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On Scope Sensitivity and its Determinants in Environmental Valuation

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ABSTRACT

This thesis investigates the determinants of sensitivity to the scope of damages caused by oil spills on an individual level. We examine the results of two contingent valuation (CV) surveys conducted in 2020 on Norwegians' WTP to avoid oil spills in coastal areas, specifically Lofoten, and the Oslofjord. There is an ongoing debate regarding sensitivity to scope in stated preference (SP) studies in the field of environmental valuation reflecting on the apparent lack of adequate scope sensitivity in survey results. These results, at times showing low, or no sensitivity to scope are seen by some as problematic, arguing that such results are not consistent with rational choice. Scope sensitivity results have consequently been regarded as a validity check for SP studies. Using the elicited WTP amounts from the two CV studies we attempt to analyze the causes of scope sensitivity/insensitivity by creating scope arc-elasticities for each respondent. In our regression analysis, we use scope elasticities as a measure of scope sensitivity in a set of generalized linear panel models.

The sample mean elasticities range from 0.17 to 0.25 in Lofoten, while in the Oslofjord the sample mean elasticities range from 0.46 to 0.57 depending on the model. We find that a significant proportion of respondents are not sensitive to scope, and some respondents have negative scope elasticities. Our estimates of scope elasticities are fairly in line with results from previous studies, and suggestions of adequate sensitivity results. We find that specific results of scope sensitivity determinants often vary across the surveys and models used in our analysis. Household income is found to be statistically significant across all models, and positively affects scope elasticities. Other demographic and socio-economic variables are also observed to affect the respondent's sensitivity to scope. Examining the effects of use/non-use values we find largely non-significant or mixed results. Regarding the attitude determinants of scope sensitivity, we find mixed results, however a strong indication of a relationship between sensitivity to scope and membership of an environmental organization is observed in the Lofoten data. We cannot properly establish a relationship between a location being regarded as iconic affecting its scope elasticity. Findings also suggest the abnormal conditions caused by the COVID-19 situation have affected respondents' scope sensitivity, specifically those suffering a negative impact on their level of happiness compared to pre-pandemic conditions. This also indicates that emotions play a role in non-market valuation. We recommend further studies be conducted into the determinants of scope sensitivity on an individual level.

PREFACE

This thesis constitutes 30 credits and our MSc in Business Administration at the University of Stavanger. This thesis is written in the field of Environmental and Resource Economics. The purpose of this research was to investigate scope sensitivity at an individual level in different oil spill scenarios in Lofoten and the Oslofjord.

The process of writing this thesis has been educational, and interesting, and additionally demanding. As this is, to our knowledge, the first research on the topic of individual level scope sensitivity in Norway, there was a limited amount of previous literature to analyze and compare results with. As such the analysis in this thesis takes the form of a more exploratory study, investigating scope sensitivity in a broad, or general manner, rather than focusing entirely on one specific sub-topic within the scope sensitivity genre. The study has taught us a quite lot about conducting research, scope sensitivity, and relating topics. We have gained valuable experience for future endeavors.

We want to give a special thank you to our supervisor Gorm Kipperberg at the University of Stavanger for bringing the topic of this thesis to our attention, for his guidance, and helpful advice throughout the writing process. His interest in the topic gave us valuable insight, his critical questions and recommendations informed our decision-making regarding this thesis.

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1. INTRODUCTION

Sensitivity to scope is a much-discussed topic in non-market valuation, and environmental and resource economics, often revolving around the expectation that respondents should have higher willingness to pay (WTP) values for preventing larger damages. Additionally, scope elasticity is a measure of, or approach of assessing scope sensitivity of WTP (Whitehead, 2016; Lopes & Kipperberg, 2020; Dugstad et al., 2020). Scope elasticity can be defined as follows: "scope elasticity measures the percentage change in WTP associated with a percentage change in the magnitude of the good" (Lopes & Kipperberg, 2020, p. 193). This provides a convenient, and unit free measure of sensitivity to scope. There is a large base of empirical literature on non-market valuation, however only a few studies use estimating elasticities as a measure of scope sensitivity. For stated preference (SP) and contingent valuation (CV), establishing significant scope sensitivity is increasingly seen as an essential validity check (e.g., Kahnemann & Knetsch, 1992; Arrow et al., 1993; Mitchell & Carson, 1989; Kling et al., 2012; Whitehead, 2016; Dugstad et al., 2020; Lopes & Kipperberg, 2020).

