Can Experts Predict Households' Willingness-to-Pay to Preserve the Amazon Rainforest? Comparing Contingent Valuation, Expert Assessment and Benefit Transfer

Abstract

The Amazon rainforest is the world's largest rainforest, and thus can be considered a global public good. Currently, at least 16 percent of the area has been lost to deforestation, and without new preservation plans 40 percent of the area is expected to be deforested by 2050. Avoiding deforestation and the resulting loss of biodiversity and ecosystem services provide benefits to both local households and households worldwide. The latter benefits seems to account for the majority of the total global benefits, because the number of affected households these benefits are aggregated over is very large. As it is very time consuming and costly to assess these global non-use values in stated preference surveys in all countries worldwide, benefit transfer exercises and expert assessment in Delphi Contingent Valuation (CV) surveys have been conducted. We test the reliability of these two approaches for predicting distant beneficiaries´ willingness-to-pay (WTP) for Amazon Rainforest preservation plans by comparing these estimates to a new CV survey of 300 Norwegian households. The CV survey found a mean WTP of 110 € (NOK 1100) per household per year to avoid further forest and biodiversity loss (which was the most ambitious of two alternative preservation plans).

Whereas benefit transfer from a North American CV survey of the same scenarios, both in terms of unit transfer with income adjustment and value function transfer, resulted in transfer errors of up to several hundred percent; the Norwegian experts in the Delphi CV survey predicted the outcome of the population CV survey well. Transfer errors were as low as 12 % in one model, and in all models below 35 %. Thus, this study provides evidence that the Delphi CV method could be a valid, as well as very time and cost effective, technique for assessing benefits of global public goods to distant beneficiaries.

JEL Classifications: Q51, Q57

1. Introduction

The Amazon rainforest is the world's largest rainforest, making up as much as 40 percent of the total remaining area of tropical forest worldwide (Andersen et al., 2002, 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 (Nunes Kehl et al., 2015; Malhi et al., 2008).

Andersen et al. (2002) identify several origins of deforestation in the Brazilian Amazon rainforest. The largest contributor is cattle ranching, which previously was heavily subsidized by the Brazilian government. It accounts for about 70 percent of the deforestation of the Amazon rainforest (Malhi et al., 2008). The second largest contributor is agricultural expansion and production; contributing 10 percent. Logging, mining, insecure property rights and road building are also important driving forces for deforestation of the Amazon.

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, 2018; Strand et al., 2017). It provides global benefits and ecosystem services in terms of, biodiversity, carbon storage, recreational values and non-use values (Strand et al., 2017; Andersen et al., 2002, p:172).

Deforestation causes loss of ecosystem services and biodiversity (Foley et al., 2007), which reduces human well-being for both local and distant beneficiaries of the forest. Therefore, it is reasonable to assume that also distant beneficiaries are willing to pay to preserve the Amazon. Amongst distance beneficiaries, non-use values dominate as most people globally have not visited the Amazon; and thus do not have recreational use values. Non-use values represent the value of benefits people obtain by the existence of ecosystem services, the enjoyment of theses services by others, and that the good is available for future generations (i.e. bequest values) (Pascual and Muradian, 2010, p:195). Even though people´s WTP per household could be small, total non-use values aggregated over the global population would be substantial. Thus, non-use values to distant beneficiaries are important to include in a global cost-benefit analysis (CBA) of preservation plans (Navrud and Strand, 2018). Existence of biodiversity, forest and tropical wildlife are examples of non-use values distant beneficiaries hold of preservation of the Amazon rainforest. Among the environmental valuation techniques, only the Stated Preference (SP) methods, i.e. Contingent Valuation and Choice Experiments, are able to measure non-use values.

Only two previous SP studies have estimated distant beneficiaries' WTP to preserve the Amazon 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 voluntary 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.

In addition to these two SP-studies, Navrud and Strand (2018) conducted a Delphi CV survey for the World Bank to estimate WTP among households in the European countries to preserve the Amazon rainforest. 48 European valuation experts from different European countries were asked to guess mean and median WTP for two preservation plans among households if a CV survey was conducted in their respective country and for Europe overall (Navrud and Strand, 2018). The study was later extended by Strand et al. (2017) by including OECD countries and low-income, lower-middle income and upper-middle-income Asian countries. The experts were asked to guess the outcome of a CV survey valuing two alternative preservation plans, A and B.

In **Plan A**, there would be no further loss of forest, nor species, by 2050. Thus, 85 percent of the total area would remain in 2050, and there would be n further loss of species. **Plan B** implied some forest loss, and 75 percent of the total area would remain by 2050. 7 percent of the species would be lost. The two preservation plans were compared to a reference (business- as-usual) scenario where 60 percent of the forest would remain by 2050 and 12 percent of the species would be lost (Navrud and Strand, 2018).

Three Norwegian environmental valuation experts were surveyed in the European Delphi CV study. The mean of their mean WTP guesses for Plan A was €65 per Norwegian household as an annual tax in round 1 (Navrud and Strand, 2018). In round 2, where they were shown the distribution of the round 1 responses from all experts and asked whether they would like adjust their "guesstimates" or not, the mean of their mean WTP guesses of the Norwegian experts was $114.20 for the most ambitious preservation Plan A For the less ambitious Plan B, the mean of mean WTP guesses from the Norwegian experts was $63 and $64; in round 1 and in round 2. (Strand et al., 2014).

As a follow-up to the Delphi CV survey, a choice experiment (CE) survey was conducted by Siikämaki et al. (ND) to determine marginal WTP estimates to avoid forest and species loss among North American households. The study finds that US and Canadian households, on average, are willing to pay $4.97 and $3.19 annually for each percentage point of potentially avoided forest area loss and species loss,

respectively. Respondents in this survey were also asked CV questions about their WTP for preservation plans A and B (Siikämaki et al., ND).

The main aim of this paper is to test the validity of both the Delphi CV method[1] and benefit transfer techniques, by comparing their results to the outcome of a new CV survey of a representative sample of 300 Norwegian households valuing the same Amazon rainforest preservation plans. As we in SP surveys never will get households´ true WTP, this comparison of estimates will be a criterion validity test (Bishop and Boyle 2019).

In the benefit transfer exercise we perform unit value transfer with income adjustment and value function transfer from the CV survey of a representative sample of US and Canadian households (Siikämaki et al. ND). Equivalence tests, t-tests and estimated transfer errors (TE) will be used to evaluate equivalence or difference between transferred mean WTP estimates and mean WTP estimates from our Norwegian CV survey. As only three Norwegian valuation experts were asked in the Delphi CV survey, only transfer errors from using the mean of their mean WTP guesses to predict the outcome of the Norwegian CV survey will be calculated (as conventional testing with only 3 observations in one sample does not make sense). Results show that unit value transfer perform better than value function transfer, with Plan A/B transfer errors of 131/68 % and 389/596%, respectively. The Delphi CV survey performs much better with 31 % or less transfer errors for both Plan A and B, considering round 2 estimates. These results illustrates that experts in Delphi CV studies could outperform traditional benefit transfer techniques in providing valid estimates for non-use values among distant beneficiaries to global public goods. However, further comparative studies for other public goods, contexts and countries should be performed to see whether, and under what conditions, these results can be generalized.

