Universitetet i Stavanger

UIS BUSINESS SCHOOL

MASTER'S THESIS

STUDY PROGRAM:	THESIS IS WRITTEN IN THE FOLLOWING SPECIALIZATION/SUBJECT:
Master of Business Administration	Economic Analysis IS THE ASSIGNMENT CONFIDENTIAL? (**NB**! Use the red form for confidential theses)

TITLE:

Temporal Stability of Norwegians' Willingness to Pay to Avoid an Oil Spill in Lofoten.

AUTHOR(S)		SUPERVISOR:
Candidate number:	Name:	Henrik Lindhjem
3062 ……	Benedicte Nessler …….	
3083 ……	Silje Helgesen van der Veen …….	

Preface

This thesis constitutes 30 credits and concludes our MSc in Business Administration at the University of Stavanger. This paper is written within the field of Environmental and Resource Economics. The purpose of this research is to investigate the temporal stability of Norwegians' willingness to pay to avoid an oil spill in Lofoten.

The process of writing this thesis has been interesting and educational, but also demanding. The process took an unexpected turn because of the Covid-19 pandemic. This gave limitations in ways of interacting and working together, but forced an alternative but efficient way of working through the different stages of the research.

We want to direct a special thank you to our supervisor Henrik Lindhjem at Menon Centre for Environmental and Resource Economics for guidance and helpful advice throughout the process. We also want to thank Gorm Kipperberg for always being available and providing additional guidance. Our interactions with both have contributed to interesting conversations as well as useful ideas and support for our research. We have gained both academic and personal experience that will be valuable as we enter a new stage in life.

Data collection for this research paper was funded by the Norwegian Research Council as a part of the two projects «COAST-BENEFIT: Ecosystem Service Valuation for Coastal Zone Management: From Promise to Practice» and «MarES: Changing uses and values of marine ecosystem services in the Norwegian Arctic».

Benedicte Nessler & Silje Helgesen van der Veen
June 2020

Abstract

This paper investigates the temporal stability of Norwegians' willingness to pay (WTP) to avoid an oil spill in Lofoten. Two questions are addressed: 1) does Norwegians' WTP to avoid an oil spill in Lofoten change over time? And 2) which factors can explain changes/stability over time? To address these questions a Contingent Valuation study has been conducted. The initial survey was conducted in 2013, and a second round of the same survey was conducted in 2020. The latter was completed under unusual circumstances, when the Covid-19 pandemic hit Norway. A statistical analysis of the data has been carried out to assess the temporal stability of WTP.

The results show a statistically significant reduction in WTP from 2013 to 2020. A significant reduction in household income between 2013 and 2020 might explain the decrease in WTP. There is reason to believe that the Covid-19 pandemic has negatively influenced WTP. Comparing properties of the two samples and different questions from the surveys indicate stability in determinants of WTP across years. Our results suggest that WTP is not stable, but preferences are. Even though components were added to control for the pandemic, our findings may not be applicable to normal economic conditions.

Table of Contents

1. Introduction **7**

2. Background **9**

2.1 Lofoten *9*

2.2 Oil Exploration in Lofoten *9*

2.3 Oil Spills *10*

2.4 Previous Large Oil Spills from Tankers Internationally *10*
2.4.1 The Prestige Accident 10
2.4.2 The Exxon Valdez Accident 11

3. Literature Review **11**

4. Non-market Valuation **15**

4.1 Theoretical Foundations *15*
4.1.1 Total Economic Value 15
4.1.2 Utility Maximization 16
4.1.3 Willingness to Pay 17
4.1.4 Willingness to Accept 18
4.1.5 Temporal Stability of WTP 18

4.2 Empirical Methods *19*
4.2.1 Stated Preference Methods 19
4.2.2 Contingent Valuation 19
4.2.3 Common Problems and Shortcomings with Contingent Valuation 20
4.2.4 Test-Retest 22

5. Data and Empirical Strategy **22**

5.1 Survey Design *22*

5.2 Questionnaire *24*
5.2.1 The WTP Questions 25
5.2.2 Background Information Section 27

5.3 Variables *27*

5.4 Data processing *29*
5.4.1 Identifying Protest Answers 29
5.4.2 Controlling for Income and Inflation 29
5.4.3 Calculation of Mean WTP 30

5.5 Empirical Strategy *30*

5.6 Hypotheses *31*

6. Results **32**

6.1 Descriptive Statistics *32*
6.1.1 Respondent Characteristics 32
6.1.2 WTP Greater Than 0 37

6.2 Mean WTP for New Respondents *39*

6.3 Regression Results *40*
6.3.1 Pooled Regression 40
6.3.2 Regression for Each Year 44
6.3.3 Checking Gauss Markov Assumptions 47
6.3.4 Sensitivity Analysis 48

6.4 Comparison of Sample who Answered Twice *49*

6.5 Questions Controlling for Covid-19 ..... *51*

6.6 Comparison of Other Questions *52*
6.6.1 Reasons for Positive WTP 53
6.6.2 Most Important Environmental Damages 53
6.6.3 Respondents' Political Views 55

7. Discussion **56**

7.1 Discussion of Results *56*

7.2 Limitations *57*

7.3 Suggestions for Future Work *58*

8. Conclusion **59**

9. References **61**

Appendix 1: Literature Review **69**

Appendix 2: Questions From Survey – Controlling for Covid-19 ..... **82**

Appendix 3: Questions From Survey – Reasons for Positive WTP **84**

Appendix 4: Questions From Survey – Most Important Environmental Damages **85**

Appendix 5: Questions From Survey – Changes in Political View **86**

List of Tables

Table 1: List of variables....28
Table 2: Hypotheses....31
Table 3: Respondent characteristics for 2013 and 2020. 34
Table 4: The importance of different community tasks on a scale from 1-5 in 2013 and 2020. 37
Table 5: Regressing LNWTP_S on the explanatory variables....41
Table 6: Regressing LNWTP_XL on the explanatory variables....43
Table 7: Regressing LNWTP_S for 2013 and LNWTP_S for 2020 on the explanatory variables 45
Table 8: Regressing LNWTP_XL for 2013 and LNWTP_XL for 2020 on the explanatory variables. 46

List of Figures

Figure 1: Standard classification of economic values....16
Figure 2: Table describing the damages of an oil spill, with and without measures 25
Figure 3: Example of the first out of four WTP questions in the questionnaire. 26
Figure 4: Regions represented in the 2013 survey. 35
Figure 5: Regions represented in the 2020 survey. 36
Figure 6: Percentage of respondents of the 2013 that reported WTP greater than zero, real zero answers and protest answers. 38
Figure 7: Percentage of respondents of the 2020 sample that reported WTP greater than zero, real zero answers and protest answers. 38
Figure 8: Mean WTP (in NOK) every year for 10 years for the different environmental damages. 39
Figure 9: Mean WTP (in NOK) for test-retest sample every year for 10 years for the different environmental damages....49
Figure 10: The level of well-being reported by the respondents before and after the Covid-19 pandemic 51
Figure 11: The reasons for WTP > 0 for 2013 and 2020 53
Figure 12: Percentage of the respondents who ranked the environmental damages as the most important one. 54
Figure 13: Shows which party the respondents voted for in 2013 and which party they would vote for today....55

1. Introduction

During the past decades there here has been an increase in the use of non-market valuation methods to value commodities and resources that have no market price. This is one way to measure the values that individuals assign to environmental goods and services (Hanley, 1989, p. 235; Segerson, 2017, p. 1). In this study, the values that individuals assign to the protection of areas of Lofoten in Norway are estimated.

Norway is one of the world's leading ocean nations. The Norwegian coastline is one of the longest in the world, and the marine areas managed by Norway is almost 5 times as large as the land areas. Many of the largest industries in Norway are ocean industries, including oil and gas, the seafood and maritime sector, and accounts for nearly 70% of the Norwegian export revenues (Norwegian Government Security and Service Organisation, 2018).

The Lofoten Islands are located in the North Western part of Norway and are known for their iconic coastal nature. The islands attract tourists from all over the world and are greatly appreciated as a part of Northern Norwegian Culture. Lofoten has a rich biodiversity, with large populations of fish, seabirds and marine mammals (Norwegian Environment Agency, 2013). There is however an ongoing debate about whether there should be oil exploration near the Lofoten islands, which creates a conflict between economic interests and preserving biodiversity and coastal nature. All oil activity carries a risk for potential oil spills.

In the past we have seen major oil spills, including the *Exxon Valdez* Oil Spill in 1998 and the *Prestige* Oil Spill in 2002, which both had severe damaging consequences for the nature and wildlife (Rafferty, n.d.). There is a large empirical literature of non-market valuation, where some are estimating the willingness to pay (WTP) to avoid such environmental damages. Several studies have tested the stability of willingness to pay over time, and have gotten mixed results. Numerous studies find evidence for temporally stable WTP estimates (see for example Brouwer, 2006; Fetene, Olsen & Bonnichsen, 2014; Neher et al., 2017). However, the results of other studies suggest significant changes in WTP over time (see for example Loureiro & Loomis, 2017; Whitehead & Aiken, 2007). There is evidence for stability in WTP over short time periods, but not for longer time periods (see Skourtos, 2010).

This research aims to investigate the temporal stability of Norwegians' WTP to avoid oil spills in Lofoten, using the environmental valuation method of Contingent Valuation (CV). This will

be done by carrying out two almost identical surveys to respondents in Norway. The initial part of this test-retest study was first conducted in 2013. 535 of the same respondents were resampled for the retest in 2020, whereas 475 were new respondents. This will contribute to the empirical literature as there is a confined amount of studies using the same respondents twice.

The research questions that we aim to investigate in this study are therefore:

1. Does Norwegians' willingness to pay to avoid oil spills in Lofoten change over time?
2. Which factors can explain changes/stability in preferences over time?

The first research question is based on the hypothetical scenario of an oil spill happening in Lofoten, thus the WTP to avoid this is measured. The WTP estimates from 2013 and 2020 are reviewed and checked for stability. Potential factors to explain changes/stability are discussed, which are the focus of the second research question.

An unexpected turn for this research happened when the Covid-19 pandemic hit the whole world in March 2020. Additional parts were added to the survey in order to control for the potential effects that the pandemic might have had on WTP and these are investigated in the analysis of this thesis.

The rest of the paper proceeds as follows: Chapter 2 covers background information about Lofoten as a recreational coastal area and previous large oil spills. Chapter 3 provides a review of the relevant empirical literature. Chapter 4 presents a theoretical foundation and discusses the empirical methods that will be useful for understanding the concept of non-market valuation. Chapter 5 covers data and empirical strategy. Chapter 6 presents the results from the surveys, including descriptive statistics, WTP estimates and regression results. Chapter 7 includes discussions of results, limitations and suggestions for future work, and chapter 8 concludes the research.

2. Background

2.1 Lofoten

Lofoten is an archipelago in Norway and is located above the arctic circle in the north of Norway in the county of Nordland. Lofoten attracts tourists from all over the world and is greatly appreciated as a part of Northern Norwegian Culture. Geographically Lofoten reaches from Røst in the southwest to Rafsundet in the northeast. The largest islands are Ausvågøya, Gimsøya, Vestvågøya, Flakstadøya and Moskenesøya (Thorsnæs, 2020). Lofoten is rich in biodiversity, and is a habitat for numerous migratory birds, mammals and fish (Cole et al., 2016, p. 31). There are large coastal areas around Lofoten, and the ocean here is unique. Because of the Gulf Stream, there is a much milder climate in Lofoten than other parts of the world at the same latitude (Visit Norway, n.d.). Here you can find mammals such as sperm whales and minke whales, as well as one of the largest coral reefs in the world (Naturvernforbundet, n.d.a).

Lofoten is known as one of the best fishing areas in Norway, and the fishing industry is highly important in the area (Larson, 2012). The ocean around Lofoten therefore plays an important role. Lofoten is especially known for its Arctic Cod fishery – one of the largest seasonal fisheries in the world. The Arctic cod migrates from the Barents Sea to spawning areas around Lofoten, and the season takes place from mid-February and lasts until the end of April (Lofoten, n.d.). This is the spawning area for the last robust cod stock in the world (Naturvernforbundet, n.d.a).

2.2 Oil Exploration in Lofoten

Northern Norway is known as one of the last great petroleum areas with large potential reservoirs. In 2006 the Norwegian Petroleum Directorate was given the mission to map the petroleum reservoirs in the areas outside Lofoten, Vesterålen and Senja (Naturvernforbundet, n.d.b). Through several years there have been political discussions on whether or not to pursue oil exploration and extraction in the Lofoten and Vesterålen areas. To this day, there are still not any agreements and there has still not been any exploration in these areas (Kaltenborn et al., 2017, p. 30).

All oil activity carries a risk, and even with the best technology and securement there is no guarantee than an oil spill will not occur (Naturvernforbundet, n.d.b). The oil exploration outside Lofoten, Vesterålen and Senja would be much closer to shore than what other oil fields in Norway are. If an oil spill occurs in the areas around Lofoten, there could be severe

consequences for the nature and animals in the area because of how close the potential accident would be to the mainland (Naturvernforbundet, n.d.a). There are also endangered species in the area, such as the Atlantic puffins. Through several years, the stock of this species, as well as the black-legged kittiwake have gone down. An oil spill could be critical for species like these (Naturvernforbundet, n.d.b).

2.3 Oil Spills

An oil spill refers to any uncontrolled release of oil, gasoline, fuels or other by-products into the environment, but will in this research refer to oil spills from oil tankers. These spills can be extremely harmful to the environment and species that come in direct contact with the polluted areas, and recovery time can be long and complex (U.S. Geological Survey, n.d.). Even though safety is a priority on board on oil tankers and amongst oil- and gas companies, oil spills have happened in the past and have had huge effects on the ecosystem. These effects include oil-drenched seabirds, making flying impossible and thus removing the natural insulation and waterproofing that feathers provide. The consequences of oil spills do also apply to humans, as it can lead to contamination and poisoning of local ecosystems and food sources, and putting water resources at risk of contamination (Ali, 2020). The following section will go through some previous large oil spills from oil tankers that has happened internationally.

2.4 Previous Large Oil Spills from Tankers Internationally

2.4.1 The Prestige Accident

One of the most impactful oil spills we have seen in history is from the sinking of the ship *Prestige* in Spanish waters in 2002. The oil tanker suffered a serious accident just 46 km from the northwest of Galicia in Spain. The oil tanker spilled more than 60 000 MT of oil and was the most serious environmental accident ever suffered in Spanish waters, contaminating 1300 km of coastline. The environmental catastrophe lasted for 4 months, affecting the coasts of Northern Spain, Southern Spain and Northern Portugal (Loureiro, Lopéz, Ribas & Ojea, 2006, p. 49)

The recovery and cleaning after the accident lasted for years, and the cleaning operations were completed in December 2004, with a total of 97 000 MT of waste emanating from the Prestige that had been collected from the coast. The total costs of the Prestige accident were estimated by Loureiro et al. (2006), which included costs from cleaning and recovery, all affected

economic sectors and environmental losses. They estimated the total costs to be €770.58 million, which excludes all future losses (Loureiro et al., 2006). Loureiro and Loomis (2017) did a contingent valuation study testing the temporal stability of WTP for avoiding an oil spill, conducting the first survey in 2006 after the Prestige Oil spill and the second survey in 2009 after Spain entered an economic recession. Their results suggested a significant reduction in WTP for avoiding an oil spill, but this change was considered as being due to the changing economic conditions.

2.4.2 The Exxon Valdez Accident

The Exxon Valdez accident happened when the tanker left the port of Valdez, Alaska in March 1989. The tanker was in the open waters of Prince William Sound when it ran into the submerged rocks of Bligh Reef (Carson, Mitchell, Hanemann, Kopp, Presser, & Ruud, 2003, p. 257). This caused oil compartments to rupture, spilling 37 000 MT of crude oil into Prince William Sound and contaminated 1300 miles of coastline. The accident became one of the biggest environmental catastrophes in US history (Carson et al., 2003, p. 257; Amadeo, 2018).

The Exxon Valdez accident lead to huge costs in form of cleaning and recovery, affected economic sectors and environmental damage. The clean-up costs after only the first year were reportedly $2 billion, and Exxon Mobil has paid $4.3 billion as a consequence of the major oil spill (ITOPF, 2018). There was also large damage to the ecosystem with about 1000 dead sea otters and 35 000 dead birds (ITOPF, 2018). Carson et al. (1997) tested the temporal reliability of contingent valuation estimates. The test-retest study was based on the Exxon Valdez oil spill and interviewed respondents for the first time in 1991 and then for the second time in 1993. They aimed to measure the WTP for a program to protect Prince William Sound from oil spills like the Exxon Valdez and its temporal reliability. Their results showed no significant differences in WTP between the two years.

3. Literature Review

The literature studying non-market valuation, and more specifically temporal stability of recreational values, is large. In preparation for this thesis 24 previous studies have been reviewed, and the majority of them are studying temporal stability of WTP and other recreational values. The studies are presented in in Appendix 1. These studies consider different topics, using different valuation methods, which are all represented in the columns in Appendix

1. After reviewing these studies, two studies are considered to be particularly relevant for this study and will be discussed more closely: "*How sensitive are Environmental Valuations to Economic Downturns*" by Loureiro and Loomis (2017) and "*Temporal Stability of Recreational Values*" by Rolfe and Dyack (2019). Studies that have been able to use the same respondents in a test-retest study are also relevant and have been taken into consideration in the literature review. The column "time period between applications" in the table in Appendix 1 refers to the time period between the conducted tests in the test-retest studies.

Loureiro and Loomis (2017) is an ex-post study that assesses the temporal stability of WTP when there are changing economic conditions, and investigates this through a Contingent Valuation Method (CVM) study. The study was conducted after the *Prestige* oil spill in Spain in 2006, and the same survey was repeated in 2009 when Spain suffered an economic recession. Their results suggested a drop in WTP, with the median WTP estimates dropping from €60.36 in 2006 to €26.92 in 2009 per household, a statistically significant reduction. The difference is suggested to be due to the changing economic conditions. Loureiro and Loomis (2017) used a Binary Logit Regression Model in their study.

Rolfe and Dyack (2019) assess the importance of temporal stability for reliability- and validity reasons. The temporal stability of the recreational values of Coorong in Australia is studied by using both the Travel Cost Method (TCM) and the CVM where the survey is repeated after a time period of 7 years, which is the same time period as our research. The study's key contribution to the literature is this combined use of a Stated Preference (SP) method and a Revealed Preference (RP) method to test for temporal stability. The CVM part of their study includes hypothetical scenarios given to the respondent. Their results show that the transfer errors were larger with TCM than with CVM. Rolfe and Dyack (2019) used the Logit Model, Poisson Model and the Negative Binomial Model.

There is a confined amount of literature testing for temporal stability by retesting the same respondents with equal or similar tests over a period of time. Fetene, Olsen and Bonnichsen (2014) conducted the same online survey to the same, but also new, respondents in 2005 and 2010. The article assesses the WTP for better protection against flooding in Jutland in Denmark, and examines how these values can be transferred over a time period of five years. By using the CVM, the results indicate that the WTP for flood risk reductions is temporally transferable over the time period of five years.

Czajkowski, Bartczak, Budziński, Giergiczny and Hanley (2016) also use the same respondents and got results suggesting that mean WTP that is stable over time. The study is testing the stability of preferences and WTP for attributes of forest management in Poland over a period of six months, using an online survey. The study uses a Random Utility Model (RUM) and analyses the respondents' choices by using a Mixed Logit Model (MXL). In 2017, Brouwer, Logar and Sheremet tested temporal stability of preferences, choices and WTP. They did a research on drinking water in Switzerland, and the same sample was surveyed three times over a period of two years by using an internet survey. The article uses Choice Experiments (CE) and RUM and analyses the respondents' choices by using a Mixed Logit Model. The follow-up response rate was at 30% and 25%, and the underlying preference parameters seem to be stable over a time period of 18 and 24 months.

There are also studies getting more mixed results than the articles mentioned above. Liebe, Meyerhoff and Hartje (2012) tested the temporal stability on CE of landscape areas of onshore wind power in Germany. They tested the same respondents with the same survey two times with eleven months apart. The test-retest estimates for the parametric analysis are not equal, but the results regarding the WTP show that there is a statistically significant difference for only one of the attributes. Overall these results indicate moderate test-retest reliability. In 2014, Shaafsma, Brouwer, Liekens and Nocker tested temporal stability of stated preferences and WTP by conducting a CE. The same respondents were surveyed twice with one year apart about the attachment they felt to landscape amenity, recreation and biodiversity in Belgium. The results show that parameter estimates are not temporally consistent, but the WTP estimates for attributes seem to be robust to transfers over time.