In the past, large oil spills such as the Exxon Valdez incident have attracted global awareness of the damages oil spills can have on the environment. Following the Exxon Valdez oil spill accident, an academic debate began, whereupon several studies discussed, and criticized the CV method and its usefulness in estimating lost passive use values caused by the damages from the oil spill (Whitehead, 2016). To some extent, this debate, and some of the issues raised in relation to SP continue to be discussed to the present day. A central tenet of this debate has been the issues surrounding scope sensitivity. In the cases where scope sensitivity is observed, but found to be rather low, the failure of CV studies to find levels of scope sensitivity deemed appropriate is a point of contention. According to Amiran and Hagen (2010) the issue is whether low levels of scope sensitivity is consistent with economic theory, and rational choice. No definitive standard has been agreed upon regarding what level of sensitivity to scope is appropriate. While the main focus of this thesis is to explore the determinants of scope sensitivity, we will also compare our sensitivity estimates to those found in other studies. By adding to the existing literature, we hope that our studies can be used to further illuminate, and improve future non-market studies conducted in fields such as environmental valuation.

The aim of this thesis is to investigate determinants for sensitivity to scope for oil spill avoidance at an individual level in Lofoten and the Oslofjord. Lofoten is an archipelago known for its unique, and iconic nature, located in the northern part of Norway (Store Norske Leksikon, 2020a). There is an ongoing debate regarding further exploration for petroleum and future petroleum activities in the area. The Oslofjord on the other hand, runs from the Skagerrak into the Norwegian capital Oslo, which is the most populated area in the country. The fjord has the largest traffic of cargo boats and ferries in the country (Store Norske Leksikon, 2020b). To our knowledge, there are no previous studies on the topic of scope sensitivity for avoiding oil spills at an individual level. We will look at Norwegian respondents' answers from two almost identical web-based surveys from 2020, one from Lofoten and one from the Oslofjord. The data collected will be used in a semi-exploratory analysis using a generalized linear panel model on individual-level arc-elasticities. The research question of this thesis is:

"WTP to avoid oil spills: who are sensitive to the scope of damage?"

The surveys pose questions regarding four hypothetical scenarios (small to very large) of oil spills in Lofoten, and the Oslofjord. The respondent's WTP to avoid oil spills is measured in Norwegian Kroner (NOK). The respondents' answers from both surveys are reviewed and checked for scope sensitivity using scope elasticities. Regression models using panel data are used to determine whether any relationships can be established between the respondents' characteristics and their scope elasticities as a measure of sensitivity to scope. The results of our analysis show different levels of scope elasticities between the two locations, as well as different determinants of scope sensitivity at the individual level across models and locations. Particularly demographic variables such as household income, and gender are found to be significant across models, and locations. To determine the impact of a variable on scope elasticity, we interpret the results of several models for both Lofoten, and the Oslofjord.

The rest of the thesis continues as follows: *Chapter 2* covers background information such as a brief history of scope sensitivity. *Chapter 3* provides a review of previous relevant literature. *Chapter 4* presents environmental valuation with theoretical foundations, discusses empirical methods, and scope sensitivity. *Chapter 5* covers the methodology, how the surveys were conducted, and the structure of the questionnaire. *Chapter 6* presents the empirical analysis including descriptive statistics, scope elasticity estimates, hypotheses, and regression results. *Chapter 7* includes discussions of the results, limitations, and suggestion for future work. Lastly, *Chapter 8* gives a conclusion of the research.