2. Data and methods

As the main aim of this paper is to compare the outcome of an actual population Contingent Valuation (CV) survey with an earlier expert assessment of the outcome of such a survey (by using the Delphi CV method) and different benefit transfer techniques; we will in the following describe the methodology of these three valuation approaches

[1] Delphi CV surveys could also be classified as a benefit transfer technique, as all benefit transfer techniques depend on experts' opinions and assessment of how previous studies can be used to estimate benefits or costs in new policy contexts (León et al., 2003; Navrud and Strand, 2018; Strand et al., 2017).

2.1. Norwegian CV survey

The CV survey conducted in Norway was constructed to be as identical as possible to the Delphi CV survey used by Navrud and Strand (2018), in order to make the CV survey directly comparable to the Delphi CV survey. An internet survey of 300 members of the NORSTAT internet panel was conducted. The respondents were randomly selected from the panel to be representative of the Norwegian population in terms of age, gender and education level. The survey was sent to 1451 individuals, which gives a response rate of 20 percent. This might seem low, but note that in this and many other internet panel surveys, invitations are sent to members of large panels without follow-up reminders, and the survey is then closed when the number of respondents aimed for is reached.

In the CV survey, respondents are first asked questions regarding their preferences for public spending on a range of public services. The questions make the respondents consider their preferences regarding public spending for different public goods, avoid a focus effect on the Amazon rainforest, and train respondents for the WTP elicitation questions (Siikämaki et al., ND). Respondents are also asked if they have ever visited a tropical rainforest in general, and the Amazon rainforest specifically.

Next, respondents are introduced to a general definition, information and characteristics of tropical rainforests, and the Amazon rainforest in particular. Maps are presented to show where the world's tropical rainforests are located (see figure 1); and the size of Norway and other European countries relative to the Amazon rainforest (see figure 2).

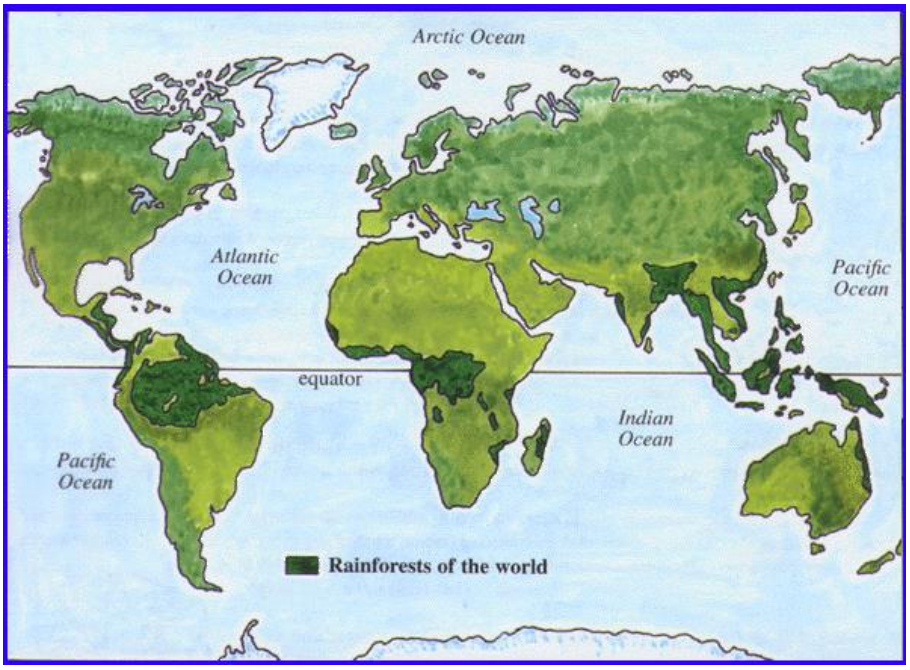
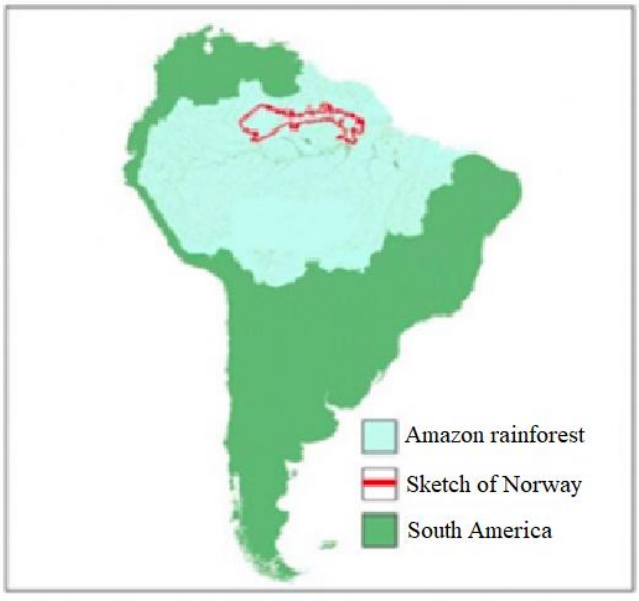


Figure 1. Rainforest of the world; as shown in the Norwegian Contingent Valuation (CV) survey and the European Delphi CV survey.



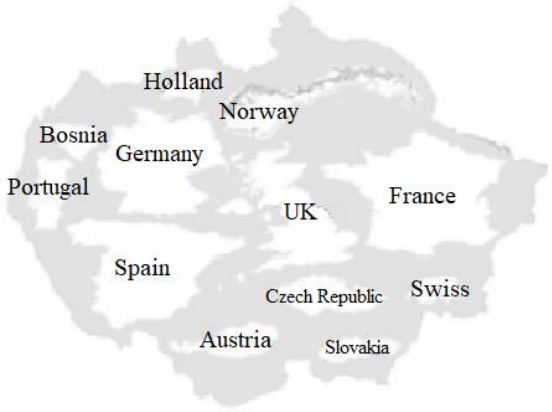


Figure 2. The Amazon rainforest compared to the size of Norway and other European countries; as shown in the Norwegian Contingent Valuation (CV) survey and European Delphi CV survey (but Norway not shown in the Delphi CV survey).

Respondents are then asked questions to reveal their knowledge about the Amazon rainforest. Then, the two different preservation plans A and B are presented. Respondents are informed that if no preservation plan for the Amazon is implemented, 24 percent of existing species and 25 percent of current forest areas in the Amazon will be lost within 2050. This is defined as the **reference scenario**.

Just like in the Delphi CV survey; a slide depicting mammals in the Amazon facing potential extinction (see figure 3) as well as maps showing the forested area with preservation plans A, B and the reference scenario are shown to the respondents; see figures 4, 5 and 6; respectively. Respondents are informed that the Brazilian government, by collaborating with NGOs, have constructed the two preservation plans A and B. However, without international funding the costs of the preservation plans are too high for implementation. **Plan A** is more extensive than Plan B and implies no further forest nor species loss within 2050, while **Plan B** implies 15 percent forest loss and 7 percent species loss within 2050 compared to current levels. The respondents are also reminded that 15 percent of the original Amazon rainforest has already disappeared since the 1970s, and will not be recovered by any of the preservation plans. Thus, even with the most ambitious preservation Plan A, 85 % (and not 100%) of the original Amazon rainforest is preserved (as stated in figure 4).