In total 24 articles have been reviewed, which are all represented in Appendix 1. These studies are conducted in 18 different countries all over the world, with 5 studies from The United States, 3 studies from Spain, 2 studies from Germany and also other countries. The different studies use different survey methods, including web-based surveys, mail surveys, phone surveys, on-site surveys and individual interviews. The most popular method among the studies reviewed is web-based surveys, which is also the method that will be used in this study. Web-based surveys are both convenient to the respondent, but also give the opportunity to reach out to a large number of respondents, giving a sufficiently large sample for the study.

When it comes to valuing non-market goods, there are different approaches to choose from. There are both RP methods and SP methods. RP methods in environmental valuation is observing actual behaviour that individuals make within markets and includes the TCM (Boyle, 2003, p. 260). When using SP methods, environmental valuation is based on data from surveys asking individuals specific questions about their preferences and thereby inferring environmental values from their stated responses and includes the CVM (Segerson, 2017, p. 21). Ten of the reviewed studies use the CVM. However, Rolfe and Dyack (2019) use both CVM and TCM and is to our knowledge the first to do this in a temporal stability study. It should be mentioned that many studies use the valuation method of CE, which is also a SP method. The overall objective of a CE is to measure economic values for attributes of an environmental good that is the subject of policy analysis (Holmes, Adamovicz & Carlsson, 2017, p. 133). CE define the change using specific levels of attributes and differ from CVM with the amount of valuation questions (Boyle, 2017, p. 122). One study combines the methods of CVM and CE, which aimed to test for temporal stability across SP question formats, and their results showed few significant differences in estimated parameters and no differences in real WTP values (Price, Dupont & Adamowicz, 2017).

The studies reviewed use a wide range of time periods in between the applications. The shortest time period is 6 months, whereas the longest time period is 30 years. The time period used in this research is 7 years. Skortous (2010) suggests that WTP is stable over short time periods (2 weeks to 5 years), but not temporally stable over 20 years.

The last column in the table in Appendix 1 represents the results from the reviewed studies. As the studies focus on different aspects of non-market valuation and temporal stability, and also use different valuation methods, the results are varied. Many of the test-retest studies present results suggesting that WTP is stable over time (Brouwer, 2006; Fetene, Olsen & Bonnichsen, 2014; Lew & Wallmo, 2017; Price, Dupont, & Adamowicz, 2017; Schaafsma, Brouwer, Liekens & Nocker, 2014; Neher, Duffield, Bair, Patterson & Neher, 2017). These studies present robust WTP estimates over their respective time periods used in their studies. However, the studies by Schaafsma et al. (2014) and Neher et al. (2017) suggest no significant changes in WTP, *but* the same conclusion is not drawn about the parameter estimates. Both studies suggest changes in parameter estimates.

A portion of the studies reviewed suggest significant differences in WTP in their test-retest studies. Liebe, Meyerhoff and Hartje (2012) get results where WTP estimates are not being equal, even when controlled for scale. Whitehead and Aiken (2007) got similar results with WTP dropping significantly from 1991 to 1996. Skourtos (2010) suggests that WTP is not stable for longer time periods. Finally, Loureiro and Loomis (2017) found that median WTP dropped, but this change was associated with the economic recession in Spain that took place after their initial survey.

4. Non-market Valuation

Non-market valuation is valuing environmental goods and services that are not traded in a market. The use of this valuation method has been increasingly used in a variety of policy and decision-making contexts. Valuing the environment through non-market valuation is fundamentally about making choices – however, since environmental goods and services does not necessarily have a market price, these choices, and thereby preferences, cannot be captured through market sales (Segerson, 2017, p. 1). This chapter provides a theoretical foundation and describes empirical methods that can be useful for understanding the concept of non-market valuation.

4.1 Theoretical Foundations

4.1.1 Total Economic Value

Total economic value is used to value environmental goods and biodiversity in monetary terms (Laurila-Pant, Lehikoinen, Uusitalo & Venesjärvi, 2015, p. 3). Figure 1 provides a conceptualization of total economic value. As can be seen, it can be broken into use values and non-use values.

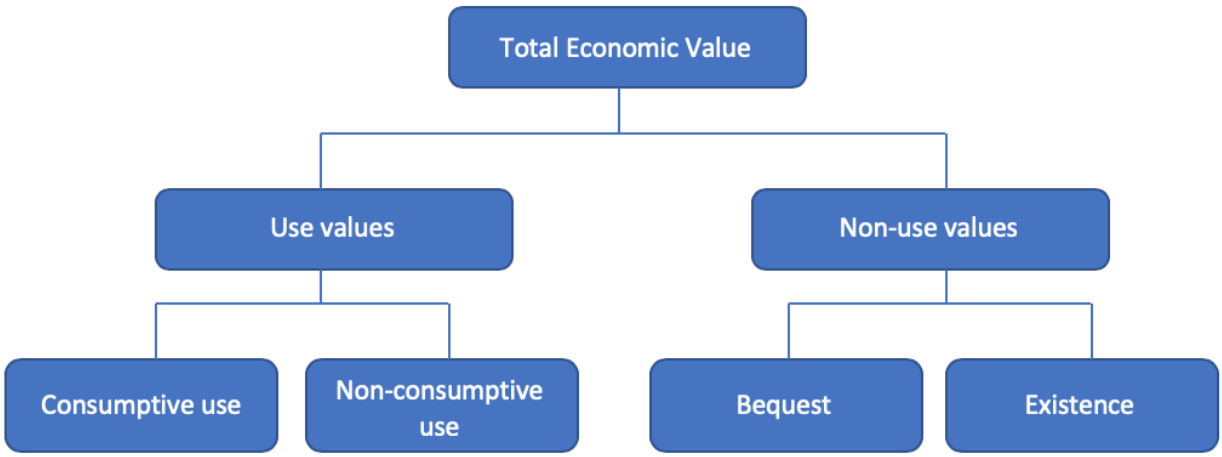


Figure 1: Standard classification of economic values

The total economic value of a natural resource or environmental goods includes both the benefits the individuals get from using the good (use values), as well as the value they place on the good even if they are not using it (non-use values). These values can be the individuals' values for the existence of species or preservation of a natural environment (Segerson, 2017, p. 10). The use values are divided into two categories: consumptive and non-consumptive use. The consumptive use values are associated with direct consumption of a natural resource, while the non-consumptive use associated with obtained values from the environment by not damaging or draining the resource (Perman, Ma, Common, Maddison & McGilyray, 2011). Some articles also include option values as a non-consumptive value. Option values are associated with the value the individuals receive from having the option to use the resource. The non-use values are divided into bequest value and existence or "passive" use value. The bequest non-use value refers to obtained benefits from ensuring preservation of the resources for future generations, while the existence or "passive" use values refers to individuals not using the resources, but would feel a loss if they were to disappear (Laurila-Pant et al., 2015, p. 4).

4.1.2 Utility Maximization

The basic welfare measures used in economic policy analysis are the direct or indirect utility functions. The indirect utility function is the representation of expenditure minimization, which is a condition necessary to hold in utility maximization. Preferences are measured in utility, and we assume individual utility maximization (Nicholson & Snyder, 2010, pp. 88). This means that the consumer chooses the situation he prefers which maximizes his individual utility function. The direct utility function represents maximization of utility U, given market goods

X, non-market goods *Q*, income *y*, and prices *P* and *q*. The utility function is given by equation 1:

Equation 1:

$$MaxU(X,Q)\ s.t.\ y \geq\ PX + qQ$$

Moreover, we can equivalently use the expenditure function to analyse welfare measures. The indirect utility function represents the highest level of utility obtainable when facing prices *P*, market goods *X*, non-market goods *Q*, and income *y*. This rests on the general microeconomic assumption that the individual is rational and seeks to maximize its utility, and thereby minimize its expenditures (Flores, 2017, pp. 31-32).

The above refers to the microeconomic concept of *duality*, because an individual would not be maximizing utility if expenditures were not minimized. Instead of maximizing utility subject to a budget constraint, the individual will minimize expenditures, subject to a given level of utility (Flores, 2017, pp. 31-32). The indirect utility function can be given by equation 2:

Equation 2:

$$Min_x\ P * X\ s.t.\ U(X,Q) \geq\ U^0\ , Q =\ Q^0$$

4.1.3 Willingness to Pay

There are generally two welfare measures that are used in economics; willingness to pay and willingness to accept (WTA). WTP refers to the maximum amount an individual would pay to obtain a good (Carson, Conaway, Mitchell, Hanemann & Presser, 2004, p. 9). In terms of environmental and resource economics, WTP would be the maximum amount a person could pay and then be indifferent about the environmental change (Bishop & Boyle, 2017, pp. 560-561). WTP is also referred to as the compensating surplus. The formal definition of WTP is given by equation 3:

Equation 3:

$$v_i(P^0, Q^0, y_i) =\ v_i(P^0, Q^1, y_i -\ WTP_i^T)$$

In the given definition, $v_i(.)$ is the indirect utility function of the consumers, *P* is a vector of prices which is assumed constant, *Q* is a vector of environmental quality attributes (non-market

good) where at least one element changes from condition Q_0 to Q_1, and y_i is income (Bishop & Boyle, 2017, pp. 560-561). The first part of the equation describes the utility state before the change, and the second part of the equation shows WTP as a compensating measure which ensures the same level of utility.

In this study, WTP will refer to the maximum amount individuals are willing to pay to *avoid* an oil spill and is therefore not directly associated with obtaining a good, but instead avoiding a negative environmental change. The WTP estimate in this study will therefore be a measure of how much the prevention of an oil spill in Lofoten is worth to Norwegian households.

4.1.4 Willingness to Accept

WTA is the minimum amount of compensation an individual would have to receive to give up a good (Carson et al., 2004, p. 9). WTA is also referred to as equivalent surplus and does, unlike WTP, not have an upper limit because of limited income (Freeman III, 2003, p. 1). Which of the two measures that is relevant depends on the situation, and will according to Carson et al. (2004) depend on who holds the relevant property rights of the good. They consider two scenarios; if the oil companies own the right to spill oil along the coast, the appropriate measure is the publics maximum WTP to avoid this oil spill. However, if the public owns the right to an oil-free coast, the appropriate measure is the publics minimum WTA to accept the oil spill (Carson et al., 2004, p. 9).

4.1.5 Temporal Stability of WTP

Microeconomic theory suggests that individuals know their preferences and that these preferences are stable over time. However, behavioural psychology suggests that individuals are continually constructing their preferences in a context dependent manner (Czajkowski et al., 2016, p. 11). This means that preferences regarding WTP for an environmental change might vary over a time period. As discussed in the literature review of this thesis, there are many studies that show results with a stable WTP over time (Brouwer, 2006; Fetene, Olsen & Bonnichsen, 2014; Lew & Wallmo, 2017; Price, Dupont, & Adamowicz, 2017; Schaafsma, Brouwer, Liekens & Nocker, 2014; Neher, Duffield, Bair, Patterson & Neher, 2017). Some studies from the literature review show significant changes WTP over time. Lindhjem, Magnussen & Navrud (2014a, p. 12) suggests the following reasons for WTP to change over time, also showing expected effect on WTP in parenthesis:

- Prices on marked goods in the utility function (+/-)

- Availability of natural and human-made substitutes to coast/sea (-)
- Scarcity of clean coastal areas (+)
- Household income (+)
- How and how frequent the individual use the coastal area (effect depends on type of activity, + for increased frequency)
- Available awareness, information and knowledge about the environmental good (+)

However, standard consumer choice theory suggests that preference parameters should be stable, and this is a crucial assumption in the valuation of a public good (Czajkowski et al., 2018, p. 11).

4.2 Empirical Methods

4.2.1 Stated Preference Methods

SP methods differ from RP methods in the type of data that is used to estimate the environmental values (Boyle, 2003, p. 261). In SP methods, the environmental valuation is based on data from surveys asking individuals specific questions about their preferences and thereby inferring environmental values from their stated responses. The survey questions used in these methods are hypothetical questions which are specifically designed to capture certain information about values individuals hold, for example WTP. SP methods include CVM and CE (Segerson, 2017, p. 21). However, valuation based on such surveys has been criticized because respondents are not engaged in real transactions (Bishop et al. 2017, p. 253).

4.2.2 Contingent Valuation

CVM is used to estimate economic values for non-market resources and recreation. This is done by using surveys to elicit information from respondents (Alberini & Kahn, 2006, p. 7). The CVM seeks to estimate individual's WTP (or WTA) for changes in the quantity or quality of goods and services and aims to get information about preferences by asking the respondents direct questions (Haab & McConnell, 2002, p. 16). As the survey design and data analysis can affect the welfare measures, it is crucial for reliability and validity of the welfare measures to do careful survey design and careful analysis of the data results (Boyle, 2017, p. 86).

Among several possible methods and formats of CV, the most common one is the Dichotomous Choice (DC) approach (Boyle, 2017, p. 105). In this format, respondents are offered to choose

between two options; a status quo option and a change scenario which involves a specific cost. Respondents are asked to answer "yes" or "no" to the DC in the stylized form of "would you be willing to pay $t", and as we assume individual utility maximization, respondents will choose the alternative that will give them the highest utility (Haab & McConnell, 2002, p. 18).

Another method of CV is Payment Card (PC). The respondents are asked to choose a specific estimate for their WTP from a list of possible WTP amounts (Boyle, 2017, p. 102). PC is the method that will be used in this study. A scenario is described to the respondent and is presented with a "card" with payments, either ranked from low to high, or from high to low (Haab & McConnell, 2002, pp. 125-126). The respondent is then asked a question of WTP, and this can according to Haab & McConnell (2002) be asked in four different ways: "pick the amount you are willing to pay", "pick the minimum amount you are willing to pay", "pick the maximum amount you are willing to pay" or "pick the range that describes the amount you are willing to pay". A common problem with the PC questions is that respondents tend to centre their WTP around round numbers (for example 1000 or 5000) and the centred/middle numbers on the scale presented to them (Lindhjem, Magnussen & Navrud, 2014b, p. 32).

4.2.3 Common Problems and Shortcomings with Contingent Valuation

There has been a substantial debate about the credibility of the CVM, and the trustworthiness has been challenged ever since the settlement of monetary damage claims after the Exxon Valdez oil spill (Bishop & Boyle, 2017, pp. 568-569). Many CV studies take the test-retest approach, and there will be a chance that the respondent remembers his previous answers from the initial survey when completing the second survey. This carry-over effect challenges the reliability of the CV studies (Bishop & Boyle, 2017, p. 569). This was tested in a study by McConnell, Strand and Valdés in 1998, and their results suggested that this was due to heterogeneous preferences (McConnell, Strand & Valdés, 1998).

The NOAA panel, which included the Nobel prize winning economists Kenneth Arrow and Robert Solow, did in 1993 consider whether CV provided credible estimates for natural resource damage (Lindhjem et al., 2014b, p. 26). Their recommendation was a qualified "yes", but they developed specific recommendations for how a credible CV study should be done. The report by Arrow et al. (1993) provided a list of several guidelines but specified that a CV survey did not have to meet all guidelines to provide reliable estimates. The guidelines include recommendations on sample type and size, reporting, careful presentation of the CV

questionnaire, and no answer-options to mention some (see all guidelines in Arrow et al. (1993)).

Valuation based on SP surveys has been criticized because respondents are not engaged in real transactions (Bishop et al., 2017, p. 253). One of the more expressive criticizing statements was done by Scott (1965) who referred to contingent valuation as a "shortcut" and said "ask a hypothetical question and you get a hypothetical answer". This refers to the fact that CV surveys are hypothetical in the sense that respondents do not actually make a payment. This often results in a difference between the stated values and the actual values. This is called "hypothetical bias" (Landry, 2017, p. 419). It is therefore crucial in a CV study that the respondent fully understands the questions, scenarios and the change being valued, and therefore provides information ensuring this. Lack of sufficient information will increase the risk of non-truthful answers. Bishop et al. (2017) investigated the problem with hypothetical bias in their study and tested whether the responses from their national representative SP survey was consistent with real economic choices that are expected from real transactions. Their results confirmed that the responses were consistent with economic decisions.

Kevin J. Boyle (2017) introduces 3 types of response categories that are misleading and should be acknowledged in a CV study. The first one includes respondents protesting some part of the CV study, thus not reporting their true willingness to pay. These respondents might answer "0" even though they hold a positive WTP value, which will downward bias the results. The second category refers to respondents that do not fully understand the scenario and change being valued and will therefore not be able to answer truthfully. If the respondents choose to answer even though they do not fully understand what they are being asked, it might result in noisy data and increase the standard error of the mean. The third and last category to mention refers to respondents that answer strategically to influence the results and thereby maybe the decision (if one is being made). If everyone who answers this way acts in a similar manner, this will bias the results and affect the central tendency measures (Boyle, 2017, p. 109).

There can also be problems in CV associated typically with two types of misleading responses; warm glow and social desirability (Boyle, 2017, p. 109). "Warm glow" might arise when a respondent gets satisfaction from making a symbolic commitment to a cause (Perman et al., 2011, p. 425). It arises from the utility respondents get from stating a WTP as a symbolic commitment to the cause, and not the actual change that is being valued. Social desirability is

most relevant in CV studies that include personal interviews and refers to when respondents answer questions in order to please another person such as the interviewer (Boyle, 2017, p. 109).

4.2.4 Test-Retest

By using results from a previous study, while collecting new results by conducting the same or similar tests, the results can be tested to see if they stand the test of time (Brouwer, 2006, p. 400) This is a common investigation approach for test-retest and checks for the reliability of the specific results. However, it should be considered that values can and some values should change over time. Thus, if statistical equivalence in values over time cannot be established, this does not disprove reliability if there are legitimate reasons for these values to have changed (Boyle, 2017, p. 118). This was shown by Loureiro and Loomis (2017), where significant changes in WTP were found, but was seen as a consequence of the economic recession in Spain.

There are certain issues that are important to acknowledge with the test-retest approach, as discussed in section 4.2.3. There can also be "carry-over" effects, which can occur when there is not enough time between the two tests and respondents remember what they answered in the first test. As the probability for this issue to arise minimizes with increased time between the tests, this will also increase the chances of the respondents' values actually change (Teisl, Boyle, McCollum & Reiling, 1995, p. 614).

5. Data and Empirical Strategy

This study aims to investigate if there are changes in Norwegians' WTP to avoid an oil spill in Lofoten, and to see which factors that can explain the potential changes/stability. This chapter gives information about the surveys that were conducted in 2013 and 2020 (5.1 and 5.2). Further, the variables that will be used in the analysis are presented (5.3), as well as data processing is discussed (5.4). Then the empirical strategy that will be used in the analysis is presented, and lastly, four hypotheses that will be discussed are given.

5.1 Survey Design

This study is based on survey data. The survey was prepared by the data collection and market analysis provider NORSTAT, as an internet-based survey. Even though interview-based

surveys generally have been considered to be the "best way" of doing CV surveys, studies have shown that internet-based surveys do not necessarily provide poorer answers (Lindhjem et al., 2014b, p. 29). At the same time, we avoid the misleading responses from the "social desirability" problem described in section 4.2.3. The carry-over effect will not be a problem as the time between the two surveys is 7 years.

The first survey was also prepared by NORSTAT as an internet-based survey in 2013. This survey was conducted twice, in February and August, but will in this study be treated as one sample[1]. Before this, Lindhjem et al. (2014b) developed a pilot study, which showed that respondents are able to understand the description of different natural resource damages and can give reliable estimates for their welfare loss related to an oil spill happening. The second survey contained an almost identical structure and contained identical information about the different oil spill scenarios, the valuation scenario and the valuation questions asking about their WTP to avoid the different oil spill scenarios. The second survey was completed in April 2020.

It should be mentioned that the completion of the second survey was done when the greatest parts of the world were in a so-called "state-of-emergency" because of the Covid-19 pandemic. Because of this, additional questions were added last minute to control for the abnormal situation. The respondents were asked to report their well-being before and after entering this crisis, if they would answer differently on the WTP questions if this was before the Covid-19 crisis, and whether their income would be affected because of the virus.

The goal of these surveys is to estimate credible WTP measures, and it is therefore essential to create a questionnaire that in the best way helps and motivates the respondents to answer their true WTP for avoiding oil spills. This gives important challenges to acknowledge; convey the best possible knowledge about the environmental change that is to be valued in the best possible way in an internet format, thus giving the respondents incentives to provide truthful answers (Lindhjem et al., 2014b, p. 30).

[1] Because Lindhjem et al. (2014) in their study got very similar results from the two surveys with no significant differences, the two samples will for simplicity be treated as one sample in this study.