2. BACKGROUND

2.1 History of scope sensitivity

According to Whitehead (2016) scope as a topic of discussion "may have begun with the Kahnemann (1986) and Kahnemann & Knetsch (1992) 'embedding' study" where they found no significant differences in WTP when the good was valued as a single component, and when it was valued as a subcomponent of a more large-scale bundle (Whitehead, 2016, pp. 17-18). Mitchell and Carson (1989) on the topic of scope, presented "part-whole bias" as a respondent valuing "a larger or a smaller entity than the researcher's intended good" because "respondents are unable to differentiate between benefit subcomponents" (Mitchell & Carson, 1989, pp. 237, 251). This is where the issue of "scope sensitivity" arose. Further focus occurred after the Exxon Valdez oil spill accident with the "CVM debate", as the state of Alaska commissioned a study to estimate lost passive use values due to the damages from the oil spill. The *Journal of Economic Perspectives* also published a symposium on the contingent valuation method (CVM) during the most active period of the debate (Whitehead, 2016, p. 18).

The National Oceanic and Atmospheric Administration (NOAA) convened a panel to address concerns regarding these issues. In the NOAA report Arrow et al. (1993) did a valuation of the criticisms surrounding the validity of CV measures of non-use values. The NOAA Panel reported a set of guidelines for CV survey construction, admin and analysis. Since the NOAA recommendations publication, testing for scope sensitivity has become a standard practice for CV studies by "specifying a reduced level of the environmental good" (Desvousges et al., 2012, p. 121). Following the Deepwater Horizon (DWH) oil spill incident, the *Journal of Environmental Perspectives* published a second symposium on the CVM. Subsequent studies concluded that CVM studies tend to pass the scope test (Whitehead, 2016, p. 18).

Scope sensitivity has also been discussed in other contexts than in oil spills. For instance, Soto Montes de Oca & Bateman (2006) presented two CV studies on WTP for water supply change in Mexico City, and found sensitivity to scope due to WTP and the household's income. More examples provided in *Ch. 3*.

2.2 Ecosystem services

The Millennium Ecosystem Assessment (MEA) describes ecosystem services as “the planet's life-support systems - for the human species and all other forms of life” (Millennium Ecosystem Assessment, 2005, p. 1). These services are the result of functioning ecosystems, which is the interactions the environment has with animals, plants, and microbes. For example, supplying fish for the market, and a beach with clear blue water can be divided into different categories: provisioning services (e.g., food and fuel), regulating services (e.g., food control and water purification), cultural services (e.g., recreational and spiritual services) and supporting services (e.g., primary production and soil formation) (Ocean Studies Board & National Research Council, 2013, p. 2).

Over the past decades, humans have directly and indirectly changed the ecosystem more rapidly, and more substantially than in any period of human history in order to meet a quickly growing demand for fresh water, food, fuel, fiber, and timber (Perman et al., 2011, p. 30). As a result, this has caused the degradation of many ecosystem services, and could grow rapidly worse in the future. Therefore, the MEA looked at implications for human well-being and ecosystem change and established a scientific basis for action to supplement conservation, and appropriate use of ecosystems, and their benefaction to human well-being (Perman et al., 2011, p. 29). CV studies are often a preferred choice in non-market valuation relating to ecosystem services, as such the issue of scope sensitivity is quite often a topic of discussion in this setting. Therefore, examining the issues surrounding CV such as scope sensitivity helps ensure that such studies find accurate and reliable results.

While the aim of this thesis is not to delve too deeply into the nuances of ecology, biology or ecosystem services, we find it is nonetheless useful to understand some of the terminology and issues related to the environmental concerns regarding the Lofoten and the Oslofjord areas. According to Mendelssohn et al. (2012) freshly spilled oil is the most “environmentally significant type of oil” as oil changes over time due to weathering processes, however the effects of oil on an ecosystem can nonetheless be persistent. Oil dissolving into the surrounding waters and depositing into sediments can in some cases be persistent several years after a spill. The long-term negative effects of spills are in some cases evident even decades after the fact, such as in the case of the 1969 Massachusetts spill caused by the barge Florida (Teal &

Howarth, 1984). An oil spill in Lofoten, or the Oslofjord could cause negative effects on fish supply for the markets, and recreational services.

