was found by inserting sample means of the Norwegian data set into the function.

[20]Note: The bids were converted to NOK using the PPP-adjusted exchange rate

Table 3.3: Logistic Regression for Function Transfer

Variable	Logistic Regression	
bid	Bid respondents are offered in NOK	-0.002*** (0.0002)
lnINC	Log of midpoint household income	0.157* (0.094)
higheduc1	1 if have a bachelor or a higher degree	0.355** (0.172)
Q331	1 if consider oneself as strong environmentalist	0.612* (0.343)
Q333	1 if not an environmentalist	-0.602*** (0.163)
planvisit	1 if plan to visit the Amazonrainforest, 0 otherwise	0.321 (0.203)
decreasing	1 if believe the are of the Amazonis decreasing, 0 otherwise	0.621*** (0.175)
Q171	Very confident that the plan will be well run	1.257** (0.403)
Q172	Somewhat confident that the plan will be well run	0.928*** (0.166)
Q174	Not confident at all that the plans will be well run	-1.435*** (0.229)
male	1 if male and 0 if female	-0.055 (0.150)
ppage	Age	-0.0032 (0.004)
_cons	Constant	-0.796 (0.660)
Log likelihood		-550.08078
AIC		1126.162
BIC		1190.04
Correct classification		73.16%
Pseudo R^2		0.2111
Number of obs		1006
Mean WTP		NOK 5238*** (610.594)
Predicted average probability of accepting offer		0.493 (0.257)

Note: *p<0.15, **p<10, ***p<0.05.

Table 3.3 depicts the the Logit model. The model and the mean WTP were estimated by following steps defined by Haab and McConnell (2002, p:32-35) and Lopez-Feldman (2012).[21] Overall, the model correctly classifies 73.16 percent, where 75 and 71 percent are correctly classified by accepting and rejecting the offer, respectively. A Pearson goodness of fit test cannot be rejected at 10 the percent level. The average predicted probability of accepting the bid is 49 percent. The model has a reasonably high pseudo R^2 and most variables are significant at the 10 percent level. The signs of the coefficients are consistent in terms of deductive reasoning and economic theory. 18 respondents who neither accepted nor rejected the given bid were dropped from the sample.

[21] Mean WTP is given by: $-\frac{\alpha+\boldsymbol{\beta}\cdot\bar{\boldsymbol{z}}}{\gamma}$, where α is the constant, $\boldsymbol{\beta}$ is a vector of coefficients of explanatory variables, excluding the coefficient for the bid variable, and $\bar{\boldsymbol{z}}$ is a vector of mean values of the explanatory variables, excluding the bid. Lastly, γ is the coefficient of the bid variable (Haab and McConnell, 2002, p:35).

3.3.3 The Delphi Method as a Benefit Transfer Technique

In addition to unit and function transfer, the Delphi method can also be classified as a BT technique. The Delphi method is used to determine information on a specified subject by surveying experts of their respective opinion (Dalkey and Helmer, 1963). It was initially applied to forecast science and technology by Dalkey and Helmer (1963), and has later been applied in several different contexts (Hsu and A. Sandford, 2007; Sackman, 1974, p:1). In the context of using the Delphi method to value environmental goods and services, experts are asked how they expect households, in a population of interest value changes in a defined environmental good or an ecosystem service. Usually, a Delphi survey consists of several rounds. In the first round, experts fill out a questionnaire and state their opinion on the specified subject, without communicating with other experts. In the later rounds, the experts are allowed to examine each other's answers anomalously for then to revise own answers. Generally, it is believed that predictions are more accurate in the later rounds (Navrud and Strand, 2016).

In general, studies which use BT to value unvalued environmental goods and ecosystem services depend on experts' opinions and assessment of previous studies and how compiled information is used by the experts (León et al., 2003; Navrud and Strand, 2016; Strand et al., 2017). Experts also accumulate experience and valuation information when conducting BT studies. Correspondingly, conducting a Delphi CV survey to value environmental goods and ecosystem services can be defined as an additional BT technique, considering that experts utilize accumulated valuation information in a Delphi CV survey when stating their respective opinions on behalf of a population of interest (Navrud and Strand, 2016).

There are few existing studies which have used the Delphi method to value environmental goods and ecosystem services (León et al., 2003; Navrud and Strand, 2016; Strand et al., 2017). However, León et al. (2003) conducted both a Delphi exercise and a CV population survey to value national parks in Spain, and to compare the two methods. Results indicate that valuation estimates derived from the Delphi method did not match values determined by the CV population survey.

We want to use equivalence tests to evaluate if the Delphi method is a reliable BT technique. The equivalence tests will test for equivalence between WTP estimates derived using the Delphi method as a BT technique, depicted in table 3.1, and WTP estimates derived using a population CV survey. If we reject the null hypothesis in the equivalence test, then we have some indications that the Delphi method is a reliable BT technique.

4. Data & Results

4.1 Survey Design

This section briefly describes the outline of the survey of the study. The survey is constructed as identical as possible to the Delphi CV survey used by Navrud and Strand (2016) to secure a high degree of comparability. The survey mode used to collect the data is an internet survey with 300 panel members. Firstly, respondents are asked about their age and gender. Then, they are provided a question of their opinion regarding public spending on public services. The questions make the respondents consider their preferences regarding public spending, which is important for the WTP questions (Siikämaki et al., ND). Further, respondents are introduced to a general definition, information and characteristics of tropical rainforests and the Amazon rainforest. A picture is used to show where the world's tropical rainforests are located, and questions related to respondents current knowledge about the Amazon rainforest are asked.

Respondents are introduced to objective information regarding deforestation of the Amazon rainforest and consequences related to this in an understandable manner. In this part of the survey the hypothetical market is constructed with relevant policy scenarios. Respondents are informed that without a new preservation plan of the Amazon rainforest, 24 percent of existing species and 25 percent of current forest areas will be lost within 2050. This is defined as the reference scenario. A neutral picture of mammals facing potential extinction and a map of changes in forest area with current preservation levels are shown to the respondents. Respondents are informed that the Brazilian government, by collaborating with NGOs, have constructed two preservation plans. However, without international funding the costs of the preservation plans are too high for implementation. The scopes of preservation Plan A and B are introduced, where Plan A is more extensive. Plan A and Plan B are hypothetical policy-relevant scenarios.

Respondents are asked, with a payment card, how much their household is willing to pay for preservation Plan A and B. A payment card is used as a response format due to a small sample, even though it breaches with the state of the art approach (Johnston et al., 2017). The payment vehicle defined in the survey is an annual national tax, where the tax payments are transferred to countries covered by the Amazon rainforest which have agreed to implement the preservation plan(s). The choice of payment vehicle is realistic, such as recommended by Johnston et al. (2017), because Norway has already funded Brazil to reduce deforestation. Additionally, respondents might be less sceptic to a tax which is directly transferred to the objective instead of an income tax. An income tax could increase scepticism (Lindhjem and Navrud, 2009). Respondents with positive WTP responses are asked to provide a comment on why they are willing to pay, in order to evaluate and categorize their WTP values.

A follow-up question is asked to zero WTP respondents with different alternatives of why they chose zero as WTP, in order to identify potential protest answers. Protest zeroes occur when respondents state zero as WTP even though they might hold a positive value for the good of interest (Boyle, 2017, p:109). If zero WTP respondents chooses "Amazonian countries should pay themselves", "The Norwegian government should pay" or "Norway has already paid enough to reduce deforestation in Brazil and other countries" in the follow-up question, we typically identify their responses as protest zeroes and exclude them from the analysis. Respondents are asked if they think the preservation plans will be fulfilled, if they believe they have to pay to mitigate deforestation of the Amazon rainforest, and if results from the survey will be used to consider policies aiming to reduce deforestation of the Amazon rainforest. The questions are included so that we can assess the truthfulness and reliability of their responses. Lastly, respondents are asked questions regarding their socio-economic characteristics, which is recommended to ask at the end of the survey (Johnston et al., 2017).

4.2 Pilot Study

A pilot study was conducted to test the survey design. The survey was sent out to 43 randomly selected Norwegian individuals which are members of an internet panel. Friends and acquaintances were also asked to answer the survey. The panel sample consisted of 47 percent women and 53 percent men with an average age of 42. Overall, 12 percent stated they 'don't know' if they were willing to pay for Plan A and 21 percent of the respondents stated zero WTP for Plan A, whereas 44 percent of the zero WTP respondents could be identified as protest zeroes. For Plan B, 9 percent did not know if they were willing to pay and also here, 21 percent had zero WTP.

A worrisome observation was that some respondents chose equal or higher WTP for Plan B than for Plan A. This is not consistent with economic theory, which could have resulted in failing to pass the scope test. It might indicate the presence of embedding effects, where respondents find it difficult to distinguish between the scope of the two preservation plans. A possible explanation is that the survey contains much text and information, which has been commented by friends and acquaintances, as well as the randomly selected respondents in the pilot sample. An issue of having much text in a survey is that respondents do not read the text carefully. Resultingly, we decided to include a table which depicts the scope of the two preservation plans and the reference scenario on the page where respondents are asked the elicitation questions for Plan A and Plan B. Additionally, we emphasized that Plan B is less ambitious in the elicitation question. We believed that these alternations would make the responses more consistent.

Respondents with positive WTP for preservation Plan A or B were asked to write in own words why they are willing to pay. Some respondents wrote that they are willing to pay to preserve species, biodiversity and forest while other wrote that it is important to secure resources for future generations. Thus, their WTP values are mostly related to existence and bequest values. Even though we purposely did not mention carbon benefits in the survey, a few respondents answered that preservation of the Amazon rainforest is important for the global climate. This indicates that WTP values among a few respondents consist of carbon storage values.

Further, we decided to include two additional questions. The first question asks how important environmental conservation (EC) is for the respondents, and the second question asks the respondents which preservation plan they believe is most realistic to be implemented. In general, responses seemed to be consistent with intuition and economic theory. Respondents with high education (master degree) stated higher WTP values than respondents with low education, and most respondents with high personal income stated higher WTP values than respondents with low personal income. At the end of the pilot survey, respondents could leave comments regarding the survey. Based on these comments, respondents seemed pleased with the survey, and some stated that the survey distributes important knowledge and information. Additionally, both the reference scenario and the preservation plans seemed credible among the respondents. However, one respondent experienced that the questions asked were leading. According to the respondent, we should use more objective questions if results from the survey were to be used in policy decisions.

4.3 Sample vs Population Characteristics

To evaluate whether the respective sample is representative for households in Norway, we must compare average general socio-economic characteristics of the sample with the population of interest.

From Table 4.1, we can see that the sex ratio of the sample is consistent with the Norwegian population. Mean household income is higher in the sample, however, household income of the sample is the midpoint of the respondents' chosen income category. This could be an explanation of the income difference between the sample and the population. The sample consists of more individuals between the age of 65-79 compared to the population. Additionally, the education level of the sample is slightly higher. There are few individuals with below upper secondary education while more with high education, both short and long, compared to the population. As both mean household income and education levels are higher for the sample, one could expect higher mean WTP values of the sample compared to the population. Lastly, the sample is quite consistent according to the distribution of households located in different regions of Norway.

Table 4.1: Sample vs Population Characteristics

		Sample (%)	Norwegian Population (%)
Gender			
	Male	50.33%	50.39%
	Felmale	49.67%	49.61%
Income			
	Mean household income	NOK 773 171	NOK 518 313
Education			
	Below upper secondary education (Grunnskole)	5%	26.5%
	Upper secondary education (Videregående skole)	29.33%	37.8%
	Tertiary vocational education (Fagbrev)	12%	2.8%
	Higher education, short (Bachelor degree)	34%	23.4%
	Higher education, long (Master or PhD degree)	19.66%	9.5%
Age categories			
	15-24	11%	12.7%
	25-49	39.33%	34.4%
	50-64	19%	18.4%
	65-79	30%	12.4%
	$\geq$ 80	0.67%	4.2%
	15-49	50.33%	47.7%
	50 or above	49.67%	52.9%
	Average age	50 years	40 years
Regions			
	Midt-Norge	12.33%	8.6%
	Nord-Norge	9%	9.3%
	Sørlandet	8.67%	5.7%
	Vestlandet	19.33%	26%
	Østlandet	50.66%	50.4%

Sources: SSB (2017c), SSB (2017d), SSB (2017a), Kommuneprofilen (2018a), Kommuneprofilen (2018b) and Kommuneprofilen (ND).

4.4 Results

The data set consists of 300 respondents. The survey was sent out to 1451 individuals with a response rate of 20.1 percent. Of the 300 respondents, 44 and 50 respondents stated zero as their willingness to pay for Plan A and Plan B, respectively. Additionally, 36 and 37 respondents chose 'don't know' when asked how much they are willing to pay for Plan A and Plan B, respectively. 'Don't know' respondents were removed from the sample. Thus, 220 respondents have positive WTP for Plan A while 213 respondents have positive WTP for Plan B.

4.4.1 Mean and Median Willingness to Pay

Excluding 'Don't know' answers and protest zeroes, the means of WTP for Plan A and B of the sample were determined. Assessing midpoints of chosen payments, except for zero, mean WTP for Plan A is NOK 945 while mean WTP for Plan B is NOK 677. A paired t-test of two dependent samples was utilized as a scope test to evaluate if mean WTP for Plan A is different compared to mean WTP for Plan B, see Table III.2 in Appendix III. The null hypothesis was rejected. This indicates a statistical significant difference between means of WTP for Plan A and Plan B. The unconditional mean WTP was also determined, from Equation (3.11). An Interval regression, excluding dependent variables, found the unconditional means of WTP to be NOK 1136 and NOK 796 for Plan A and B, respectively.

Table 4.2: Mean and Median Willingness to Pay

	Mean WTP Plan A	Mean WTP Plan B	St. Dev Plan A	St. Dev Plan B	95% conf. interval Plan A		95% conf. interval Plan B	
Payment card value	730	525	1310	920	572	889	413	637
Midpoint value	945	677	1578	1156	746	1145	531	823
Interval censored value	1136	796			994	1279	697	895
	Median WTP Plan A	Median WTP Plan B	St. Dev Plan A	St. Dev Plan B	95% conf. interval Plan A		95% conf. interval Plan B	
Payment card value	300	200	1379	920	134	466	89	311
Midpoint value	550	250	1627	1233	345	755	95	405

An OLS model with midpoint WTP as dependent variable was estimated to assess the difference in the means of WTP with sample means and population means of education and age categories. This is because our sample is overrepresented by individuals with high education and individuals ranging from age 65 to 79. The model is presented in Table IV.3 in Appendix IV. The means of WTP for Plan A were found to be NOK 945 with sample means and NOK 759 with population means. For Plan B, mean WTP changed from NOK 673 to NOK 524. Thus, results indicate that the mean WTP values with sample means are overestimated, assuming unbiased coefficients of the model.

Zero WTP Respondents

Respondents with zero WTP were asked why they were not willing to pay for Plan A and/or Plan B. They were provided five alternative reasons for Plan A and six for Plan B. Respondents could also specify alternative reasons, which are categorized as 'other reasons'. Table 4.3 depicts reasons for zero WTP among respondents for Plan A and B.

Table 4.3: Reasons for Zero WTP

Reasons for Zero WTP, Plan A	Perc.	Freq.	**Reasons for Zero WTP, Plan B**	Perc.	Freq.
(1) Can't afford to pay	15.91	7	(1) Can't afford to pay	18	9
(2) There are more important things to pay for than preserving forest and species in the Amazon rainforest	18.18	8	(2) There are more important things to pay for than preserving forest and species in the Amazon rainforest	22	11
(3) The Norwegian government should pay	6.82	3	(3) The Norwegian government should pay	4	2
(4) Governments in Brazil and other countries should pay	6.82	3	(4) Governments in Brazil and other countries should pay	12	6
(5) Norway has already paid Brazil a lot of money to stop deforestation of the Amazon rainforest	31.82	14	(5) Norway has already paid Brazil a lot of money to stop deforestation of the Amazon rainforest	22	11
(6) Other reasons; Specified	20.45	9	(6) Plan B is not extensive enough	3	6
			(7) Other reasons; Specified	8	16
Total	100	44		100	50

We could identify and remove protest zeroes from the sample. From Table 4.3, we identified alternative three, four and five as protest zeroes. Respondents who specified own reasons for zero WTP were assessed and either removed or kept, dependent on their answer. Thus, in total, 22 respondents were identified with zero as true WTP for Plan A, while 30 respondents had zero as true WTP for Plan B. We can see that the most dominant reason for zero WTP is alternative five.

Positive WTP

Respondents were asked an open question why they were willing to pay for Plan A and/or Plan B to not mislead respondents to consider carbon storage benefits. Six categories of values were identified based on their responses: i) existence, ii) bequest, iii) CO_2, iv) social responsibility, v) don't know, and vi) prefer Plan A. Several respondents stated that it is our responsibility to take care of our planet. These were identified in category iv) social responsibility. However, social responsibility values in this context are reviewed as non-use values. Further, some respondents stated that they did not know why they were willing to pay. They were classified in category 'don't know'. As we only asked one question why they were willing to pay for Plan A/B, respondents who only valued Plan A most likely found it difficult to answer the open question. Thus, several respondents stated that they prefer Plan A. These were identified in category 'prefer Plan A'. Table 4.4 depicts percentage and frequency of the five categories. In percentage, existence values seem to be of greater importance. In total, existence, bequest and social responsibly values are identified as non-use values. Thus, 66.82 percent of WTP values are categorized as non-use values. If we only consider positive WTP respondents, the midpoint means of WTP of non-use values for Plan A and B are NOK 1000 and NOK 813, respectively.