5.2 Questionnaire

The questionnaires from 2013 and 2020 are almost identical (for full questionnaire, see Appendix 3 in "Velferdstap ved miljøskader fra oljeutslipp fra skip: En pilotstudie" (2013) by Lindhjem, Magnussen, Navrud & Gudding). Some minor modifications were made in the 2020 questionnaire in order to reveal more information about potential changes in the last 7 years. The questionnaire starts with some demographic questions, such as age, gender and the respondents' location in Norway. In the next question the respondents are asked to state how important they think certain community tasks are, as for instance to reduce greenhouse gas emissions, increase the oil securement along the coasts, and make better educational programs in the schools. Further on, the purpose of the survey is mentioned, along with a picture of northern Norway.

The next part includes some RP questions. This section includes questions on actual visitations to Lofoten. There are questions on the number of trips the respondents have taken to Lofoten during the last year, as well as questions about the purpose of their stay if there has been any. They were also asked to state how many percent of their trip that was related to leisure activities.

The next section of the questionnaire contains information and questions about oil spills related to oil exploration and oil activity. Pictures and examples are shown to demonstrate. The respondents are asked a question on whether they have heard about seven previous oil spill accidents. Further on, information about possible consequences of an oil spill in Lofoten are given, and the respondents have to answer whether they have experienced some of these consequences themselves.

Some of the challenges with surveys like these are to provide information about the environmental changes that will be valued in the best possible way, and to provide this information to respondents in a way so that they will answer truthfully. To provide information about the environmental consequences of an oil spill, there were tables showing the environmental damages with and without measures for a small, medium, large and very large oil spill included. Figure 2 shows the table describing the damages of an oil spill, with and without measures, that is presented to the respondents.

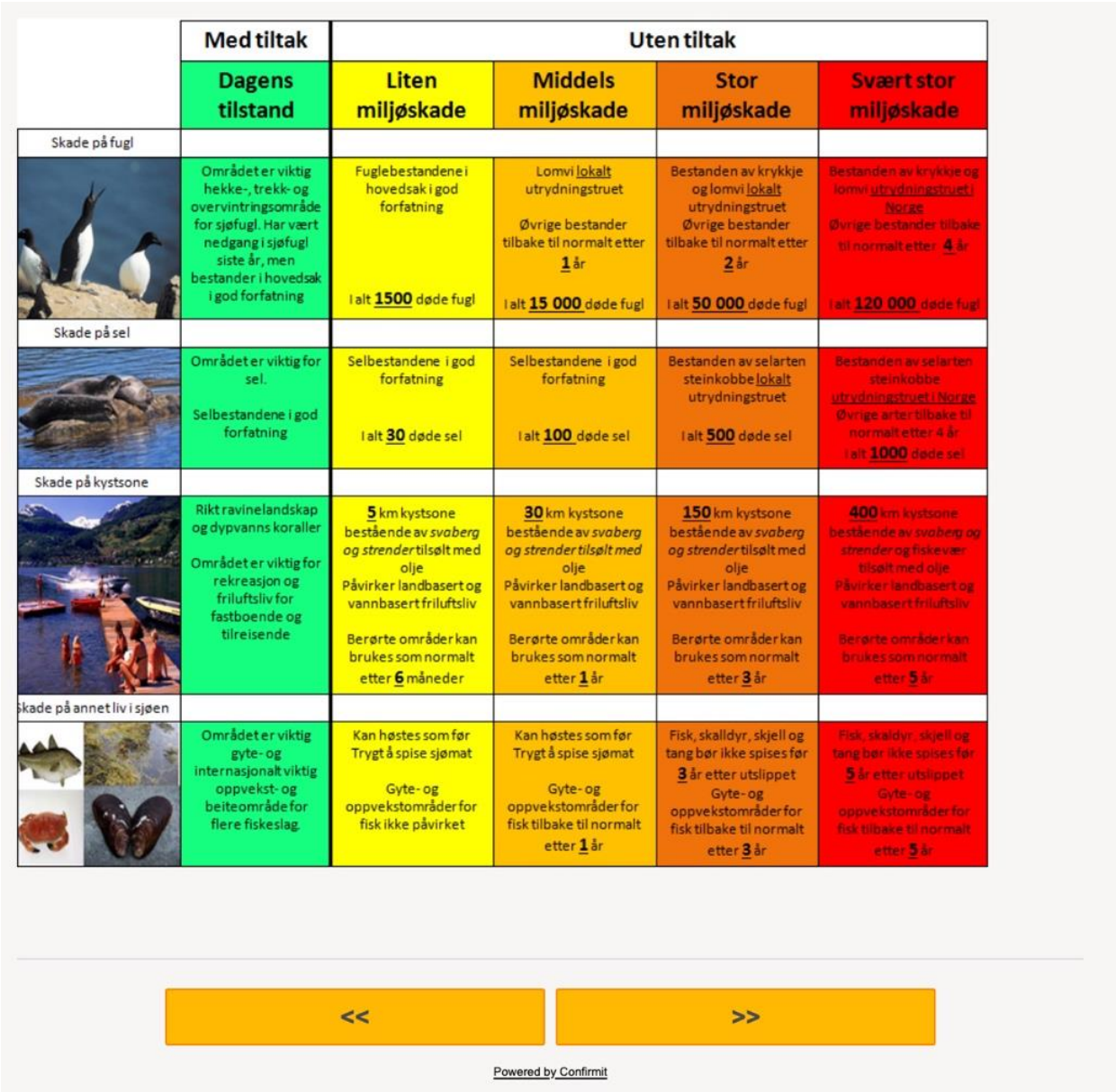


Figure 2: Table describing the damages of an oil spill, with and without measures

5.2.1 The WTP Questions

It is specified to the respondent that the payment vehicle in the WTP questions will be in the form of increased taxes for the household every year for the next 10 years to avoid environmental damages of different sizes. A common problem here is that respondents can be triggered to protest because of resistance for higher taxes (Boyle, 2017, p. 98). The respondents are then reminded that this means less available household income for other things. The WTP questions were presented to the respondent in the form of a payment card with a horizontal "glider" that the respondent could move and choose his household's WTP from "0 NOK" to "more than 15 000 NOK". The first out of the four WTP questions are shown in figure 3 below.

The respondent could also choose to answer "I don't know". As mentioned previously, a common problem with payment card questions is that respondents tend to centre their answers around round numbers and to middle/centred numbers. An attempt to avoid this was done by having a horizontal glider and mostly avoiding round WTP amounts.

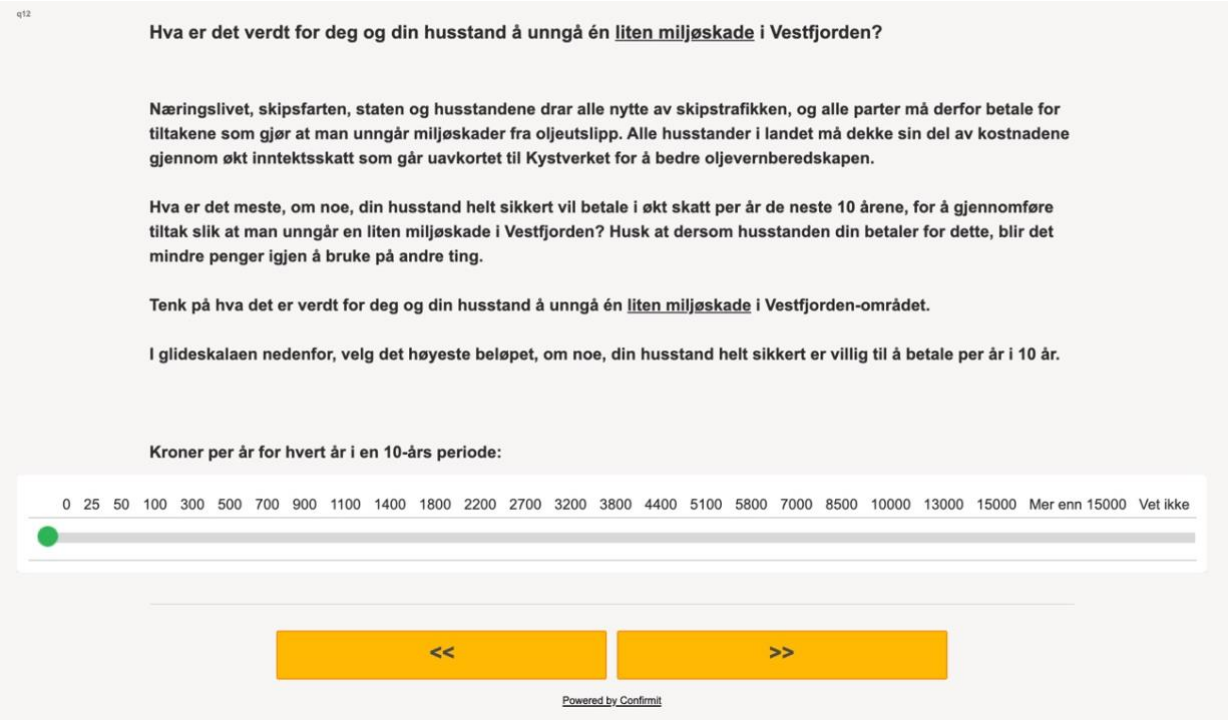


Figure 3: Example of the first out of four WTP questions in the questionnaire.

After asking the respondents about their households' WTP to avoid a small environmental damage, the next three WTP questions come in their respective order with an identical representation. The respective tables and maps describing the environmental damage are shown in each question. It is reminded to the respondents that the WTP amount they answer in the next following questions, will come as an additional amount to the amount they answered in the first WTP question.

How the questionnaire follows after each WTP question is depending on the respondents' answer. If the answer is "more than 15 000 NOK", the respondent will have to specify an amount that reflects his households' WTP. If the answer is either "0 NOK" or "I don't know", there is a follow up question asking the respondent to specify the most important reason for his answer. This includes a list of different alternatives and a box where the respondent can further specify his reasoning.

5.2.2 Background Information Section

The questionnaire ends with a section asking about some background information about the respondents, including income, household income, education and occupation. This is important to reveal characteristics of the population and to help evaluate the validity of the answers and if the answers match basic economic theory. This section also includes questions concerning the respondents' well-being and income before and after the Covid-19 pandemic. The respondents were asked about their general life satisfaction on a scale from 1-10 before and during the crisis. They were then asked if their income would be affected by the current crisis, and if their WTP would be the same if there were normal circumstances. Respondents were also asked to report if they were members of an environmental organization.

5.3 Variables

The variables included in the analysis of this thesis are presented and described in table 1. These variables will be used as explanatory variables for the Ordinary Least Squares (OLS) regression in the analysis. The continuous variables are in logarithmic form and the others are dummy variables. Expected coefficient signs that conform with economic theory and intuition are shown in last column.

Table 1: List of variables

Variable	Description	Exp. sign
LNWTP_S	Logarithm of respondent's WTP to avoid a small environmental damage caused by an oil spill.	
LNWTP_M	Logarithm of respondent's WTP to avoid a medium environmental damage caused by an oil spill.	
LNWTP_L	Logarithm of respondent's WTP to avoid a large environmental damage caused by an oil spill.	
LNWTP_XL	Logarithm of respondent's WTP to avoid a very large environmental damage caused by an oil spill.	
DMALE	Dummy for respondent's gender.	(+ / -)
LNAGE	Logarithm of the respondent's age.	(+ / -)
EDULEVEL	Respondent's education level.	(+ / -)
LNHHINC	Logarithm of the annual household income for the respondent.	(+)
DCLIMATE_GASES	Dummy for respondent reporting that reducing climate gas emissions is highly important.	(+)
DENVORG	Dummy for member of environmental organization.	(+)
DAGAINST_EXPL	Dummy for respondent strongly against oil exploration in Lofoten.	(+)
DFOR_EXPL	Dummy for respondent strongly for oil exploration in Lofoten.	(-)
DKNOWHIGH	Dummy for respondent with high knowledge about previous oil spill accidents.	(+)
PERS_EXP	Dummy for respondent having personal experience with oil spill damage.	(+)
NOINCREASE_TAX	Dummy for respondent does not believe he has to pay higher taxes if measures are implemented.	(-)
EFFICIENT_MEASURE	Dummy for respondent thinks that measures for avoiding oil spills are efficient.	(+)
NOEFFICIENT_MEASURE	Dummy for respondent does not think that measures for avoiding oil spills are efficient.	(-)

KYSTVERKET_USE	Dummy for respondent believes that the Norwegian Coastal Administration will use the results from the survey	(+)

5.4 Data processing

5.4.1 Identifying Protest Answers

An important part when processing the data is to decide how to deal with respondents reporting a WTP of "0" or "I don't know" on one or more of the WTP questions. If these answers are removed from the data, we implicitly assume that their WTP is equal to the mean WTP of the respondents reporting WTP greater than 0. However, if we assume that the respondents who answer in this manner does so because they cannot afford it or because it doesn't provide them any utility, we are likely to underestimate the mean WTP of the sample. This is because some of those who answer either "0" or "I don't know" to one or more WTP questions are so-called protest answers, in which they protest to some component of the survey and do not report their true WTP. Because the payment vehicle used in this survey is increased taxes every year for 10 years, it is likely that someone will for instance protest against higher taxes in their answer. This is the reason why the respondent has to specify the reason for their answer, so that the respondents who actually hold a WTP of 0 because they cannot afford it, or because it does not provide them with any utility, can be identified. By doing this, we can distinguish between "real zero answers" and "protest answers". Don't know answers were coded as zero and treated the same way as zero answers.

5.4.2 Controlling for Income and Inflation

As done in previous studies, some answers where the respondents' WTP exceeded 2% of their household income were taken out because the amount does not conform with economic theory and is unrealistic (Kemp & Maxwell, 1993, p. 230; Lindhjem et al., 2014a, p. 36). This is to avoid upward bias in the estimation of mean WTP for the sample. By doing these cleaning measures, it will help ensure more accurate WTP estimates. Eiswerth and Shaw (1997) stated that comparisons of monetary estimates should be done in real terms. Because it is 7 years between the two surveys, it was controlled for inflation using the consumer price index.

5.4.3 Calculation of Mean WTP

When the respondents were asked to report their WTP to avoid environmental changes caused by oil spills of different sizes, they were asked to choose between 23 different WTP amounts on a payment card scale from 0 NOK and 15 000 NOK. The respondent could also answer "I don't know" or specify an amount higher than 15 000 NOK. For calculations it was assumed that the respondents WTP lies between their indicated WTP amount and the next higher amount on the payment card (Cameron & Huppert, 1989, p. 231). This means that if the respondent answered 1100 NOK on the question, their WTP will lie between 1100 NOK and the next higher amount on the payment card which is 1400 NOK. Mean WTP was then calculated by taking the mean of the midpoints of the respondents indicated WTP. This means that it is assumed that the respondent's WTP is the midpoint of the interval, even though there is equal probability for every value in the interval. Cameron and Huppert (1989) stated that if there are many and close intervals on the payment card, the midpoint calculation could give quite realistic WTP estimates.

5.5 Empirical Strategy

For the empirical strategy, the OLS model will be used for the regression. This model has been applied in similar non-market valuation studies, such as Whitehead and Aiken (2007) and Rosenberger and Loomis (2017). OLS as a regression model can be applied to check the validity of the monetary values that have been found using CV. By using the OLS model, the variables predicted to be key determinants of preferences on WTP can be tested (O'Garra & Mourato, 2007, pp. 389-390). The econometric analysis will be carried out in STATA. The regression will be based on the variables from table 1, and gives the following models[2]:

Equation 4:

$$\begin{aligned}\mathrm{LN}\, WTP\_S = {} & \beta_0 + \beta_1 DMALE_i + \beta_2 LNAGE_i + \beta_3 EDULEVEL_i + \beta_4 LNHHINC_i \\ & + \beta_5 DCLIMATE\_GAS_i + \beta_6 DENVORG_i + \beta_7 DAGAINST\_EXPL_i \\ & + \beta_8 DFOR\_EXPL_i + \beta_9 DKNOWLEDGE\_ACC_i + \beta_{10} PERS\_EXP_i \\ & + \beta_{11} NOINCREASE\_TAX_i + \beta_{12} EFFICIENT\_MEASURE_i \\ & + \beta_{13} NOEFFICIENT\_MEASURE_i + \beta_{14} KYSTVERKET\_USE_i + \varepsilon_i\end{aligned}$$

[2] Because the explanatory variables are the same across all regression models, only the equation for a small environmental damage is shown.

The Gauss-Markov theorem can be used to justify the use of the OLS method. The Gauss-Markov theorem relies on a set of assumptions – the multiple linear regression (MLR) assumptions. There are five assumptions, MLR.1 to MLR.5. The assumptions are linearity in parameters (MLR.1), random sampling (MLR.2), no perfect collinearity (MLR.3), zero conditional mean (MLR.4) and homoskedasticity (MLR.5). The Gauss-Markov theorem states that the OLS estimators are the best linear unbiased estimators (BLUE) – given that the five assumptions of the multiple linear regression model hold (Pedace, 2013, p. 101; Wooldridge, 2014, pp. 71-90). The Gauss-Markov assumptions will be tested in the analysis in chapter 6.

5.6 Hypotheses

Based on the data and literature review there has been formulated hypotheses that will be investigated through the analysis and are all presented in table 2.

Table 2: Hypotheses

	Hypothesis
Hypothesis 1	The WTP estimates are temporally stable and do not significantly differ between 2013 and 2020.
Hypothesis 2	People who are strongly against oil exploration in Lofoten will have a higher WTP for avoiding an oil spill.
Hypothesis 3	People who are a member on an environmental organization will have a higher WTP for avoiding an oil spill.
Hypothesis 4	The Covid-19 pandemic has affected the respondents' reported WTP.

Hypothesis 1 suggests that the WTP estimates for the different environmental damages are stable over time and that there will not be significant differences between 2013 and 2020. This is consistent with a large portion of the literature reviewed for this study, in which their results show temporally stable WTP estimates.

The second hypothesis suggests that people who are strongly against oil exploration in Lofoten will have a higher WTP for avoiding an oil spill in this specific area. It seems likely that people who are strongly against oil exploration in this area will have a greater utility loss if Lofoten suffers oil spill damage, and thus have a higher WTP to avoid this.

Hypothesis 3 suggests that people who are member of an environmental organization will have a higher WTP to avoid an oil spill in Lofoten. Being a member of an environmental organization is included in the variables used for the analysis. People who are members of such organizations are often opponents of petroleum related activities, and it is therefore likely that they will have a higher WTP for avoiding oil spills.

The last hypothesis is based on the unexpected pandemic, and states that the Covid-19 pandemic has significantly affected the respondents' reported WTP for avoiding oil spills. The survey in this study was conducted when Norway was in a state of emergency because of the Covid-19 pandemic. This severely impacted the economy, creating massive insecurity about future economic outlook and thousands of workers were temporally laid off. There is reason to believe that this has a significant effect on the WTP estimates.

6. Results

In this chapter we present the basic statistics on the respondents from the two samples (6.1). Then we present a statistical summary and comparison of the respondents' stated WTP (6.2). Further, we present results from the regression analysis along with validity and sensitivity analyses (6.3). Lastly, we compare other questions from the survey and how the answers have changed (6.4).

6.1 Descriptive Statistics

6.1.1 Respondent Characteristics

2631 people were invited to do the survey from 2020, which resulted in 1010 respondents completing the survey. 1819 respondents completed the survey in 2013. The 2020 survey was administered to 535 of the same respondents as in 2013, and 475 new respondents. This means that 52.9% of the 2020 respondents have been sampled twice. To get an overview of the characteristics of the samples, some simple descriptive statistics are provided as follows. Table 3 presents an overview of the respondent characteristics from the sample in average terms.

6.1.1.1 2013 Survey

The sample of respondents from the 2013 survey provides a wide range in terms of age. The mean age of the sample is 46.23 years, with the youngest respondent being 18 years old and the

oldest respondent being 79 years old. There is also great variation when it comes to the education level of the respondents. The most frequent groups are the higher education groups, with 27.87% report holding a bachelor's degree, 20.78% holding a master's degree and 7.48% holding a PhD. However, 33.21% answered that their education level was high school and 5.83% answered junior high school as their completed education level.

There is also great variation in the occupations of the respondents. The most frequent occupation group is full-time employee with 51.07% of the sample, while 6.60% is part-time employed. Students and retirees were also represented, accounting for 10.89% and 13.08% of the sample, respectively. Further, 2.09% reported being unemployed, while 5.10% work for their own company. 4.84% of the respondents reported being on sick leave. The last 3.29% of the sample include respondents being on military duty, leave of absence, being on maternity leave and homemakers.

6.1.1.2 2020 Survey

The sample of 2020 also provides a wide range in terms of age. The mean age of the sample is 53.8 years, with the youngest respondent being 18 and the oldest respondent being 86 years old. There is also great variation when it comes to the education level of the respondents. The most frequent groups are the higher education groups, with 40.59% report holding a bachelor's degree, 17.43% holding a master's degree and 1.88% holding a PhD. However, 32.28% answered that their education level was high school, 3.27% answered junior high school and 3.47% answered elementary school as their completed education level.