An example where the ecosystem services has negatively been impacted from an oil spill is the DWH oil spill accident in the Gulf of Mexico. The Gulf of Mexico is a highly productive marine ecosystem and is at risk by numerous stressors such as habitat loss, overfishing and pollution due to oil and gas development. The ecosystem services in the Gulf of Mexico suffered losses in wetlands, fisheries, marine mammals, and the deep-sea ecosystems. These provide direct, and indirect benefits to the millions of people living in the region (Ocean Studies Board & National Research Council, 2013, pp. 3, 5, 7 and 9). Similarly to the Exxon Valdez oil spill, incidents such as these are often the focus of studies attempting to determine the true costs of the environmental damages. These studies often use SP methods such as CV to calculate the cost of damages, and as such sensitivity to scope is a recurring topic in oil spill scenarios.

2.3 Lofoten

Lofoten is a series of islands located in Nordland along the north side of the Vestfjorden. The are in Lofoten is known for its unique landscape and nature with mountains, open sea, beaches and unspoiled land. Moreover, the area has the world's largest cold-water coral reef just west of Røst which is 35 kilometers long (Rapp, 2007). The area has a high density of sea eagles, cormorants, and puffins. Furthermore, "Approximately 70% of all fish caught in the Norwegian and Barents seas use its waters as a breeding ground" (M.F., 2017). It also houses the feeding area of the last robust cod stock in the world (Naturnvernforundet, 2019). The fishing industry in Lofoten is in one of Norway's best fishing areas (Larson, 2012). The islands are a popular destination for tourists, and cruise ships, primarily in the summer (Store Norske Leksikon, 2020a). The Lofoten area is also important for many Norwegians, especially for recreation and many locals' livelihoods.

2.3.1 Oil Exploration in Lofoten

Norwegian oil production has typically been located far offshore where the extraction of petroleum resources could not be seen from land. This has kept the interests of the petroleum industry and the interests and values of coastal areas separate. However, after some examination of areas closer to the shores of mainland Norway, seismic results indicate large reservoirs of oil in some locations such as the Lofoten area (Olsen, 2009). The Norwegian Petroleum Directorate estimates in their seismic report on the prospects in the area approximately 202 million Sm^3 (Standard cubic metres) of oil equivalent which corresponds to roughly 1.27 billion BOE (barrels of oil equivalent) (Oljedirektoratet, 2010, p. 4). As such the area surrounding Lofoten has for some time been an area of interest for further exploration and extraction of petroleum recourses.

In 2006 the Norwegian government presented the parliament with a report (white paper) on the management of the marine environment of the Barents Sea and the surrounding seas of the Lofoten islands in which several northern areas (e.g., the Lofoten/Vesterålen areas) were closed for exploration and drilling for petroleum resources due to considerations for the environment and fisheries (Naturvernforbundet, 2019; Miljøverndepartement, 2006, p. 122-125). In 2019 the government published a political platform known as the *Granavolden-plattformen* in which the parties pledged not to open the sea areas outside Lofoten, Vesterålen, and Senja for petroleum activities in the period 2017-2021 (Regjeringen, 2019, p. 92). Following this the updated report on the management of the marine environments reaffirmed that the areas outside Lofoten would not be opened (Klima- og Miljødepartementet, 2020, p. 132-134).