Table 4.4: Willingness to Pay Categories

	WTP Values						
	Existence	Bequest	Carbon	Social responsibility	Don't know	Prefer Plan A	Total
Percentage	45.45	8.64	9.55	12.73	17.73	5.91	100
Frequency	100	19	21	28	39	13	220

Furthermore, to assess whether respondents who are identified in category 'carbon' have, on average, higher WTP for Plan A and Plan B compared the other positive WTP respondents, t-tests of mean difference between two independent samples were performed. Test results are presented in Table III.2 in Appendix III. The means of WTP for Plan A and B among carbon respondents are NOK 2141 and NOK 1297, respectively. However, among the other positive WTP respondents, the means of WTP are NOK 885 for Plan A and NOK 657 for Plan B.[22] T-tests of mean difference confirm a statistical significant difference in the means of WTP for Plan A and for Plan B between carbon respondents and other positive WTP respondents. However, validity of test results should be questioned due to large difference in sample sizes, as well as it might not be reasonable to assume equal variance of the two sub-samples and normality.

Overall, the means of WTP among positive WTP respondents are NOK 1001 and 728 using midpoint estimates, while the unconditional means of WTP using interval censored

[22]Note: When excluding zero WTP respondents, mean WTP is derived as following: $e^{\alpha+\frac{\sigma^2}{2}}$, where α is the constant and σ is the standard deviation of the error term, when transforming the dependent variable to logarithm (Lindhjem and Navrud, 2011).

estimates are NOK 978 and NOK 714 for Plan A and Plan B, respectively.

Sensitivity Analysis

A sensitivity analysis was performed to evaluate the reliability of the midpoint means of WTP of Plan A and B, referred to as baseline estimates. Four sensitivity cases were defined. One-sided t-tests were performed to evaluate whether the baseline mean WTP of Plan A is different from a specified mean value which is derived by performing sensitivity adjustments. Additionally, scope tests, both parametric and non-parametric, for each case were performed. See Table III.2 and Section III.3 in Appendix III for test results.

Table 4.5: Sensitivity Analysis

	Baseline	Case 1	Case 2	Case 3	Case 4
Midpoint WTP Plan A	945	1074	908	990	763
St Dev Plan A	1578	1871	1468	1666	1465
Total amount of respondents	242	108	241	107	300
Change in percentage	0%	14%	4%	5%	19%
Midpoint WTP Plan B	677	406	677	406	548
St Dev Plan B	1156	854	1156	854	1074
Total amount of respondents	243	107	243	107	300
Change in percentage	0	40%	0	40%	19%

Case 1: remove obs. where $WTP_{\text{Plan A}} \geq WTP_{\text{Plan B}}$, Case 2: remove obs. where $WTP > 0.02 \cdot hhinc$, Case 3: remove obs. from Case 1 and 2, Case 4 assumes all zero WTP are true and all don't know answ. are 0.

In Case 1, inconsistent observations where WTP for Plan A is greater or equal to WTP for Plan B were dropped. In total, 134 observations were removed and the midpoint mean WTP for Plan A in this case is NOK 1074. In Case 2, observations where WTP for either Plan A or B is greater than 2 percent of household income were dropped. Only one observation was dropped for Plan A while no observations were dropped for Plan B. In Case 3, all inconsistent observations from Case 1 and Case 2 were removed. Thus, 107 respondents were kept. The mean WTP for Plan A among only consistent responses is NOK 990, using midpoint estimates. Lastly, in Case 4 we included all zero WTP respondents. Additionally, we classified respondents who stated 'don't know' with WTP equal to zero.

The most pessimistic and perhaps unrealistic scenario, Case 4, implies a 19 percent lower estimate. Oppositely, Case 1 and Case 2 imply a 14 and a 5 percent higher estimate, respectively, which indicates that the baseline WTP estimate for Plan A is underestimated due to inconsistent responses. Overall, the baseline mean WTP estimate for Plan A seems to perform well in the sensitivity analysis. Each case does not imply substantial changes. Additionally, we failed to reject the null hypothesis of each test of difference between the baseline mean WTP for Plan A and specified mean values derived by performing sensitivity adjustments, except for Case 4. Thus, test results indicate robustness and high reliability of the baseline WTP estimate for Plan A. For Plan B, sensitivity adjustments in Case 1/2 had quite substantial effect on the mean WTP with a decrease of 40 percent.

This indicates that the baseline mean WTP estimate for Plan B is sensitive, and perhaps overestimated, due to inconsistent responses. Lastly, in each scope test, both parametric and non-parametric, we could reject the null hypothesis of equality between mean/median WTP for Plan A and B.

4.5 Regression Analyses

To answer the defined hypotheses in chapter 1, several interval and OLS regression models were estimated. As the WTP estimates are right-skewed and due to linearity concerns, a log-transformation of WTP for both Plans was utilized (Cameron and Huppert, 1989). The dependent variable is defined as ln(WTP + 1). Thus, log-log models are presented in this chapter as continues independent variables are also transformed into their natural logarithmic form. The interval regression models are believed to be more reliable. Midpoint OLS models of WTP, as shown by Cameron and Huppert (1989), yield biased estimates. However, interval regression models yield biased estimates if homoskedasticity or linearity assumptions are not met (Wooldridge, 2013, p:603).

Evaluating the reliability of different interval and OLS models was done by assessing AIC, BIC, number of observations, R^2 and how well a model answers hypotheses for the study. Lower AIC and BIC values are associated with improved quality of a model, and a high R^2 value indicates a better fit of a model (Cameron and Trivedi, 2010, p:359). Ramsey reset tests for linearity and Breusch Pagan tests for heteroskedsticity were performed in the midpoint OLS models. In models where we could reject the null hypothesis of homoskedasticity, robust standard errors were utilized. All models were examined for multicollinearity issues.

4.5.1 Introducing Independent Variables

Table 4.6 provides an overview of independent variables which are included in the regression analyses, presented in this chapter and in Appendix IV. The table includes mean, standard deviation, min and max values and the number of observations for each variable.

Table 4.6: Description of Independent Variables

Var	Description	Mean	St Dev	Min	Max	Obs
hhinc	midpoint household income	773171	449752	100000	4000000	246
lnhhinc	Log of midpoint household income	13.39	0.618	11.51	15.20	246
age	age of respondets	50.4	17.99	18	82	300
agesq	age squared	2863.22	1768.7	324	6724	300
lnage	Log of age	3.84	0.413	2.89	4.41	300
male	dummy, 1 if male, 0 otherwise	0.503	0.5	0	1	300
hhsize	household size	2.31	1.14	1	10	300
married	dummy, 1 if married, 0 otherwise	0.64	0.481	1	0	300
higheduc	dummy, 1 if bachelor degree or higher, 0 otherwise	0.523	0.50	0	1	300
masterphd	dummy, 1 if master degree or higher, 0 otherwise	0.183	0.388	0	1	300
oslo	dummy, 1 if from Oslo, 0 otherwise	0.123	0.329	0	1	300
highinttime	dummy, 1 if interview time is 10+ minutes, 0 otherwise	0.3	0.46	0	1	300
posq1r5	dummy for Q.1, 1 if believe we must spend much or a little more public money on EP in South America	0.277	0.448	0	1	300
vistrainf	dummy for Q.2, 1 if have visited a tropical rainforest, 0 otherwise	0.8	0.4	0	1	300
visitamazon	dummy for Q.3, 1 if have visited the Amazon rainforest, 0 otherwise	0.07	0.256	0	1	300
planvisrain	dummy for Q.4, 1 if quite or very sure will visit a tropical rainforest, 0 otherwise	0.14	0.348	0	1	300
smaller	dummy for Q.5, 1 if believed Amazon was smaller than showed in maps, 0 otherwise	0.51	0.501	0	1	300
lesssploss	dummy for Q.7, 1 if believed less species would disappear with current deforestation rates, 0 otherwise	0.647	0.479	0	1	300
contpolicy	dummy for Q.12, 1 if believe results form survey will be used in policy decisions, 0 otherwise	0.047	0.211	0	1	300
payfordef	dummy for Q.13, 1 if believe one has to pay tax to reduce deforestation in the Amazon rainforest, 0 otherwise	0.043	0.204	0	1	300
envlist	dummy for Q.15, 1 if believe EC is fairly or very important, 0 otherwise	0.703	0.46	0	1	300
envmember	dummy for Q.16, 1 if member of an environmental organization, 0 otherwise	0.03	0.171	0	1	300
nnf	dummy for Q.16, 1 if member of Norges Naturvernforbund, 0 otherwise	0.03	0.171	0	1	300
member	dummy for Q.16, 1 if member of an environmental/outdoor organization, 0 otherwise	0.291	0.455	0	1	300
unrealplans	dummy for Q.18, 1 if believe non of the preservation plans are realistic, 0 otherwise	0.14	0.348	0	1	300
realplans	dummy for Q.18, 1 if believe plan A and Plan B are realistic, 0 otherwise	0.15	0.358	0	1	300
existence	dummy, 1 if reason for being WTP for Plan A/B is related to existence of species and forest, 0 otherwise	0.415	0.494	0	1	241
bequest	dummy, 1 if reason for being WTP for Plan A/B is related to future generations, 0 otherwise	0.079	0.270	0	1	241
co2	dummy, 1 if reason for being WTP for Plan A/B is related to carbon, 0 otherwise	0.087	0.283	0	1	241
volunteer	dummy, 1 if respondents perform voluntarily work, 0 otherwise	0.355	0.479	0	1	296

4.5.2 Econometric Models for Zero and Positive WTP

The models, presented in Table 4.7, are considered and will be referred as the main models in Chapter 5. Even though they have higher AIC and BIC values and lower R^2 compared to models presented in Table IV.4 in Appendix IV, the main models provide valuable information to answer the hypotheses. We also had linearity and multicollinearity concerns in some of the other models. We failed to reject the null hypothesis of linearity in the OLS models presented in Table 4.7. The table presents interval and OLS regression models for Plan A and Plan B. We have included the same variables in the interval regression models as in the OLS models and presented them together so that a comparison of the methods can be performed. However, results of the interval models will be used to assess marginal effects.

Table 4.7: Log-normal Models of WTP

	Interval Regression		Midpoint OLS Regression	
Variables	Model 5, Plan A	Model 5, Plan B	Model 5, Plan A	Model 5, Plan B
lnhhinc	0.343*	0.527***	0.340	0.529***
	(0.227)	(0.246)	(0.255)	(0.265)
higheduc		0.267		0.265
		(0.292)		(0.302)
male	-0.500**	-0.233	-0.505***	-0.234
	(0.262)	(0.268)	(0.254)	(0.281)
lnage		0.319		0.314
		(0.358)		(0.355)
oslo	0.889***	0.879***	0.889***	0.877***
	(0.371)	(0.374)	(0.318)	(0.385)
highinttime	0.457**	0.626***	0.459**	0.629***
	(0.278)	(0.287)	(0.266)	(0.288)
envlist	0.828***	0.896***	0.821***	0.889***
	(0.312)	(0.323)	(0.343)	(0.361)
posq1r5	0.955***	0.743***	0.953***	0.741***
	(0.290)	(0.307)	(0.230)	(0.289)
unrealplans		-2.201***		-2.209***
		(0.410)		(0.576)
realplans	0.472*		0.471**	
	(0.333)		(0.264)	
envmember	0.588	0.208	0.597	0.213
	(0.432)	(0.444)	(0.455)	(0.500)
contpolicy	0.682	0.382	0.682***	0.381
	(0.597)	(0.600)	(0.334)	(0.590)
vitisamazon	0.145	0.120	0.148	0.125
	(0.517)	(0.522)	(0.768)	(0.730)
planvisrain	0.201		0.196	
	(0.390)		(0.254)	
married	-0.125	-0.463*	-0.126	-0.467
	(0.293)	(0.314)	(0.299)	(0.337)
smaller	0.685***	0.261	0.684***	0.255
	(0.265)	(0.283)	(0.269)	(0.289)
volunteer		0.654***		0.654***
		(0.286)		(0.263)
_cons	-0.298	-4.081	-0.234	-4.065
	(2.976)	(3.471)	(3.411)	(4.051)
Log likelihood	-632	-598	-399	-390
AIC	1295	1230	826	813
BIC	1344	1286	872	865
R^2	0.264	0.343	0.263	0.342
Adj. R^2			0.212	0.287
Number of obs	200	195	200	195
Mean WTP	1362***	889***	1490***	839***
	(215)	(144)	(211)	(137)
Median WTP	282	179	273***	46
	(-)	(-)	(39)	(61)

Note: *p<0.15, **p<0.10, ***p<0.05.

The models have relatively few observations as household income is included as an independent variable. Several respondents were reluctant to provide information regarding personal and household income. The log of household income was used to determine the income elasticity of WTP, which is easier to interpret. The variable is significant at the 5 percent level for models of WTP for Plan B, and at the 15 percent level in the interval regression model of WTP for Plan A. For Plan A, the coefficient of the logarithm of household income is similar in the interval regression model and the OLS model, and is about 0.343. Thus, if income increases by 1 percent, WTP for Plan A, on average, increases by 0.343 percent, all things being equal. For Plan B, the coefficient is slightly higher and in this case WTP, on average, will increase by 0.53 percent, all things being equal.

Age was left out in the model for Plan A as it was insignificant, and correlated with the dummy variable for respondents who believe they will visit the Amazon in the future. In the other models, age is not significant and the coefficient of age is small. The log of age is included in the main model for Plan B, but also here it is not significant. The same holds for the dummy variable taking value one for individuals with high education and zero otherwise.[23] However, as expected, the sign of the age and the high education coefficients is positive. This is interesting as the sample is overrepresented with respondents ranging from age 65 to 79 as well as respondents with high education. Thus, the model indicates that age and high education do not significantly affect WTP.

Furthermore, if respondents regard (EC) to be very or fairly important, the model predicts that, holding all other variables constant, WTP for Plan A, on average, will change positively with 83 percent compared to if respondents chose a different response alternative. The model predicts that WTP for Plan B will be lower if respondents regard none of the preservation plans as realistic, compared to respondents who find either one or both plans realistic. Consistently, respondents who regard both plans as realistic is significantly associated with higher WTP for Plan A compared to respondents who do not believe so.

Males seem to have significantly lower WTP for Plan A, at the 15 percent significant level, relative to females. Respondents who are quite or very sure that they will visit the Amazon rainforest in the future have insignificantly higher WTP for Plan A compared to respondents who do not consider such a visit. The relationship is also positive and insignificant among respondents who previously have visited the Amazon rainforest, for both plans. Members of environmental organisations seem to insignificantly affect WTP positively compared to non-members.

Overall, there are minor differences between the interval regression and the midpoint OLS models. Coefficients and standard errors differ slightly. The major visible difference between the two econometric methods, for Plan A, is for the dummy variable taking value one for respondents who believe results from the survey will be used in policy making decisions and zero otherwise. The coefficient of the dummy variable is the same, however, a lower standard error in the OLS regression makes the variable significant at the 5 percent level. In the interval regression model the dummy variable is not significant.

[23]See Table IV.5 in Appendix IV.

4.5.3 Only Positive Log-normal Models

Log-normal models with only positive WTP responses were also estimated. The most reliable OLS and interval regression models, for Plan A and B, are presented in the table below. We can see that signs and significance levels of variables in model 4, from Table 4.8, are consistent with the results in model 5 from Table 4.7. Also here, interval and OLS models for Plan A and B are presented together.

Table 4.8: Positive WTP Log-normal Models

	Interval Regression		Midpoint OLS Regression	
Variables	Model 4, Plan A	Model 4, Plan B	Model 4, Plan A	Model 4, Plan B
lnhhinc	0.190*	0.120	0.187*	0.118
	(0.119)	(0.123)	(0.124)	(0.135)
higheduc	0.052	0.297**	0.054	0.298***
	(0.155)	(0.160)	(0.163)	(0.151)
male	-0.304***	-0.204*	-0.312***	-0.207
	(0.140)	(0.142)	(0.147)	(0.143)
lnage	0.302**	0.388***	0.306*	0.389***
	(0.180)	(0.181)	(0.188)	(0.187)
oslo	0.583***	0.407***	0.585***	0.407***
	(0.197)	(0.195)	(0.206)	(0.198)
highinttime	0.323***	0.469***	0.326***	0.473***
	(0.148)	(0.149)	(0.156)	(0.164)
envlist	0.419***	0.352***	0.409***	0.342***
	(0.174)	(0.178)	(0.182)	(0.174)
posq1r5	0.456***	0.328***	0.456***	0.325***
	(0.156)	(0.158)	(0.164)	(0.160)
envmember	0.613***	0.529***	0.628***	0.543**
	(0.228)	(0.231)	(0.238)	(0.306)
contpolicy	0.472*	0.482*	0.475*	0.486**
	(0.308)	(0.322)	(0.324)	(0.282)
vitisamazon	0.797***	0.347	0.799***	0.353
	(0.297)	(0.294)	(0.311)	(0.341)
payfordef	-0.631**	-0.290	-0.637**	-0.300
	(0.366)	(0.364)	(0.383)	(0.476)
co2	0.836***	0.726***	0.835***	0.723***
	(0.240)	(0.237)	(0.252)	(0.213)
bequest	0.622***	0.983***	0.617***	0.996***
	(0.259)	(0.257)	(0.272)	(0.337)
_cons	1.768	1.980	1.819	2.016
	(1.650)	(1.719)	(1.727)	(1.933)
Log likelihood	-477	-443	-244	-232
AIC	986	919	518	493
BIC	1037	970	566	541
R^2	0.367	0.362	0.366	0.362
Adj. R^2			0.313	0.307
Number of obs	183	176	183	176
Mean WTP	770***	570***	742***	482***
	(33.80)	(24.86)	(85.79)	(52.14)
Median WTP	510	382	466	309***
	(-)	(-)	(373)	(33.43)

Note: *p<0.15, **p<0.10, ***p<0.05.