Figure 3. Mammal species in the Amazon rainforest at risk of extinction. Slide shown in in the Norwegian Contingent Valuation (CV) survey and Delphi CV survey.

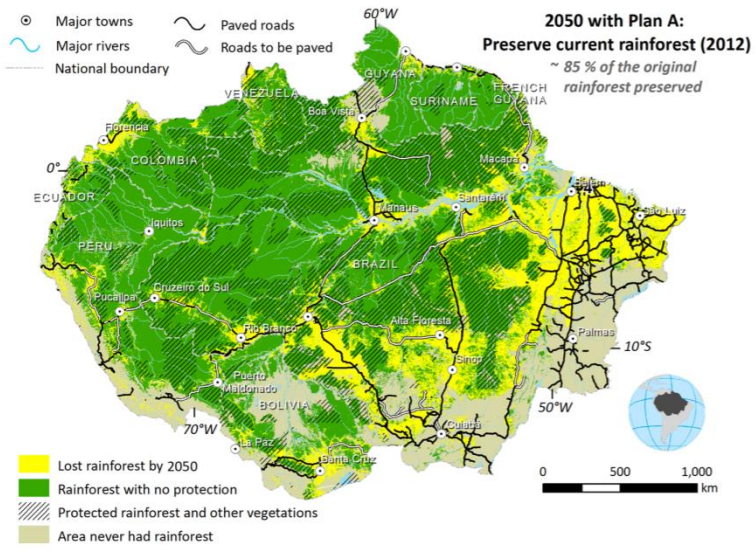


Figure 4. Preservation Plan A, as shown in the Norwegian Contingent Valuation (CV) survey and the European Delphi CV survey.

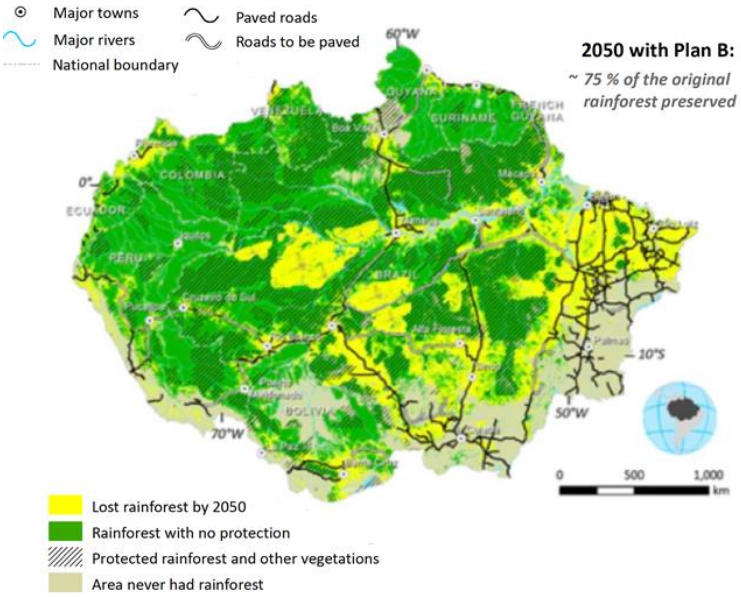


Figure 5. Preservation Plan B, as shown in the Norwegian Contingent Valuation (CV) survey and the European Delphi CV survey.

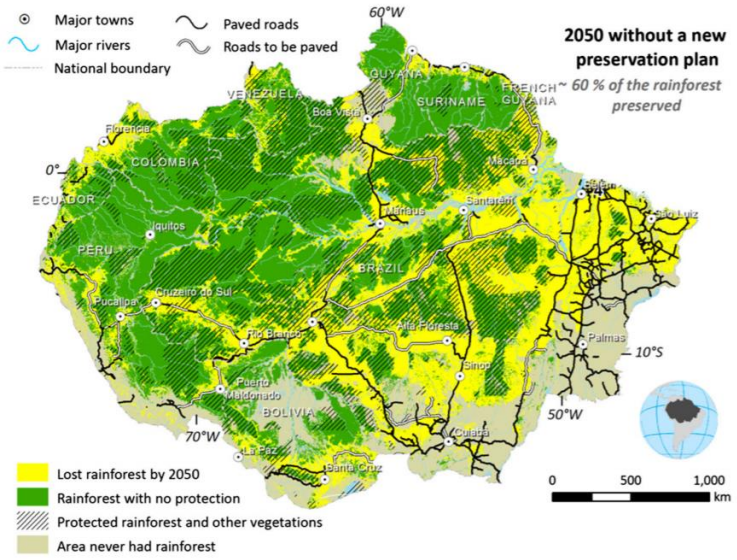


Figure 6. Reference scenario (i.e. no preservation plan), as shown in the Norwegian Contingent Valuation (CV) survey and the European Delphi CV survey.

Respondents are then asked the most, if anything, their household is certainly willing to pay for preservation Plans A and B, respectively; by indicating an amount on a payment card (PC), shown as a horizontal list of amounts from zero to 12000 NOK (120 euro) /household/year. The payment vehicle (PV) is an extra annual national tax, where the tax payments are transferred to the eight Amazon rainforest countries which have agreed to implement the preservation plan(s). The choice of PV is realistic, as recommended by Johnston et al. (2017), because Norway has already set aside money to pay Brazil to reduce deforestation. Additionally, respondents might be less sceptic to a tax which is earmarked for this specific purpose than a general increase in the income tax (Lindhjem and Navrud, 2009). Respondents reporting positive WTP are asked an open-ended question on *why* they are willing to pay, in order to evaluate and group their WTP response by motivation for paying.

A follow-up question is also asked respondents stating zero WTP. They are asked to choose the most important reason for stating zero WTP, among a pre-specified set of reasons. This is used to distinguish “true zeros” from “protest zeros”: The latter group is respondents that have positive WTP but answer zero because they protest some part of the CV scenario. As their answer do not reflect their true WTP, they are excluded from the sample used to calculate mean WTP (and thus we implicitly assume that the protest zeros have a WTP equal to the mean WTP of this remaining sample of respondents). If zero WTP respondents chose "Amazonian countries should pay themselves", "The Norwegian government should pay", or "Norway has already paid enough to reduce deforestation in Brazil and other

countries", we identified them as protest zero responses, and excluded them from further analysis.

Respondents are then asked: i) if they think the preservation plans will be implemented, ii) if they believe they really have to pay the amounts they state, and iii) whether the results from the survey will be used as decision support for policies aiming to reduce deforestation of the Amazon rainforest. These questions are used to test the level of payment and policy consequentiality; and thus assess the truthfulness and reliability of the responses (Johnston et al., 2017). Data on age, gender, education and other socioeconomic variables are also collected.

In order to estimate mean WTP and WTP functions for the two preservation plans, ordinary leased squares (OLS) and interval censored regression models were applied. In the OLS models we assume that respondent´ "true" WTP is the midpoint of the respondents' chosen amount and the next amount on the PC. However, OLS models might yield biased estimates, as they do not consider that stated WTP amounts are uncertain, and might also not be the midpoint value (Cameron and Huppert, 1989; Yang et al., 2012).