Like the 2013 sample, there is also great variation in the occupations of the respondents from 2020. The most frequent occupation group is full-time employee with 41.31% of the sample, while 7.85% is part-time employed. Students and retirees were also represented, accounting for 7.55% and 27.21% of the sample, respectively. Further, 7.55% receive unemployment benefits and 5.16% work for their own company. The last 3% of the sample include respondents being on military duty, jobseekers and being on maternity leave.

Table 3: Respondent characteristics for 2013 and 2020.

Respondent Characteristics	**2013**	**2020**
Higher education >4 years (%)	28.26	20.56
Member of environmental org. (%)	5.83	7.33
Married (with or without children) (%)	61.90	66.20
Female (%)	48.60	46.24
Average age (years)	46.23	53.80
Household income (mean, NOK, both in 2020 equivalent values)	800 309	730 710

The respondent characteristics are in many ways similar for 2013 and 2020 as most of the variables show few differences, which can be seen in table 3. The sample from 2020 is on average 7,57 years older than the sample from 2013. This makes sense as there is 7 years between the surveys and 535 of the respondents from 2020 also answered the survey in 2013. Household income from 2013 has been transformed to 2020 equivalent values, showing higher household income in 2013. The difference between the two means has been tested with an unpaired two-sided t-test. We reject the null and can therefore say that there is a significant difference in household income between 2013 and 2020.

6.1.1.3 Regions Represented

The respondents were asked to report their location, in the form of postal code, county and municipality. The respondents are here represented in terms of country region for simplicity and because the location of the respondents is spread all over Norway. Oslo is represented as its own region because of its large size and high population number.

In 2013, the region with the highest number of respondents are East Norway with 35%. Further, West Norway represents 19% of the respondents, while Oslo represents 14%. Mid Norway

represent 13%, North Norway represent 10%, and South Norway represents 9% of the respondents. The distribution of the regions represented in 2013 is shown in figure 4.

In 2020 the region with the highest number of respondents is East Norway with 29%, followed by Northern Norway with 22%. Further, West Norway is represented with 16%, Oslo with 13%, Mid Norway with 11% and South Norway with 9%. The distribution of the regions represented in 2020 is shown in figure 5.

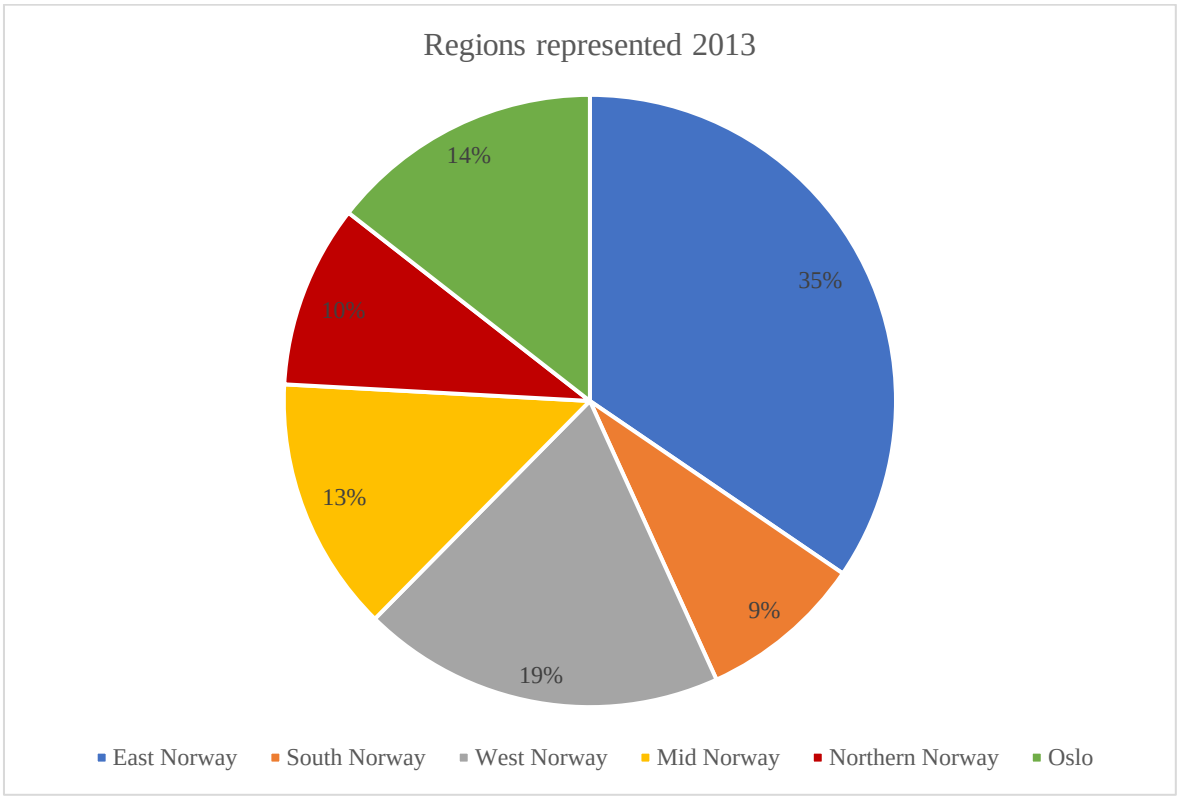


Figure 4: Regions represented in the 2013 survey.

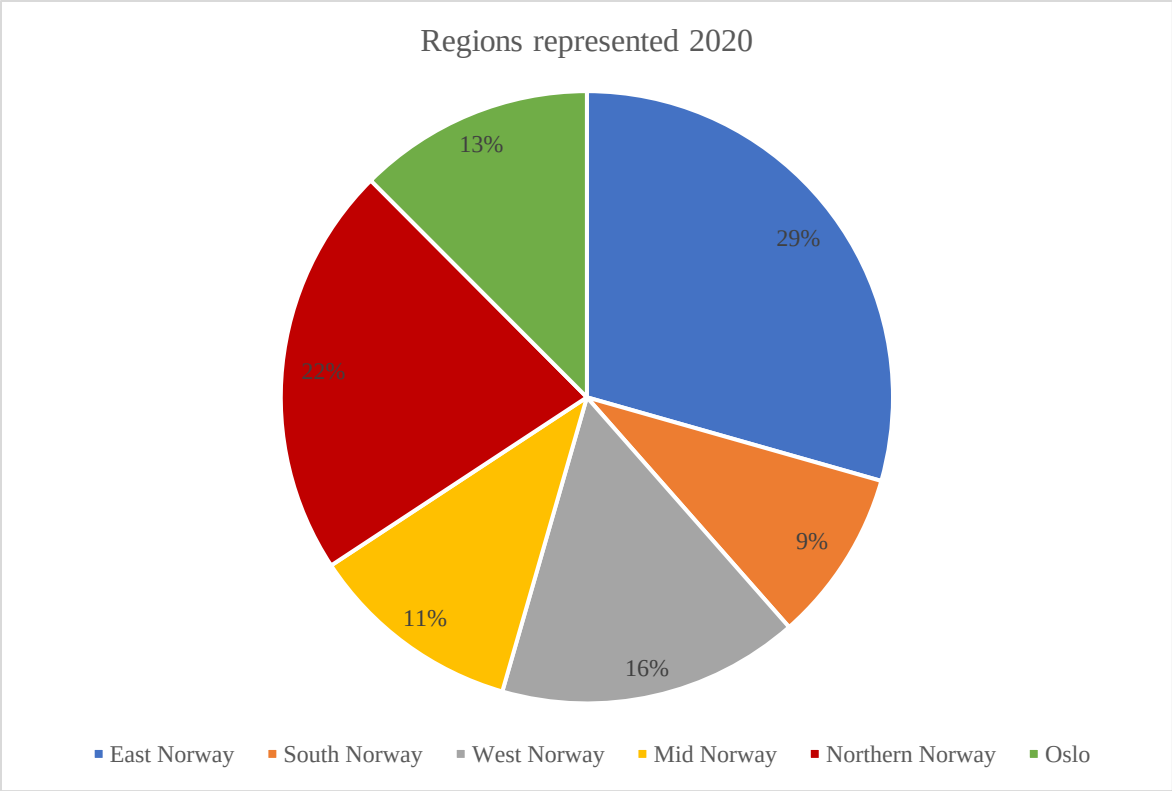


Figure 5: Regions represented in the 2020 survey.

6.1.1.4 Most Important Community Tasks

The respondents were asked to report how important they consider certain community tasks to be. This included reducing greenhouse gas emissions, increasing protective measures and improve education programs in primary and secondary school. Table 4 depicts the different community tasks and how the respondent reported regarding the importance of these tasks. The respondents answered on a scale from "very important" to "not important at all", and for the purpose of this analysis these answers have been transformed to a numeric scale from 1-5. 1 represents "very important" and 5 represents "not important all". The respondents could also answer "I don't know" and this was replaced with the average score.

Table 4: The importance of different community tasks on a scale from 1-5 in 2013 and 2020.

Community tasks	**2013**		**2020**	
	Mean (score)	***Std.err.***	***Mean (score)***	***Std.err.***
Reduce greenhouse gas emissions	2.02	0.023	1.99	0.033
Reduce hospital waiting lists	1.51	0.016	1.59	0.021
Build new roads	1.90	0.022	2.18	0.033
Increase protective measures for oil spills	1.98	0.020	2.00	0.028
Improve education in primary and secondary school	1.64	0.017	1.88	0.025
Improve elderly care	1.54	0.016	1.59	0.021

In both years, reducing hospital waiting lists and improving elderly care are ranked as the two most important community tasks in both years. Improving education in primary and secondary school also gets a high score in both years but has decreased some in 2020. Reducing greenhouse gas emissions and increasing protective measures for oil spills have quite stable scores between 2013 and 2020. Lastly, building new roads scored higher in 2013 with 1.90 compared to 2.18 in 2020, where it was on average ranked last out of all the different community tasks.

6.1.2 WTP Greater Than 0

As previously explained, it is crucial to decide how to treat the so-called protest answers among the respondents reporting WTP equal to zero. Protest answers were identified and taken out and real zero answers retained. Don't know-answers were coded as zero and treated the same way as the zero answers. This gives the possibility of classifying the respondents into three categories; respondents reporting WTP greater than 0, real zero answers and don't know/protest answers. The distribution is shown in figures 6 and 7 below for 2013 and 2020, respectively. This clearly shows that there are very similar distributions in 2013 and 2020. 78% of the sample reported a WTP greater than zero in 2013, whereas in 2020 this category accounts for 77% of the sample. This is a first indication of temporal stability in preferences among the two samples.

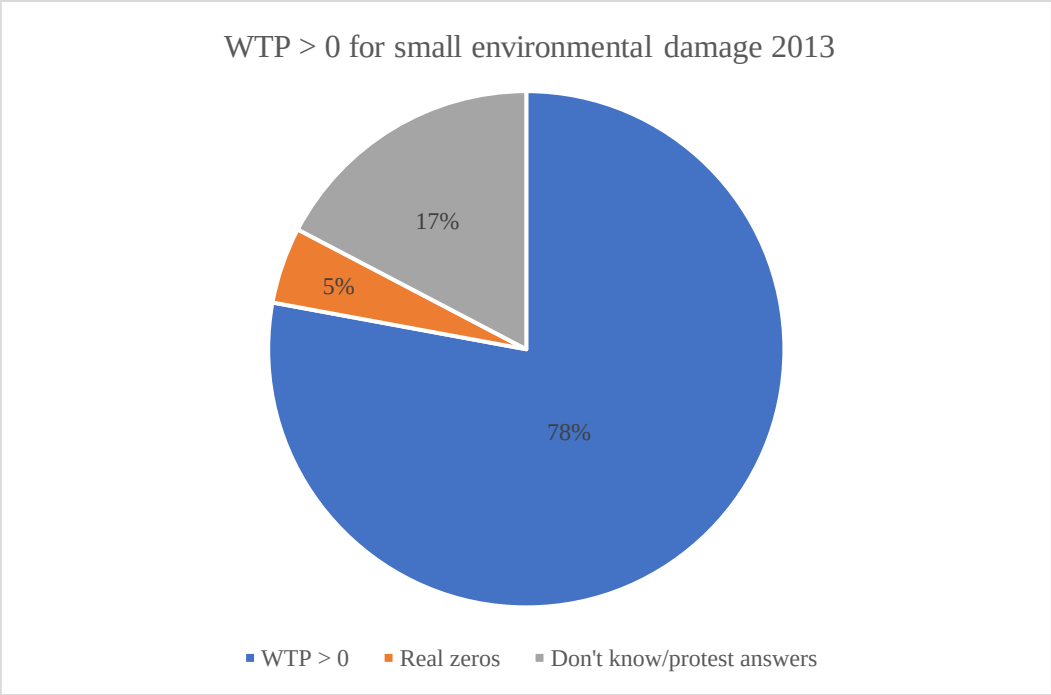


Figure 6: Percentage of respondents of the 2013 that reported WTP greater than zero, real zero answers and protest answers.

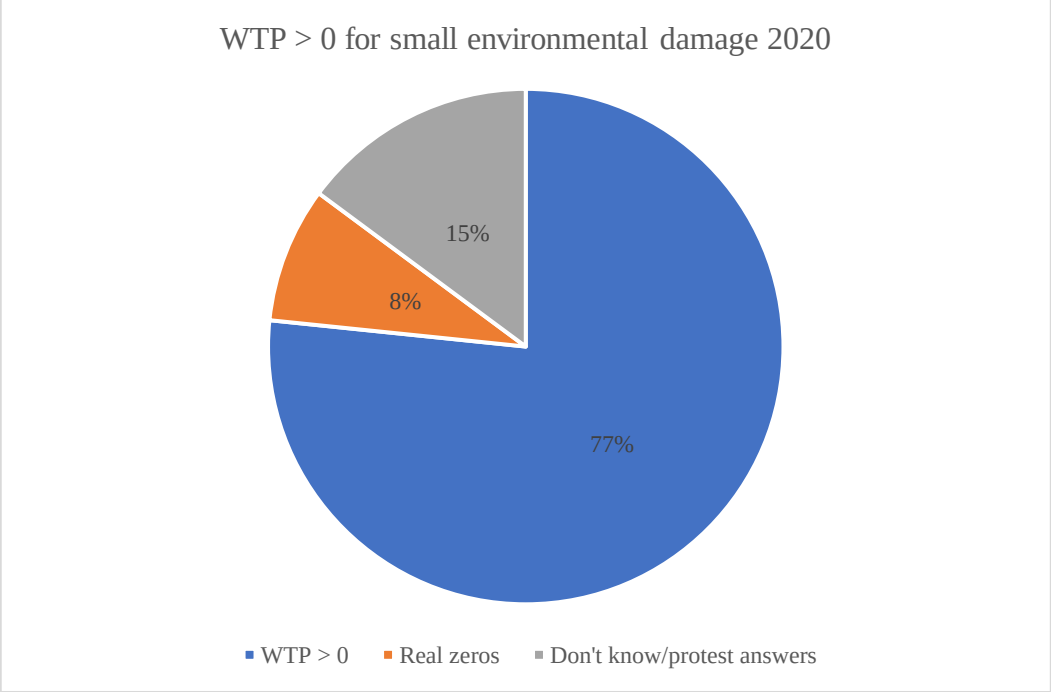


Figure 7: Percentage of respondents of the 2020 sample that reported WTP greater than zero, real zero answers and protest answers.

Note that the figures above only show an acceptance measure for WTP greater than zero for small environmental damages. The distributions show consistency for all the different environmental damage levels.

6.2 Mean WTP for New Respondents

The first part of the analysis includes the respondents from both years who answered the survey for the first time. This part will explicitly address research question 1. As explained, the WTP estimates from 2013 were adjusted for inflation using the consumer price index. Mean WTP was then calculated by taking the mean midpoints of the respondents' indicated WTP. As should be expected, mean WTP increases with larger environmental damages in both years. Figure 8 shows mean WTP for the different damage scenarios for both samples. The exact mean WTP estimates from 2013 are shown on top of the graph and the bottom estimates represent the 2020 sample.

Note: 2013 estimates adjusted for inflation and transformed to 2020 equivalent values.

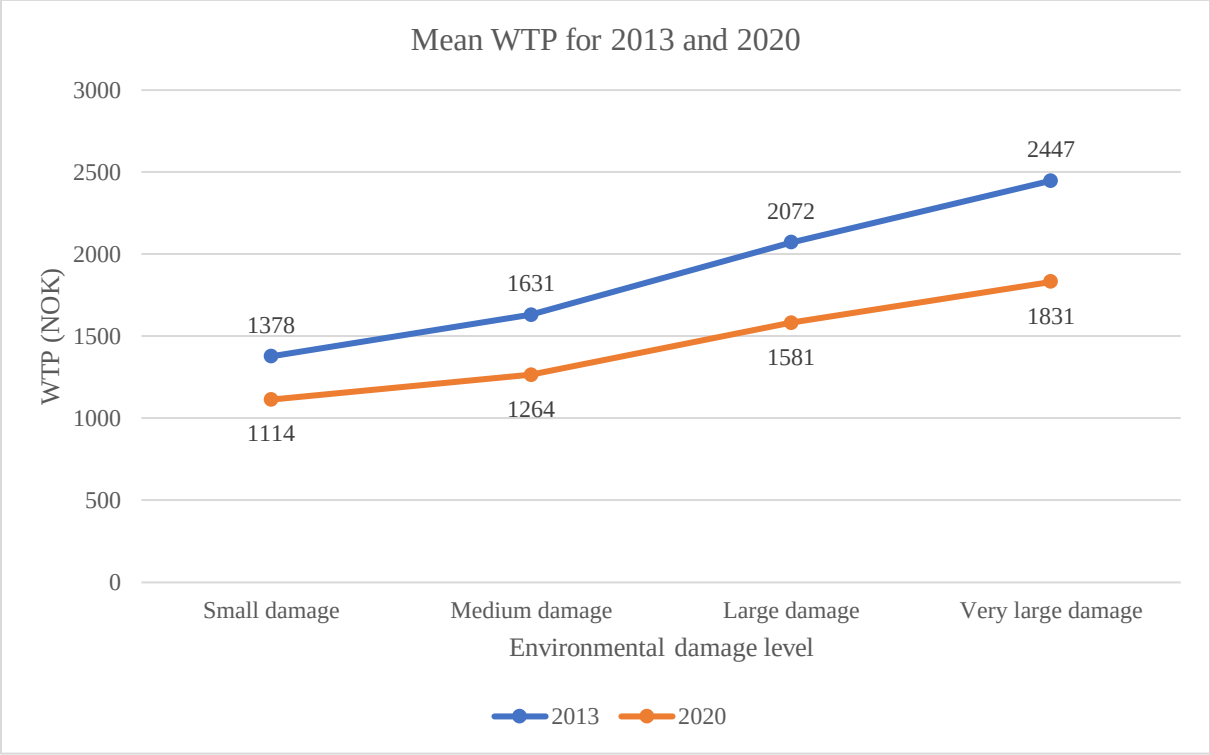


Figure 8: Mean WTP (in NOK) every year for 10 years for the different environmental damages.

To test the differences between the means there have been performed a two-sided unpaired t-test for all the WTP estimates for both years. This gives the following hypotheses:

$$H_0: WTP\_S_{2013} = WTP\_S_{2020}$$

$$H_A: WTP\_S_{2013} \neq WTP\_S_{2020}$$

The two-sided t-test comparing the means of WTP for a small environmental damage gives a p-value of 0.0364, which means that we reject the null hypothesis at a 5% significance level because the p-value is less than 0.05. We can therefore say with 95% confidence that the differences between the means of WTP for a small environmental damage in 2013 and 2020 are statistically significant.

$$H_0: WTP\_XL_{2013} = WTP\_XL_{2020}$$

$$H_A: WTP\_XL_{2013} \neq WTP\_XL_{2020}$$

The two-sided t-test comparing the means of WTP for a very large environmental damage gives a p-value of 0.0005, which means that we reject the null hypothesis. We can therefore say with 95% confidence that the differences between the means of WTP for a very large environmental damage from 2013 and 2020 are statistically significant.[3]

These findings do not support hypothesis 1 (specified in section 5.6), because it shows a significant difference between the WTP estimates from the two years. It should be remembered from descriptive statistics that household income was significantly lower in 2020 compared to 2013. Household income is even lower for the respondents who answered the survey for the first time. This could drive WTP to be lower in 2020 compared to 2013. There can also be unobservable factors not controlled for in the surveys that could contribute to the decrease in WTP. These findings give answer to the first research question, and suggests that Norwegians' WTP to avoid an oil spill in Lofoten has actually changed over time.