The logarithm of household income significantly affects WTP for Plan A, both using interval and OLS regression. The income elasticity of WTP for Plan A is 0.19, which is lower than previous results. Contrary to previous results, high education seems to significantly affect WTP for Plan B positively. The coefficient of high education is approximately the same as in Table 4.7 for Plan B. The logarithm of age significantly affects WTP positively. For Plan A, if age increases by 1 percent, WTP increases by 0.302 percent, holding all other variables constant.

Respondents who have visited the Amazon rainforest are significantly associated with high WTP values for Plan A compared to non-visitors. This is not a significant relationship in the models for Plan B nor in previous results. Thus, the model indicates that respondents who hold use-values of the Amazon, in terms of recreation and eco-tourism, have higher WTP for Plan A compared to non-visitors. Respondents who stated CO_2 or bequest values are significantly associated with high WTP values, where the coefficients ranges from 0.62 to 1. This indicates that CO_2 benefits are important among positive WTP respondents.

An interesting observation to notice is that the variable 'contpolicy' is positive and significant at the 15 percent level in all models. This indicates that respondents who believe results obtained from the survey will be utilized to assess policy decisions are associated with high WTP values both for Plan A and B. Implicitly, this can encourage truthful revelation of WTP. Oppositely, it can imply that respondents can overstate their WTP if they find the topic of the survey important, while they also believe results will be used in policy decision processes.

Respondents who believe they actually have to pay to reduce deforestation of the Amazon rainforest are significantly associated with low WTP values for Plan A compared to respondents who do not believe so or do not know. Intuitively, respondents potentially state lower WTP values, as they are worried they have to pay. This indicates that some respondents behave strategically which affects WTP negatively. Lastly, we can see that members of environmental organisations have significantly higher WTP for Plan A and B compared to non-members. For Plan A, members have about 61 percent higher WTP compared to non-members, holding all other variables constant.

4.5.4 Positive vs Zero WTP

Logit models for Plan A and Plan B were estimated to assess how characteristics, preferences and other factors influence the decision of stating positive versus zero WTP. Protest zeroes were excluded from the logit models, resulting in 22 zero respondents and 220 positive respondents for Plan A. Goodness of fit tests and classification tests of zero versus positive WTP respondents were performed. Models presented in the table below passed the goodness of fit test. They correctly classify positive WTP respondents very well, however, correct classification of zero WTP respondents is substantially lower.

Table 4.9: Logit Models for Positive vs Zero WTP

	Logistic Regression					
Variables	Model 1, Plan A	Model 1, Plan B	Model 2, Plan A	Model 2, Plan B	Model 3, Plan A	Model 3, Plan B
lnhhinc			0.134	0.499	0.528	0.780*
			(0.579)	(0.478)	(0.585)	(0.506)
higheduc	0.552	0.381	0.441	-0.135		
	(0.538)	(0.466)	(0.762)	(0.628)		
male	-0.529	-0.438	-0.233	-0.310	0.188	0.194
	(0.548)	(0.471)	(0.686)	(0.585)	(0.721)	(0.625)
age	-0.026*	-0.006	-0.044***	-0.025	-0.038**	-0.018
	(0.016)	(0.014)	(0.021)	(0.017)	(0.021)	(0.018)
envlist	0.992**	1.101***	1.227**	1.307***	1.315**	1.461***
	(0.538)	(0.460)	(0.682)	(0.591)	(0.736)	(0.647)
unrealplans	-2.286***	-2.150***	-2.920***	-2.775***	-3.311***	-3.293***
	(0.564)	(0.502)	(0.759)	(0.649)	(0.822)	(0.727)
volunteer	1.655***	1.517***	2.619***	2.163***	3.052***	2.552***
	(0.792)	(0.654)	(1.124)	(0.847)	(1.149)	(0.915)
lesssploss			1.759***	1.571***	1.691***	1.548***
			(0.700)	(0.604)	(0.722)	(0.629)
payfordef			-1.740	-1.318		
			(1.287)	(1.232)		
member					-1.475***	-1.127**
					(0.745)	(0.653)
oslo					1.152	0.612
					(1.239)	(0.935)
married					-1.205	-1.623***
					(0.852)	(0.788)
_cons	3.252***	1.801***	1.541	-4.465	-2.991	-7.538
	(0.947)	(0.764)	(7.534)	(6.116)	(7.405)	(6.362)
Log likelihood	-56	-70	-37	-46	-34	-42
AIC	125	154	93	112	89	105
BIC	149	178	125	145	125	141
Pseudo R^2	0.2426	0.2248	0.3670	0.3466	0.4175	0.4102
Number of obs	238	239	196	195	194	193
Correct classification	92	88	94.9	90.8	94.3	92.8
Average predicted Prob.	0.908***	0.874***	0.913***	0.882***	0.912***	0.881***
	(0.017)	(0.019)	(0.017)	(0.019)	(0.016)	(0.018)

Note: *p<0.15, **p<0.10, ***p<0.05.

In model 1, household income was dropped in order to obtain more observations. Even though model 1 has more observations, we can see that both AIC and BIC have higher values while pseudo R^2 is lower compared to the other models. Additionally, model 1 only classifies 23 and 20 percent correctly as zero WTP respondents for Plan A and Plan B, respectively. The model is therefore reviewed as weaker compared to the other models presented in Table 4.9. Model 3 has the lowest AIC and BIC while also the highest pseudo R^2. This holds for Plan A and Plan B. Additionally, the model classifies 99.44 and 98.24 percent correctly as positive WTP respondents and 41.18 and 52.17 percent correctly as zero WTP respondents for Plan A and Plan B, respectively. Therefore, model 3 is reviewed as the strongest model.

Firstly, each model predicts reasonably similar significant average probabilities of stating positive WTP. We can see that the average predicted probabilities of stating positive WTP are around 90 percent for Plan A and 88 percent for Plan B, all are highly significant. Household income is positively associated with stating positive WTP values for Plan A and B. The relationship is statistically significant at the 15 percent level for Plan B in model 3. High education is positively associated with stating positive WTP values for Plan A and B, however, the relationship is not significant. Higher age seems to significantly increase the likelihood of stating zero WTP for Plan A. This seems reasonable as old individuals often have low or zero WTP. As the sample is overrepresented by individuals ranging from age 65 to 79, the margins command in Stata was utilized to evaluate how the average probability of stating positive WTP varied at different ages in model 3 for Plan A. The average probability of stating positive WTP was reduced by almost 10 percentage points, analysing ages from 40 to 80 years. The average predicted probability of stating positive WTP is significantly 83 percent at age 80.

Respondents who regard EP as fairly or very important are significantly more likely to have positive WTP. Additionally, respondents who find none of the preservation plans as realistic are significantly more likely to state zero as WTP. This holds in all models presented in Table 4.9, and corresponds well to the relationships we established in the models presented in Table 4.7. Utilizing the margins (average marginal effects) command in model 3 for Plan A, we find that if a respondent finds none of the plans realistic, the probability of stating zero increases by 29 percentage points. This is rather interesting as it might be an indication of presence of hypothetical bias, where respondents state low or zero WTP as they do not find the hypothetical market in the survey realistic. Each model predicts that respondents who have worked as volunteers are more likely to state positive WTP. Previous results, Table 4.7, indicate a statistically significant relationship between WTP for Plan B and voluntarily work. Furthermore, respondents who believed less species would disappear in the Amazon are significantly more likely to state positive WTP values.

4.5.5 Models for Consistent Answers

Interval and midpoint OLS models were also estimated by only including consistent answers. As in case 3 from Table 4.5, respondents where $WTP_{\text{Plan A}} \geq WTP_{\text{Plan B}}$ were removed, as well as the only outlier who was willing to pay above 2 percent of annual household income for Plan A. Resultingly, 135 respondents were removed. Household income was included in the regression analysis, thus, the models for Plan A and Plan B only have 89 and 88 observations, respectively.

Table 4.10: Models for Only Consistent Answers

	Interval Regression		Midpoint OLS Regression	
Variables	Model 3, Plan A	Model 3, Plan B	Model 3, Plan A	Model 3, Plan B
lnhhinc	0.187	0.220	0.182	0.224
	(0.390)	(0.389)	(0.421)	(0.419)
male	-0.136	0.204	-0.144	0.208
	(0.491)	(0.494)	(0.521)	(0.540)
oslo	0.901*	0.881*	0.902	0.876
	(0.607)	(0.589)	(0.695)	(0.615)
envlist	1.558***	1.966***	1.551***	1.958***
	(0.535)	(0.540)	(0.609)	(0.601)
posq1r5	1.596***	1.159***	1.595***	1.158***
	(0.479)	(0.488)	(0.396)	(0.456)
member	-0.936***	-0.788**	-0.934**	-0.787
	(0.482)	(0.485)	(0.556)	(0.579)
unrealplans	-1.330***	-1.264***	-1.330***	-1.273***
	(0.551)	(0.541)	(0.652)	(0.644)
payfordef	-2.299***	-1.329	-2.304**	-1.311
	(0.1.108)	(1.122)	(1.360)	(1.357)
smaller	1.128***	0.860**	1.129***	0.855**
	(0.476)	(0.484)	(0.499)	(0.490)
_cons	1.251	-0.456	1.338	-0.490
	(5.118)	(5.247)	(5.667)	(5.595)
Log likelihood	-290	-270	-192	-190
AIC	601	561	404	400
BIC	630	589	429	425
R^2	0.391	0.349	0.390	0.348
R^2			0.322	0.273
Number of obs	90	89	90	89

Note: *p<0.15, **p<0.10, ***p<0.05.

There are minor differences in results using interval regression and midpoint OLS. Furthermore, signs of coefficients and significant variables are similar to previous results. Age and education were dropped as they did not affect WTP significantly. Household income still affects WTP positively, however, not significantly.

5. Discussion & Conclusion

5.1 Research Questions & Hypotheses

RQ.1 and RQ.2

Research question 1 and 2 ask what the mean and the total WTP values among Norwegian households are to preserve the Amazon rainforest, considering Plan A and B. The means of WTP for Plan A and B were estimated by an OLS regression model with the midpoint of WTP as dependent and an interval regression model, without explanatory variables. We found that the mean WTP for Plan A among sample households is NOK 945 using midpoint estimates. The unconditional mean for Plan A is NOK 1136 using interval censored estimates, as an annual tax payment. For Plan B, the midpoint mean WTP is NOK 677 and the unconditional mean WTP is NOK 796, as an annual tax payment.

Mean estimates are derived from a sample of 300 respondents, where only 242/243 respondents were considered. Sample selection bias and/or an unrepresentative sample potentially result in biased estimates. Thus, the estimates might not be representative for the population. Reviewing sample and population characteristics, we found that the sample is overrepresented with individuals ranging from age 65 to 79. Age has showed to insignificantly affect WTP for Plan A and B in the main models which include zero and positive WTP respondents. On the other hand, higher age seem to increase the likelihood of stating zero WTP.

Furthermore, the sample's education level is considerably higher compared to the Norwegian population. One would then expect higher sample mean WTP estimates compared to the population. However, high education seems to insignificantly affect WTP for Plan A, as well as the likelihood of stating positive WTP. Only for Plan B, high education significantly affects WTP positively. An OLS regression model, depicted in Table IV.3, was estimated to assess how much midpoint mean WTP changed with sample and population means of age and education categories. A negative change of 20 percent indicates that the baseline mean estimate for Plan A is overestimated. However, the baseline midpoint mean estimate for Plan A seemed to be underestimated due to inconsistent responses in the sensitivity analysis. For Plan B, results indicate that the baseline midpoint mean WTP estimate is overestimated.

Assuming the sample is representative for Norwegian households, we have found that, on average, Norwegian households are willing to pay between NOK 950-1100 as an annual tax for implementation of preservation Plan A. In total, this is more than 2.2 billion Norwegian kroner as an annual transfer to Amazonian countries. Further, Norwegian households are, on average, willing to pay between NOK 677 and 800 as an annual tax to secure implementation of preservation Plan B. The total value of Plan B is above 1.6 billion Norwegian kroner as an annual transfer to Amazonian countries.

RQ.3

Research question 3 asks to assess the reliability of utilizing the Delphi method as a BT technique. Therefore, reliability tests of equivalence and difference of transferred and derived mean WTP estimates were performed. Results from equivalence tests and t-tests are presented in Table III.1 and III.2, respectively, in Appendix III. We performed two equivalence tests for each plan, one where we allowed a transfer error of 20 percent and one with 40 percent. Test results failed to reject the null hypothesis in each equivalence test. This could indicate lack of reliability of utilizing the Delphi method as a BT technique. However, the sample size of the transferred estimates from the Delphi studies is only three. We found that rejection of the null hypothesis failed due to the low sample. Therefore, the results of the equivalence tests are considered as invalid.

Further, if one fail to reject the null hypothesis in an equivalence test, then one should perform a t-test to test for mean difference (Kristófferson and Navrud, 2007). Test results of tests for mean difference between two independent samples indicate equality between transferred estimates from the Delphi studies and derived WTP estimates. Intuitively, this could indicate that the Delphi method is a reliable BT technique. However, we still need to question the validity of the test results due to the low sample size of the transferred values. A high pooled standard deviation and unequal sample sizes make it difficult to reject the null hypothesis.

Table 5.1: Transfer Errors of Delphi Estimates

	Midpoint Mean Estimate	Unconditional Mean Estimate
TE Plan A Round 1	47.1%	56.0%
TE Plan A Round 2	23.4%	2.6%
TE Plan B Round 1	5.0/%	19.2%
TE Plan B Round 2	3.4%	17.8%

Instead, transfer errors can be used to assess the reliability of the Delphi method as a BT technique. Transferred mean values from the Delphi studies, depicted in Table 3.1, are NOK 1166 for Plan A Round 2 and NOK 654 for Plan B. Thus, the transfer error for Plan A is only 2.6 percent when utilizing the unconditional mean WTP estimate. For Plan B, the transfer error is only 5 percent when utilizing the midpoint mean WTP estimate. The low transfer errors indicate that the Delphi method is a reliable BT technique. Thus, the means of WTP per household per year for Plan A and Plan B are directly comparable when derived from a population CV survey and a Delphi CV survey. However, the hypothesis that carbon storage values and a higher percentage of species loss in the population CV survey would yield higher WTP estimates was proven to be wrong. The transferred mean WTP estimates from the Delphi CV studies were found to be higher in value.

RQ.4

Research question 4 asks to assess how reliable international unit value transfer and function transfer are for this study. We transferred marginal mean values of WTP to avoid forest and species loss in the Amazon rainforest from Siikämaki et al. (ND), and multiplied these with percentage of avoided forest and species loss for Plan A and for Plan B. One-sided t-tests of mean difference were performed for Plan A and B, displayed in Table III.2. The null hypothesis was rejected in each test. The transfer errors are 131 percent for Plan A and 68 percent for Plan B, utilizing the midpoint means of WTP of this study. Thus, both transfer errors are well above average errors for international BT studies (Ready and Navrud, 2006). This indicates that, for this study, unit transfer with income adjustment is not a reliable BT technique. However, we must consider that the preservation plans defined for the transferred values are different compared to plans defined in this study. Interestingly, transferred WTP estimates could be high due to inclusion of carbon storage values, as carbon storage benefits of preserving the Amazon was indirectly mentioned in their survey. If we compare mean WTP for Plan A among carbon respondents of this study with transferred mean WTP based on marginal WTP estimates, we obtain a transfer error of 2 percent.

Table 5.2: Transfer Errors of International Benefit Transfer

	Midpoint WTP estimate	Unconditional Mean Estimate
TE Plan A Unit Transfer with Income Adjustment	131.4%	92.5%
TE Plan B Unit Transfer with Income Adjustment	67.9%	42.8%
TE Plan A Function Transfer	488.1%	389.3%
TE Plan B Function Transfer	721.0%	598.5%

Note: Transferred estimates of unit transfer assume income elasticity equal to one.

A logistic regression was estimated by utilizing the data set from Siikämaki et al. (ND). Average values from the Norwegian data set were inserted into the function. Resultingly, mean WTP using function transfer was estimated to be NOK 5558 as an annual payment among Norwegian households. As discussed in Section 3.3.2, the preservation plan defined in the dichotomous choice question was relatively similar to Plan B defined in this study. However, a transfer error of above 600 percent for Plan B indicates that the function used is not reliable to determine mean WTP for Plan B among Norwegian households. Overall, mean WTP values transferred internationally using the BT techniques unit values with income adjustment and function transfer, are not directly comparable to mean WTP estimates of the Norwegian sample. However, why transferred values are higher is difficult to know, but it might be due to inclusion of carbon storage values in the transferred estimates, as hypothesis 4.1 indicated, and different population preferences.