2.4 The Oslofjord

The Oslofjord is a fjord that extends from the Skagerrak into the capital of Oslo. The outer Oslofjord runs from Færder lighthouse and in the south to Hurumlandet, where it divides into Drammensfjord and inner Oslofjord. More than 40% of the Norwegian population live less than 45 minutes of driving from the fjord. The Oslofjord has the largest traffic of cargo boats and ferries in the country. With boating, cabin life and fishing, it is important as a recreational area (Store Norske Leksikon, 2020b). Parts of the Oslofjord are among Norway's most flora-rich and species-rich coastal areas (Visit Oslofjorden, n.d.).

2.4.1 Oil shipping in the Oslofjord

While there is no oil extraction in the Oslofjord, there is a fair amount of shipping in the area. All ships are at risk of causing oil spills regardless of cargo as they use oil as fuel, however in this section the focus will be on the ships that transport oil. These ships have the potential to cause the most damage, as such the scope of the damages to the environment and non-use/passive use values will be considerable.

In the period Q1 2011 to Q3 2020 there were a total of 3707 registered dockings in ports in the Oslofjord area carrying liquefied gas, crude oil, or oil products (See *table 1*). While the ships carrying crude oil were by far the smallest category, they carried the largest loads overall. With by far the highest registered maximum cargo load and the highest median cargo weight. Ships carrying liquefied gas had the smallest registered maximum cargo load and lowest median weight. Finally, the most numerous transport category, the ships carrying oil products took a middle-of-the-road approach with a maximum cargo weight of 427 716t and a median weight of 15 404t. In total 2321 of the registered dockings were unloading cargo, and 1386 were loading cargo. Crude oil shipments in particular, largely unloaded their cargo in the Oslofjord area, with only a few instances of loading (285 to 42).[1]

Table 1: Summary of oil shipping in the Oslofjord

	Liquefied Gas	Crude Oil	Oil Products
Number of Ships	949	327	2,431
Min cargo weight	0	0	0
Median cargo weight	12 205	67 245	15 404
Max cargo weight	154 805	936 561	427 716

Ships that do not transport oil are also at risk for oil spills, as was seen previously with the ship "Full City" in 2009 and "Godafoss" in 2011. The bulk carrier MV "Full City" had 1100 tonnes of heavy oil, and grounded at Såstein due to bad weather conditions. The incident polluted the coastline with 191 tonnes of oil. This led to contamination of several bird sanctuaries and protected areas. Estimated final cost of the incident was approximately 250 million NOK (Kystverket, 2017). Similarly, the cargo ship MV "Godafoss" ran aground in the Hvaler municipality and cold weather conditions created major challenges for the oil spill response operation. The ship carried approximately 900 m3 (approx. 800 tonnes)[2] of heavy oil as fuel on board. Spilled oil was spread with the coastal current into the Oslofjord. This led to contamination in several counties and beach cleaning was carried out in multiple locations.

[1] Sincere thanks to SSB and Statistikkbanken who were kind enough to send us the data detailing maritime transport and shipping of oil in the Oslofjord area upon request. Data can be downloaded (in part) here: https://www.ssb.no/statbank/table/08923/

[2] Conversions of oil quantities are included for convenience, and provides a unified metric. Calculator oil mass/density to weight (tonnes): https://www.thecalculatorsite.com/conversions/substances/oil.php

Mussels were contaminated to the extent they were not suitable for human consumption. In addition, it resulted in the death of approximately 1500 seabirds (Kystverket, 2016).

2.5 Previous large oil spills

With the ever-present production and consumption of oil and gas, as well as focus on local and global problems caused by pollution, the topic of oil spill prevention and preparedness has received quite a bit of attention in the recent years. Examples of previous large oil spills that have drawn attention from the media and the public include the Exxon Valdez oil spill in 1998, the Prestige oil spill in 2002 and the Deepwater Horizon in 2010. All three have had major damaging consequences on use and passive use values (Carson et al., 2003; Loureiro et al., 2006; Alvarez et al., 2014). The purpose of this section is to understand the consequences a large oil spill can have on the environment, and the societal losses that follow.