6.3 Regression Results

6.3.1 Pooled Regression

An OLS regression has been performed to identify which variables might have an underlying effect on WTP. The variables from table 1 were used. A variable controlling for the Covid-19 pandemic was considered to be included in the regression, but was finally excluded in order to compare the two years with the exact same variables. The regression was performed with robust standard error because of heteroskedasticity, which is safe because of our large sample size

[3] Note that this only shows the two-paired t-tests for the small and very large environmental damage. We reject the null hypothesis also for the medium and large environmental damage levels.

(Wooldridge, 2014, p. 216). This includes a pooled sample, combining the samples from both years who answered the survey for the first time. The logarithm of WTP to avoid a small environmental damage has been regressed on the explanatory variables, where the continuous explanatory variables are also in logarithmic form[4]. Taking the logarithm of the continuous variables gives a more normal distribution (Wooldridge, 2014, p. 157). Following the approach similar to Whitehead and Aiken (2007), a new dummy variable was defined which indicates if the data is from the 2013 sample (*RESP2013*). If this dummy variable gets a statistically significant coefficient, this will indicate a significant time-effect on WTP and the direction it affects is decided by the coefficient sign.

The significance levels of each explanatory variable are indicated in the tables by p-value < 0.1 (*), p-value < 0.05 (**) and p-value < 0.001 (***). Tables 5 and 6 show the coefficient estimates from regressing the logarithm of WTP for small and very large damage respectively on the explanatory variables[5]. The interpretation of the coefficients will be done on the ceteris paribus assumption, that all else are held constant. Description of explanatory variables are available in table 1.

Table 5: Regressing LNWTP_S on the explanatory variables.

Small damage **Variable**	**Coefficient**
RESP2013	0.402 **
DMALE	-0.118
LNAGE	0.018
EDULEVEL	-0.074
LNHHINC	0.401 ***
DCLIMATE_GASES	-0.155
DENVORG	0.519 **
DAGAINST_EXPL	0.689 ***

[4] Protest-answers and outliers have been removed from the WTP answers for all the regressions.
[5] As the regression results show consistency across damage levels, only the tables for small and very large damage is included.

DFOR_EXPL	-0.919 ***
DKNOW_HIGH	-0.242
PERS_EXP	0.357 **
NOINCREASE_TAX	-0.638 **
EFFICIENT_MEASURE	0.702 ***
NOEFFICIENT_MEASURE	-0.892 **
KYSTVERKET_USE	0.416
CONSTANT	0.128
N = 1899 R_2 = 0.0858	

Note: Significance level: 1% (***), 5% (**), 10% (*).

It can be seen from the results that the dummy variable for 2013, *RESP2013*, is positive and statistically significant. These results indicate that the WTP to avoid a small environmental damage is higher in 2013 compared to 2020. This further address the first research question and suggests that WTP has changed. All else constant, WTP to avoid a small environmental damage is 40.2% greater in 2013 compared to 2020. WTP increases with household income and its respective variable is significant at a 1% significance level. This conforms with expectations and basic economic theory.

Other results that conform with expectations is that the variables *DENVORG*, *DAGAINST_EXPL*, *PERS_EXP* and *EFFICIENT_MEASURE* have a significant positive effect on WTP. Respondents who are member of an environmental organization have a 51.9% higher WTP than non-members. Respondents who are strongly against oil exploration in Lofoten have a 68.9% higher WTP than respondents that do not share this view. Respondents who believe the measures against oil spills described in the survey are efficient have 70.2% higher WTP and respondents who have personal experience with environmental changes have a 35.7% higher WTP. It is also as expected that being strongly for oil exploration in Lofoten, or not believing that the measures against oil spills are efficient, have a negative effect on WTP, with the respective variables being statistically significant. This is theoretically expected and strengthen

the validity of our findings. However, *DCLIMATE_GASES* and *DKNOW_HIGH* have negative coefficient signs and do not conform with expectations.

Table 6: Regressing LNWTP_XL on the explanatory variables

Very large damage **Variable**	**Coefficient**
RESP2013	0.387 **
DMALE	-0.139
LNAGE	-0.125 *
EDULEVEL	0.202 *
LNHHINC	0.689 ***
DCLIMATE_GASES	-0.121
DENVORG	0.477 **
DAGAINST_EXPL	0.766 ***
DFOR_EXPL	-0.945 ***
DKNOW_HIGH	-0.538 **
PERS_EXP	0.269 **
NOINCREASE_TAX	-0.491 *
EFFICIENT_MEASURE	0.510 **
NOEFFICIENT_MEASURE	-0.804 ***
KYSTVERKET_USE	0.198
CONSTANT	-2.805
N = 1844 R_2 = 0.1207	

Note: Significance level: 1% (***), 5% (**), 10% (*).

The results from regressing the logarithm of WTP to avoid a very large environmental damage are similar with the results from the small damage. The dummy variable for 2013, *RESP2013*, is positive and statistically significant. The variable for the logarithm of household income is

still positive and statistically significant, which shows that WTP increases with household income.

The variables *DENVORG*, *DAGAINST_EXPL*, and *EFFICIENT_MEASURE* are still significant and have a positive coefficient estimate. The dummy variable for having high knowledge about previous oil spills, *DKNOW_HIGH*, goes from not being insignificant, to being significant in the regression for a very large damage. However, the coefficient estimate is still negative which does not conform with expectations. Similar to the regression for small damage, the dummy for being strongly for oil exploration in Lofoten, *DFOR_EXPL*, and the dummy for not believing that measures are effective, *EFFICIENT_MEASURE*, both have negative coefficient estimates and are significant at a 1% significance level. R_2 is higher in the regression for a very large damage than for a small damage. The regression results from each damage level show that R_2 is higher when the damage level increases. R_2 is relatively low, but this is normal in studies like these (Lindhjem et al., 2014b, p. 37).

The variable *DAGAINST_EXPL* has the coefficients 0.689 for a small damage and 0.766 for a very large damage and is significant at a 1% level for both sizes. These results are consistent across all damage levels. As the coefficients have a positive sign, it will have a positive effect on WTP. This supports hypothesis 2 and indicates that the respondents strongly against oil exploration in Lofoten will have a higher WTP for avoiding an oil spill in Lofoten.

The variable *DENVORG* has the coefficients 0.519 for a small oil spill and 0.477 for a very large damage. It is significant at a 5% level for both sizes. These results are consistent across all damage levels. The coefficients have positive signs and will thus have a positive effect on WTP. This supports hypothesis 3 saying that people who are a member of an environmental organization will have higher WTP for avoiding an oil spill in Lofoten.

6.3.2 Regression for Each Year

To further compare and investigate the differences in significant variables between 2013 and 2020, there has been performed regressions for each year separately. This will help address research questions 2. This follows a similar approach done by Loureiro and Loomis (2017). This regression includes the same samples as in the pooled regression in section 6.3.1, the respondents who answered for the first time in 2013 and 2020. This gives the opportunity to

see which variables can explain variation in the logarithm of WTP in both years separately. The logarithm of WTP to avoid a small and a very large environmental damage has been regressed on the explanatory variables and gives the coefficient estimates shown in tables 7 and 8[6]. Note that coefficients are interpreted on the ceteris paribus assumption, that all else are held constant.

Table 7: Regressing LNWTP_S for 2013 and LNWTP_S for 2020 on the explanatory variables

Variable	*2013 coefficients*	*2020 coefficients*
DMALE	-0.235 **	0.182
LNAGE	0.001	0.240
EDULEVEL	-0.121	0.067
LNHHINC	0.434 ***	0.277 *
DCLIMATE_GASES	-0.283 **	0.298
DENVORG	0.410 **	0.808 **
DAGAINST_EXPL	0.659 ***	0.714 ***
DFOR_EXPL	-0.907 ***	-0.986 *
DKNOW_HIGH	-0.295	0.228
PERS_EXP	0.351 **	0.309
NOINCREASE_TAX	-0.423	-0.765 **
EFFICIENT_MEASURE	0.749 ***	0.537
NOEFFICIENT_MEASURE	-0.785 *	-0.707
KYSTVERKET_USE	0.441	0.338
CONSTANT	0.227	0.492
	N = 1494 *R^2 = 0.0841*	*N = 405* *R^2 = 0.1132*

Note: Significance level: 1% (***), 5% (**), 10% (*).

[6] Medium and large environmental damage have been left out because the regression results are similar to the results for the very large environmental damage.

A difference to be noted in the regression results for a small environmental damage for each year, is that the variable for the logarithm of household income is significant at a 1% significance level for 2013, but is only significant at a 10% significance level in 2020. The coefficients are positive in both years, indicating a positive effect on *LNWTP_S*. The variables *DENVORG* and *DAGAINST_EXPL* are positive and significant in both years. However, it can be seen from table 7 that there are some variables that go from significant in 2013 to insignificant 2020 (if we use 5% significance level). These include *DMALE, DFOR_EXPL, PERS_EXP* and *EFFICIENT_MEASURE.*

Table 8: Regressing LNWTP_XL for 2013 and LNWTP_XL for 2020 on the explanatory variables.

Variable	*2013 coefficients*	*2020 coefficients*
DMALE	-0.180	-0.082
LNAGE	-0.120 *	-0.016
EDULEVEL	0.199 *	0.243
LNHHINC	0.677 ***	0.732 ***
DCLIMATE_GASES	-0.258 **	0.321
DENVORG	0.266	0.999 ***
DAGAINST_EXPL	0.652 ***	1.051 ***
DFOR_EXPL	-1.031 ***	-0.567 ***
DKNOW_HIGH	-0.591 **	0.003
PERS_EXP	0.293 **	0.138
NOINCREASE_TAX	-0.192	-0.741 **
EFFICIENT_MEASURE	0.362	0.876 **
NOEFFICIENT_MEASURE	-0.763 ***	-0.754 **
KYSTVERKET_USE	0.433	-0.474
CONSTANT	-2.129	-4.177
	N = 1446 *R_2 = 0.1118*	*N = 398* *R_2 = 0.1674*

Note: Significance level: 1% (***), 5% (**), 10% (*).

The regression results from the very large environmental damage show that the logarithm of household income is positive and significant in both years. Unlike the separate regressions for a small environmental damage, there is higher consistency in which variables that are significant in both years in the regression for a very large damage. This is also the case for the medium and large environmental damage, which is why the regression tables are not included in the analysis. Being member of an environmental organization, *DENVORG*, is not significant in the regression for a very large damage in 2013. However, this variable is significant across all the other damage levels for both years.

Both *DKNOWHIGH* and *DCLIMATE_GASES* go from negative in 2013 to positive in 2020, which is more in line with expectations. The results show that R_2 is increasing with damage levels and is consistently higher for the 2020 models compared to the 2013 models. In regard to research question 2; even though there are some differences in significant variables between the two years, there are no obvious differences to point out.

An important thing to remember from the descriptive statistics section is that household income was significantly higher in 2013 than in 2020. This could be a factor that explains the change in WTP. Even though household income is only significant at a 10% level in the small damage regression for 2020, is it significant at a 5% significance level in the medium and large damage regressions and at a 1% significance level in the very large damage regression. However, there could be unobservable factors not controlled for in the survey that could influence WTP.

6.3.3 Checking Gauss Markov Assumptions

To check the validity of the regression models, we have tested if the Gauss Markov assumptions hold. We were not able to formally test MLR.1 in STATA, and this assumption is not easy to explore. However, equation 4 is written with linear parameters.

The samples from both years are random and MLR.2 therefore holds. The models were tested for multicollinearity among the predictors using the variance inflation factor (VIF). The general thumb rule is that VIF should not be greater than 10 (Wooldridge, 2014, p. 86). None of the predictors from the regression models have VIF greater than 10, indicating no collinearity among predictors. MLR.3 therefore holds.

The next assumption is MLR.4 and zero conditional mean. We were not able to formally test this assumption in STATA. There are some circumstances under which this MLR.4 will not hold, for example under omitted variable bias. Omitted variable bias is when a variable that belongs in the true model is excluded (Wooldridge, 2014, p. 76). This is a possibility as we could not include all possible variables that can affect WTP, because this would mean a way too long survey.

The Breusch Pagan test was used to test for heteroskedasticity, where the null hypothesis for constant variance for residuals was rejected. This indicates heteroskedasticity and that MLR.5 was violated. However, this is often seen in variables related to income or spending (Wooldridge, 2014, p. 48). For respondents with low household income, the variance in WTP estimates may be smaller because of limited income. For respondents with high household income there may be higher WTP variability, causing variance to increase with income. Even though the OLS estimator remains unbiased, it is no longer BLUE. Under heteroskedasticity the t-tests are not valid, but with robust standard error the procedures are valid in large samples. All regressions were therefore performed with robust standard error, which is an heteroskedasticity-robust method (Wooldridge, 2014, p. 215).

6.3.4 Sensitivity Analysis

To further investigate the validity and robustness of the presented results, the regressions were also performed without taking out the protest zero-answers and WTP-answers who exceeded 2% of income. We wanted to check if our conclusions hold when the assumptions were changed. Regression results when including the protest-answers generally show robust results. The coefficients have the same signs and generally show the same significance. The dummy variable for 2013 (*RESP2013*) is still positive and statistically significant, which further strengthens the theory that respondents from 2013 have a higher WTP. Important variables that show a high level of significance across all the damage levels are also significant and show the same coefficient sign. This includes the dummy for being member of an environmental organization, *DENVORG*, and dummy for being strongly against oil exploration in Lofoten, *DAGAINST_EXPL*, amongst others. These findings further support hypotheses 2 and 3.

Household income is not significant when WTP-answers who exceeded 2% of income are included. However, household income is again highly significant across all damage levels when these outliers are excluded but protest zero-answers are still included. This demonstrates the importance of cleaning measures.

6.4 Comparison of Sample who Answered Twice

The first part of our regression analysis compares the mean WTP from 2013 and 2020 for the respondents from both years who answered the survey for the first time. This further addresses research questions 1. Some of the respondents who answered the survey in 2020 had also answered the survey conducted in 2013. This will be referred to as the test-retest sample. In this part of the analysis, only the test-retest sample will be included in the analysis. Figure 9 shows the mean WTP in 2013 and 2020 for the test-retest sample. The answers from the test-retest sample were not able to be matched on an individual level, so the analysis is based on the average results.

Note: 2013 estimates adjusted for inflation and transformed to 2020 equivalent values.

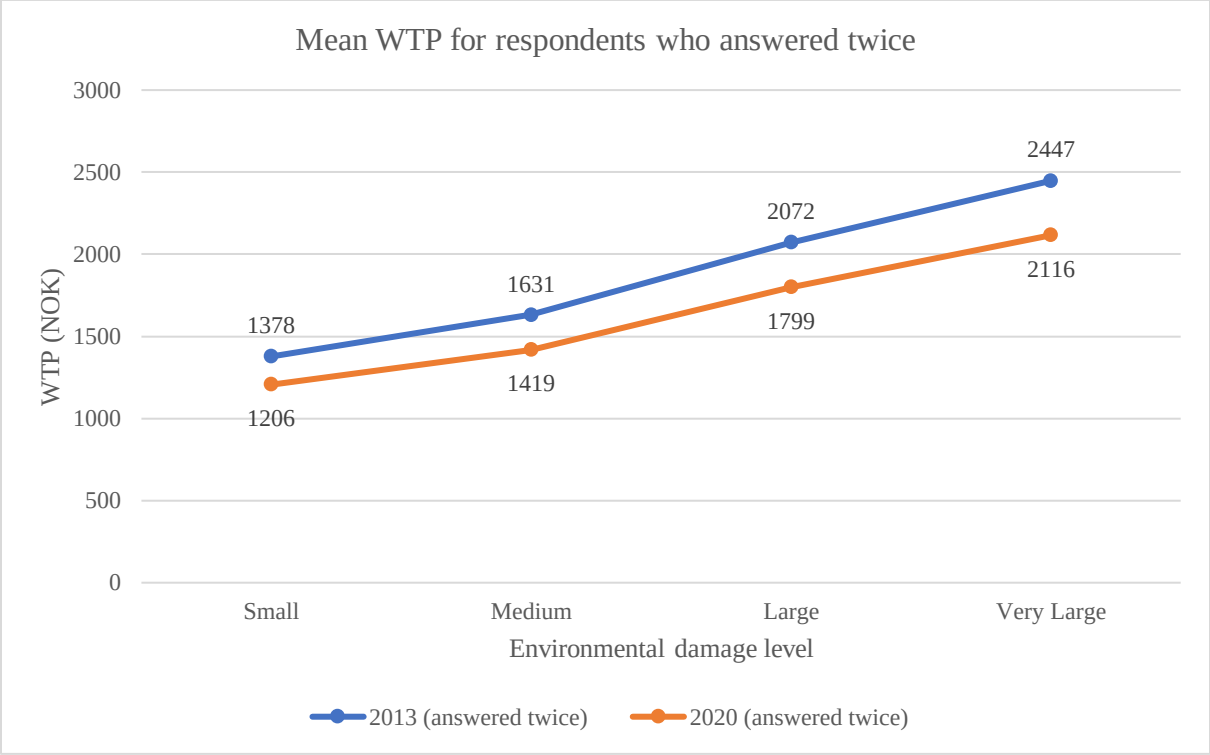


Figure 9: Mean WTP (in NOK) for test-retest sample every year for 10 years for the different environmental damages.

The distance between the two WTP curves is less for the test-retest sample, showing more similar WTP estimates. However, the 2013-curve is still higher than the 2020-curve. To test the differences between the means there have been performed a two-sided unpaired t-test for all the WTP estimates for both years for the test-retest sample. This gives the following hypotheses:

$$H_0: WTP\_Stwice_{2013} = WTP\_Stwice_{2020}$$

$$H_A: WTP\_Stwice_{2013} \neq WTP\_Stwice_{2020}$$

The two-sided t-test comparing the means of WTP for a small environmental damage gives a p-value of 0.0476, which means that we reject the null hypothesis at a 5% significance level because the p-value is less than 0.05. We can therefore say with 95% confidence that there are statistically significant differences between the means of WTP for a small environmental damage in 2013 and 2020.

$$H_0: WTP\_XLtwice_{2013} = WTP\_XLtwice_{2020}$$

$$H_A: WTP\_XLtwice_{2013} \neq WTP\_XLtwice_{2020}$$

The two-sided t-test comparing the means of WTP to avoid a very large environmental damage gives a p-value of 0.009, which means that we reject the null hypothesis. We can therefore say with 95% confidence that the differences between the means of WTP to avoid a very large environmental damage from 2013 and 2020 for respondents who answered twice are statistically significant[7].

These findings do not support hypothesis 1 (specified in section 5.6), as there is also here a significant decrease in the WTP estimates. Even though there is still a significant difference in mean WTP between 2013 and 2020, the difference is less than for the new respondents. These results imply that WTP to avoid an oil spill in Lofoten is more stable over time for respondents who answered the survey twice. Whitehead and Aiken (2007) got similar findings, with more stable WTP for the test-retest sample compared to their non-identical sample. These findings give answer to the first research question, and further suggests that Norwegians' WTP to avoid an oil spill in Lofoten has changed over time. It should be mentioned that mean household income is higher for the test-retest sample than the respondents from 2020 who answered the survey for the first time (739 219 NOK vs. 710 710 NOK). This could drive WTP to be higher for the test-retest sample, and thus closer to the WTP estimates from 2013.

[7] Note that this only shows the two-paired t-tests for the small and very large environmental damage. We reject the null hypothesis also for the medium and large environmental damage levels.

6.5 Questions Controlling for Covid-19

Due to the unforeseen Covid-19 pandemic that hit Norway in 2020, some questions were included in the questionnaire from 2020 to control for the effects this pandemic may have had on the respondents' answers. The respondents were asked to rate their level of well-being on a scale from 0 to 10, both before and after the Covid-19 pandemic hit. The questions can be reviewed in Appendix 2. Figure 10 shows the reported results. There has been a clear change in level of well-being reported. The mean of the well-being reported before the pandemic was 7.81 out of 10 while the mean during the pandemic was 5.54.