RQ.5

Of the 242 respondents who stated positive WTP, 21 respondents were identified as valuing carbon storage values. This is only 10 percent of the positive WTP respondents. Thus, WTP values mostly consist of non-use values and undefined values categorized as 'don't know' and 'prefer Plan A'. One could state that carbon storage values are not an important reason why respondents have positive WTP to preserve the Amazon rainforest. However, in model 4 for only positive WTP respondents, depicted in Table 4.8, the variable 'co2' is positively correlated with WTP and is highly significant for both Plan A and Plan B. The model predicts, holding all other variables constant, that carbon respondents have, on average, 84 percent higher WTP for Plan A compared to other positive WTP respondents. This indicates that carbon storage is an important reason why respondents have high WTP values to preserve the Amazon rainforest. Further, the means of WTP among respondents categorized as 'carbon' were found to be NOK 2141 for Plan A and NOK 1297 for Plan B, using midpoint WTP estimates. Comparably, the means of WTP among the other positive WTP respondents are NOK 885 and NOK 657 for Plan A and Plan B, respectively. This is substantially lower. Therefore, t-tests were performed to assess the mean difference between 'carbon' respondents and the rest of positive WTP respondents. In both tests we could reject the null hypothesis. This implies that carbon respondents have significantly higher means of WTP for Plan A and Plan B compared to non-carbon respondents. Test results are presented in Table III.2 in Appendix III.

RQ.6 and RQ.7

Of the 44 respondents who stated zero as WTP, 14 of these justified their choice because 'Norway has already paid Brazil a lot of money to stop deforestation of the Amazon rainforest'. Of the provided reasons for zero WTP, which are depicted in Table 4.3, this is the most dominant reason and stands for almost 32 percent for Plan A. Further, providing respondents with such an alternative can lead them to chose the alternative. It might remind them that Norway has funded Brazil to reduce deforestation of the Amazon rainforest. It is therefore difficult to answer research question 6 sufficiently.

Regarding research question 7, t-tests were also here performed to assess the representativeness of the initial Norwegian payments to Brazil through the Amazon Fund, which equals approximately NOK 500 per household annually over 10 years. The null hypotheses of equality between the means of WTP and the value 500 were rejected in both t-tests for Plan A and for Plan B. Thus, we have evidence that the sample and potentially Norwegian households, on average, are willing to pay more annually compared to what the Amazon Fund Implies, if we assume the objectives are the same for the Amazon Fund and the preservation plans.

RQ.8

Table 1.1 in Chapter 1 presents the main hypotheses of the study. Mainly, results from the interval regression models for Plan A and Plan B in Table 4.7 will be used to discuss the hypotheses related to RQ.8. The models include zero and positive WTP respondents.

H8.1 Income Hypothesis 8.1 states that higher household income affects WTP positively. Unfortunately, several respondents were reluctant to reveal their income. Thus, econometric models where household income is included as an independent variable have relatively few observations. We used the logarithm of household income so that we could assess the income elasticity of WTP. The models predict a positive relationship between WTP and household income. The relationships are significant at the 15 and the 5 percent level for Plan A and Plan B, respectively, in the main model using interval regression. Here, the income elasticities of WTP are 0.343 for Plan A and 0.527 for Plan B. Thus, results indicate that if household income increases by one percent, WTP, on average, increases more for Plan B compared to Plan A, holding all other variables constant. This is seemingly inconsistent. However, one explanation might be that respondents find Plan B to be more realistic. In model 4, the main models with only positive WTP respondents, the income elasticity of WTP is higher and significant for Plan A compared to Plan B. Table IV.1 in Appendix IV depicts the income elasticities of WTP for Plan A and Plan B in an interval regression excluding additional independent variables. Here, the income elasticities of WTP are 0.294 for Plan A and 0.377 for Plan B, including true zero WTP respondents. The income elasticities of WTP are significant at the 15 percent level for Plan B and at the 22 percent level for Plan A. Thus, if household income increases by one percent, WTP for Plan A, on average, increases by 0.294 percent and WTP for Plan B, on average, increases by 0.377 percent. We fail to reject the H8.1.

H8.2 Gender The models find a negative relationship between WTP and males. In the main models, model 5 which includes both zero and positive WTP respondents, the male dummy is significant at the 10 percent level with a coefficient of around -0.5 for Plan A. Thus, other things being equal, males seem to have, on average, 50 percent lower WTP for Plan A compared to females. In the main models with only positive WTP respondents, model 4, the male dummy is also significant at the 5 percent level, for Plan A, with a coefficient around -0.3. The relationship is not significant in the main models for Plan B. Thus, it seems that, at least for Plan A, hypothesis 8.2 has been proven wrong.

H8.3 Age Hypothesis 8.3 states that age affects WTP positively. Age, in general, seems to have a limited effect on WTP. Model 4, the main model for only positive WTP respondents, predicts positive and significant relationships between WTP for Plan A and B and the logarithm of age. For Plan A, if age increases by one percent, WTP, on average, increases by 0.302 percent, while for Plan B WTP, on average, increases by 0.39 percent, holding all other variables constant. In model 2 and 3 for positive WTP respondents, presented in Table IV.6 in Appendix IV, a quadratic and significant relationship between age and WTP for Plan A was found. In the logit models, we found that age significantly affects the log odds of stating positive WTP negatively. The margins command in Stata was utilized, and found that the average probability of stating positive WTP for Plan A is 10 percentage point lower at age 80 compared to at age 40. Thus, we might have more zero WTP values compared to the Norwegian population. This is because the sample is overrepresented by respondents who, on average, are more likely to state zero as WTP. Overall, we fail to reject hypothesis 8.3. The age seemingly affects WTP positively.

H8.4 Education We were not able to establish a significant relationship between high education and WTP in models which includes zero and positive WTP respondents. A problem was that the household income and the high education variables were correlated, resulting in minor multicollinearity issues. Therefore, education was not prioritized as an independent variable. However, a significant and positive relationship between WTP for Plan B and high education was found in the main models with only positive WTP respondents. Here, all things being equal, respondents with high education have, on average, about 30 percent higher WTP for Plan B compared to others. High education seems not to significantly affect the decision of stating a positive versus zero WTP value in the logit models. However, we fail to reject hypothesis 8.4 as some models, presented in Table IV.4 and IV.6, in Appendix IV, establish a positive significant relationship between WTP and high education.

H8.5 Public Spending in South America We found a positive and significant relationship between WTP, for Plan A and Plan B, and respondents who believe we must spend some or much more money on forest and biodiversity conservation in South America. This holds in each model which includes the dummy variable for hypothesis 8.5. From the main models for Plan A, we find that respondents who believe we must spend more money on forest and biodiversity conservation have, on average, 95 percent higher WTP compared to respondents who chose a different response alternative, holding all other variables constant. Thus, we fail to reject hypothesis 8.5.

H8.6 Might Visit or Have Visited the Amazon Rainforest In the main models we found a positive and insignificant relationship between WTP for Plan A and B and respondents who have visited the Amazon rainforest. A positive relationship between WTP for Plan A and respondents who believe they will visit the Amazon in the future was established, also insignificant. However, in models for Plan B, presented in Table IV.4 in Appendix IV, a statistical and significant relationship was established between WTP and respondents who might consider to visit the Amazon in the future. This indicates that respondents who hold option values of the Amazon are associated with higher WTP for Plan B. Considering only positive WTP respondents, we found a statistically significant positive relationship between WTP for Plan A and respondents who have visited the Amazon rainforest. Here, visitors have, on average, 80 percent higher WTP for Plan A compared to non-visitors, other things being equal. This indicates that positive WTP respondents who hold use-values of the Amazon, in terms of recreation and eco-tourism, are associated with higher WTP for Plan A. Thus, we fail to reject the hypothesis 8.6.

H8.7 Unrealistic Preservation Plans In the main models which include zero and positive WTP respondents, we find a strong significant negative relationship between respondents who find none of the preservation plans realistic and WTP for Plan B, compared to respondents who chose a different response alternative. Consistently, we found a positive and significant relationship in the main models for Plan A between WTP and respondents who find both preservation plans realistic, compared to respondents who chose a different response alternative. Furthermore, we found that the probabilities of stating positive WTP for Plan A or Plan B decrease if respondents find none of the respective preservation plans realistic. The dummy variable for if respondents find the preservation plans unrealistic was not included in the main models for only positive WTP respondents as it had limited effect on WTP. However, we fail to reject hypothesis 8.7.

H8.8 Environmental Conservation Respondents were asked if they believe EC is important. Respondents who chose the alternative that EC is somehow or very important were expected to affect WTP positively, compared to respondents who chose a different alternative. In each model with WTP as dependent variable, the dummy variable for hypothesis 8.8 is positive and significant. Additionally, the log odds of stating positive WTP for Plan A or Plan B are positively and significantly affected by the dummy variable for hypothesis 8.8. Other things being equal, respondents who find EC to be somehow or very important have, on average, 83 percent higher WTP for Plan A and 89 percent higher WTP Plan B, compared respondents who chose a different alternative, according to the main models presented in Table 4.7. Thus, we fail to reject hypothesis 8.8.

H8.8 Member of an Environmental Organization Respondents were asked if they are members of an environmental organization. A dummy variable was created taking value one if respondents are members of an environmental organization and zero otherwise. From the main models presented in Table 4.7, the dummy variable for members of environmental organisations is positive but not significant for Plan A and Plan B. Model 3, presented in Table IV.4 in Appendix IV, finds a positive and significant relationship between members of environmental organizations and WTP for Plan A. Among only positive WTP respondents, we also find a significant and positive relationship between WTP, for both plans, and members of environmental organizations. Thus, all things being equal, members of environmental organizations with positive WTP seem to have, on average, 61 and 53 percent higher WTP for Plan A and Plan B, respectively, compared to non-member with positive WTP. We fail to reject H8.8.

5.2 Validity

Validity of the estimates will now be discussed in terms of content validity and construct validity. As stated previously, criterion validity is not relevant for this study as we are mainly determining non-use values

5.2.1 Construct Validity

Convergent validity: To asses the convergent validity, we transferred estimates from two studies which utilized different valuation methods, and tested for equivalence and difference. From Siikämaki et al. (ND), we transferred unit values from a choice experiment and a function from a dichotomous choice question. T-tests were conducted and test results indicate statistically significant difference between transferred and estimated mean WTP values. Transfer errors were also determined to be higher compared to average errors of international BT studies. The transfer errors of the function transfer were found to be higher compared to the transfer errors of unit transfer with income adjustment. In general, function transfer is considered a more reliable BT technique (Ready and Navrud, 2006). Conclusively, one could question the convergent validity of the estimated mean WTP values. However, different population characteristics can potentially explain the outcome of the tests, as well as different scopes of preservation plans in the North American study and this study. As stressed by Kristófferson and Navrud (2007, p:207), there are no reasons to believe that WTP estimates are equal between two different populations. In these circumstances, we should be careful to draw the conclusion that we have weak convergent validity.

We also transferred values from the Delphi CV studies by Navrud and Strand (2016) and Strand et al. (2017). The transferred values could be used to evaluate the convergent validity of the estimates. However, as transferred mean WTP values only rely on the opinion of three Norwegian environmental valuation experts, it is more relevant to test and evaluate the convergent validity of the Delphi studies. The equivalence tests indicate lack of equivalence between transferred and derived WTP estimates. On the other hand, low transfer errors and failing to reject the null hypothesis of equality in paired t-tests indicate either acceptable convergent validity of derived estimates or transferred estimates from the Delphi studies. Still, it is important to stress that test results are most likely invalid, as the performed tests breach with assumptions of normality and variance equality. Further, we must emphasize that the experts surveyed in the Delphi CV studies were asked to only value non-use values and potential recreational values. In the analysis we have confirmed that several of the respondents valued carbon storage values which, on average, are valued higher than non-use values. If we exclude carbon storage respondents, then we obtain a larger transfer error for Plan A and a smaller transfer error for Plan B at 24 and 0.5 percent, respectively, using midpoint estimates.

Additionally, scope tests, both parametric and non-parametric, of difference between the means and the medians for Plan A and Plan B were performed, where protest zeroes and don't know answers were excluded. Economic theory suggests one should be able to reject the null hypothesis of the scope test, as Plan B entails more species and forest loss compared to Plan A. Thus, respondents should value Plan A greater (Veisten et al., 2004). The null hypothesis of each scope test, for baseline values and for cases defined in the sensitivity analysis, was rejected, see Appendix III. This potentially strengthens the reliability of the WTP estimates. However, a scope test and a test of mean difference of WTP for Plan A between two independent samples would strengthen the reliability additionally. This is referred to as a test-retest (Boyle, 2017, p:118) and it entails additional costs. However, as stressed by Boyle (2017, p:120), a scope test, in general, is a weak test for validity. A scope test says little about the external validity. Furthermore, for the most realistic cases in the sensitivity analysis, we failed to reject the null hypothesis of one-sided t-tests to evaluate whether the baseline midpoint mean WTP for Plan A is different from a specified mean value derived by performing sensitivity adjustments. This indicates high reliability of the baseline midpoint WTP estimate with the risk of committing a Type II error.

Theoretical Validity: As slightly discussed in Chapter 4, expected signs of coefficients of interest seem to correspond well with theory and common sense. We have seen that income correlates positively with WTP. The income elasticity of WTP is rather small and in some models not significant. A quadratic relationship between WTP and age was established in several models. We failed to establish a significant relationship between high education and WTP in the main models. However, a significant and positive relationship between WTP for Plan B and high education was determined among positive WTP respondents. The sign of the dummy variable for high education is positive which corresponds well to our expectations. Furthermore, we expected that respondents who value EC highly are associated with higher WTP values, and members of environmental organizations have higher WTP compared to non-members. These expectations can be supported by deductive reasoning, and results correspond well to our expectations. Overall, this strengthens the theoretical validity of the study.

5.2.2 Content Validity

Performing a pilot study is important to assess the content validity of the study (Johnston et al., 2017). Errors and corrections based on results from the pilot survey were discussed in Section 4.2. The pilot study indicated the presence of scenario misspecification, a bias where several respondents valued Plan B greater or equal to Plan A. Adjustments in the survey were made to correct for the scenario misspecification bias. However, it still seems to be a concern in the final study. Of the 242 respondents, excluding protest zeroes and don't know answers, only 108 responded consistently when asked about their WTP for the preservation plans. A potential reason is that, according to the descriptive statistics of the data, respondents find Plan B to be more realistic than Plan A. In total, 37 percent finds Plan B to be most realistic, while only 15 percent for Plan A. Therefore, it is reasonable to assume that some respondents weight Plan B greater or equally. This weakens the content validity of the study.

The protest rate of the sample is below 8 percent for Plan A. Potentially, respondents might protest due to the payment vehicle used, as they disagree that a binding national tax should be imposed on the population (Freeman et al., 2014, p:410). Additionally, since Norway already has financed Brazil and other countries to reduce deforestation of tropical rainforests, respondents potentially protested as they might feel Norway has already paid enough. We found that the most dominant reason for protesting was indeed that Norway has already paid. However, as discussed previously, providing respondents with such an alternative might lead them to choose the respective alternative. Further, respondents might disagree with the assumed property rights and, therefore, allege that they have the right to the current quality of the Amazon rainforest. Correspondingly, a WTA compensation question could have been framed instead (Mitchell and Carson, 1989, p:253).

The response format utilized in the survey weakens the content validity of the study. The state of the art approach recommends to use an incentive compatible response format (Johnston et al., 2017). A payment card is not incentive compatible, as respondents might behave strategically. Our results potentially indicate strategic behaviour. Respondents who believe results obtained from the study will be used in policy-making decisions significantly affect WTP positively. It can imply strategic behaviour. WTP values among the respective respondents might be overvalued, as they might want to influence potential policy decisions and the provision of the good (Mitchell and Carson, 1989, p:145). An additional indication of strategic behaviour is that respondents who believe they must pay to reduce deforestation is significantly associated with low WTP values. Here, respondents tend to underbid, which can be associated with free riding to secure reduced financial constraints (Mitchell and Carson, 1989, p:145). Another significant relationship which could indicate a different type of bias, namely hypothetical bias, is that respondents who find none of the preservation plans as realistic affect WTP negatively. Thus, they might state low or zero WTP values as they find the hypothetical scenarios unrealistic. According to Mitchell and Carson (1989, p:233), it will not yield biased results, however, it potentially results in a reliability problem. Indications of strategic and hypothetical bias weaken the validity of the survey. However, due to a low sample size, a single dichotomous-choice question provides limited information. Thus, a payment card serves as the best alternative for the study (Boyle, 2017, p:107).

5.2.3 Reliability

The reliability of the WTP estimates depends on the sample size. The standard error of the mean (SME) depends on the sample size and SME decreases as the sample size increases (Mitchell and Carson, 1989, p:224). The low sample size of the study potentially weakens the reliability and the external validity of the study. A test-retest of reliability should be performed to evaluate variance reliability (Boyle, 2017, p:118).