2.5.1 The Exxon Valdez Accident

In March 1989, the tanker *Exxon Valdez* ran into the submerged rocks of Bligh Reef and caused the largest tanker spill in U.S waters. About 11 million gallons (approx. 37 000 tonnes) of crude oil was spilled into the Prince William Sound. It was considered to be one of the largest environmental disasters in the U.S history. Lost passive use value was estimated to be 2.8 billion dollars. Subsequently, Exxon spent more than 2 billion dollars on cleanup cost. The accident also caused losses to the wildlife, for example the total number of bird deaths ranged between 75 000 – 150 000 (Carson et al., 2003, pp. 257-278). The wildlife in the area continued to suffer with chronic exposures from oil which seeped into the sediments several years after the oil spill (Peterson et al., 2003). Following the Exxon Valdez oil spill, there have been several studies (e.g., Bishop et al., 2017) and criticisms (e.g., Hausman, 2012) surrounding the methods for natural resource damage assessment (i.e., CV). This is known as the “CVM debate” where the scope effects became a central topic (Whitehead, 2016). See *section 2.1*, and *section 4.2.2* for further elaboration.

2.5.2 The Prestige Accident

In November 2002, the oil tanker *Prestige* had an accident 46 km from the Northwest coast of Galicia in Spain. This is considered to be the most extreme environmental disaster in Spanish waters. The tanker carried 77 000t of heavy oil, of which 60 000t was spilled, polluting more than 13 00 km of coastline. The accident resulted in contamination of multiple protected areas, in addition to fish, shellfish, birds and mammals (Loureiro et al., 2006, p. 50). The study estimates losses in terms of utility reduction for the society in several sectors such as tourism. Loureiro et al. (2006) estimated the environmental loss in total cleaning and recovery cost to be EUR 770.58 million, for the years 2002-2004. Subsequently, Loureiro et al. (2009) presented a study using the CVM for the estimation of environmental losses on use and passive use values caused by the Prestige oil spill. This was an economic valuation for the Spanish society, losses were estimated to be approximately EUR 574 million.

2.5.3 The Deepwater Horizon Accident

The *Deepwater Horizon* accident occurred on April 2010, when an explosion on the DWH drilling rig led to immense oil and gas blowout in the Gulf of Mexico. It took 87 days for the well to be capped, and around 500 000 m^3 (approx. 436 500 tonnes) of crude oil was leaked into the ocean, including several hundred thousand tonnes of hydrocarbon gases. It resulted in the contamination of deep-water habitats, and soiled more than 2100 km of shoreline in U.S. states such as Louisiana, Mississippi, Florida and Alabama (Beyer et al., 2016). This corresponds to a spill 10-20 times the size of the Exxon Valdez spill. It resulted in the deaths of seabirds, marine wildlife, and oiled beaches (Kling et al., 2012). The DWH accident had a negative impact on marine anglers across all fishing modes. Losses in non-market values was estimated to half a billion US dollars (Alvarez et al., 2014).

3. LITERATURE REVIEW

The literature studying sensitivity to scope in environmental valuation of oil spills is fairly limited. A complete review of all environmental valuation studies is too ambitious this thesis, as such we have chosen to focus on two main valuation contexts: oil spill prevention, and wind power externality. In preparation for this thesis 26 previous studies have been reviewed, as presented in *Appendix A*. In the discovery phase we set out a few criteria for selecting scientific articles for this review. First, each article should be about either oil spills or wind power. By examining articles related to wind power in addition to oil spills, we expand the base of literature from which to draw information, and inspiration, and cover a wider range of the topic at hand. Second, the article should ideally be a CV study, as this is the valuation technique used to elicit WTP in the Lofoten, and the Oslofjord data. Third, the article should be about, or related to the issue of scope sensitivity, or it should be possible to extract some information about scope sensitivity from the article. As a rule, we selected those articles that met the first criterion, and at least one of the other two criteria. Some of the reviewed literature does not focus on scope sensitivity specifically, and may not even include scope discussion at all. However, the literature may otherwise be useful to identify the commonly used variables, methods, and considerations made in stated preference studies. Meaning, factors that affect WTP could also influence sensitivity to scope. This information will then influence our own methodology and models later on.