Interval censored regression models take this uncertainty into account and assumes normality. Interval regression models utilize the maximum likelihood estimator (MLE), but yield biased estimates if assumptions regarding normality and homoscedasticity are not met (Wooldridge, 2013, p:603). The log likelihood function of n independent observations can be defined as (Cameron and Trivedi, 2005, p:534)):

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

where y are observed point data of WTP, $\boldsymbol{x_i}$ is a vector of independent variables, $\boldsymbol{\beta}$ is a vector of coefficients which explains how independent variables affect WTP, a_j is the respondent i's chosen amount on the PC and a_{j+1} is the next (and higher) amount on the PC.

2.2. Delphi CV survey

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 ecosystem services, valuation practitioners/experts are asked how they expect

households, in a population of interest, to value specified changes in an environmental good. Usually, a Delphi survey consists of several rounds. In the first round, experts fill in a questionnaire and state their opinion about the specified subject, without communicating with other experts. In the later rounds, the experts are shown what the other experts answered (without knowing the identity of the other experts), and are then allowed to revise their own answers. Generally, it is believed that predictions are more accurate in the later rounds (Navrud and Strand, 2018). A Delphi CV survey has the potential of providing quick and cheap WTP estimates, but the question is how they compare to a population CV survey; which is what we would like to test here.

The Delphi CV survey we are comparing our population CV survey in Norway with is the Norwegian part of the European Delphi CV survey reported by Navrud and Stand (2018); which was also included in the extension of the Delphi CV survey to other parts of the world (see Strand et al 2017).

2.3. Benefit transfer

The fundamental purpose of benefit transfer is to transfer valuation information from previous study sites to a new policy site. There are three main benefit transfer techniques for results from existing Stated Preference studies; i) unit transfer (i.e. transferring mean WTP/household/year estimates) without or with adjustments for different income at the study and policy site; ii) value function transfer (i.e. transferring the WTP function from a policy in terms of e.g. WTP as a function of the characteristics of the environmental good valued and characteristics of the respondents), and iii) meta analysis (i.e. transferring a WTP function estimated as a meta-regression function of data from a number of previous valuation studies valuing the same type of environmental good; including characteristics of the valuation studies in the value function to be used for benefit transfer) (Navrud, 2004).

3. Results and Discussion

3.1 Delphi CV survey

As the Norwegian valuation experts (as well as experts from other European countries) were asked to state WTP in euros using the exchange rate we need to convert these amounts to NOK using the exchange rate at the time the Norwegian experts were surveyed. We then used the Norwegian consumer price index (CPI) to convert 2012-NOK to 2018-NOK, as the Delphi CV survey was conducted in 2012 and the population CV survey in early 2018.[2] Table 1 reports the initial expected mean

[2] The Norwegian experts in the Delphi CV were surveyed in April (Round 1) and June (Round 2) 2012, and they were asked to state the amount in euro using the exchange rate. The b average exchange rate for these two months of 2012 was 1 euro= 7,55 NOK.https://www.norges-bank.no/Statistikk/Valutakurser/valuta/EUR. Inflation

WTP values among Norwegian households for Plan A and B in round 1 and 2 from the Delphi CV study. As the experts were shown the results from the other experts (without knowing their names) in Round 2, and were asked whether they would to like to keep or adjust their results, we rely most on Round 2 replies. Among the three Norwegian experts, one kept his/her answer, one adjusted upwards and one downwards in Round 2.

Table 1: Delphi CV survey results for Norway. Mean WTP per household (hh) / year (y) for Preservation Plans A and B in Round 1 and 2.

Plan/Round	Mean WTP/hh/y from Delphi CV Survey (2012-euro)	Mean WTP/hh/y (2012-NOK)	Mean WTP/hh/y (2018-NOK)
Plan A/Round 1	€65	NOK 491	NOK 557
Plan A/Round 2	€98	NOK 740	NOK 841
Plan B/Round 1	€58	NOK 438	NOK 497
Plan B/Round 2	€64	NOK 483	NOK 549

3.2. Benefit transfer

We also tested international BT from a North American Choice Experiment (CE) survey of the same preservation plans for the Amazon rainforest. A representative sample of US and Canadian households were on average willing to pay US $4.97 and $3.19 for avoiding one percent loss in forest and species , respectively (Siikämaki et al., ND). Multiplying defined marginal WTP estimates with the avoided percentage loss of forest area and species for preservation Plans A and B, we obtain estimates of mean WTP for the respective preservation plans among North American households. Unit transfer with income adjustment can then be applied to determine mean WTP among Norwegian households for Plan A and Plan B (Ready and Navrud, 2006; Navrud and Ready, 2007). We use PP adjusted exchange rates and correct for inflation. Correspondingly, mean WTP among Norwegian households is NOK 2187 for Plan A and NOK 1137 for Plan B (again assuming an income elasticity of WTP equal to one).

Unit transfer does not take into account different characteristics and preferences of households at the policy site (Here: USA and Canada) and study site (here: Norway). To try to overcome this problem, the value function transfer technique can be applied. Access to the data set from Siikämaki et al. (ND) made it possible to also perform a value function transfer. A logit-model, utilizing the data set of Siikämaki et al. op. cit was estimated. The transferred value function was derived from a dichotomous choice CV question (which was also part of the SP survey, in addition to the CE), and is

was adjusted for by using the Norwegian Consumer Price Index (CPI) from May 2012 to February2018, (i.e. increased 13,6 %) to get it into 2018-NOK

presented in Table 2.[3] 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. The model and the mean were estimated by following steps defined by Haab and McConnell (2002, p:32-35) and Lopez-Feldman (2012).[4]

Table 2: Value 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)
male	1 if male and 0 otherwise	-0.055
		(0.150)
ppage	Age	-0.0032
		(0.004)
higheduc1	1 if have bachelor or a higher degree, 0 otherwise	0.355**
		(0.172)
strEnv	1 if consider oneself as a strong environmentalist, 0 otherwise	0.612*
		(0.343)
noEnv	1 if not an environmentalist, 0 otherwise	-0.602***
		(0.163)
planvisit	1 if plan to visit the Amazon rainforest, 0 otherwise	0.321
		(0.203)
decrforest	1 if believe Amazon rainforest area is decreasing, 0 otherwise	0.621***
		(0.175)
planWL	Very confident that the plan will be implemented	1.257**
		(0.403)
planOK	Somewhat confident that the plan will be implemented	0.928***
		(0.166)
planNWL	Not confident at all that the plans will be implemented	-1.435***
		(0.229)
_cons	Constant	-0.796
		(0.660)
Log Likelihood		-550.08
AIC		1126.16
BIC		1190.04
Correct classification		73.16%
Pseudo R^2		0.21
Number of observations		1006
Mean WTP		NOK 5238***
		(610.594)
Pred. average probability		0.493
		(0.257)

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

[3]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 to 30 percent forest loss and 24 percent species loss if no preservation plan was implemented.

[4]Mean WTP is given by: $-\frac{\alpha+\beta\cdot\bar{z}}{\gamma}$, where α is the constant, β 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, is the coefficient of the bid variable (Haab and McConnell, 2002, p:35).