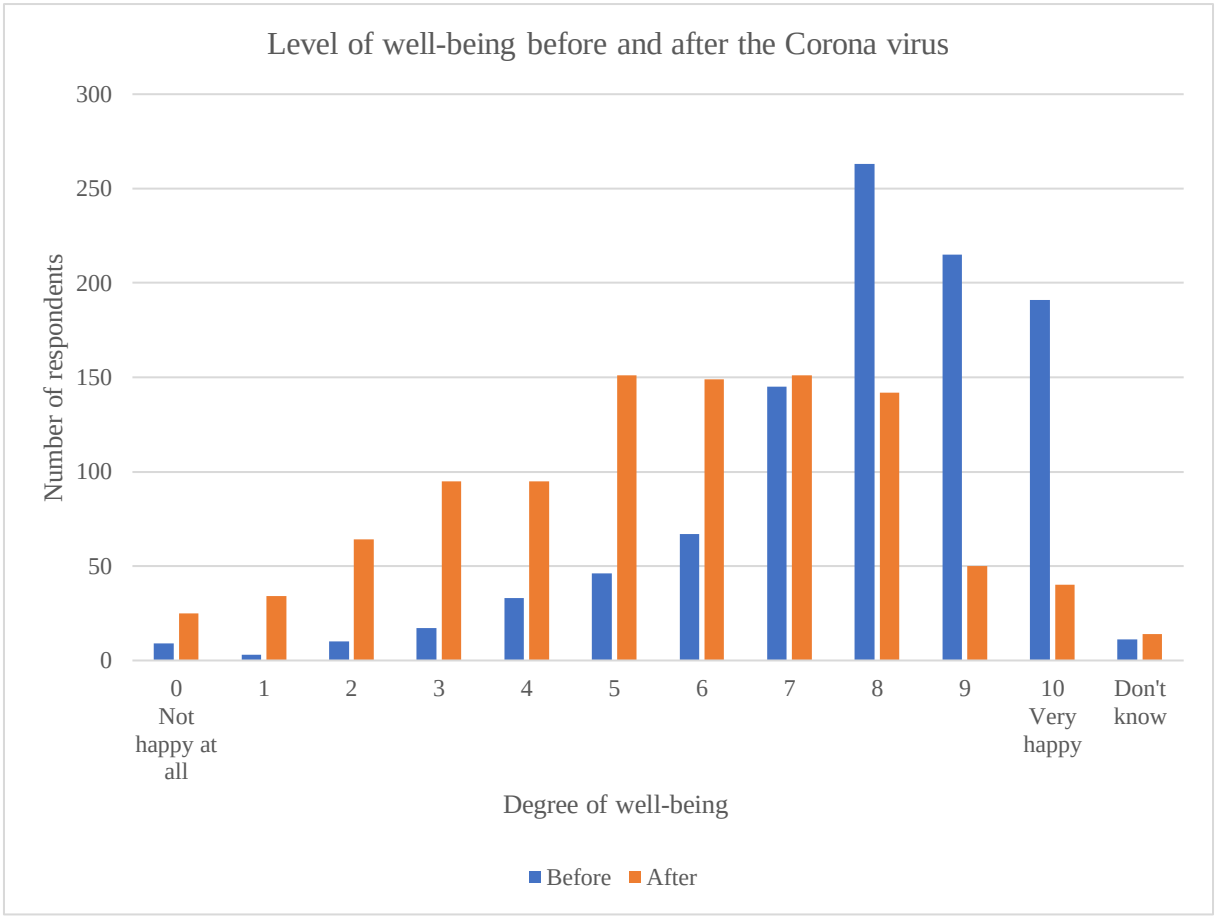


Figure 10: The level of well-being reported by the respondents before and after the Covid-19 pandemic

These results lead us in the direction of the findings in Loureiro and Loomis (2017). The results showed that conducting a CV survey during abnormal economic conditions may lead to results that are not applicable in normal economic conditions. The changes in level of well-being before and after the Covid-19 pandemic hit show that this has significantly affected the well-being of the respondents. Taking this into consideration, as well as thousands of Norwegians

being temporarily laid off and the economic outlook being very unsure and unstable, it is reasonable to say that the time of the survey does not match normal economic conditions.

The respondents were asked to state if the pandemic made them answer differently regarding the WTP and if the pandemic would affect their household income. Only 77 out of the 1010 respondents reported that they would have answered differently. However, 78 reported that their household income would be much lower and 220 reported that their household income would be a little lower because of the pandemic. It is reasonable to believe that this has affected WTP negatively, as we know that there is a strong positive and significant relationship between household income and WTP. Lindhjem et al. (2014a) describes changes in income as one of the main reasons for WTP to change over time. Results show that the mean of WTP for all damage levels are lower if the respondent reported that their income would be lower because of Covid-19.

Mean WTP is lower for respondents who reported that they would have answered differently if the survey was before the pandemic. This result is robust across all damage levels, and further indicates that this have had a negative impact on WTP.

6.6 Comparison of Other Questions

This section will compare answers from other questions from the survey. This gives the opportunity to control for potential differences between the samples that might have influenced the WTP.

6.6.1 Reasons for Positive WTP

If the respondents had a WTP greater than zero, they were asked to specify their reasons for this. The questions can be reviewed in Appendix 3. The distribution of the different reasons is shown in figure 11.

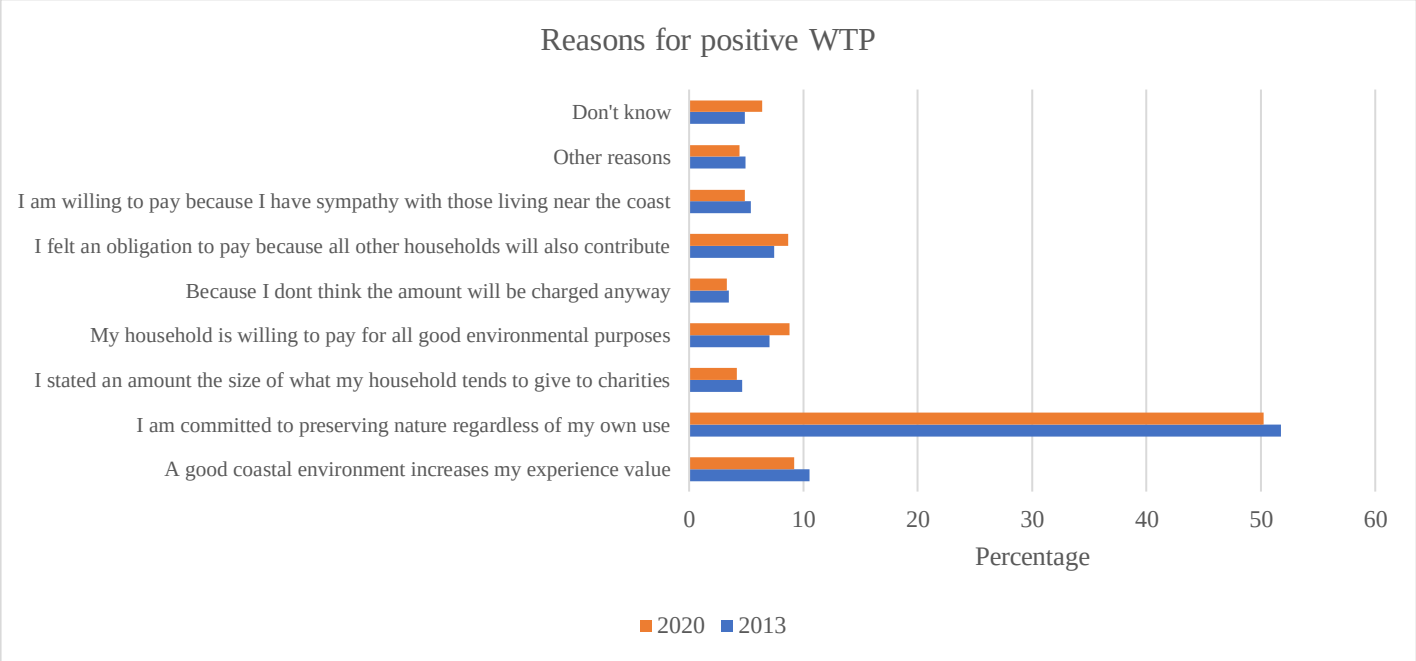


Figure 11: The reasons for WTP > 0 for 2013 and 2020

There is a high level of consistency when it comes to reasons for positive WTP between the two years. The majority of both samples (around 50%) have reported "*I am committed to preserving nature regardless of my own use"* as their main reason. The answers here show a high level of stability.

6.6.2 Most Important Environmental Damages

The respondents were asked to rank four different environmental damages; damage on birds, damage on seals, damage on coastal area and damage on other marine life. The questions can be reviewed in Appendix 4. Figure 12 shows the environmental damages and the percentage of respondents who ranked them as the most important one.

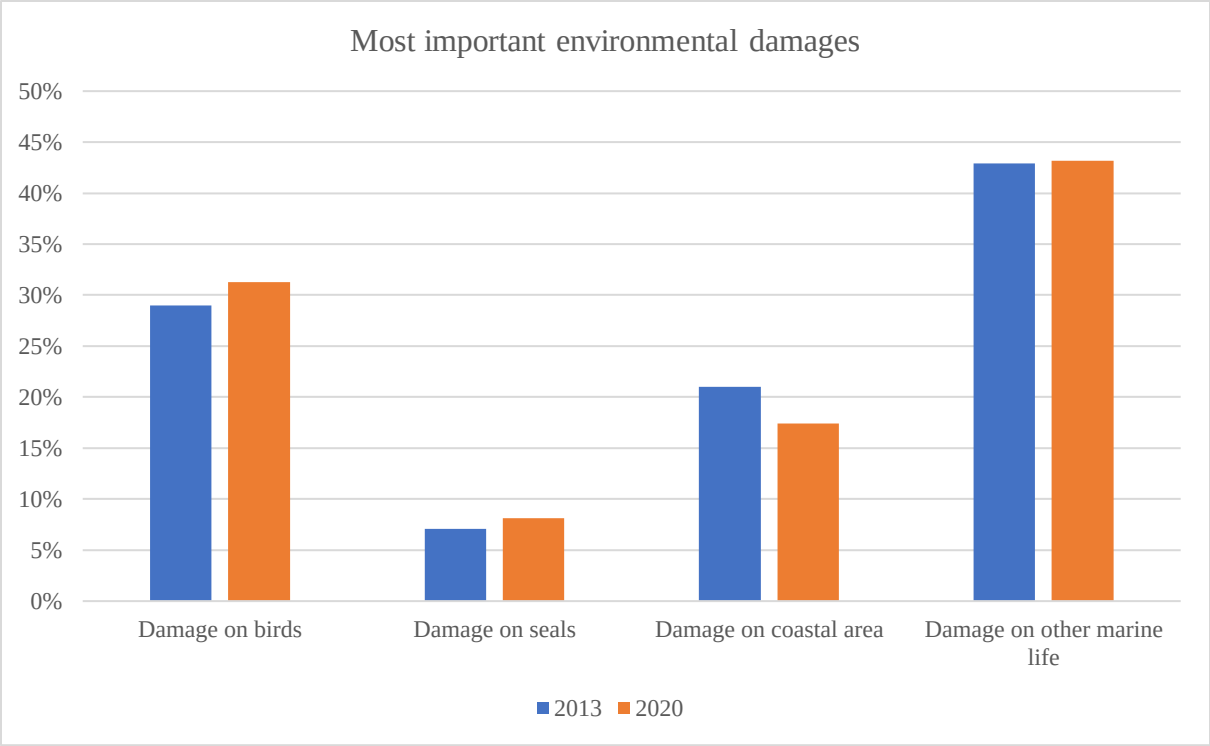


Figure 12: Percentage of the respondents who ranked the environmental damages as the most important one.

There is a high level of consistency when it comes to the most important environmental damages between the two years. In both years, damage on seals has the least percentage of respondents that rank it as the most important. The highest percentage (43% in both years) of respondents ranked damage on other marine life as the most important environmental damage. The answers here also show a high level of stability.

6.6.3 Respondents' Political Views

To control for potential changes in political views, the respondents from the 2020-survey were asked to report what party they voted for in the election in 2013 and then what they would vote if there was an election today. The questions can be reviewed in Appendix 5. Figure 12 shows the changes in political views from 2020 to 2013.

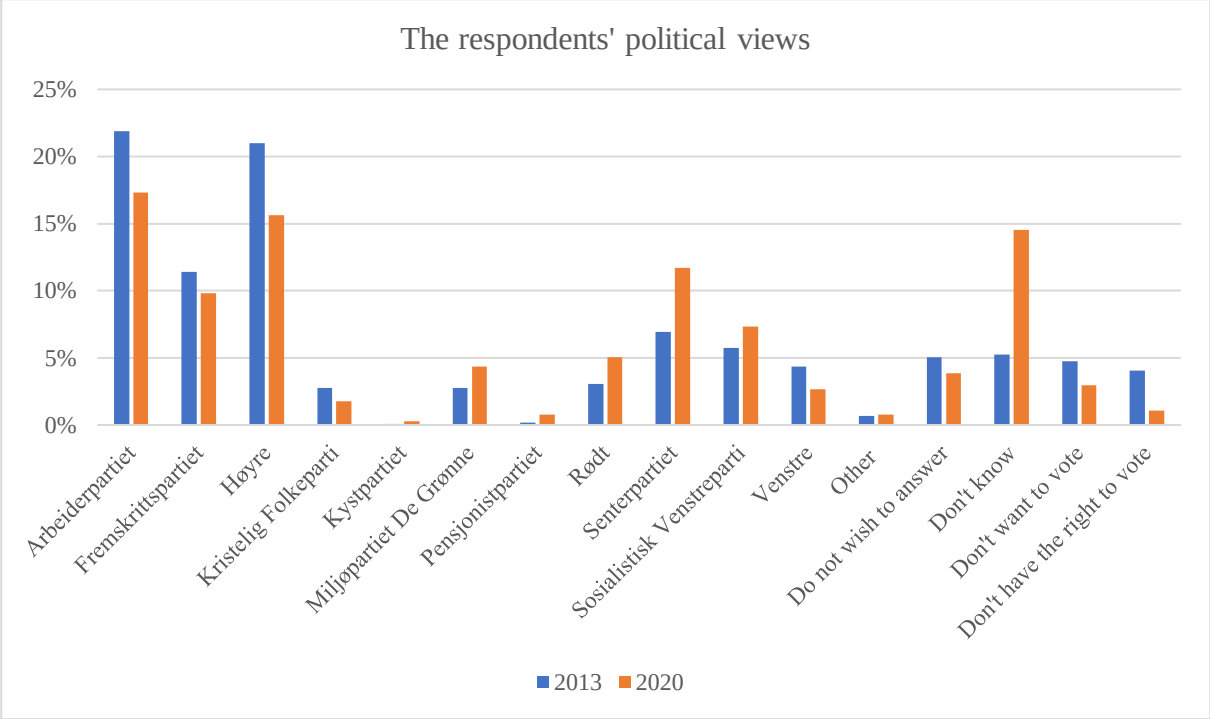


Figure 13: Shows which party the respondents voted for in 2013 and which party they would vote for today

The tendency shows that even though the biggest parties in 2013 are still the big parties in 2020, some smaller parties have increased support in 2020. The parties that most of the respondents voted for in 2013 were Arbeiderpartiet (22%), Fremskrittspartiet (11%) and Høyre (21%). In 2020, 17%, 10% and 16% of the respondents, respectively, would have voted for these parties. Miljøpartiet De Grønne, Sosialistisk Venstreparti and Venstre have increased support in 2020. However, 14.55% report that they don't know what they would vote if they were to vote today. As a relatively large portion reports that they don't know what they would vote today, we cannot conclude if there is an actual change in political views and thus not conclude if this has affected WTP.

7. Discussion

7.1 Discussion of Results

The results from this study suggest a significant decrease in WTP to avoid an oil spill in Lofoten. The regression results show a positive and significant dummy variable indicating if the respondent is from the 2013 sample. There is a decrease in WTP across all the damage levels, but it seems that the respondents who answered the survey for the second time (test-retest sample) have a smaller decrease than the respondents who answered for the first time. These findings are similar to Whitehead and Aiken (2017), who also found greater stability in WTP for the test-retest sample.

When transforming household income from 2013 to 2020 equivalent values, there is higher household income in 2013. The difference between the means were tested with a two-sided t-test, showing a statistically significant difference. This means that the increase in household income has been less than the increase in price level. Household income is on a general basis highly significant in the regression models, showing that WTP to avoid an environmental damage increases with household income. It should be mentioned that there was a severe crisis in the oil industry in 2014, which was after the first survey. Statistics show that the *real* growth in salary was just above 0 in 2015, which was seen as a consequence of the oil crisis (Fafo, 2017).

In addition to this, the survey results show that 298 out of the 1010 respondents from 2020 reported that their income would be lower because of the Covid-19 pandemic. The mean WTP for these respondents are lower across all damage levels. 77 respondents reported that they would have answered differently if the survey was before the pandemic, and the mean WTP is also lower for these respondents. The reported level of well-being is also significantly lower after the pandemic hit. The pandemic meant highly unsure future economic outlooks and thousands of Norwegians being temporally laid off from their job. This implies changing economic conditions and Loureiro and Loomis (2017) describes this as a violation if the ceteris paribus assumption. The results from Loureiro and Loomis (2017) show that if a major survey happens to fall during a recession, the results might not be applicable to normal economic conditions. Our results indicate similar findings.

Comparing other properties of sample from each year show many similarities. The demographic variables, excluding household income, show high stability. There is also high stability in the distribution of WTP greater than 0, protest answers and real zero answers, which is an indication of preference stability. The main reason for WTP answers greater than zero is also consistent between the two years. The most important environmental damages reported also show a high level of stability. What the respondents' ranked as the most important community tasks does not show a lot of differences between 2013 and 2020. This indicates stability in preferences regarding WTP. Even though there are some differences in significant variables in the separate regressions for a small environmental damage, the regressions for the other damage levels show stability in significant variables. No obvious differences in significant variables were found. It shows that members of environmental organizations and respondents who are strongly against oil exploration have a higher WTP to avoid an oil spill in Lofoten, which is consistent with our hypotheses 2 and 3 in table 2.

This study contributes to the empirical literature as there is few studies that have been able to use the same respondents in the first and second survey in a test-retest study. This has given the opportunity to compare WTP stability among respondents who answered for the second time, as well as comparing the 2013-estimates with new respondents. To our knowledge, this is also the first Norwegian study who tests temporal stability of WTP over such a long period as 7 years. There is also a confined amount of studies testing the temporal stability of WTP to avoid oil spills, and this research will contribute to the existing literature.

7.2 Limitations

Due to GDPR guidelines[8], it was not possible to match the answers for the respondents who answered both the first and the second survey on an individual level. Because of this, we were only able to compare the average results based on the whole sample. Being able to compare the data and WTP estimates on an individual level would give the opportunity to investigate the temporal stability of individual preferences and could give more accurate results.

The 2020 survey took place when Norway was in a state-of-emergency because of the Covid-19 pandemic. Due to the dramatic circumstances, questions were added last minute to control

[8] The General Data Protection Regulation (GDPR) is a legal framework that sets guidelines for the collection and processing of personal information for individuals who live in the EU (Investopedia, 2019).

for the effects of the pandemic on WTP. Results show that many of the respondent experience a decrease in their level of well-being and some expected a decrease in income because of the pandemic. This is likely to have impacted the results and might overshadow other effects on WTP that would have been visible if this was before the pandemic hit. Loureiro and Loomis (2017) found that if a major survey falls in a recession, the results may not be applicable to normal economic conditions. Therefore, our results may not reflect normal economic conditions and may not be appropriate in a decision-making context.

The data show heteroskedasticity, which violates the assumptions of Gauss Markov. The consequences of heteroskedasticity is that even though the OLS estimators remain unbiased, the estimator is no longer BLUE and thus does not produce valid t-statistics. The regressions were thus performed with robust standard error which ensures valid t-statistics. This is a heteroskedasticity-robust method for large samples, because it produces valid estimates (Wooldridge, 2014, p. 215).

In both years, there are rather few respondents that report that they believe that the Norwegian Coastal Administration will actually use the survey results in a decision-making context. Also, not many respondents reported that they believe that income taxes the next 10 years will be increased if the measures described in the survey were implemented. This means that the respondents see the measures from the survey as hypothetical and not consequential. This could mean hypothetical bias, which is one of the main criticisms of the CVM. However, the regression results mostly have the expected signs.

7.3 Suggestions for Future Work

The limitations of this research paper can give valuable opportunities for improvements for future work on this topic. This paper was written during the Covid-19 pandemic in Norway. As this period may not reflect normal economic conditions in Norway, it can be valuable to conduct a similar survey when the economic conditions are stable and normal. This can give indications on how the WTP to avoid oil spills in Lofoten would be in stable economic conditions, but it could also be possible to measure the real effects the Covid-19 pandemic had on the WTP to avoid an oil spill in Lofoten.

For future work it may also be suggested to match the respondents of the first sample and the test-retest sample on an individual level. This could ensure more accurate analysis of changes of respondents' preferences.

This paper does not address the role of use and non-use values of the WTP to avoid an oil spill in Lofoten. Egeland and Frøystein (2016) wrote a master thesis at the University of Stavanger covering this topic. An idea for future work could be to replicate this research in order to investigate temporal stability of WTP with focus on use and non-use values.