To ensure an up-to-date literature review reflecting the most recent thinking in the field of scope sensitivity, we opted to focus on studies carried out after the year 2000. While this is a somewhat arbitrary cut-off point, it was chosen in order to balance presenting a literature review of recent thinking and developments, and breadth of literature ensuring we have enough sources on which to build our thesis. Furthermore, during the discovery phase for this thesis we came across some articles that do not entirely fit with the criteria we have presented, yet we believe we would be remiss not to mention. See *section 3.5* (articles also included in *Appendix A*).

3.1 CV and oil spill

In the context of CV and oil spill, studies conducted by Lopes & Kipperberg (2020), Van Biervliet et al. (2006), Carson et al. (2003), and Lazaro (2010) all include scope discussion. Of the studies examining oil spills only Lopes & Kipperberg (2020) employs scope elasticities as a measure of scope sensitivity. Van Biervliet et al. (2006), and Lazaro (2010) use more conventional measures, while Carson et al. (2003) uses specific variables regarding the respondent's beliefs in scope of damages and usefulness of preventative measures in their estimated models to infer certain information regarding scope sensitivity, and provide some discussion on this topic. Van Biervliet et al. (2006) looked at social attitudes and Lazaro (2010) looked at basic socio-economic characteristics.

Lopes & Kipperberg (2020) explored explanations for scope insensitivity in an ex-post analysis of a CV survey on WTP for avoiding oil spills in Norway. They found that few studies have presented explorations of scope in specific case analysis. The WTP over four different oil spill scenarios are estimated to be statistically different in avoidance of a small vs. a very large oil spill (1086 and 1869 NOK), with an indication of partial scope sensitivity. The partial and total scope elasticities are 0.27 and 0.18. Interestingly, when controlling for confounding factors the scope elasticity gives a higher estimate with partial and scope elasticities of 0.41 and 0.30. The overall WTP appears to be inelastic in relation to the scope of the damage.

The results in Van Biervliet et al. (2006) indicate a significant potential welfare loss if there is no action taken regarding oil spills on the Belgian coast. Losses were estimated to be EUR 120-606 million based on the size and frequency of the damage. The lower range estimate assumes that those who refused to participate in the questionnaire have a WTP of zero, and also includes protest answers. The higher range estimate does not include protest answers or make assumptions regarding the WTP of non-participants of the survey. According to Van Biervliet et al. there is no order-effect or scope-effect, however "both effects together … seem to have an influence on the WTP" (Van Biervliet et al., 2006, p. 19). On the other hand, the study by Lazaro (2010) estimates both external and internal scope tests, and results signal sensitivity to scope because answers to compensation questions indicate that respondents will pay more to avoid larger environmental damages (Lazaro, 2010, pp. 167, 207-210, 227, 238-239). Nevertheless, Lazaro also questions whether CV is a useful method when estimating environmental losses as WTP are "not proportional to the damages described" (Lazaro, 2010, pp. 4, 227).

Carson et al. (2003) provides a detailed list of variables in their model(s) and the reasoning behind their inclusion, as well as the interpretation of the estimation results. Carson et al. do not elicit WTP for multiple different scenarios in order to examine sensitivity to scope, they instead use certain variables such as respondent's belief in the extent of a hypothetical future damage and respondent's belief in the efficacy of the proposed measures to mitigate oil spill risks. By controlling for these variables in their models, Carson et al. use the estimated values to infer some insight into scope sensitivity from the collected data. By using this method of inferring scope sensitivity from model variables they conclude that the variables "taken together provide suggestive evidence of respondent sensitivity to the scope of the good valued" (Carson et al., 2003, p. 275).