5.3 Conclusion

The thesis has confirmed that distant beneficiaries are indeed willing to pay to prevent further forest and species loss in the Amazon rainforest. Through a panel-based internet CV survey, 300 Norwegian respondents were asked to state their respective household's WTP for two different preservation plans, Plan A and Plan B, on a payment card. Results indicate that Norwegian households are, on average, willing to pay between NOK 950 to NOK 1100 as a an annual tax to ensure no further forest and species loss in the Amazon rainforest. This implies an annual binding transfer to Amazonian countries of above 2.2 billion Norwegian kroner. For the less extensive preservation plan, Plan B, Norwegian households seem to have an average WTP between NOK 677 to NOK 800. Interestingly, the thesis confirms that Norwegian households' WTP to preserve the Amazon relate mostly to non-use values. Carbon storage values seem to be of importance and are, on average, higher compared to non-use values. Thus, results indicate that non-use values are an important part of the Total Economic Value of preserving the Amazon rainforest. A policy recommendation is to include non-use values if a global benefit-cost analysis were to be conducted of an extensive preservation plan to preserve the Amazon rainforest. However, it is practically difficult to distinguish between values which respondents might hold.

Norway, through the Amazon Fund, has already funded Brazil to reduce deforestation of the Amazon rainforest. The thesis confirms that average annual Norwegian transfers to Brazil through the Amazon Fund, which equals around 750 millions Norwegian kroner over ten years, are substantially lower compared to 2.2 billion Norwegian kroner. The Amazon Fund is mostly a policy measure to reduce carbon emissions by reducing deforestation and forest degradation. On the other hand, the thesis primarily estimates non-values associated with avoiding loss of forest and species. However, the thesis confirms that the sample are, on average, willing to pay more as an annual tax to preserve the Amazon rainforest compared to what the Amazon Fund implies. This shows that non-use values might be equally important to consider as carbon benefits of preserving the Amazon rainforest.

Taking into account that most protest respondents did not want to pay as Norway has already paid, it is reasonable to believe that the mean WTP estimates are underestimated. On the other hand, high education and older age categories were overrepresented in the sample, compared to the population. A linear OLS regression model finds that the means of WTP for Plan A and B are overestimated using sample means of age and education compared to population means. However, education and age were found not to significantly affect WTP in the main models. This indicates that the estimates can still be underestimated. A sensitivity analysis confirms a relative robust midpoint mean WTP for Plan A where results indicate that the baseline mean is underestimated. However, if one were to generalize derived WTP estimates among Norwegian households, a similar CV survey must be imposed on a larger representative sample which confirms representativeness of the estimates.

The thesis has evaluated the reliability of utilizing BT techniques to determine the means of WTP among Norwegian households for preservation Plan A and B. Three techniques were utilized, namely unit transfer with income adjustment, function transfer and transferred mean WTP estimates from a Delphi CV survey. Results indicate that unit transfer with income adjustment is not a reliable BT technique to determine the means of WTP among Norwegian households for preservation Plan A and B. This was confirmed by large transfer errors and t-tests. Furthermore, results also indicate that utilizing function transfer is not a reliable BT technique to determine the means of WTP for preservation Plan A or B among Norwegian households. The function transferred was perhaps not reliable. However, in general, different characteristics and preferences among North American households and Norwegian households and additional carbon storage values of transferred estimates might explain why the BT techniques were not reliable.

Three Norwegian valuation experts provided guestimates of the means of WTP among Norwegian households for Plan A and Plan B in a Delphi study. The thesis finds, through performing t-tests and assessing transfer errors, that WTP estimates derived from a Delphi CV survey are directly comparable to mean WTP estimates derived from a population CV survey, where the population of interest is Norwegian households. Thus, the Delphi method is a reliable BT technique for this study. The thesis also finds a weakness of utilizing equivalence tests to test for equivalence between mean WTP values of a Delphi CV study and a population CV study. It is difficult to reject the null hypothesis in an equivalence test when the sample size is small and variances are large, which often is the case in Delphi studies. Assumptions are not met with regard to normality and variance equality.

5.3.1 Policy Recommendation

Few studies have compared estimates from a Delphi CV survey and CV population survey, and evaluated the reliability of the Delphi method as a BT technique. Thus, the thesis provides new insights to this field of research. This can potentially be of importance for later research. Conclusively, for policy recommendation and for future research, Delphi CV surveys might be of important value when population CV surveys are either difficult, time consuming and/or costly to implement. A Delphi CV survey is an alternative which entails fast and inexpensive results as long as there exist experts within a field of interest. Furthermore, as suggested by Navrud and Strand (2016) and Strand et al. (2017), performing Delphi CV surveys provide useful policy information of global benefits from cultural services of global public goods, especially non-use values. A substantial amount of CV population surveys must be implemented to obtain relatively similar information. Additionally, the latter alternative entails considerably higher costs and time expenditures.

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Appendices

Appendix I

The Survey

Please login to see additional testing features

Hva er din alder?

Er du mann eller kvinne?

Mann	○
Kvinne	○

Hva er ditt postnummer?

Please login to see additional testing features

Synes du samfunnet skal bruke mye mindre, litt mindre, like mye, litt mer eller mye mer penger på følgende områder?

	Mye mindre penger	Litt mindre penger	Like mye penger	Litt mer penger	Mye mer penger	Vet ikke
Vern av skog og artsmangfold i Norge	○	○	○	○	○	○
Skole og utdanning	○	○	○	○	○	○
Flomvern og tiltak mot jord- og snøskred	○	○	○	○	○	○
Helse og eldreomsorg	○	○	○	○	○	○
Vern av regnskog og artsmangfold i Sør-Amerika	○	○	○	○	○	○

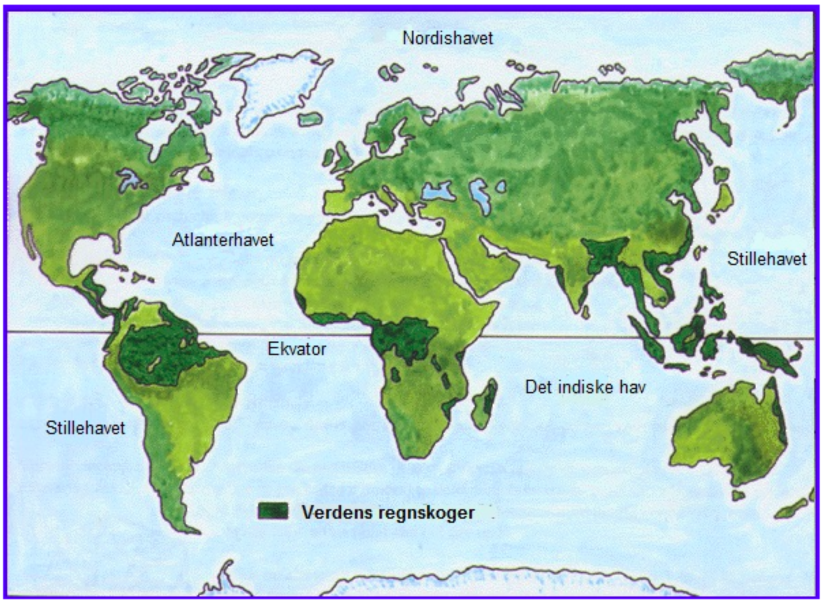
Har du noen gang besøkt en regnskog?

- Ja
- Nei
- Vet ikke

Hvike(n) regnskog(er) har du besøkt)?

Tropiske regnskoger er økosystemer man finner nær ekvator. Disse skogene har høy temperatur, høy luftfuktighet og mye nedbør. Dette kartet viser hvor man finner verdens regnskoger.

Regnskoger dekker bare en liten del av jordens overflate; omtrent 6 %. Likevel finner vi over halvparten av verdens plante- og dyrearter her. Amazonas-regnskogen er verdens største regnskog, og utgjør 40% av verdens regnskogsområder. Amazonas-regnskogen er det økosystemet på jorden med flest arter. Omtrent 20 % av alle verdens plantearter og minst 10 % av alle verdens pattedyrarter finnes her.



Har du noen gang besøkt Amazonas-regnskogen i Brasil, Peru, Coumbia, Equador eller Bolvia?

- Ja
- Nei
- Vet ikke

Hvor sikkert eller usikkert er det at du vil besøke Amazonas-regnskogen i fremtiden?

- Helt sikkert
- Ganske sikkert
- Ganske sikkert ikke
- Helt sikkert ikke
- Vet ikke

Amazonas-regnskogen ligger i Sør-Amerika. Mesteparten av regnskogen ligger i Brasil, men deler av den finnes også i åtte andre land blant annet Peru, Colombia, Equador og Bolivia. For at du skal få et inntrykk av størrelsen av Amazonas-regnskogen har vi lagt inn størrelsen av Norge og noen andre land i Europa.

Amazona-regskogen dekker et areal på 5,5 millioner kvadratkilometer. Det er 15 ganger så stort som Norges areal.

Før du så dette kartet, tenkte du at Amazonas-regnskogen var mindre, større eller som vist i figuren?

Mindre

Større

Som vist i figuren

Vet ikke

Tror du regnskogsområdet i Amazonas nå øker, avtar eller holder seg omtrent konstant?

Øker

Avtar

Holder seg konstant

Vet ikke

Dette flyfotoet viser en liten del av Amazonas-regskogen.

En rapport fra Verdensbanken viser at dersom dagens utvikling fortsetter vil en betydelig del av Amazonas-regnskogen forsvinne. Det er flere menneskeskapte årsaker til dette. En viktig årsak er avskogning fra kvegfarmer og beiting, og en annen er tømmerhogst. Områdene der skogen forsvinner vil bli omdannet til mindre tett skog og gresskledde sletter. En betydelig del av trærne vil tørke ut og dø. Økosystemet vil endre seg, og flere arter vil forsvinne. Mange av disse artene finnes bare i Amazonas.

Hvis ingenting gjøres for å redusere avskogingen i Amazonas anslår forskerne at **24 % av pattedyrartene kan være utryddet** i år 2050. Det betyr at 105 av de 442 artene vi vet finnes der nå vil forsvinne. Av de 105 som forsvinner, finnes 83 **bare** i Amazonas.

Figuren viser 26 av de pattedyrartene som har høy risiko for å forsvinne om ikke verneplaner settes iverk.

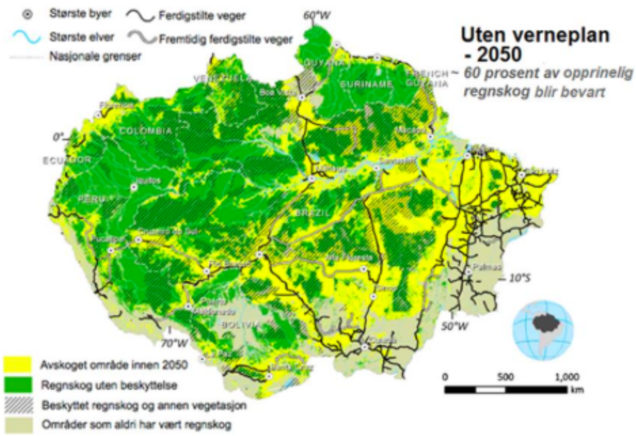
Forskning viser at omtrent **den samme andelen (24 %) av andre arter** som fugl, amfibier, insekter og planter også vil ha høy risiko for å **utryddes**.

Forskning viser at omtrent **den samme andelen (24 %) av andre arter** som fugl, amfibier, insekter og planter også vil ha høy risiko for å **utryddes**.

Kjente du til at at arter vil forsvinne fra Amazonas-regnskogen om avskogningen fortsetter?

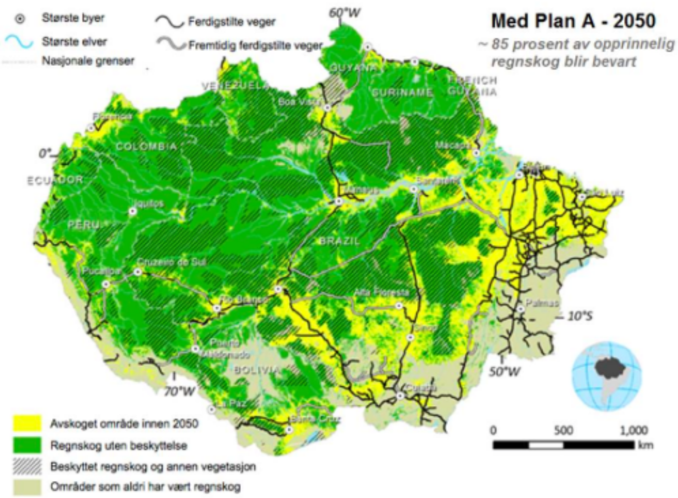
- Ja, men trodde færre arter vil forsvinne
- Ja, men trodde flere arter vil forsvinne
- Nei, visste ikke at arter ville forsvinne
- Nei, trodde avskogningen hadde stoppet opp
- Vet ikke

Om ikke en ny verneplan for Amazonas settes iverk, vil det være igjen bare 60% av den opprinnelige Amazonas-regnskogen i år 2050. Sammenlignet med 1970-årene er det i dag igjen 85 % av den opprinnelige regnskogen. Vi vil altså tape ytterligere 25 % av regnskogsarealet om vi ikke får en ny verneplan. I dette kartet viser de **gule områdene hvor regnskogen vil forsvinne** i år 2050 **uten** en verneplan.

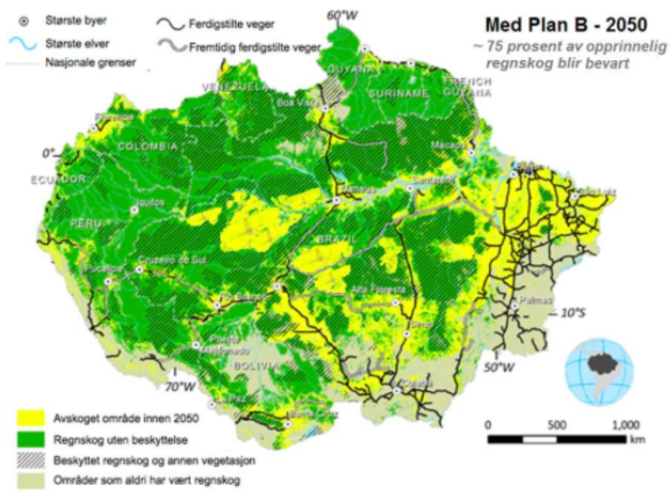


Brasilianske myndigheter, i samarbeid med eksperter fra internasjonale organisasjoner, har laget to ulike verneplaner for Amazonas-regnskogen. Begge verneplanene vil bli kostbare siden bøndene og andre grunneiere må kompenseres for inntekstapet de har ved at deres skogområder vernes. Dette kan ikke gjennomføres av brasilianske myndigheter uten ytterligere økonomisk støtte. Dersom pengene fra brasilianske myndigheter og internasjonale bidrag overstiger kostnadene av vern, vil verneplanene bli satt i verk og en nasjonal skatt bli samlet inn fra husholdninger i alle land.

Med **Plan A** blir det **ingen** ytterligere avskoging. Dagens regnskogområde i Amazonas vil altså være det samme i år 2050 som i dag, Dette er den mest ambisiøse verneplanen.



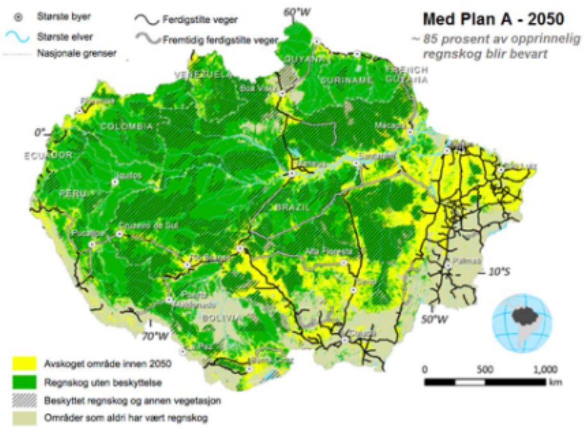
Med **Plan B** vil noe av regnskogen forsvinne, men mindre enn om ingen plan hadde blitt iverksatt. 75 % av regnskogen (mot 85 % i plan A) vil bli bevart og 93 % av artene (mot 100 % i plan A).

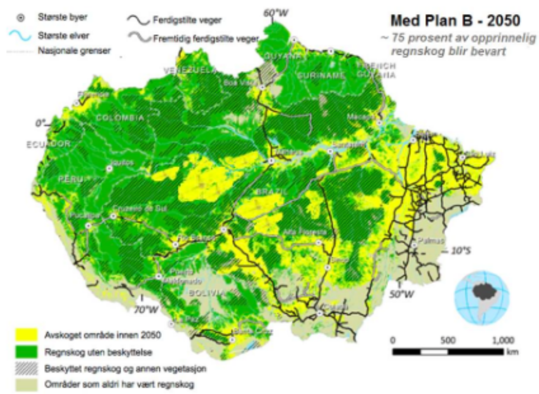


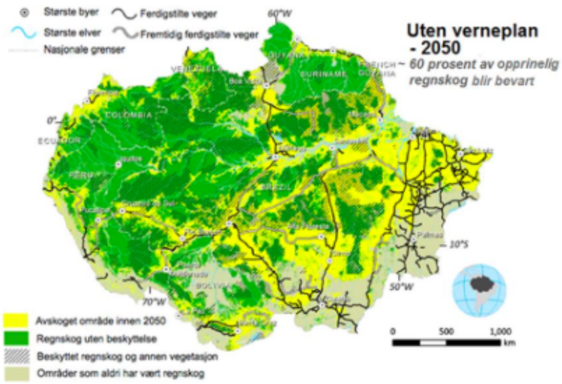
Vi vil nå spørre deg om hva det er verdt for deg og din husholdning å få de to verneplanene A og B. Tabellen nedenfor viser hvor stort tapet av regnskogareal og arter vil være i år 2050 med Verneplan A og B og uten verneplan.