8. Conclusion

This study uses CVM to assess the temporal stability of Norwegians' WTP to avoid an oil spill in Lofoten. This was investigated with a test-retest approach, with the initial survey taking place in 2013 and a second wave of the same survey taking place in 2020. However, the second survey was completed during the Covid-19 pandemic and the results may not reflect normal economic conditions. Two research questions have been addressed: 1) "does Norwegians' WTP to avoid an oil spill in Lofoten change over time?" and 2) "which factors can explain changes/stability in preferences over time?".

OLS was used for regression models. The regression results are consistent with economic theory as the coefficient estimates mostly show the expected signs. WTP increases with damage levels and household income, as should be expected. Results shows that being member of an environmental organization, being strongly against oil exploration in Lofoten and having personal experience with environmental changes have a significant positive effect on WTP. This confirm validity of results.

The results from this research show a significant decrease in WTP across all damage levels from 2013 to 2020. A significant decrease in household income and a negative impact from the Covid-19 pandemic might drive WTP to be lower in 2020. However, there could be unobservable factors not controlled for in the surveys that could contribute to the decrease in WTP. Comparing properties of the two samples and different questions from the surveys give evidence for stability in preferences regarding WTP.

We further acknowledge that our analysis would be stronger if we could match the respondents on an individual level. The results may not be applicable to normal economic conditions due to the unforeseen Covid-19 pandemic. This further strengthens the findings by Loureiro and Loomis (2017). However, much more work needs to be done in order to know the real effect that the pandemic had on WTP and this provides valuable opportunities for future research.

9. References

Ali, U. (2020). Effects of oil spills: What impact does it have on wildlife and humans? Retrieved from: https://www.offshore-technology.com/features/effects-oil-spills/

Allo, M. & Loureiro, M. L. (2013). Estimating a meta-damage regression model for large accidental oil spills. *Ecological Economics*, 86, 167-175.

Amadeo, K. (2018). The True Costs of the Exxon Valdez Oil Spill. Retrieved from: https://www.thebalance.com/exxon-valdez-oil-spill-facts-effects-on- economy-3306206

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R. & Schuman, H. (1993). Report of the NOAA Panel on Contingent Valuation. *Federal Register, 58*(10), 4601-4614.

Bishop, R. C. & Boyle, K. J. (2017). Reliability and Validity in Nonmarket valuation. *Environmental and Resource Economics*, 72, 559-582.

Bishop, R. C., Boyle, K. J., Carson, R. T., Chapman, D., Hanemann, W. M., Kanninen, B., … Scherer, N. (2017). Putting a value on injuries to natural assets: The BP oil spill. *Science, 356*(6335), 253–254.

Bliem, M., Getzner, M. & Rodiga-Laßnig, P. (2012). Temporal stability of individual preferences for river restoration in Austria using a choice experiment. *Journal of Environmental Management, 103*, 65-73.

Boman, M., Mattsson, L., Ericsson, G. & Kriström, B. (2011). Moose Hunting Values in Sweden Now and Two Decades Ago: The Swedish Hunters Revisited. *Environmental and Resource Economics, 50*, 515-530.

Boyle, K. J. (2017). Contingent Valuation in Practice. In P. A. Champ, K. J. Boyle, & T. C. Brown (Eds.), *A Primer in Nonmarket Valuation* (pp. 83-133). Netherlands: Springer Science Business Media.

Boyle, K. J. (2003). Introduction to Revealed Preference Methods. In *A primer on nonmarket valuation* (pp. 259–267). New York: Springer Science Business Media.

Brouwer, R. (2006). Do stated preference methods stand the test of time? A test of the stability of contingent values and models for health risks when facing an extreme event. *Ecological Economics*, 299-406.

Brouwer, R. & Bateman, I. J. (2005) Temporal stability and transferability of models of willingness to pay for flood control and wetland conservation. *Water Resources Research, 41*(3), W03017.

Brouwer, R., Logar, I. & Sheremet, O. (2017). Choice Consistency and Preference Stability in Test-Retests of Discrete Choice Experiment and Open-Ended Willingness to Pay Elicitation Formats. *Environmental and Resource Economics, 68*, 729-751.

Cameron, T., & Huppert, D. (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.

Carson, R. T., Conaway, M. B., Mitchell, R. C., Hanemann, M. & Presser, S. (2004). Scenario Identification and Survey Design. In *Valuing Oil Spill Prevention*. Kluwer Academics Publishers.

Carson, R. T., Hanemann, M. W., Kopp, R. J., Krosnick, J. A., Mitchell, R. C., Presser, S. ,..., Martin, K. (1997). Temporal Reliability of Estimates from Contingent Valuation. *Land Economics, 73*(2), 151-163.

Carson, R. T., Mitchell, R. C., Hanemann, M., Kopp, R. J., Presser, S., & Ruud, P. A. (2003). Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill. *Environmental and Resource Economics*, *25*, 257–286.

Chuang, Y. & Shechter, L. (2015). Stability of experimental and survey measures of risk, time, and social preferences: A review and some new results. *Journal of Development Economics*, 117, 151-170.

Czajkowski, M., Bartczak, A., Budziński, W., Giergiczny, M. & Hanley, N. (2016). Preference and WTP stability for public forest management. Forest Policy and Economics, 71, 11-22.

Cohen, M. J. (1995). Technological Disasters and Natural Resource Damage Assessment: An Evaluation of the Exxon Valdez Oil Spill. *Land Economics*, 71(1), 65-82.

Cole, S. G., Kinell, G., Söderqvist, T., Håkansson, C., Hasselström, L., Izmalkov, S., ... & Soutukorva, Å. (2016). Arctic games: an analytical framework for identifying options for sustainable natural resource governance. *The Polar Journal*, 6(1), 30-50.

Egeland, I. & Frøystein, I. N. (2016). Willingness to Pay for Preventing an Oil Spill in Vestfjorden: The Role of Use versus Non-Use Values (Master thesis, University of Stavanger). Retrieved from: https://uis.brage.unit.no/uis-xmlui/handle/11250/2412129

Eiswerth, M., & Shaw, W. (1997). Adjusting benefits transfer values for inflation. *Water Resources Research, 33*(10), 2381-2385.

Fetene, G. M., Olsen, S. B. & Bonnichsen, O. (2014). Disentangling the Pure Time Effect From Site and Preferance Heterogeneity Effects in Benefit Transfer: An Empirical Investigation of Transferability. *Environmental and Resource Economics, 59*, 583-611.

Flores, N. E. (2017). Conceptual Framework for Nonmarket Valuation. In P. A. Champ, K. J. Boyle, & T. C. Brown (Eds.), *A Primer in Nonmarket Valuation* (pp. 27-52). Netherlands: Springer Science Business Media.

Forskningsstifelsen Fafo (2017). Lønn og lønnsutvikling i Norge. Retrieved from: https://www.arbeidslivet.no/Lonn/Tariffavtaler/Lonn-og-lonnsutvikling-i-Norge-i-tall-og-fakta/

Frankenfield, J. (2019). General Data Protection Regulation (GDPR). In *Investopedia*. Retrieved from: https://www.investopedia.com/terms/g/general-data-protection-regulation-gdpr.asp

Freeman III, M. A. (2003). Economic Valuation: What and Why. In P. A. Champ, K. J. Boyle, & T. C. Brown (Eds.), *A Primer in Nonmarket Valuation* (pp. 1-25). Netherlands: Kluwer Academic Publishers.

Haab, T. C., & McConnell, K. E. (2002). *Valuing Environmental and Natural Resources*. Edward Elgar Publishing Limited.

Hanley, N. D. (1989). Valuing non-market goods using contingent valuation. *Journal of Economic Surveys, 3*(3), 235-252.

Holmes, T. P., Adamowicz, W. L. & Carlsson, F. (2017). Choice Experiments. In P. A. Champ, K. J. Boyle, & T. C. Brown (Eds.), *A Primer in Nonmarket Valuation* (pp. 133-182). Netherlands: Springer Science Business Media.

ITOPF. (2018). EXXON VALDEZ, Alaska, United States, 1989. Retrieved from: http://www.itopf.org/in-action/case-studies/case-study/exxon-valdez-alaska-united-stated-1989/

Jorgensen, B., Syme, G., Smith, L., & Bishop, B. (2004). Researchers reliability and limitations of contingent valuation. *Journal of Economic Psychology, 25*, 41–59.

Kaltenborn, B. P., Linnell, J. D. C., Thomassen, J. & Lindhjem, H. (2017). Complacency or resilience? Perceptions of environmental and social change in Lofoten and Vesterålen in northern Norway. *Ocean & Coastal Management, 138*, 29-37.

Kemp, M.A. & Maxwell, C. (1993) *Contingent Valuation: A Critical Assessment*. Elsevier Science B.V.

Landry, C. E. (2017). Experimental Methods in Valuation. In P. A. Champ, K. J. Boyle, & T. C. Brown (Eds.), *A Primer in Nonmarket Valuation* (pp. 391-426). Netherlands: Springer Science Business Media.

Larson, N. (2012, March 2). Oil versus fish in idyllic Norwegian islands. *Phys.org*. Retrieved from: https://phys.org/news/2012-03-oil-fish-idyllic-norwegian-islands.html

Laurila-Pant, M., Lehikoinen, A., Uusitalo, L., & Venesjärvi, R. (2015). How to value biodiversity in environmental management? *Ecological Indicators, 55*(C), 1-11.

Lew, D. K. & Wallmo, K. (2017). Temporal stability of stated preferences for endangered species protection from choice experiments. *Ecological Economics*, *131*, 89-97.

Liebe, U., Hundeshagen, C., Beyer, H. & von Cramon-Taubadel, S. (2016). Context effects and the temporal stability of stated preferences. *Social Science Research*, *60*, 135-147.

Liebe, U., Meyerhoff, J. & Hartje, M. (2012). Test–Retest Reliability of Choice Experiments in Environmental Valuation. *Environ Resource Econ*, *53*, 389–407.

Lindhjem, H., Magnussen, K., Navrud, S. & Gudding, P. (2013). *Velferdstap ved miljøskader fra oljeutslipp fra skip: En pilotstudie (Vedlegg 3: Spørreskjemaer).* (VISTA Analyse Rapport 27/2013). Retrieved from: https://www.vista-analyse.no/site/assets/files/5758/pilotrapport_kystverket_vedlegg_3_juli_2013-2.pdf

Lindhjem, H., Magnussen, K., & Navrud, S. (2014a). *Verdsetting av velferdstap ved oljeutslipp fra skip: Er betalingsvilligheten stabil over året?* (VISTA Analyse Rapport 12/2014). Retrieved from: https://www.vista-analyse.no/site/assets/files/5702/va-rapport_2014-12_velferdstap_ved_oljeutslipp_fra_skip-er_betalingsvilligheten_stabil.pdf

Lindhjem, H., Magnussen, K., & Navrud, S. (2014b). Verdsetting av velferdstap ved oljeutslipp fra skip - Fra storm til smulere farvann (?). *Samfunnsøkonomen*, *6*(39), 25–39.

Lofoten. (n.d.). Lofotfishing. Retrieved from: https://lofoten.info/en/Lofotfishing/?Article=3

Loureiro, M. L. & Loomis, J. (2017). How sensitive are Environmental Valuations to Economic Downturns? *Ecological Economics*, *140*, 235–240.

Loureiro, M. L., Lopéz, E., Ribas, A. & Ojea, E. (2006). Estimated costs and admissible claims linked to the Prestige oil spill. Ecological Economics, *59*, 48–63.

Matthews, Y., Scarpa, R. & Marsh, D. (2017). Stability of Willingness-to-Pay for Coastal Management: A Choice Experiment Across Three Time Periods. *Ecological Economics*, *138*, 64–73.

McConnell, K. E., Strand, I. E. & Valdés, S. (1998). Testing temporal reliability and carry-over effect: The role of correlated responses in test-retest reliability studies. Environmental and Resource Economics, *12*, 357-374.

Mohit, K. (2020, January 10). 11 Major Oil Spills Of The Maritime World *Marine Insight*. Retrieved from: https://www.marineinsight.com/environment/11-major-oil-spills-of-the-maritime-world/

Meier, S. & Sprenger, C. D. (2015) Temporal Stability of Time Preferences. *The Review of Economics and Statistics,* 97(2): 273–286

Mørkbak, M. R. & Olsen, S. B. (2014). A within-sample investigation of test–retest reliability in choice experiment surveys with real economic incentives. *Australian Journal of Agricultural and Resource Economic*s, 59, 375–392.

Naturvernforbundet, (n.d.a). Lofoten, Vesterålen, Senja og oljeboring. Retrieved from: https://naturvernforbundet.no/lofoten-vesteralen-og-senja/lofoten-vesteralen-senja-og-oljeboring-article16568-1467.html

Naturvernforbundet, (n.d.b). Derfor må olja bli liggende. Retrieved from: https://naturvernforbundet.no/lofoten-vesteralen-og senja/category1467.html?gclid=Cj0KCQjwsYb0BRCOARIsAHbLPhFc8TiyhquNKXY8BQtHWT11cYwGSTFC3VltA8-ZqSQ1dhDVm414fxcaAu2KEALw_wcB

Neher, C., Duffield, J., Bair, L., Patterson, D. & Neher, K. (2017). Testing the Limits of Temporal Stability: Willingness to Pay Values among Grand Canyon Whitewater Boaters Across Decades. *Water Resources Research*, *53*(12), 10108– 10120.

Nicholson, W., & Snyder, C. (2012). *Microeconomic theory: basic principles and extensions*. The United States: Cengage Learning.

Norwegian Environment Agency (2013). Barents Sea-Lofoten area. Retrieved from: https://www.environment.no/topics/marine-and-coastal-waters/barents-sealofoten-area/

Norwegian Government Security and Service Organisation (2018). The ocean nation of Norway. Retrieved from: https://www.regjeringen.no/en/topics/havet/the-ocean-nation-of-norway/id2609341/

O'Garra, T., & Mourato, S. (2007). Public Preferences for Hydrogen Buses: Comparing Interval Data, OLS and Quantile Regression Approaches. *Environmental and Resource Economics, 36*(4), 389-411.

Pedace, R. (2013). *Econometrics for dummies*. Hoboken, N.J.: John Wiley & Sons.

Perman, R., Ma, Y., Common, M., Maddison, D. & McGilvray, J. (2011). *Natural Resource and Environmental Economics*. England: Pearson education limited.

Price, J., Dupont, D. & Adamowicz, W. (2017). As Time Goes By: Examination of Temporal Stability Across Stated Preference Question Formats. *Environ Resource Econ, 68*, 643–662.

Rafferty, J. P. (n.d.). 9 of the biggest oil spills in history. In *Encyclopædia Britannica*. Retrieved from: https://www.britannica.com/list/9-of-the-biggest-oil-spills-in-history

Rolfe, J. & Dyack, B. (2019). Testing Temporal Stability of Recreation Values. Ecological Economics, *159*, 75–83.

Rosenberger, R. S. & Loomis J. B. (2017). Benefit Transfer. In P. A. Champ, K. J. Boyle, & T. C. Brown (Eds.), *A Primer in Nonmarket Valuation* (pp. 431-458). Netherlands: Springer Science Business Media.

Schaafsma, M., Brouwer, R., Liekens, I. & Nocker, L. D. (2014). Temporal stability of preferences and willingness to pay for natural areas in choice experiments: A test–retest. *Resource and Energy Economics, 38*, 243–260.

Scott, A. (1965). The valuation of game resources: Some theoretical aspects. Canadian Fisheries Report, iv, Ottawa, Ontario, Canada: Department of Fisheries of Canada.

Segerson, K. (2017). Valuing Environmental Goods and Services, An Economic Perspective. In P. A. Champ, K. J. Boyle, & T. C. Brown (Eds.), *A Primer in Nonmarket Valuation* (pp. 1-27). Netherlands: Springer Science Business Media.

Skourtos, M., Kontogianni, P., & Harrison, P. A. (2010). Reviewing the dynamics of economic values and preferences for ecosystem goods and services. *Biodivers Conserv, 19*, 2855–2872.

Statistisk Sentralbyrå. (2020) Konsumprisindeksen. Retrieved from: https://www.ssb.no/kpi

Teisl, M. F., Boyle, K. J., McCollum, D. W. & Reiling, S. D., (1995). Test-Retest Reliability of Contingent Valuation with Independent Sample Pretest and Posttest Control Groups. *American Journal of Agricultural Economics*, *77*(3), pp. 613–619.

Thorsnæs, G. (2020). Lofoten. In *Store Norske Leksikon*. Retrieved from: https://snl.no/Lofoten.

U.S. Geological Survey. (20xx/n.d.). Large Oil Spills. Retrieved from: https://www.usgs.gov/mission-areas/water-resources/science/large-oil-spills?qt-science_center_objects=0#qt-science_center_objects

United States Environmental Protection Agency. (2017). Deepwater Horizon – BP Gulf of Mexico Oil Spill. Retrieved from: https://www.epa.gov/enforcement/deepwater-horizon-bp-gulf-mexico-oil-spill

Visit Norway, (n.d.). Lofoten – Discover Norway's untamed islands. Retrieved from: https://www.visitnorway.com/places-to-go/northern-norway/the-lofoten-islands/?lang=primary

Whitehead, J. C. & Aiken, R. (2007) Temporal reliability of willingness to pay from the National Survey of Fishing, Hunting and Wildlife-Associated Recreation. *Applied Economics*, *39*(6), 777-786.

Wooldridge, J. (2014). *Introduction to econometrics* (Europe, Middle East and Africa ed.). Andover: Cengage Learning.