3.2. CV survey

Table 3 reports the characteristics of the 300 respondents in the national sample of Norwegian household in the CV survey, and the corresponding numbers for the overall Norwegian population. While the sample seems representative in terms of gender, age and distribution on different geographical regions; households with high education and high income seem to be overrepresented.

Table 3: CV survey sample vs Population Characteristics

		Sample	Norwegian Population
Gender			
	Male	50.33%	50.39%
	Female	49.67%	49.61%
Income			
	Mean household income	NOK 773 171	NOK 518 313
Education			
	Below upper secondary education ((< 11 years)	5%	26.5%
	Upper secondary education (11-13 years	29.33%	37.8%
	Tertiary vocational education	12%	2.8%
	Higher education, short (Bachelor degree)	34%	23.4%
	Higher education, long (Master or PhD degree)	19.66%	9.5%
Age categories	Classification A:		
	15-24	11%	12.7%
	25-49	39.33%	34.4%
	50-64	19%	18.4%
	65-79	30%	12.4%
	≥80	0.67%	4.2%
	Classification B:		
	15-49	50.33%	47.7%
	50 or above	49.67%	52.9%
Geographical regions			
	Mid-Norway	12.33%	8.6%
	Northern Norway	9%	9.3%
	Southern Norway	8.67%	5.7%
	Western Norway	19.33%	26%
	Eastern Norway	50.66%	50.4%

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

Out of the 300 respondents, 44 and 50 respondents stated zero as their willingness to pay for Plan A and Plan B, respectively. 36 and 37 respondents replied 'don't know' when asked how much they are willing to pay for Plan A and Plan B, respectively. Excluding 'Don't know' answers and protest zeros, the means of WTP for Plan A and B of the sample were estimated; see table 4. Overall, 220 respondents have positive WTP for Plan A while 213 respondents have positive WTP for Plan B.

Using the midpoints (between the stated amount, and the next higher amount on the PC), except for zero (where the "true" zeros were recorded as zeros) mean WTP for Plan A is NOK 945 while mean WTP for Plan B is NOK 677. The unconditional interval censored means of WTP were found to be NOK 1136 and NOK 796 for Plan A and B, respectively. A scope test was performed to evaluate whether households´ WTP for the more extensive preservation Plan A was significantly higher than for Plan B. The bootstrapped distribution of the difference between WTP for Plan A and B was estimated using 1000 replications. Further, we estimated the percentile-t method 95% confidence interval of the difference (143.43, 432.05).[5] As zero is not present, we can reject the null hypothesis of equality.[6] This is consistent with economic theory, as more forests and species preserved should be valued higher (Veisten et al., 2004).

Table 4: Mean and Median Willingness to Pay

	Mean WTP Plan A	Mean WTP Plan B	95% CI Plan A		95% CI Plan B	
PC Value	730	525	572	889	413	637
Midpoint value	945	677	746	1145	531	823
Interval censored value	1136	796	994	1279	697	895
	Median WTP Plan A	Median WTP Plan B	95% CI Plan A		95% CI Plan B	
PC Value	300	200	134	466	89	311
Midpoint Value	550	250	345	755	95	405

Note: the confidence interval for the interval censored means are obtained by the Delta-method.

An OLS model with midpoint WTP as the dependent variable was estimated to assess the difference in mean WTP with sample means and population means of education and age categories. This is because our sample is overrepresented by individuals ranging from age 65 to 79. Additionally, the education levels between the sample and the population are unbalanced 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. However, education and age did not have a significant effect on WTP in the regression models.

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. Firstly, observations inconsistent with economic theory, i.e. stating WTP for Plan B greater or equal to

[5] In comparison with the percentile method, the percentile-t method has asymptotic refinement (Cameron and Trivedi, 2005, p:364)

[6] In addition, a paired t-test and a non-parametric sign test of two dependent samples were estimated. The null hypothesis of equality was rejected in each scope test.

WTP for Plan A, were removed. Mean WTP for Plan A, estimated from the midpoints, then increased from NOK 945 to 1074. In total, 134 observations were removed. Thus, a substantial part of the sample responded inconsistently with economic theory. This could be due to the fact that households found Plan B to be more realistic than A, and thus stated their WTP as an expected value in terms of their "true" WTP multiplied with a probability lower than 1 that Plan A would be implemented. This is supported by the results from a follow-up question, showing that 37 percent of the respondents find Plan B to be "very realistic", while the corresponding number for Plan A was only 15 percent. Diminishing marginal utility of increased preservation could also explain why several respondents value Plan B equally to Plan A.

Respondents were asked an open-ended question about their reason for being willing to pay something for Plan A and/or Plan B. The reason for keeping this an open-ended question was that we would like to avoid influencing the respondents by listing reasons for WTP. This was particularly important we did not want the respondents to include the carbon storage benefits of forests in their WTP estimate, in order to compare the estimate from this CV survey with the Delphi CV survey, where the valuation experts were explicitly told *not* to include the carbon storage benefits. In the CV survey of US and Canadian households (

Five motivational categories (WTP categories) were identified based on their responses: i) existence value, ii) bequest value, iii) CO2 capture (Carbon), iv) social responsibility, v) don't know. As we only asked one question why they were willing to pay something for Plan A/B, respondents who only valued Plan A most likely found it difficult to answer the open question. Thus, several respondents just stated that they prefer Plan A. Thus, we added a sixth WTP category; "vi) Prefer Plan A".

Table 5: Percentage of Zero WTP responses (excluding protest zeros), and the percentage (of the total sample) of respondents with positive Willingness to Pay (WTP) distributed on their main reason (WTP Categories) for being willing to pay something for Amazon rainforest preservation

	WTP Categories						
Zero WTP	Existence	Bequest	Carbon	Social Resp.	Don't know	Prefer Plan A	Total
9,01	41.32	7.85	8.68	11.57	16.12	5.37	100

Existence values seem to dominate the motivation for positive WTP, and non-use values (in terms of existence, bequest and social responsibly values) make up 2/3

of the positive WTP. Note that less than 9% seem to include the carbon storage values in their WTP. To assess whether theses respondents have higher mean WTP for Plan A and Plan B compared to the other respondents with positive WTP, a Welch's t-test of mean difference between two independent samples were performed. Mean WTP for Plan A and B among the "Carbon" respondents is NOK 2141 and NOK 1297 for Plan A and B, respectively. However, among the other respondents with positive WTP, the corresponding mean WTP is NOK 885 and NOK 657. Test results confirm a statistical significant difference in the means of WTP for Plan A and for Plan B between carbon respondents and other respondents with positive WTP. However, as the "Carbon" respondents make up less than 9 % of the respondents, the WTP estimates should be very comparable to the Delphi CV survey. However, in order to get a "cleaner" test we can also exclude the "carbon" respondents from the sample, without losing many respondents, when comparing the CV and the Delphi CV surveys.

Tables 6 and 7 reports the independent variables and results from the regression models from the CV survey, respectively. Results are consistent, both with economic theory and results from previous CV survey of forest preservation .