Tap i forhold til i dag	**VERNEPLAN A**	**VERNEPLAN B**	**UTEN VERNEPLAN**
Regnskogsareal	Intet tap	15 % tap	25% tap
Pattedyrarter og andre arter	Intet tap	7 % tap	24% tap

Gul farge på kartene over Amazonas-regnskogen viser områdene som vil være avskoget.







Tenk på hva det er verdt for deg og din husholdning å få den mest omfattende Plan A og den mindre omfattende Plan B, sammenlignet med situasjonen i år 2050 uten verneplan.

Merk at tilgangen til regnskogen vil være den samme som i dag med verneplan A og B, både for nasjonal og internasjonal turisme, og for lokalbefolkningen som bor i regnskogen.

For noen i Norge vil det være verdt mye å unngå avskoging og tap av arter i Amazonas, mens for andre vil det være viktigere å bevare andre områder eller bruke penger på andre ting. Det er derfor ingen riktige eller feil svar her. Vi vil at du tenker nøye gjennom hva det er verdt for deg og din husholdning å få gjennomført hver av disse to verneplanene.

Tap i forhold til i dag	**VERNEPLAN A**	**VERNEPLAN B**	**UTEN VERNEPLAN**
Regnskogsareal	Intet tap	15 % tap	25% tap
Pattedyrarter og andre arter	Intet tap	7 % tap	24% tap

Hva er det meste, om noe, din husholdning helt sikkert er villig til å betale i en årlig skatt til staten, som vil være øremerket til bruk for Verneplan A?

Vis i figuren nedenfor ved å flytte markøren til ønsket beløp.

Kr per husholdning per år

0	50	100	150	200	300	400	500	600	700	900	1100	1300	1500	2000	4000	6000	8000	12000	Mer enn 12000	Vet ikke
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Hva er det meste, om noe, din husholdning helt sikkert er villig til å betale i en årlig skatt til staten, som vil være øremerket til bruk for den mindre omfattende Verneplan B?

Vis i figuren nedenfor ved å flytte markøren til ønsket beløp.

Kr per husholdning per år

0	50	100	150	200	300	400	500	600	700	900	1100	1300	1500	2000	4000	6000	8000	12000	Mer enn 12000	Vet ikke
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Hva er den viktigste årsaken til at du ikke vil betale noe for Verneplan A?

- Har ikke råd til å betale noe
- Synes det er viktigere ting å betale for enn bevaring av artsmangfoldet og regnskogen i Amazonas
- Synes myndighetene i Norge skal betale
- Synes myndighetene i Brasil og andre land skal betale
- Norge har allerede betalt Brasil mye penger for å stoppe avskogingen i Amazonas
- Andre årsaker; oppgi hva.

Hva er den viktigst årsaken til at du ikke betale noe for Verneplan B?

- Har ikke råd til å betale noe
- Synes det er viktigere ting å betale for enn bevaring av artsmangfoldet og regnskogen i Amazonas
- Synes myndighetene i Norge skal betale
- Synes myndighetene i Brasil og andre land skal betale
- Norge har allerede betalt Brasil og andre land mye penger for å stoppe avskogning i Amazonas
- Synes ikke Verneplan B er omfattende nok
- Andre årsaker; oppgi hva:

Hva er den viktigst årsaken til at du er villig til å betale noe for Verneplan A og/eller B?

Hvor sikkert eller usikkert tror du det er at resultatene fra denne undersøkelsen vil bidra til beslutningen om verneplaner for å redusere avskogingen i Amazonas?

- Vil helt sikkert bidra
- Vil ganske sikkert bidra
- Vil ganske sikkert ikke bidra
- Vil helt sikkert ikke bidra
- Vet ikke

Hvor sikkert eller usikkert tror du det er at husholdningen din må betale en årlig øremerket skatt for å redusere avskogningen i Amazonas?

- Helt sikkert
- Ganske sikkert
- Ganske sikkert ikke
- Helt sikkert ikke
- Vet ikke

Hvor sikkert eller usikkert tror du det er at verneplanene vil redusere avskogningen i Amazonas som vist på kartene?

- Helt sikkert
- Ganske sikkert
- Ganske sikkert ikke
- Helt sikkert ikke
- Vet ikke

Hvor opptatt er du av miljøvern?

- Svært opptatt av miljøvern
- Meget opptatt av miljøvern
- Ganske opptatt av miljøvern
- Lite opptatt av miljøvern
- Ikke opptatt av miljøvern

Er du medlem av en miljøorganisasjon og/eller friluftslivsforening. Kryss av alt som er relevant.

- Norges Naturvernforbund ☐
- Greenpeace Norge ☐
- Natur og Ungdom ☐
- Norges Jeger og Fiskerforening ☐
- Den Norsk Turistforening (DNT) ☐
- Verdens Naturfond (WWF) ☐
- Regnskogsfondet ☐
- Skiforeningen ☐
- Andre miljø- og friluftslivsorganisasjoner; spesifiser: ________ ☐

- Vet ikke ○
- Ikke medlem i slike organisasjoner ○

Hvor mange personer er det i din husholdning, medregnet deg selv?
(Med en husholdning menes de personer som har felles kjøleskap)

________ personer

Hva er din høyeste fullførte utdanning?

- Grunnskole (7-10 år)
- Videregående skole/gymnas
- Fagbrev
- 3-4-årig universitetsutdanning (bachelor/cand.mag.)
- 5-årig universitetsutdanning (mastergrad/profesjonsutdanning)
- PhD/doktorgrad
- Usikker/vet ikke

Hvilken verneplan tror du det er mest realistisk at vil bli gjennomført?

- A
- B
- A og B er like realistiske
- Verken A eller B er realistisk
- Vet ikke

Omtrent hvor stor er din personlige årlige bruttoinntekt (dvs. før skatten er trukket)?

- 0-200.000 NOK
- 200.001-400.000 NOK
- 400.001-600.000 NOK
- 600.001-800.000 NOK
- 800.001-1000.000 NOK
- 1.000.001-1.300.000 NOK
- 1.300.001-1.500.000 NOK
- 1.500.001 NOK eller mer ; oppgi omtrent hvor mye:
- Vet ikke

Omtrent hvor stor er husstandens samlede årlige bruttoinntekt (dvs. før skatten er trukket)?

- 0-200.000 NOK
- 200.001-400.000 NOK
- 400.001-600.000 NOK
- 600.001-800.000 NOK
- 800.001-1000.000 NOK
- 1.000.001-1.300.000 NOK
- 1.300.001-1.500.000 NOK
- 1.500.001 NOK eller mer, oppgi omtrent hvor mye:

Vet ikke

Takk for at du deltok i undersøkelsen! Har du kommentarer kan du skrive dette her:

Ingen ekstra kommentarer

Appendix II

Unit Transfer of WTP

In section 1.1 we defined that North American households, on average, are willing to pay \$4.97 and \$3.19 for avoiding one percent loss in forest and species threats, respectively. Multiplying defined marginal WTP estimates with avoided percentage of forest and species loss related to Plan A and Plan B, we obtain an estimate of mean WTP for the respective preservation plans among North American households. Implicitly, for Plan A we assume that North American households, on average, are willing to pay \$200 per year. For Plan B, North American households are assuminly willing to pay \$104 per year. To derive mean WTP by using unit transfer from the North American study, we use equation (3.19). First, we assume the income elasticity of WTP (β) is equal to one. Then, we calculate mean WTP among Norwegian households assuming that the income elasticity of WTP is 0.5, which was derived in the European Delphi study (Navrud and Strand, 2016).

Respondents in the North American study were personally interviewed in 2015. Median US and Canadian household income in 2015 was \$56 516 and \$58 406, respectively, and median household income in Norway the same year was NOK 491 100 (Proctor et al., 2016; SSB, 2017d; Statistics Canada, 2017). We need to convert the average of the median US and Canadian household income, which is \$57 461, into NOK.[1] This is done by multiplying \$57 461 with the average standard exchange rate (\$/NOK) in 2015 which was 8,0739. Further, we need to convert the estimated mean WTP for Plan A, which is defined in US dollars, into NOK. We do this by multiplying \$200 with average PPP-adjusted exchange rate (Dollar/Nok) in 2015. This is illustrated in the equation below:

$$\text{WTP}_A = \text{NOK}9,733 \cdot \$200 \cdot \left(\frac{\text{NOK}491.100}{\text{NOK}8,0739 \cdot \$57.461} \right) = \underline{\text{NOK } 2061} \qquad \text{(II.1)}$$

From the equation, we can see that by using unit transfer with income adjustment from the North American study, estimated mean WTP among Norwegian households is NOK 2061. However, we need to correct for inflation by using CPI for December 2017. Correspondingly, the transferred mean WTP among Norwegian households is NOK 2187. By using income elasticity of WTP equal 0.5, transferred mean WTP among Norwegian households is NOK 2125. Following the same procedure for Plan B, where estimated mean WTP for Plan B among North American households based on marginal WTP estimates defined in section 1.1, estimated means of WTP among Norwegian households are NOK 1137 using income elasticity of WTP equal to 1 and NOK 1105 using income elasticity of WTP equal to 0.5.

[1] The median household income in Canada in 2015 was CAD 80 940. I converted this to US dollar by multiplying with the average exchange rate, CAD/USD, in 2015 which was 0.7216 USD.

Appendix III

Tests

III.1 Equivalence test

First, we need to estimate the pooled standard deviation for estimated mean WTP in this study and transferred values for both preservation plans. The formula is given by the following formula (Kristóferson and Navrud, 2007, p:215):

$$s_p = \sqrt{\frac{(\mathrm{n}_1 - 1)\, s_1^2 + (\mathrm{n}_2 - 1)\, s_2^2}{\mathrm{n}_1 + \mathrm{n}_2 - 2}}$$

A concern for the statistical analysis is that the sample from the Delphi studies is only three. We will get a high standard deviation, which makes it difficult to reject the null hypothesis of difference between the estimates (Kristófersson and Navrud, 2005). However, we conduct two equivalence tests for each plan, where one test allows a transfer error of 20 percent while the other allows a transfer error of 40 percent. We reject the null hypotheses if the absolute value of the t-values, t_1 and t_2, are greater than the critical value.

Table III.1: Equivalence Tests

	Dof	Sign.lvl	Critical value	Pooled St.Dev	Difference	Accepted transfer error	t_1	t_2	Reject H_0
Plan A	239	0.05/2	1.65	1574	-221	189 (20%)	-0.45	0.45	☒
Plan B	240	0.05/2	1.65	1152	23	135 (20%)	-0.17	0.17	☒
Plan A	239	0.05/2	1.65	1574	-221	378 (40%)	-0.66	0.66	☒
Plan B	240	0.05/2	1.65	1152	23	271 (40%)	-0.37	0.37	☒

As illustrated in the table, we fail to reject the null hypothesis of each equivalence test, even though the difference between mean WTP values is only 23 at the lowest. Therefore, a further investigation of why was performed. By assuming that the pooled standard errors remained the same, changes in the size of both sample sizes were performed. Increasing the size of the sample size of the data for this thesis had no effect on the t-values, however, increasing the size of the Delphi sample yielded higher t-values. Assuming, for Plan A, a pooled standard error of 1575 and 20 percent accepted transfer error, a sample 50 for the Delphi sample allowed us to reject the null hypothesis of difference, while holding the other sample size equal to initial value. Thus, a low sample size from the Delphi study explains why we fail to reject each null hypothesis.

III.2 T-test

Table III.2: T-test Results

	H_0 vs H_1	df	sign.lvl	critical value	(Pooled) St.Dev	Difference	|t-value|	Reject H_0
Scope test (Paired T-test Dependent Sample)								
Baseline	H_0:$\mu_A - \mu_B$=0 vs H_1:$\mu_A - \mu_B > 0$	238	0.05	1.645	956	241	3.90	☑
Case 1	H_0:$\mu_A - \mu_B$=0 vs H_1:$\mu_A - \mu_B > 0$	104	0.05	1.66	1318	626	4.87	☑
Case 2	H_0:$\mu_A - \mu_B$=0 vs H_1:$\mu_A - \mu_B > 0$	237	0.05	1.66	748	202	4.17	☑
Case 3	H_0:$\mu_A - \mu_B$=0 vs H_1:$\mu_A - \mu_B > 0$	103	0.05	1.66	996	541	5.54	☑
Case 4	H_0:$\mu_A - \mu_B$=0 vs H_1:$\mu_A - \mu_B > 0$	299	0.05	1.645	889	214	4.18	☑
Test of mean Plan A before and after sensitivity adjustments (One Sample T-test)								
Case 1	H_0:$\mu_A = 1074$ vs H_1:$\mu_A \neq 1074$	241	0.05/2	1.96	1578	-129	1.27	☒
Case 2	H_0:$\mu_A = 908$ vs H_1:$\mu_A > 908$	241	0.05	1.645	1578	37	0.36	☒
Case 3	H_0:$\mu_A = 990$ vs H_1:$\mu_A \neq 990$	241	0.05	1.96	1578	-45	0.44	☒
Case 4	H_0:$\mu_A = 763$ vs H_1:$\mu_A > 763$	242	0.05	1.645	1578	182	1.79	☑
RQ.3 (Two Independent Samples T-test)								
Plan A Round 2	H_0:$\mu_A = \mu_{A2}$ vs H_1:$\mu_A \neq \mu_{A2}$	239	0.05/2	1.96	(1574)	-221	0.24	☒
Plan B Round 2	H_0:$\mu_B = \mu_{B2}$ vs H_1:$\mu_A \neq \mu_{B2}$	240	0.05/2	1.96	(1152)	23	0.03	☒
RQ.4: Unit transfer (One Sample T-test)								
Plan A ($\beta = 1$)	H_0:$\mu_A = 2187$ vs H_1:$\mu_A \neq 2187$	241	0.05/2	1.96	1578	-1242	12.22	☑
Plan B ($\beta = 1$)	H_0:$\mu_A = 1137$ vs H_1:$\mu_A \neq 1137$	242	0.05/2	1.96	1156	-460	6.20	☑
RQ.5 Non-carbon vs Carbon (Two Independent Samples T-test)								
Plan A	H_0:$\mu_A = \mu_{CA}$ vs H_1:$\mu_A \neq \mu_{CA}$	219	0.05/2	1.96	(1587)	-1256	3.52	☑
Plan B	H_0:$\mu_B = \mu_{CB}$ vs H_1:$\mu_B \neq \mu_{CB}$	212	0.05/2	1.96	(1194)	-640	2.38	☑
RQ.7 (One Sample T-test)								
Plan A	H_0:$\mu_A = 500$ vs H_1:$\mu_A \neq 500$	241	0.05/2	1.96	1578	445	4.39	☑
Plan B	H_0:$\mu_B = 500$ vs H_1:$\mu_A \neq 500$	242	0.05/2	1.96	1156	177	2.39	☑

Note: case 1 removes obs. where $\text{WTP}_{\text{Plan A}} \geq \text{WTP}_{\text{Plan B}}$, case 2 removes obs. where WTP$>$ 0.02·hhinc, case 3 removes obs. frm case 1 and 2, case 4 assumes all zero WTP are true and all don't know answ. are 0.

Note: () around the St. Dev implies the deviation is pooled between two samples.