Appendix 1: Literature Review

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Allo & Luoreiro (Ecological Economics, 2013)	Spain.	Examining the main determining factors of the damage caused by oil spills. The article focuses on which role the legislation played when it came to preventing these accidents.	Marginal Contribution	N/A	Data collected from data bases.	More restrictive legislation reduces the economic damage caused by vessel oil spill. The application of strict liability reduces the average damage of a spill by $236.18 million.
Bliem, Getzner & Rodiga-Laßnig (Journal of Environmental Management, 2012)	On the stretch of the Danube River (between Vienna and the border to Slovak Republic).	Testing temporal stability of individual preferences for river respiration by carrying out identical two surveys, in 2007 and 2008. Elicits marginal WTP for the reduction of flood risks and the improvement of water quality.	Choice experiments and RUM	13 months.	Web based survey.	Preferences and WTP estimates for program attributes are not sensitive to time. No findings that show that respondents' perception changed over time. In the absence of an extreme event, individual preferences are robust over a short time period.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Boman, Mattsson, Ericsson & Kriström (Environmental and Resource Economics, 2011)	Sweden.	Examining the economic value of game for hunting in 2005/2006, and compare it with the hunting value in 1986/1987. The second survey repeats relevant parts from the first one.	CVM	19 years.	Mail survey.	Moose hunting value has increased significantly between 1986/1987 and 2005/2006, and quantities of moose meat and moose hunting costs have decreased significantly.
Brouwer (Ecological Economics, 2006)	The Netherlands.	Examining health risks associated with bathing water quality before and during extreme weather conditions, and testing the effect of time on stated preferences for a seasonal good and the effect of the extreme event on these preferences. Carries out two identical studies.	CVM	8 months.	Mail survey.	WTP values before and during the event appear to be robust. The results before and during the extreme event remain transferable when accounting for theoretically expected factors in simple multivariate transfer model.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Brouwer & Bateman (Water Resources Research, 2005)	Norfolk and Sufford, England.	Investigates the temporal stability and transferability of DC WTP responses and their determinants from two large-scale CV surveys in the area of flood control and wetland conservation. The first survey was conducted in 1991, while the other was conducted in 1996.	CVM	5 years.	On-site interviews.	Visitor valuation has decreased across the period between the two surveys. Mean WTP calculated from linear-logistic model is 13 percent lower in 1996 than in 1991, while it's 30 percent lower calculated by the Turnbull model.
Brouwer, Logar & Sheremet (Environmental and Resource Economics, 2017)	Switzerland.	Tests temporal stability of preferences, choices and WTP. The same sample is surveyed three times over the period of two years.	RUM and Choice Experiment.	2 years.	Internet survey.	Follow-up response rate: 30% and 25%. The underlying preference parameters in the estimated RUM seems to be stable over a time period of 18 and 24 months.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Chuang & Shechter (Journal of Development Economics, 2015)	Paraguay.	Test stability of individuals' choices in panel data, in 2002, 2007, 2009 and 2010.		2002, 2007, 2009 and 2010.	In-person survey	Answers to social preference survey questions are quite stable. Experimental measures of risk, time and social preferences do not exhibit much stability.
Cjazkowski, Bartczak, Budziński, Giergiczny & Hanley (Forest Policy and Economics, 2016)	Poland.	Testing the stability of preferences and willingness to pay for attributes of forest management - both within one survey and between two different moments of time.	RUM	6 months.	Online survey.	Higher consistency for status quo choices than for enhanced environmental management choices is apparent. Respondents' mean WTP is fairly stable both within survey and between moments of time.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Cohen (Land Economics, 1995)	Alaska, The United States of America.	Evaluates the economic losses on southcentral Alaska's fisheries caused by the Exxon Valdez oil spill in 1989.	-	N/A	On-site harvests and measurements.	First-year social costs on these resources is $108 million. Second-year effects may have been as high as $47 million.
Fetene, Olsen & Bonnichsen (Environmental and Resource Economics, 2014)	Jutland, Denmark.	Investigating temporal reliability associated with a transfer of value estimated over a 5-year time horizon (2005-2010).	CVM	5 years.	On-site interviews.	The CVM results concerning WTP for flood risk reductions are temporally transferable over a time horizon of 5 years.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Lew & Wallmo (Ecological Economics, 2017)	The United States of America.	Uses data from two identical choice experiment surveys on different samples from the same population that occurred 17 months apart (spring 2009 and fall 2010) to estimate and compare mean WTP and preference parameters associated with threatened and endangered marine species protection.	Choice Experiment and RUM.	17 months.	E-mail invitations with a link to a web-based survey. Reminded via e-mail and then by phone.	Results suggest that both types of heterogeneity matter. Tests of preference stability suggest stable preferences between 2009 and 2010. Furthermore, WTP values estimated from both surveys are not statistically different. This provides evidence that economic values estimated using CE methods are temporally stable.
Liebe, Hundeshagen, Beyer & von Cramon-Taubadel (Social Science Research, 2016)	Germany.	Test two assumptions: individuals' answers reflect true preferences and are stable over time. Using choice experiment study on ethical consumption that measures preferences for a Peace Product jointly produced by Israeli and Palestinian producers as well as for organic products. Tests the assumption of temporal	Choice Experiment and RUT.	10 months.	Web based survey.	High temporal stability of stated preferences with regard to all attributes in the choice experiment.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
		stability by repeating a second survey based on a new sample ten months after the first.				
Liebe, Meyerhoff & Hartje (Environ Resource Econ, 2012)	Germany.	Test–Retest Reliability of Choice Experiments in Environmental Valuation. Respondents were answering the same five choice sets at two different points in time.	Choice Experiment	11 months.	Phone Survey	The parametric analysis shows that the test and retest estimates are not equal, even when we control for scale. statistically significant difference for one of the attributes.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Loureiro & Loomis (Ecological Economics, 2017)	Spain.	Testing temporal stability of WTP. Used data from a CVM study conducted in 2006, after the Prestige oil spill in Spain, and repeated the same survey in 2009.	CVM	3 years.	Individual Interviews	Median WTP estimates dropped from €60.36 in 2006 to €26.92 in 2009 per household, a statistically significant reduction.
Loureiro, Lopéz & Ribas, Ojea (Ecological Economics, 2006)	Spain.	Evaluates the societal costs caused by the Prestige oil spill that occurred in 2002.	-	N/A.	Data gathered from database.	Short-term losses in all affected economic sectors, cleaning and recovery costs, and all environmental losses , add to a lower bound estimate of €770.58 million, excluding financial and future possible losses.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Matthews, Scarpa & Marsh (Ecological Economics, 2017)	New Zealand.	This study tests the stability of WTP for beach erosion management by using discrete choice experiment. Doing the survey two times over a time period of six months.	Discrete Choice Experiment/RUM	6 months.	Web-based Survey	Stability does not improve with the additional repetition as the preference discovery hypothesis implies it might. Sufficient evidence to reject equality of joint and individual parameters in the WTP-space models in different time periods.
Meier & Sprenger (The Review of Economics and Statistics, 2015)	The United States of America.	Testing temporal stability of time preferences by conducting a large field study over two years.	Intertemporal Choice Experiments	2 years.	On-site Survey	Distributions of time preference parameters are stable over time, and the one-year individual-level correlations are high by both estimates generated from the aggregate analysis and standards in psychology.

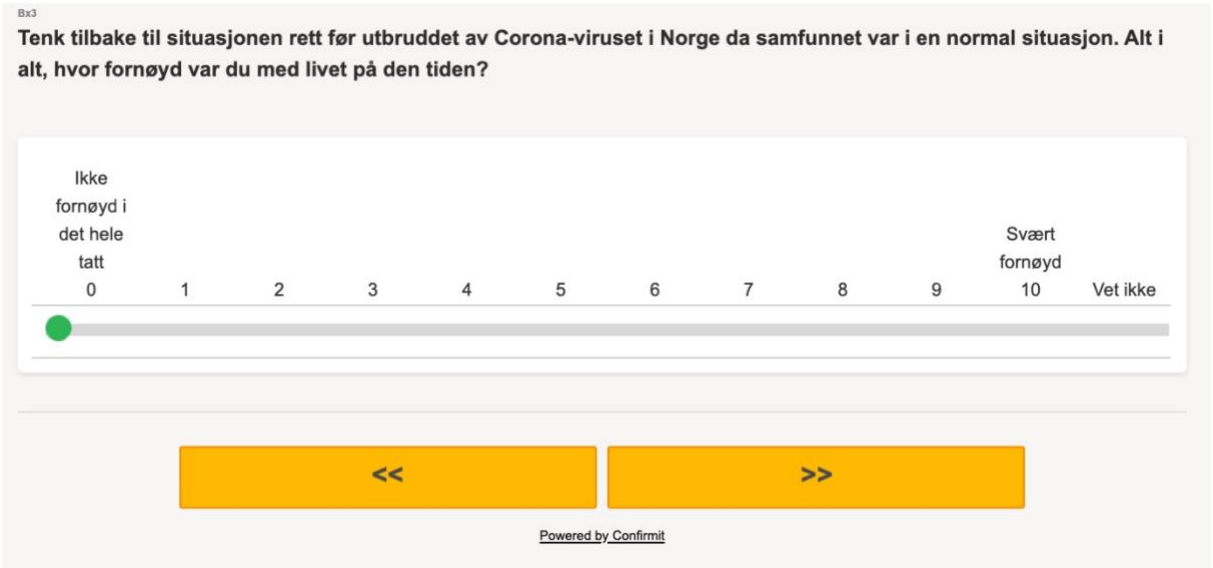
Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Mørkbak & Olsen (Australian Journal of Resource and Agricultural Economics, 2014)	Denmark/Australia.	Investigates the level of agreement between respondents' choices in a test-retest choice experiment for a market good with real economic incentives. The same sample of respondents were given the same questionnaire twice, with two weeks in between the surveys.	Choice Experiment, RUM	2 weeks.	In-person Survey/Experiment	Across four different tests, there are good agreement between the two choice experiments – both with respect to overall choices and with respect to preferences.
Neher, Duffield, Bair, Patterson & Neher (Water Resources Research, 2017)	The United States of America.	Testing temporal stability for WTP by comparing trip WTP values for private party Grand Canyon boaters between 1985 and 2015. Two studies conducted with a time gap of 30 years.	CVM	30 years.	Mail-back Survey	No statistically significant differences were detected between the adjusted Bishop et al. (1987) and the current study mean WTP estimates. However, there were found differences in WTP functions.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Price, Dupont & Adamowicz (Environ Resource Econ, 2016)	Canada.	Evaluates the temporal stability of WTP values. Two identical stated preference surveys are undertaken - one in 2004 and the other in 2012.	Discrete Choice Experiment, CVM	8 years.	Web-based Survey	No significant differences in WTP between the two surveys.
Rolfe & Dyack (Ecological Economics, 2019)	Australia.	Tests the temporal stability of recreation values for the Coorong in Australia. The travel cost model (TCM) and contingent valuation method (CVM) have been assessed. The experiments have been repeated seven years apart.	TCM, CVM	7 years.	Drop-off and Collect Survey	Transfer errors were larger with the TCM (62%) than with the CVM (19%). Testing showed that the TCM models and values were significantly different over the seven year period, but the CVM models and values were not, even though the same recreation good was involved.

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Schaafsma, Brouwer, Liekens & Nocker (Resource & Energy Economics, 2014)	Belgium.	Tests temporal stability of stated preferences and WTP values from a Choice Experiment (CE) in a test-retest. The same respondents were asked the same choice tasks twice, in a time interval of one year.	Choice Experiment - RUM	1 year.	Web-based Survey	The results suggest that although parameter estimates do not appear to be temporally consistent, the WTP estimates for attributes are mostly robust to transfers over time.
Skourtos, Kontogianni & Harrison (Biodivers Conserv, 2010)	Greece/UK.	Reviewing the dynamics of economic values and preferences for ecosystem goods and services	CVM	20 years.	Secondary Data.	WTP not stable for longer periods (20 years)

Paper	Location	Research	Valuation Method	Time period between applications	Survey	Results
Whitehead & Aiken (Applied Economics, 2007)	The United States of America.	Temporal reliability of willingness to pay from the National Survey of Fishing, Hunting and Wildlife-Associated Recreation. In 1991 and 1996 similar value elicitation formats were used.	CVM	5 years.	Phone/In-person Interview	WTP for wildlife recreation trips from FHWAR survey changed over a 5-year period. WTP for hunting, fishing and wildlife-watching are significantly lower in 1996 relative to 1991.

Appendix 2: Questions From Survey – Controlling for Covid-19



Bx5

Hvordan tror du husholdningsinntekten din vil bli i 2020, som følge av Corona-viruset, sammenliknet med en normalsituasjon?

- ○ Mye lavere
- ○ Litt lavere
- ○ Omtrent samme
- ○ Litt høyere
- ○ Mye høyere
- ○ Vet ikke

<< >>

Powered by Confirmit

Bx6

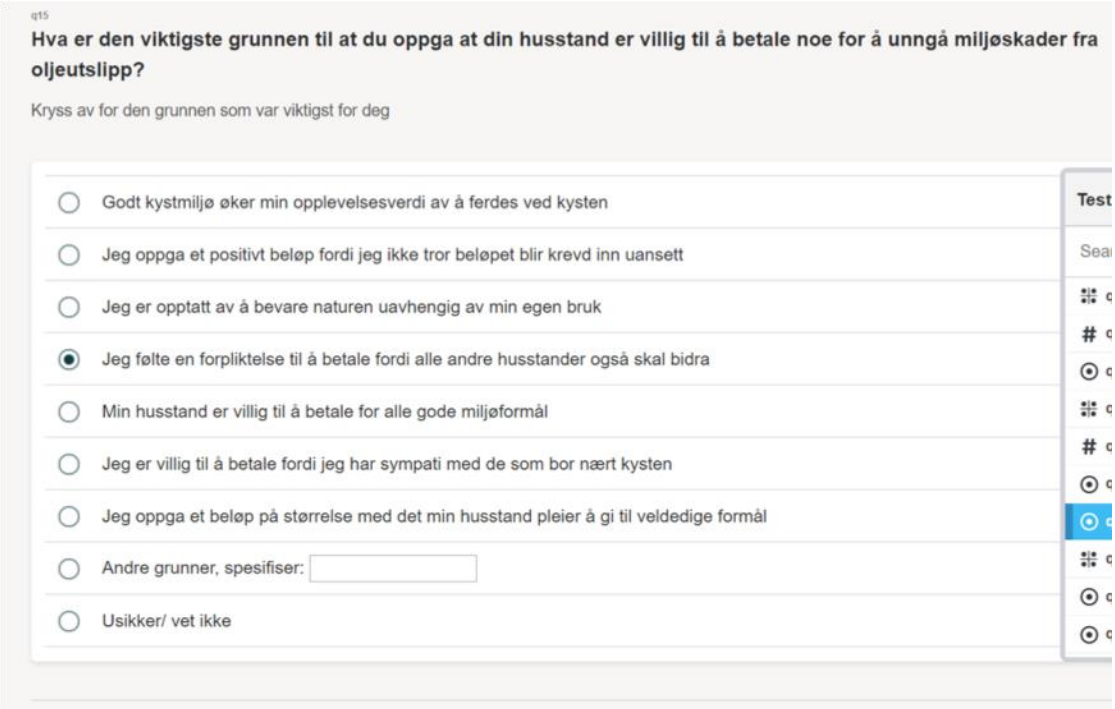
Tenk tilbake på spørsmålene om betalingsvillighet for å unngå miljøskader fra oljeutslipp.
Ville du svart det samme i en normalsituasjon uten utbrudd av Corona-virus?

- ○ Ja, ville oppgitt samme beløp
- ○ Nei, ville oppgitt høyere beløp
- ○ Nei, ville oppgitt lavere beløp
- ○ Vet ikke

<< >>

Powered by Confirmit

Appendix 3: Questions From Survey – Reasons for Positive WTP



q15

Hva er den viktigste grunnen til at du oppga at din husstand er villig til å betale noe for å unngå miljøskader fra oljeutslipp?

Kryss av for den grunnen som var viktigst for deg

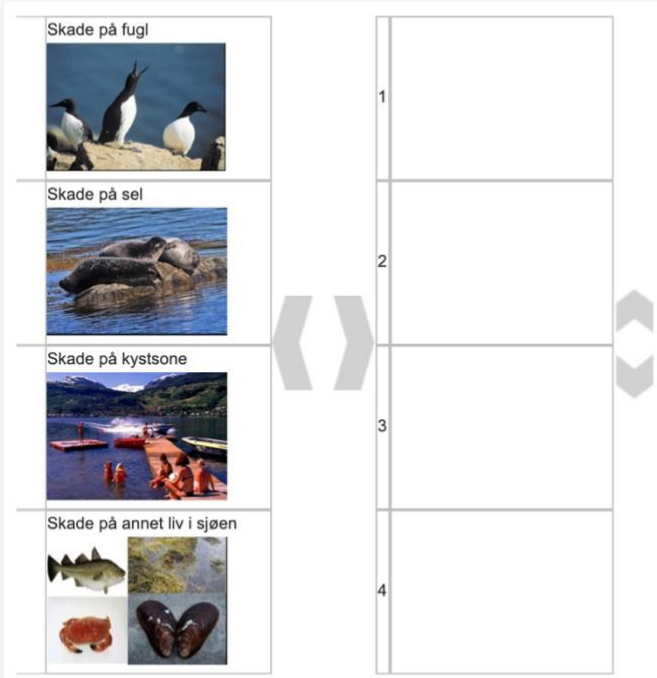
- ○ Godt kystmiljø øker min opplevelsesverdi av å ferdes ved kysten
- ○ Jeg oppga et positivt beløp fordi jeg ikke tror beløpet blir krevd inn uansett
- ○ Jeg er opptatt av å bevare naturen uavhengig av min egen bruk
- ◉ Jeg følte en forpliktelse til å betale fordi alle andre husstander også skal bidra
- ○ Min husstand er villig til å betale for alle gode miljøformål
- ○ Jeg er villig til å betale fordi jeg har sympati med de som bor nært kysten
- ○ Jeg oppga et beløp på størrelse med det min husstand pleier å gi til veldedige formål
- ○ Andre grunner, spesifiser: [ ]
- ○ Usikker/ vet ikke

Appendix 4: Questions From Survey – Most Important Environmental Damages

q10

Hvilke av disse fire typene miljøskader er viktigst for deg?

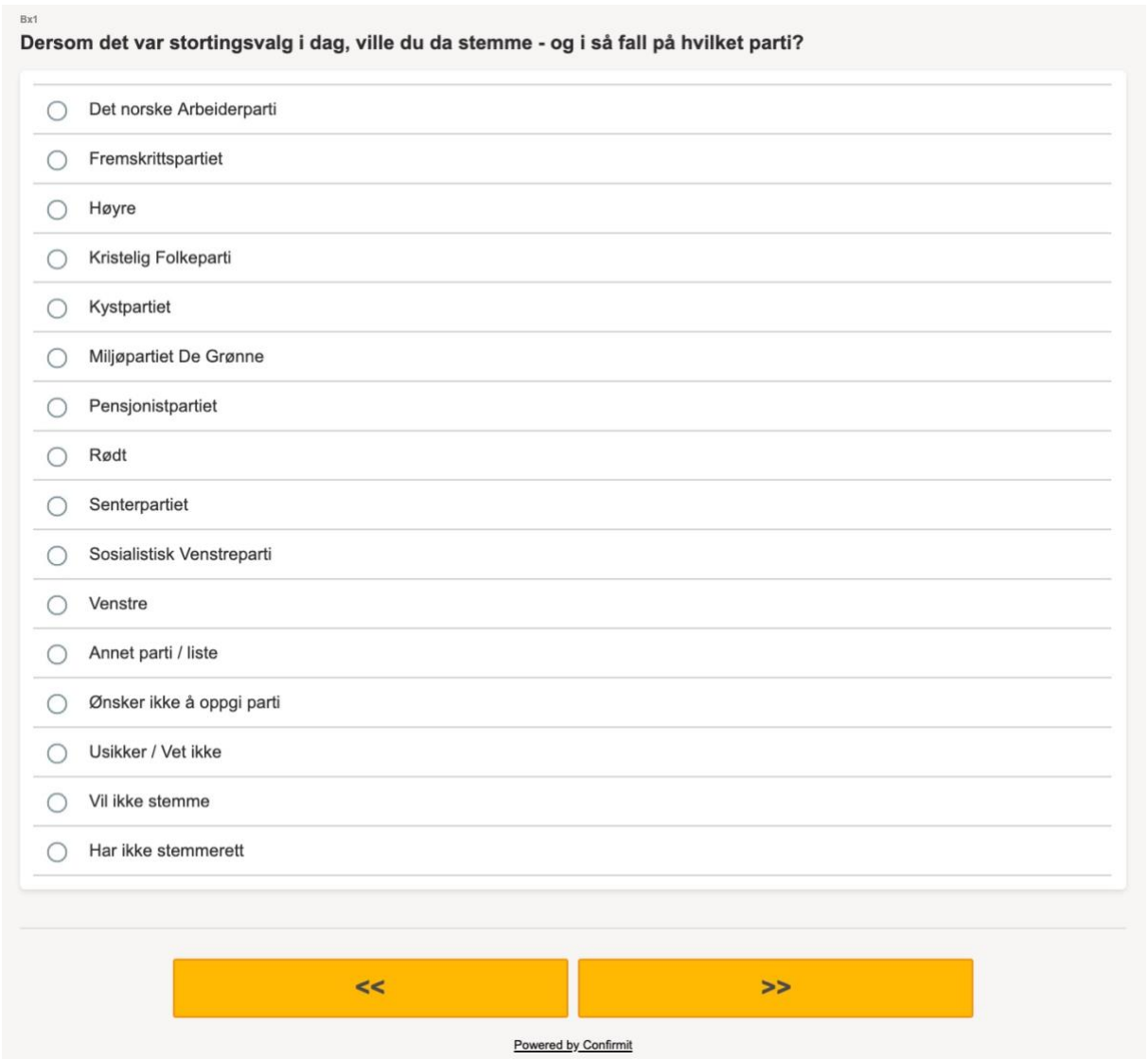
Rangér skadene på fugl, sel, på kystsone og på livet ellers i sjøen. Dra bildene over i boksene i den rekkefølgen som er viktigst for deg. Du kan flytte på bildene etter at de er plassert



<< >>

Powered by Confirmit

Appendix 5: Questions From Survey – Changes in Political View



Bx1

Dersom det var stortingsvalg i dag, ville du da stemme - og i så fall på hvilket parti?

- Det norske Arbeiderparti
- Fremskrittspartiet
- Høyre
- Kristelig Folkeparti
- Kystpartiet
- Miljøpartiet De Grønne
- Pensjonistpartiet
- Rødt
- Senterpartiet
- Sosialistisk Venstreparti
- Venstre
- Annet parti / liste
- Ønsker ikke å oppgi parti
- Usikker / Vet ikke
- Vil ikke stemme
- Har ikke stemmerett

<< >>

Powered by Confirmit

Bx2

Stemte du ved stortingsvalget i 2013, og hvilket parti stemte du i så fall på?

- ◯ Det norske Arbeiderparti
- ◯ Fremskrittspartiet
- ◯ Høyre
- ◯ Kristelig Folkeparti
- ◯ Kystpartiet
- ◯ Miljøpartiet De Grønne
- ◯ Pensjonistpartiet
- ◯ Rødt
- ◯ Senterpartiet
- ◯ Sosialistisk Venstreparti
- ◯ Venstre
- ◯ Annet parti / liste
- ◯ Ønsker ikke å oppgi parti
- ◯ Husker ikke / Vet ikke
- ◯ Stemte ikke
- ◯ Hadde ikke stemmerett

<< >>