Table 6: Description of Independent Variables

Variables	Description	obs	mean	SD	min	max
lnhhinc	Log of midpoint household income	300	13.386	0.579	11.513	15.202
higheduc	dummy, 1 if bachelor degree or higher	300	0.523	0.500	0	1
male	dummy, 1 if male	300	0.503	0.501	0	1
lnage	Log of age	300	3.844	0.413	2.890	4.407
oslo	dummy, 1 if from Oslo	300	0.123	0.329	0	1
highinttime	dummy, 1 if interview time is 10+ minutes	300	0.300	0.459	0	1
envlist	dummy, 1 if believe EC is fairly or very important	300	0.703	0.458	0	1
moremoneySA	dummy, 1 if believe we must spend much or a little more public money on EP in South America	300	0.277	0.448	0	1
unrealplans	dummy, 1 if believe non of the preservation plans are realistic	300	0.140	0.348	0	1
realplans	dummy, 1 if believe plan A and Plan B are realistic	300	0.150	0.358	0	1
envmember	dummy, 1 if member of an environmental organization	300	0.087	0.079	0	1

contpolicy	dummy, 1 if believe results form survey will be used in policy decisions	300	0.047	0.211	0	1
visitamazon	dummy, 1 if have visited the Amazon rainforest	300	0.070	0.256	0	1
planvisitrain	dummy, 1 if quite or very sure will visit a tropical rainforest	300	0.140	0.348	0	1
smaller	dummy, 1 if believed Amazon was smaller than showed in maps	300	0.510	0.501	0	1
volunteer	dummy, 1 if respondents perform voluntarily work,	296	0.355	0.479	0	1
payfordef	dummy, 1 if believe one has to pay tax to reduce deforestation in the Amazon rainforest	300	0.043	0.204	0	1
co2	dummy, 1 if reason for being WTP for Plan A/B is related to carbon	241	0.087	0.283	0	1
bequest	dummy, 1 if respondents perform voluntarily work	241	0.079	0.270	0	1

Table 7: Regression Results

	Interval Regression		Midpoint OLS Regression	
	Whole sample		Whole sample	
Variables	Plan A	Plan B	Plan A	Plan B
lnhhinc	0.318*	0.499***	0.316*	0.500***
	(0.212)	(0.230)	(0.222)	(0.238)
higheduc		0.252		0.250
		(0.269)		(0.278)
male	-0.552***	-0.373*	-0.557***	-0.373*
	(0.237)	(0.248)	(0.227)	(0.256)
lnage		0.252		0.248
		(0.321)		(0.331)
oslo	1.074***	1.008***	1.072***	1.005***
	(0.350)	(0.358)	(0.293)	(0.370)
highinttime	0.418**	0.677***	0.420*	0.679***
	(0.258)	(0.266)	(0.261)	(0.275)
envlist	0.860***	0.854***	0.853***	0.847***
	(0.280)	(0.291)	(0.310)	(0.300)
moremoneySA	0.959***	0.723***	0.957***	0.721***
	(0.273)	(0.285)	(0.206)	(0.294)
unrealplans		1.952***		1.960***
		(0.382)		(0.395)
realplans	0.558**		0.557***	
	(0.321)		(0.259)	
envmember	0.504	0.380	0.512	0.386

	(0.423)	(0.436)	(0.418)	(0.450)
contpolicy	0.794	0.511	0.798***	0.508
	(0.573)	(0.583)	(0.280)	(0.603)
visitamazon	0.979	-0.036	0.098	-0.030
	(0.483)	(0.494)	(0.636)	(0.510)
planvisitrain	0.162		0.158	
	(0.357)		(0.231)	
smaller	0.537***	0.186	0.536***	0.181
	(0.244)	(0.258)	(0.250)	(0.268)
volunteer	0.621***	0.721***	0.618***	0.719***
	(0.254)	(0.263)	(0.239)	(0.272)
constant	-0.270	-3.768	-0.213	-3.736
	(2.844)	(3.185)	(3.032)	(3.290)
Log likelihood	-746	-734	-476	-485
AIC	1522	1501	979	999
BIC	1575	1556	1028	1051
R^2	0.29	0.32	0.29	0.32
Adj. R^2			0.25	0.28
Number of obs	238	239	238	239

Note: Age and higheduc was exclded in the best-fitting model for Plan A. They were also found to insignificantly affect WTP for Plan A in separate models.

4. Comparison of CV, Delphi CV and Benefit Transfer

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 WT_{PE} is the true estimated mean WTP (Kristófferson and Navrud, 2007, p:213):

$$TE = \frac{|WTP_{BT} - WTP_{E}|}{WTP_{E}}$$

Tables 8 and 9 reports the transfer errors of the Delphi CV survey and the Benefit Transfer exercise. Results show that the Delphi CV survey; after Round 2 gives low and in most cases acceptable transfer errors for policy decisions; whereas the benefit transfer techniques (both unit and value transfer) do not perform well.

Table 8. Transfer Error (TE) for Delphi CV survey

	Midpoint Mean WTP	Unconditional Censored Mean WTP
TE Plan A Round 1	41.1%	51.0%
TE Plan A Round 2	12.2%	26.0%
TE Plan B Round 1	26.6%	37.6%
TE Plan B Round 2	18.9%	31.0%

Table 9. Transfer Error (TE) for Benefit transfer; Unit and Value Function transfer

	Midpoint Mean WTP	Unconditional Censored Mean WTP
TE Plan A Unit Transfer	131.4%	92.5%
TE Plan B Unit Transfer	67.9%	42.8%
TE Plan A Function Transfer	488.1%	389.3%
TE Plan B Function Transfer	721.0%	598.5%

Table 10. Transfer Error (TE) for Delphi CV Survey; Excluding CO_2 Respondents

	Midpoint Mean WTP	Unconditional Censored Mean WTP
TE Plan A Round 1	32.6%	41.1%
TE Plan A Round 2	1.8%	11.0%
TE Plan B Round 1	19.1%	31.5%
TE Plan B Round 2	10.6%	24.4%

Previously, we found that 9% of the respondents included carbon storage values in their WTP and that the respective share have on average higher WTP. However, in the Delphi CV survey, the experts were asked to neglect carbon benefits when guessing mean WTP. The transfer errors in Table 9 do not neglect carbon benefits among the Norwegian respondents. Excluding respondents who included carbon storage values, the unconditional censored mean WTP for Plan A and B are €97 (NOK 953) and €74, while the midpoint means are €84 (NOK 827) and €63 (NOK 614), respectively. The transfer errors of the Delphi CV survey are substantially lower when carbon values are excluded. This strengthens the conclusion the Delphi CV survey; after Round 2 gives low and in most cases acceptable transfer errors for policy decisions; whereas the benefit transfer techniques (both unit and value transfer) do not perform well.

Results do not only show that the Delphi method outperforms benefit transfer techniques (both unit and value transfer) in terms of transfer errors. Additionally, the Delphi method outperforms unit transfer in terms of predicting households' ranking of the different preservation plans. The percentage difference between mean WTP for Plan A and B is 42% in the Delphi exercise, while 63% using unit transfer. In comparison, the percentage difference between the sample means is 35%. Consistent with our findings, León et al. (2003) found that expert opinion was useful to predict ranks of environmental goods.