III.3 Non-parametric Scope Test - Sign Test

The scope tests of mean difference between two dependent samples assumes normality. The mean WTP estimates are right-skewed, and therefore a non-parametric test of mean difference between two dependent samples, known as a sign test, is appropriate to utilize. The null hypothesis of difference in median between Plan A and Plan B was rejected for each sensitivity case.

```
Sign test

        sign |    observed    expected
-------------+------------------------
    positive |          86        51.5
    negative |          17        51.5
        zero |         136         136
-------------+------------------------
         all |         239         239

One-sided tests:
  Ho: median of midwtpA - midwtpB = 0 vs.
  Ha: median of midwtpA - midwtpB > 0
      Pr(#positive >= 86) =
         Binomial(n = 103, x >= 86, p = 0.5) =  0.0000

  Ho: median of midwtpA - midwtpB = 0 vs.
  Ha: median of midwtpA - midwtpB < 0
      Pr(#negative >= 17) =
         Binomial(n = 103, x >= 17, p = 0.5) =  1.0000

Two-sided test:
  Ho: median of midwtpA - midwtpB = 0 vs.
  Ha: median of midwtpA - midwtpB != 0
      Pr(#positive >= 86 or #negative >= 86) =
         min(1, 2*Binomial(n = 103, x >= 86, p = 0.5)) =  0.0000

. **Note: Baseline estimates exclude protest zeroes and don't know ansers.
```

Figure III.1: Scope Test of Baseline WTP Estimates

```
Sign test

        sign |    observed    expected
-------------+------------------------
    positive |          86          43
    negative |           0          43
        zero |          19          19
-------------+------------------------
         all |         105         105

One-sided tests:
  Ho: median of midconsi~A - midconsistentB = 0 vs.
  Ha: median of midconsi~A - midconsistentB > 0
      Pr(#positive >= 86) =
         Binomial(n = 86, x >= 86, p = 0.5) =  0.0000

  Ho: median of midconsi~A - midconsistentB = 0 vs.
  Ha: median of midconsi~A - midconsistentB < 0
      Pr(#negative >= 0) =
         Binomial(n = 86, x >= 0, p = 0.5) =  1.0000

Two-sided test:
  Ho: median of midconsi~A - midconsistentB = 0 vs.
  Ha: median of midconsi~A - midconsistentB != 0
      Pr(#positive >= 86 or #negative >= 86) =
         min(1, 2*Binomial(n = 86, x >= 86, p = 0.5)) =  0.0000

. **Note: Case 1 exludes all observations where WTP for Plan B is greater og equal
. //to WTP for Plan A
```

Figure III.2: Scope Test of Case 1 WTP Estimates

```
Sign test

        sign |    observed    expected
-------------+------------------------
    positive |          85          51
    negative |          17          51
        zero |         136         136
-------------+------------------------
         all |         238         238

One-sided tests:
  Ho: median of hhmidwtpA - midwtpB = 0 vs.
  Ha: median of hhmidwtpA - midwtpB > 0
      Pr(#positive >= 85) =
         Binomial(n = 102, x >= 85, p = 0.5) =  0.0000

  Ho: median of hhmidwtpA - midwtpB = 0 vs.
  Ha: median of hhmidwtpA - midwtpB < 0
      Pr(#negative >= 17) =
         Binomial(n = 102, x >= 17, p = 0.5) =  1.0000

Two-sided test:
  Ho: median of hhmidwtpA - midwtpB = 0 vs.
  Ha: median of hhmidwtpA - midwtpB != 0
      Pr(#positive >= 85 or #negative >= 85) =
         min(1, 2*Binomial(n = 102, x >= 85, p = 0.5)) =  0.0000

. **Note case 2 exludes all observations where WTP>household income*0.02
```

Figure III.3: Scope Test of Case 2 WTP Estimates

```
Sign test

        sign |    observed    expected
-------------+------------------------
    positive |          85        42.5
    negative |           0        42.5
        zero |          19          19
-------------+------------------------
         all |         104         104

One-sided tests:
  Ho: median of midwtpco~t - midconsistentB = 0 vs.
  Ha: median of midwtpco~t - midconsistentB > 0
      Pr(#positive >= 85) =
         Binomial(n = 85, x >= 85, p = 0.5) =  0.0000

  Ho: median of midwtpco~t - midconsistentB = 0 vs.
  Ha: median of midwtpco~t - midconsistentB < 0
      Pr(#negative >= 0) =
         Binomial(n = 85, x >= 0, p = 0.5) =  1.0000

Two-sided test:
  Ho: median of midwtpco~t - midconsistentB = 0 vs.
  Ha: median of midwtpco~t - midconsistentB != 0
      Pr(#positive >= 85 or #negative >= 85) =
         min(1, 2*Binomial(n = 85, x >= 85, p = 0.5)) =  0.0000

. **Note, case 3 exludes all inconsitent observations from Case 1 and Case 2
```

Figure III.4: Scope Test of Case 3 WTP Estimates

```
Sign test

        sign |    observed    expected
-------------+------------------------
    positive |          89        53.5
    negative |          18        53.5
        zero |         193         193
-------------+------------------------
         all |         300         300

One-sided tests:
  Ho: median of q8atest - q8btest = 0 vs.
  Ha: median of q8atest - q8btest > 0
      Pr(#positive >= 89) =
         Binomial(n = 107, x >= 89, p = 0.5) =  0.0000

  Ho: median of q8atest - q8btest = 0 vs.
  Ha: median of q8atest - q8btest < 0
      Pr(#negative >= 18) =
         Binomial(n = 107, x >= 18, p = 0.5) =  1.0000

Two-sided test:
  Ho: median of q8atest - q8btest = 0 vs.
  Ha: median of q8atest - q8btest != 0
      Pr(#positive >= 89 or #negative >= 89) =
         min(1, 2*Binomial(n = 107, x >= 89, p = 0.5)) =  0.0000

. **Note: case 4 assumes all zero WTP are true and don't know answers are zero
```

Table III.3: Scope Test of Case 4 WTP Estimates

Appendix IV

Econometric Analysis

IV.1 Income Elasticity of WTP

Table IV.1: Income Elasticity of WTP

		lnhhinc coeff.	Std. Err.	z	p>z	95% Conf. Interval	
Zero and Positive Respondents							
	Plan A	0.294	0.240	1.22	0.22	-0.177	0.764
	Plan B	0.377	0.255	1.47	0.140	-0.124	0.877
Only Positive respondents							
	Plan A	0.303	0.140	2.18	0.030	0.030	0.577
	Plan B	0.288	0.142	2.03	0.043	0.009	0.567

Note: Results are derived by using interval regression with the logaritm of lower and upper bound of WTP as dependent variable

IV.2 Distribution and Normality tests of WTP

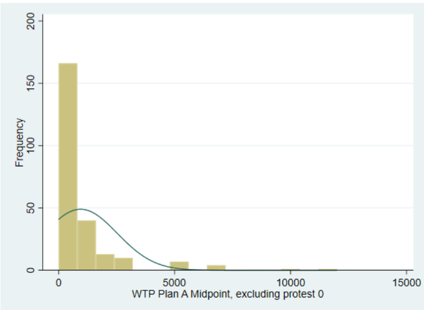


Figure IV.1: Distribution Midpoint WTP A

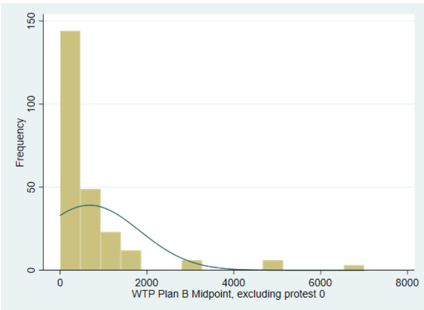


Figure IV.2: Distribution Midpoint WTP B

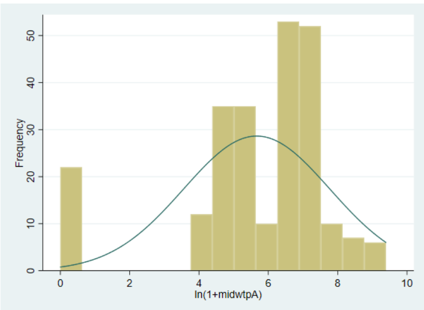


Figure IV.3: Distribution ln of Midpoint WTP A incl. Zero

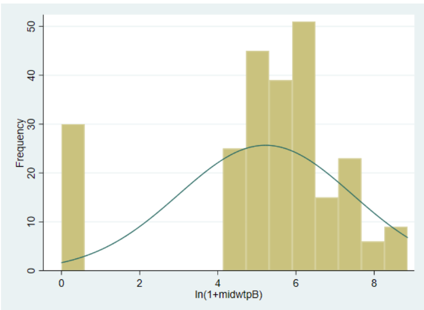


Figure IV.4: Distribution ln of Midpoint WTP B incl. Zero

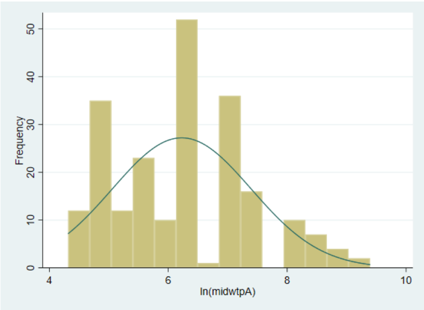


Figure IV.5: Distribution ln Midpoint WTP A

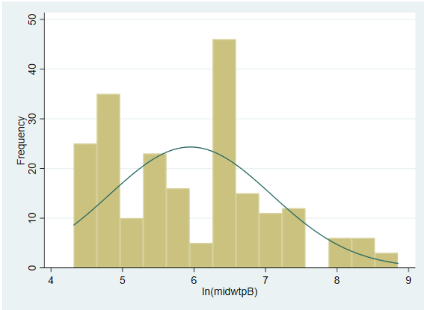


Figure IV.6: Distribution ln Midpoint WTP B

Table IV.2: Skewness/Kurtosis Tests for Normality of WTP

					——joint——	
Variable	Var Desc.	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
midwtpA	Midpoint WTP Plan A	242	0.0000	0.0000	.	0.0000
midwtpB	Midpoint WTP Plan B	243	0.0000	0.0000	.	0.0000
lnmidwtpA	ln(midwtpA+1)	242	0.0000	0.0001	52.47	0.0000
lnmidwtpB	ln(midwtpB+1)	243	0.0000	0.0066	40.30	0.0000
lnmidwtpA1	ln(midwtpA)	220	0.0431	0.0860	6.71	0.0348
lnmidwtpB1	ln(midwtpB)	213	0.0112	0.2205	7.42	0.0245

IV.3 Model for Change in Mean WTP with Population and Sample Means

This model is a level-level regression where the dependent variable is in initial form, WTP.

Table IV.3: Model for Population Means and Sample Means

		Midpoint OLS Regression	
Variables		Model 1, Plan A	Model 1, Plan B
agecat1	dummy, 1 if respondents age is between 15-24, 0 otherwise	245.81	346.48
		(302.84)	(226.87)
agecat2	dummy, 1 if respondents age is between 25-49, 0 otherwise	-20.35***	-15.94***
		(7.44)	(5.69)
agecat3	dummy, 1 if respondents age is between 50-64, 0 otherwise	229.10	353.64
		(348.94)	(267.99)
agecat4	dummy, 1 if respondents age is between 65-79, 0 otherwise	208.25	289.07*
		(228.81)	(173.79)
agecat5	dummy, 1 if respondents age is 80 or above, 0 otherwise	-840.19***	-379.72**
		(247.32)	(191.44)
gskole	1 if respondents education level is 'grunnskole', 0 otherwise	-1029.42***	-873.11***
		(386.04)	(290.98)
vgskole	1 if respondents education level is 'videregaaende skole', 0 otherwise	-786.89**	-751.22***
		(379.92)	(278.37)
fagbrev	1 if respondents education level is 'fagbrev', 0 otherwise	-911.30***	-803.74***
		(366.88)	(285.20)
bachelor	1 if respondents education level is 'bachelor', 0 otherwise	-634.31*	-468.66
		(373.75)	(302.78)
male	1 if respondents sex is male, 0 otherwise	-724.27***	-357.78**
		(205.09)	(150.50)
_cons	constant	1812.00***	1210.88***
		(416.21)	(323.08)
R^2		0.096	0.104
Adj. R^2		0.056	0.065
Number of obs.		242	243
Mean WTP inserting sample means		945.51***	683.59***
		(100.56)	(73.32)
Mean WTP inserting population means		759.26***	506.58***
		(108.48)	(58.86)

Note: *p<0.10, **p<0.05, ***p<0.01.

IV.4 Models for WTP Including Zero Responses

The table below depicts different OLS and interval regression models where zero WTP values, except protest zeroes, are included. The dependent variable in the models, WTP, is transformed into natural logarithm. Thus, the models are log-linear regressions.

Table IV.4: Models Incl. Zero Responses

	Interval Regression, Plan A				Midpoint OLS Regression, Plan A				Interval Regression, Plan B				Midpoint OLS Regression, Plan B			
Variables	M.1	M.2	M.3	M.4	M.1	M.2	M.3	M.4	M.1	M.2	M.3	M.4	M.1	M.2	M.3	M.4
lnhhinc	0.187	0.288		0.437***	0.184	0.285		0.471***	0.295	0.371*		0.439**	0.296	0.371*		0.441**
	(0.266)	(0.218)		(0.234)	(0.269)	(0.242)		(0.250)	(0.282)	(0.230)		(0.234)	(0.286)	(0.247)		(0.256)
higheduc	0.514*		0.128		0.514*		0.130		0.425		0.470**	0.307	0.419		0.468**	0.304
	(0.312)		(0.247)		(0.317)		(0.268)		(0.307)		(0.257)	(0.289)	(0.335)		(0.270)	(0.307)
age	0.000	0.003	0.029	0.015	0.000	0.003	0.029	0.015	0.008	0.017***	0.010	0.011	0.008	0.017***	0.010*	0.010
	(0.009)	(0.008)	(0.044)	(0.044)	(0.009)	(0.008)	(0.042)	(0.045)	(0.009)	(0.009)	(0.007)	(0.051)	(0.009)	(0.008)	(0.007)	(0.047)
agesq			-0.000	-0.000			-0.000	-0.000				-0.000				-0.000
			(0.000)	(0.000)			(0.000)	(0.000)				(0.001)				(0.001)
male	-0.657***	-0.472**	-0.588***	-0.373*	-0.662***	-0.477**	-0.593***	-0.379*	-0.692***	-0.691***	-0.387*	-0.270	-0.692***	-0.629***	-0.386*	-0.272
	(0.289)	(0.264)	(0.237)	(0.248)	(0.255)	(0.264)	(0.238)	(0.257)	(0.307)	(0.281)	(0.249)	(0.274)	(0.312)	(0.275)	(0.255)	(0.286)
hhsize	0.010				0.009				-0.05				-0.05			
	(0.139)				(0.141)				(0.146)				(0.148)			
oslo		0.973***	1.013***	1.027***		0.972***	1.012***	1.026***		0.672**	0.866**	0.920***		0.668**	0.864***	0.918***
		(0.377)	(0.353)	(0.331)		(0.330)	(0.291)	(0.344)		(0.390)	(0.360)	(0.367)		(0.352)	(0.346)	(0.381)
nnf				1.498***				1.515***		1.647***				1.664***		
				(0.506)				(0.527)		(0.756)				(0.409)		
posq1r5		0.987***	1.133***	0.858***		0.930***	0.984***	1.073***		0.841***	0.786***	0.680***		0.839***	0.784***	0.677***
		(0.302)	(0.276)	(0.321)		(0.260)	(0.238)	(0.253)		(0.318)	(0.285)	(0.308)		(0.282)	(0.261)	(0.278)
envlist		0.823***	0.877***	0.916***		0.827***	0.816***	0.909***		0.854***	0.896***	1.061***		0.846***	0.888***	1.054***
		(0.321)	(0.291)	(0.342)		(0.419)	(0.373)	(0.355)		(0.341)	(0.293)	(0.334)		(0.401)	(0.322)	(0.375)
visitamazon		0.062		0.643		0.064		0.646								
		(0.516)		(0.704)		(0.736)		(0.730)								
planvisrain										0.710**		0.731**		0.710***		0.727**
										(0.430)		(0.423)		(0.364)		(0.373)
smaller		0.730***	0.654***			0.730***	0.654***			0.797***	0.275***			0.792***	0.270	
		(0.268)	(0.240)			(0.281)	(0.240)			(0.281)	(0.258)			(0.287)	(0.260)	
highinttime			0.471**	0.529***			0.472**	0.530***			0.685***	0.686***			0.687***	0.689***
			(0.256)	(0.256)			(0.263)	(0.266)			(0.266)	(0.282)			(0.265)	(0.291)
contpolicy		0.699	0.863*	1.060***		0.697**	0.867***	1.062***			0.529				0.526	
		(0.593)	(0.571)	(0.346)		(0.392)	(0.363)	(0.362)			(0.560)				(0.561)	
envmember		0.573	0.794**			0.582	0.800**				0.545				0.553	
		(0.437)	(0.291)			(0.458)	(0.438)				(0.422)				(0.451)	
member				-0.592***				-0.590***				-0.658***				-0.657***
				(0.306)				(0.317)				(0.288)				(0.315)
unrealplans				-1.591***				-1.591***			-1.960***	-2.205***			-1.967***	-2.209***
				(0.386)				(0.601)			(0.382)	(0.385)			(0.525)	(0.541)
married				-0.471*				-0.472*								
				(0.294)				(0.305)								
volunteer		0.521**				0.518***						0.815***				0.815***
		(0.284)				(0.262)						(0.284)				(0.263)
_cons	3.273	0.186	3.300	-1.533	3.325	0.249	3.327	-1.475	1.178	-1.800	3.451***	-2.334	1.187	-1.763	3.482***	-2.307
	(3.368)	(2.923)	(1.067)	(3.055}	(3.418)	(3.296)	(0.961)	(3.170)	(3.578)	(3.087)	(0.448)	(3.129)	(3.632)	(3.385)	(0.468)	(3.611)
Log likelihood	-658	-622	-762	-621	-242	-393	-486	-384	-645	-624	-750	-590	-433	-412	-497	-386
AIC	1330	1269	1550	1273	861	810	997	809	1304	1270	1527	1211	879	844	1017	799
BIC	1353	1312	1596	1326	880	850	1038	860	1327	1306	1572	1260	898	877	1059	845
R^2	0.05	0.258	0.266	0.307	0.05	0.257	0.266	0.307	0.055	0.236	0.295	0.354	0.054	0.235	0.295	0.354
Adj. R^2					0.025	0.213	0.231	0.254					0.030	0.199	0.261	0.308
Number of obs.	200	196	242	198	200	196	242	198	199	199	243	193	199	199	243	193

Note: *p<0.15, **p<0.10, ***p<0.05.

Log-log models of WTP With Zero and Positive WTP respondents.