References

Andersen, L., C. W. J. Granger, E. J. Reis, D. Weinhold, and S. Wunder (2002). *The Dynamics of Deforestation and Economic Growth in the Brazilian Amazon*. Cambridge: Cambridge University Press.

Bishop, R.C. and K.J. Boyle (2019): Reliability and Validity in Nonmarket Valuation. *Environmental and Resource Economic*s 72; 559–582.

Boyle, K. J. (2017). Contingent Valuation in Practice. In P. A. Champ and T. C. Boyle, Kevin J. & Brown (Eds.), *A Primer on Nonmarket Valuation* (2nd ed.), Volume 13, Chapter 4, pp. 83–131. Dordrecht: Springer Nature.

Cameron, T. A. and D. D. Huppert (1989). OLS versus ML Estimation of Non-market Resource Values with Payment Card Interval Data. *Journal of Environmental Economics and Management* 17 (3), 230–246.

Cameron, A. C. and Trivedi, P. K (2005). *Microeconometrics: Methods and Applicat-Ions*. Cambridge: Cambridge University Press.

Dalkey, N. and O. Helmer (1963). An Experimental Application of the DELPHI Method to the Use of Experts. *Management Science* 9 (3), 458–467.

Foley, J. A., G. P. Asner, M. H. Costa, M. T. Coe, R. DeFries, H. K. Gibbs, E. A. Howard, S. Olson, J. Patz, N. Ramankutty, and P. Snyder (2007). Amazonia Revealed: Forest Degradation and Loss of Ecosystem Goods and Services in the Amazon Basin. *Frontiers in Ecology and the Environment* 5 (1), 25–32.

Freeman, A. M., J. A. Herriges, and C. L. Kling (2014). *The Measurement of Environmental and Resource Values: Theory and Methods* (Third ed.). Abingdon: RFF Press.

Haab, T. and K. McConnell (2002). *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*. New Horizons in Environmental Economics Series. Cheltenham: Edward Elgar Publishing Limited.

Horton, B., G. Colarullo, I. J. Bateman, and C. A. Peres (2003). Evaluating Non-user Willingness to Pay for a Large-scale Conservation Programme in Amazonia: a UK/Italian Contingent Valuation Study. *Environmental Conservation* 30 (2), 139–146.

Hsu, C.-C. and B. A. Sandford (2007). The Delphi Technique: Making Sense of Consensus. *Practical Assessment Research & Evaluation* 12 (10), 1–8.

Johnston, R. J., K. J. Boyle, W. Adamowicz, J. Bennett, R. Brouwer, T. A. Cameron, W. M. Hanemann, N. Hanley, M. Ryan, R. Scarpa, R. Tourangeau, and C. A. Vossler (2017). Contemporary Guidance for Stated Preference Studies. *Journal of the Association of Environmental and Resource Economists* 4 (2), 319–405.

Kommuneprofilen (2018a). *Befolkning fordelt på kvinner og menn. Antall og andel. 2000 - 2018. Landet i alt*. Available at: http://www.kommuneprofilen.no/profil/Befolkning/DinRegion/bef_kjonn_region.aspx [Online]. First accessed: 12.03.2018.

Kommuneprofilen (2018b). *Gjennomsnittlig alder. 2000-2018. Landet i alt*. Available at: http://www.kommuneprofilen.no/Profil/Befolkning/DinRegion/bef_alder_region.aspx [Online]. First accessed: 12.03.2018.

Kommuneprofilen (N.D.*). Gjennomsnittlig inntekt, formue, gjeld og skatt per*

*innbygger**. *Landet i alt*. Available at: http://www.kommuneprofilen.no/Profil/Inntekt/DinRegion/innt_hovedposter_region.aspx [Online]. First accessed: 12.03.2018.

Kramer, R. A. and D. E. Mercer (1997). Valuing a Global Environmental Good: U.S. Residents' Willingness to Pay to Protect Tropical Rain Forests. *Land Economics* 73 (2), 196–210.

Kristófersson, D. and S. Navrud (2005). Validity Tests of Benefit Transfer - are we Performing the Wrong Tests? *Environmental and Resource Economics* 30 (3), 279–286.

Kristófferson, D. and S. Navrud (2007). Can Use and Non-use Values be Transferred Across Countries? In S. Navrud and R. Ready (Eds.), *Environmental Value Transfer: Issues and Methods*, Volume 9, Chapter 11, pp. 207–225. Dordrecht: Springer.

León, C. J., F. J. Vázquez-Polo, and R. L. González (2003). Elicitation of Expert Opinion in Benefit Transfer of Environmental Goods. *Environmental and Resource Economics* 26 (2), 199–210.

Lindhjem, H. and S. Navrud (2009). Asking for Individual or Household Willingness to Pay for Environmental Goods? *Environmental and Resource Economics* 43 (1), 11–29.

Lindhjem, H. and S. Navrud (2011). Are Internet Surveys an Alternative to Face-to-Face Interviews in Contingent Valuation? *Ecological Economics* 70 (9), 1628-1637.

Malhi, Y., J. T. Roberts, R. A. Betts, T. J. Killeen, W. Li, and C. A. Nobre (2008). Climate Change, Deforestation, and the Fate of the Amazon. *Science* 319 (5860), 169–172.

Mitchell, R. C. and R. T. Carson (1989). *Using Surveys to Value Public Goods : the Contingent Valuation Method*. Washington, D.C: Resources for the Future.

Navrud, S. (2004). Value Transfer and Environmental Policy. In T. Tietenberg and H. Folmer (Eds.), *The International Yearbook of Environmental and Resource Economics 2004/2005: A Survey of Current Issues*, Chapter 5, pp. 189–217. Edward Elgar Publishing LImited: Cheltenham.

Navrud, S. and R. Ready (2007). Review of Methods for Value Transfer. In S. Navrud and R. Ready (Eds.), *Environmental Value Transfer: Issues and Methods*, Volume 9, Chapter 1, pp. 1–10. Dordrecht: Springer.

Navrud, S. and J. Strand (2018). Valuing Global Ecosystem Services: What do European Experts Say? Applying the Delphi Method to Contingent Valuation of the Amazon Rainforest. *Environmental and Resource Economics* 70 (1), 249–269.

Nunes Kehl, T., V. Todt, M. Roberto Veronez, and S. Cesar Cazella (2015*). Real Time Deforestation Detection Using ANN and Satellite Images: The Amazon Rainforest Study Case. The Amazon Rainforest study case*. Cham: Springer International Publishing.

Pascual, U. and R. Muradian (2010). The Economics of Valuing Ecosystem Services

and Biodiversity. In P. Kumar (Ed.), *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*, Chapter 5, pp. 183–256. London: Earthscan Ltd.

Ready, R. and S. Navrud (2006). International Benefit Transfer: Methods and Validity Tests. *Ecological Economics* 60 (2), 429–434.

Sackman, H. (1974). *Delphi Assessment: Expert Opinion, Forecasting, and Group Process*. Santa Monica: The Rand Corporation.

Siikämaki, J., A. Krupnick, J. Strand, and J. Vincent (N.D.). International Willingness to Pay for the Protection of the Amazon Rainforest. Unpublished manuscript. Resources for the Future/World Bank.