Table IV.5: Log-Log Model Incl. Zero and Positive WTP Respondents

	Interval Regression		Midpoint OLS Regression, Plan A	
Variables	Model 6, Plan A	Model 6, Plan B	Model 6, Plan A	Model 6, Plan B
higheduc	0.158	0.449**	0.158	0.447**
	(0.248)	(0.261)	(0.268)	(0.271)
male	-0.582***	-0.320	-0.587	-0.319
	(0.238)	(0.250)	(0.240)	(0.259)
lnage	0.445	0.364	0.443	0.360
	(0.343)	(0.338)	(0.359)	(0.322)
oslo	0.967***	0.983	0.955***	0.980***
	(0.353)	(0.362)	(0.292)	(0.354)
highinttime	0.448**	0.672***	0.449**	0.674***
	(0.255)	(0.268)	(0.258)	(0.272)
envlist	0.816***	0.841***	0.810***	0.833***
	(0.289)	(0.296)	(0.338)	(0.334)
posq1r5	1.088***	0.719***	1.085***	0.717***
	(0.279)	(0.289)	(0.225)	(0.260)
unrealplans		-1.929***		-1.938***
		(0.387)		(0.531)
realplans	0.499*		0.498***	
	(0.312)		(0.255)	
envmember	0.673*	0.361	0.680*	0.367
	(0.420)	(0.441)	(0.429)	(0.466)
contpolicy	0.745	0.522	0.749***	0.519
	(0.579)	(0.589)	(0.342)	(0.535)
visitamazon	0.131	0.004	0.131	0.010
	(0.487)	(0.501)	(0.652)	(0.620)
planvisitrain	0.267		0.273	
	(0.389)		(0.281)	
married	-0.081	-0.172	-0.083	-0.175
	(0.262)	(0.278)	(0.264)	(0.277)
smaller	0.613	0.180	0.612***	0.174
	(0.243)	(0.268)	(0.243)	(0.280)
volunteer		0.679***		0.676***
		(0.268)		(0.245)
_cons	2.438**	2.506***	2.470***	2.550***
	(1.270)	(1.243)	(1.260)	(1.163)
Log likelihood	-761	-737	-485	-487
AIC	1553	1505	1000	1004
BIC	1609	1561	1052	1056
R^2	0.275	0.312	0.274	0.312
Adj. R^2			0.230	0.269
Number of obs.	242	239	242	239

Note: *p<0.15, **p<0.10, ***p<0.05.

IV.5 Models for WTP With Only Positive Responses

The table below depicts different OLS and interval regression models with only positive WTP values. The dependent variable in the models, WTP, is transformed into natural logarithm. Thus, the models are log-linear regressions.

Table IV.6: Models for Only Positive WTP Responses

	Interval Regression, Plan A			Midpoint OLS Regression, Plan A			Interval Regression, Plan B			Midpoint OLS Regression, Plan B		
Variables	M.1	M.2	M.3	M.1	M.2	M.3	M.1	M.2	M.3	M.1	M.2	M.3
lnhhinc	0.215*	0.135	0.134	0.212*	0.131	0.135	0.167	0.123	0.094	0.168	0.120	0.093
	(0.150)	(0.124)	(0.122)	(0.140)	(0.129)	(0.128)	(0.141)	(0.128)	(0.139)	(0.154)	(0.155)	(0.144)
higheduc	0.328**	0.039	0.06	0.329**	0.042	0.063	0.478***	0.229*	0.304***	0.475***	0.231*	0.306***
	(0.179)	(0.154)	(0.154)	(0.172)	(0.161)	(0.161)	(0.178)	(0.160)	(0.146)	(0.181)	(0.156)	(0.152)
age	0.005	0.055***	0.057***	0.005	0.055***	0.058***	0.006	0.036	0.040	0.006	0.036	0.040
	(0.005)	(0.027)	(0.026)	(0.005)	(0.028)	(0.028)	(0.005)	(0.027)	(0.295)	(0.005)	(0.031)	(0.031)
agesq		-0.000**	-0.001***		-0.000**	-0.001**		-0.000	-0.000		-0.000	-0.000
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
hhsize	-0.008			-0.008			-0.048			-0.050		
	(0.078)			(0.071)			(0.076)			(0.077)		
oslo		0.508***	0.597***		0.508***	0.599***		0.316*	0.414***		0.316**	0.414***
		(0.209)	(0.195)		(0.209)	(0.205)		(0.199)	(0.187)		(0.188)	(0.196)
male	-0.309**	-0.219*	-0.278***	-0.316**	-0.226*	-0.286***	-0.218	-0.159	-0.191	-0.229	-0.161	-0.194
	(0.165)	(0.141)	(0.140)	(0.169)	(0.148)	(0.157)	(0.164)	(0.144)	(0.139)	(0.167)	(0.149)	(0.145)
posq1r5		0.433***	0.443***		0.434***	0.443***		0.332***	0.321***		0.329***	0.318***
		(0.158)	(0.155)		(0.165)	(0.163)		(0.160)	(0.153)		(0.166)	(0.160)
visitamazon		0.770***	0.805***		0.772***	0.807***		0.406	0.352		0.409	0.358
		(0.291)	(0.295)		(0.305)	(0.310)		(0.292)	(0.322)		(0.368)	(0.338)
envlist		0.463***	0.490***		0.452***	0.479***		0.364***	0.388***		0.352**	0.377***
			(0.177)		(0.189)	(0.186)		(0.187)	(0.169)		(0.183)	(0.176)
envmember		0.682***	0.679***		0.697***	0.695***		0.546***	0.554**		0.558**	0.570**
		(0.233)	(0.229)		(0.244)	(0.241)		(0.239)	(0.292)		(0.327)	(0.307)
bequest		0.700***	0.652***		0.697***	0.647***		1.074***	0.998***		1.090***	1.101***
		(0.273)	(0.258)		(0.286)	(0.272)		(0.273)	(0.309)		(0.352)	(0.327)
co2		0.971***	0.830***		0.971***	0.829***		0.864***	0.722***		0.865***	0.718***
		(0.257)	(0.239)		(0.270)	(0.251)		(0.258)	(0.203)		(0.225)	(0.214)
smaller		0.248**			0.249**			0.310***			0.306***	
		(0.141)			(0.147)			(0.143)			(0.152)	
existence		0.118			0.120			0.093			0.097	
		(0.157)			(0.164)			(0.161)			(0.163)	
contpolicy			0.505**			0.509*			0.496**			0.500**
			(0.306)			(0.322)			(0.277)			(0.293)
highinttime			0.359***			0.362***			0.486***			0.490***
			(0.149)			(0.156)			(0.155)			(0.162)
payfordef			-0.600**			-0.606*			-0.279			-0.289
			(0.364)			(0.382)			(0.456)			(0.472)
_cons	3.155**	2.127	2.156	3.208**	2.191	2.211	3.394**	2.312	2.690*	3.415**	2.361	2.728*
	(1.915)	(1.605)	(1.571)	(1.878)	(1.680)	(1.649)	(1.934)	(1.690)	(1.765)	(1.967)	(1.962)	(1.840)
Log likelihood	-512	-479	-475	-279	-286	-384	-473	-447	-443	-262	-235	-231
AIC	1037	990	985	569	522	517	961	926	920	535	501	495
BIC	1060	1041	1039	588	570	568	983	977	974	554		545
R^2	0.075	0.354	0.377	0.075	0.353	0.376	0.104	0.336	0.364	0.103	0.334	0.364
Adj. R^2				0.049	0.299	0.320				0.077	0.276	0.305
Number of obs.	183	183	183	183	183	183	176	176	176	176	176	176

Note: *p<0.15, **p<0.10, ***p<0.05.

IV.6 Models for WTP With Only Consistent Responses

The table below depicts different OLS and interval regression models where zero WTP values, except protest zeroes, are included. The dependent variable in the models, WTP, is transformed into natural logarithm. Thus, the models are log-linear regressions.

Table IV.7: Models for Consistent Responses

	Interval Regression, Plan A			Midpoint OLS Regression, Plan A			Interval Regression, Plan B			Midpoint OLS Regression, Plan B		
Variables	M.1	M.2	M.3	M.1	M.2	M.3	M.1	M.2	M.3	M.1	M.2	M.3
lnhhinc	0.238	0.199	0.187	0.232	0.195	0.182	0.515	0.294	0.220	0.518	0.298	0.224
	(0.481)	(0.398)	(0.390)	(0.498)	(0.423)	(0.421)	(0.478)	(0.399)	(0.389)	(0.495)	(0.419)	(0.419)
higheduc	0.850*	0.272		0.853*	0.276		0.297	-0.330		0.287	-0.338	
	(0.561)	(0.507)		(0.581)	(0.535)		(0.556)	(0.512)		(0.576)	(0.568)	
age	-0.014	-0.004		-0.014	-0.004		-0.012	-0.003		-0.012	-0.003	
	(0.017)	(0.014)		(0.017)	(0.123)		(0.017)	(0.014)		(0.017)	(0.013)	
male	-0.838*	-0.165	-0.136	-0.844*	-0.173	-0.144	-0.532	0.017	0.204	-0.529	0.173	0.208
	(0.552)	(0.492)	(0.491)	(0.571)	(0.542)	(0.521)	(0.549)	(0.503)	(0.491)	(0.568)	(0.559)	(0.540)
hhsize	0.094			0.094			0.060			0.061		
	(0.218)			(0.226)			(0.212)			(0.219)		
oslo		0.853	0.901*		0.853	0.902		1.056**	0.881*		1.054	0.876
		(0.652)	(0.607)		(0.785)	(0.695)		(0.627)	(0.589)		(0.736)	(0.615)
envlist		1.488***	1.558***		1.481***	1.551***		1.984^{***}$	1.966***		1.978***	1.958***
		(0.545)	(0.535)		(0.655)	(0.609)		(0.550)	(0.540)		(0.626	(0.601)
pos1r5		1.493***	1.596***		1.491***	1.595***		1.182***	1.159***		1.182***	1.158***
		(0.506)	(0.479)		(0.423)	(0.396)		(0.516)	(0.488)		(0.465)	(0.456)
member		-0.992***	-0.936***		-0.991**	-0.934**		-0.773*	0.788$^{**}		-0.770	-0.787
		(0.492)	(0.482)		(0.572)	(0.556)		(0.488)	(0.485)		(0.595)	(0.579)
unrealplans		-1.384***	-1.330***		-1.384***	-1.340***		0.807***	-1.264***		-1.173**	-1.273***
		(0.565)	(0.482)		(0.674)	(0.652)		(0.555)	(0.541)		(0.653)	(0.644)
payfordef		-2.233**	-2.299***		-2.237*	-2.304**		-1.453	-1.329		-1.441	-1.311
		(1.165)	(1.108)		(1.407)	(1.359)		(1.169)	(1.122)		(1.453)	(1.357)
smaller		1.046***	1.128***		1.047**	1.129***		0.807*	0.860**		0.802*	0.855**
		(0.486)	(0.476)		(0.539)	(0.496)		(0.492)	(0.484)		(0.524)	(0.490)
contpolicy		0.804			0.814			0.516			0.503	
		(1.123)			(0.802)			1.301)			(0.568)	
_cons	2.680	1.296	1.251	2.771	1.381	1.338	-1.946	-1.207	-0.456	-1.969	-1.241	-0.490
	(6.331)	(5.267)	(5.118)	(6.556)	(5.664)	(5.667)	(6.271)	(5.246)	(5.093)	(6.493)	(5.644)	(5.595)
Log likelihood	-309	-290	-290	-211	-191	-192	-287	-269	-270	-207	-190	-189
AIC	633	607	602	434	409	404	588	567	561	427	406	400
BIC	650	642	630	449	441	429	605	601	589	442	438	425
R^2	0.069	0.398	0.391	0.069	0.400	0.390	0.040	0.354	0.349	0.040	0.353	0.348
Adj. R^2				0.013	0.303	0.322				-0.018	0.251	0.273
Number of obs.	90	90	90	90	90	90	89	89	89	89	89	89

Note: *p<0.15, **p<0.10, ***p<0.05.

IV.7 Average Marginal Effects of Logit-model

Average marginal effects (AME) of Logit-Model 3 for Plan A, presented in table 4.9.

Figure IV.7: Average Marginal Effects of Model 3, Plan A

VARIABLES	(1) Marginal effects
lnhhinc	0.0261
	(0.0287)
1.male	0.00938
	(0.0361)
age	-0.00186*
	(0.00101)
1.envlist	0.0766
	(0.0481)
1.unrealplans	-0.291***
	(0.0833)
1.volunteer	0.117***
	(0.0303)
1.lesssploss	0.0936**
	(0.0421)
1.member	-0.0838*
	(0.0451)
1.oslo	0.0473
	(0.0405)
1.married	-0.0549
	(0.0348)
Observations	194

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Average Predicted Probability for Plan A at Different Ages

The table below depicts how the average predicted probability of stating positive WTP for Plan A changes at different ages.

Figure IV.8: Average Predicted Probability for Plan A at Different Ages

```
Predictive margins                              Number of obs     =        194
Model VCE    : OIM

Expression   : Pr(yA), predict(pr)

1._at        : age             =          40

2._at        : age             =          50

3._at        : age             =          60

4._at        : age             =          70

5._at        : age             =          80
```

_at	Margin	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	.9275783	.0169221	54.81	0.000	.8944115	.9607451
2	.9098353	.0166702	54.58	0.000	.8771624	.9425082
3	.8890137	.0223829	39.72	0.000	.8451441	.9328834
4	.8648411	.0347715	24.87	0.000	.7966902	.932992
5	.8371035	.0525958	15.92	0.000	.7340176	.9401894

IV.8 Kernel Density Plots of Main OLS Models

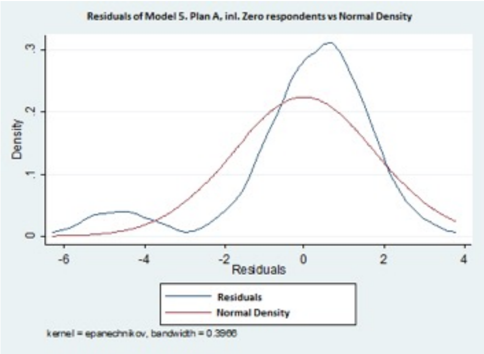


Figure IV.9: Residuals Model 5 Plan A Incl. Zero Responses

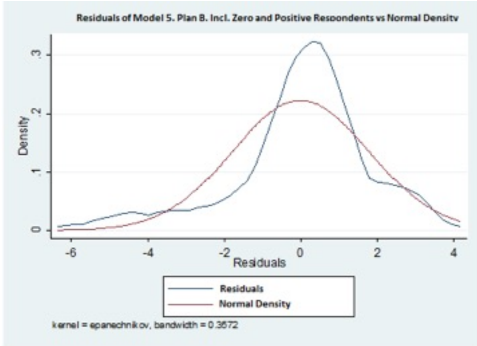


Figure IV.10: Residuals Model 5 Plan B Incl. Zero Responses

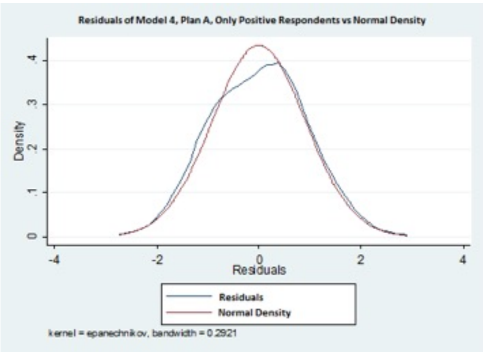


Figure IV.11: Residuals Model 4 Plan A Excl. Zero Responses

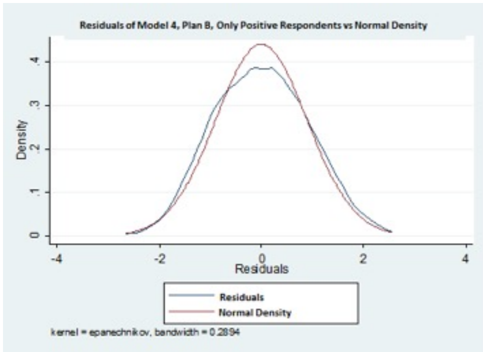


Figure IV.12: Residuals Model 4 Plan B Excl. Zero Responses

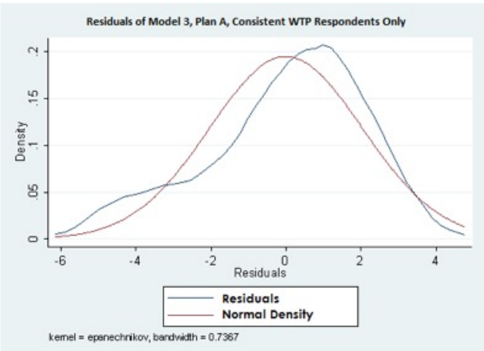


Figure IV.13: Residuals Model 4 Plan A Consistent Responses

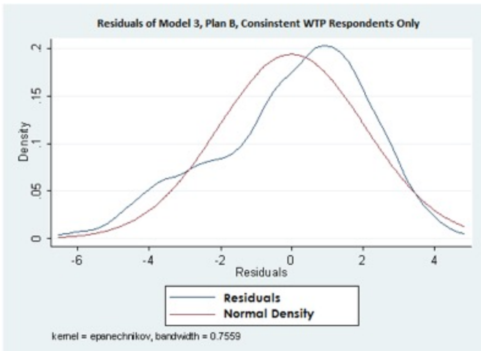


Figure IV.14: Residuals Model 4 Plan B Consistent Responses

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