SSB (2017a, 6). *Befolkningens utdanningsnivå*. Available at: https://www.ssb.no/utdanning/statistikker/utniv [Online]. First accessed: 12.03.2018.

SSB (2017b, 9). *Familier og husholdninger*. Available at: https://www.ssb.no/familie/ [Online]. First accessed: 12.03.2018.

SSB (2017c, 1). *Folkemengd, etter land, kjønn og alder. Nordiske land. 1. januar 2017. Tal og prosent (SÅ 63)*. Available at: https://www.ssb.no/314742/folkemengd-etter-land-kjonn-og-alder.nordiske-land.1.januar-2017.tal-og-prosent-sa-63(1)) [Online]. First accessed: 12.03.2018.

SSB (2017d, 12). *Inntekts- og formuesstatistikk for husholdninger*. Available at: https://www.ssb.no/inntekt-og-forbruk/statistikker/ifhus [Online]. First accessed: 12.03.2018.

Strand, J., R. T. Carson, S. Navrud, A. Ortiz-Bobea, and J. R. Vincent (2017). Using the Delphi Method to Value Protection of the Amazon Rainforest. *Ecological Economics* 131, 475–484.

Strand, J. Carson, R. T., Navrud, S., Ortiz-Bobea, A. Vincent, J. (2014). A "Delphi Exercise" as a Tool in Amazon Rainforest Valuation. Policy Research Working Paper No. 7143. World Bank Group, Washington, DC. World Bank.

Uhl, C. (1987). Factors Controlling Succession Following Slash-and-Burn Agriculture in Amazonia. *Journal of Ecology* 75 (2), 377–407.

Veisten, K., H. F. Hoen, S.Navrud, and J. Strand (2004). Scope Insensitivity in Contingent Valuation of Complex Environmental Amenities. *Journal of Environmental Management* 73 (4), 317 – 331.

Wooldridge, J. M. (2013*). Introductory Econometrics: A Modern Approach* (Fifth ed.). Mason: South-Western, Cenage Learning.

Yang, S. H., W. Hu, M. Mupandawana, and Y. Liu (2012). Consumer Willingness to Pay for Fair Trade Coffee: A Chinese Case Study. *Journal of Agricultural and Applied Economics* 44 (1), 21–34.

Appendix 1

Table A1: Regression models for respondents with positive WTP only

	Interval Regression		Midpoint OLS Regression	
	Positive WTP respondents		Positive WTP respondents	
Variables	Plan A	Plan B	Plan A	Plan B
lnhhinc	0.212**	0.155	0.210**	0.154
	(0.119)	(0.122)	(0.123)	(0.131)
higheduc	0.014	0.248**	0.016	0.250**
	(0.143)	(0.146)	(0.149)	(0.139)
male	-0.296***	-0.206*	-0.304***	-0.207*
	(0.130)	(0.130)	(0.135)	(0.131)
lnage	0.284**	0.320***	0.285**	0.322**
	(0.167)	(0.167)	(0.174)	(0.173)
oslo	0.620***	0.418***	0.622***	0.417***
	(0.186)	(0.183)	(0.194)	(0.173)
highinttime	0.390***	0.506***	0.392***	0.509***
	(0.139)	(0.138)	(0.144)	(0.150)
envlist	0.500***	0.443***	0.491***	0.434***
	(0.159)	(0.160)	(0.165)	(0.158)
moremoneySA	0.504***	0.346***	0.505***	0.343***
	(0.147)	(0.147)	(0.153)	(0.148)
envmember	0.672***	0.602***	0.684	0.614***
	(0.223)	(0.224)	(0.231)	(0.286)
contpolicy	0.621***	0.626***	0.632***	0.628***
	(0.299)	(0.306)	(0.310)	(0.266)
visitamazon	0.673***	0.279	0.675***	0.285
	(0.276)	(0.271)	(0.287)	(0.292)
payfordef	-0.644**	-0.466*	-0.649**	-0.468
	(0.342)	(0.319)	(0.355)	(0.394
co2	0.675***	0.627***	0.674***	0.623***
	(0.225)	(0.221)	(0.235)	(0.211)
bequest	0.566***	0.912***	0.558***	0.920***
	(0.232)	(0.227)	(0.241)	(0.274)
constant	1.430	1.683	1.474	1.717
	(1.630)	(1.684)	(1.692)	(1.864)
Log likelihood	-571	-535	-476	-282
AIC	1173	1101	623	593
BIC	1228	1155	674	644
R^2	0.36	0.35	0.35	0.35
Adj. R^2			0.31	0.30
Number of obs	219	212	219	212

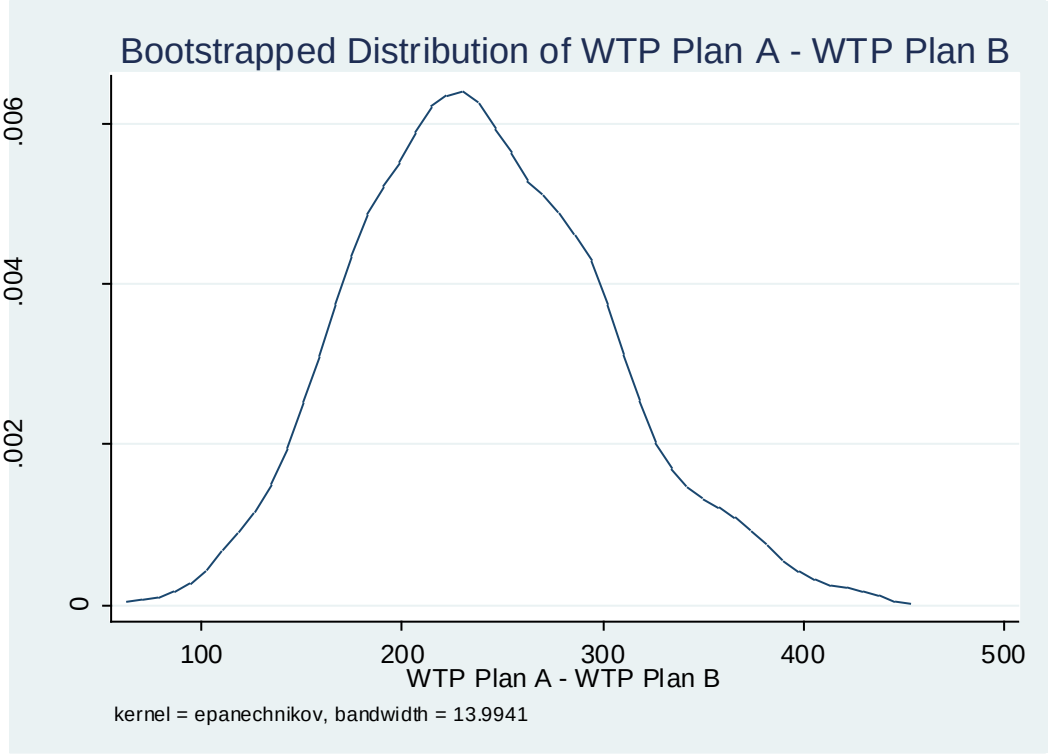


Figure A1: Non-parametric Bootstrapped Distribution of Difference between WTP Plan A and WTP Plan B