In the context of oil spill studies without scope discussion, we have included studies by Ahtiainen (2007), Loureiro et al. (2009), Loureiro and Loomis (2013), León et al. (2014) and Lee et al. (2018). When looking at the listed articles in *Appendix A*, virtually all the studies mentioned examine demographics and/or socio-economic attributes to some extent. In addition to demographics, Loureiro et al. (2009) and Ahtiainen (2007) also examine protest responses, while Loureiro and Loomis (2013) include effectiveness of proposed solution, concern (for the issue) and altruism in their study. León et al. (2014) also includes emotional responses.

After the Prestige oil spill, Loureiro et al. (2009) used CVM to estimate environmental losses (in Spain) based on a parametric and non-parametric approach, where the latter approach gives the highest WTP. In other words, the chosen approach can affect WTP estimates, and may also affect scope sensitivity estimates. Loureiro and Loomis (2013) used CVM to estimate WTP for avoiding another similar sized spill off the coast of Spain. In this study however, WTP estimates were created for respondents from multiple countries: Spain, the UK, and Austria. Positive WTP was found in all countries, but varied by location, meaning distance, or separation, from the site of the accident may affect WTP, and by extension scope sensitivity. In both cases "do not know" and "no answer" responses on WTP have been recoded as negative responses (zero WTP), which is also the case in Ahtiainen (2007) and Carson et al. (2003). This gives a more conservative estimate of WTP which Carson et al. lists as one of the objectives to keep in mind when using CVM (Carson et al., 2003, p. 261).

León et al. (2014) expands on the commonly used framework of using socioeconomic characteristics to explain WTP responses and heterogeneity, arguing that the emotional responses of the individual can be used to increase the accuracy of predicting behaviour in constructed markets for damage assessment. They find that oil spills are a major public concern which cause "extreme emotions across ordinary citizens" (León et al., 2014, p. 130). Interestingly León et al. further find that "upsetting reactions lead to … a larger probability of being included either in the group of largest WTP or in the group with zero WTP" (León et al., 2014, p. 134).

The Korean Government sought an implementation plan to reduce oil spill incidents in the rivers by half. Subsequently, Lee et al. (2018) estimated WTP to achieve this reduction and find that the non-use value reflects altruistic values. Similarly, results in Ahtiainen (2007) indicates that respondents value the nature in the area and ecosystem higher than its recreational use value. A reason for this could be that respondents were informed that the total recovery time was 10 years, if another oil spill did not occur (Ahtiainen 2007, p. 10).

3.2 Non-CV and oil spill

In the context of non-CV, oil spill studies, only Casey et al. (2008) included scope discussion in their study. Casey et al. use discrete choice experiments (DCE) to examine non-use values and willingness to accept (WTA) related to oil transport in the Amazon. They find that respondents require compensation for damages beyond direct (monetary) losses for oil spill damages, suggesting non-use values still apply in the case of poor subsistence level populations (Casey et al., 2008, p. 552). Similarly to Carson et al. (2003), Casey et al. (2008) includes several variables in their models which can be used to infer something about scope sensitivity. Their findings suggest that the respondents require more compensation for larger oil spills, and for higher risk leading to more frequent oil spills. No effect could be established for the duration of the spill. Overall, the findings suggest the respondents are sensitive to the scope of the damages related to non-use values. Neither age, gender, nor ownership of property were found to have any effect on required compensation (Casey et al., 2008, pp. 557-558)

By contrast, Liu et al. (2009) and Alvarez et al. (2014) did not include scope discussion in their studies. Liu et al. (2009) looked at monetary attributes and individual’s characteristics and find positive WTP for oil spill prevention. Alvarez et al. (2014) included attributes on income, anglers, such as length of fishing trips and historical catch (use variables).

3.3 CV and wind power

In the context of CV and wind power, studies by Mozumder et al. (2011), Koto & Yiridoe (2019) and Mirasgedis et al. (2014) all included scope discussion. Variables such as education, income, visitation, and concerns about the environmental good being valued are examined and their effects on WTP are estimated (Mozumder et al., 2011; Koto & Yiridoe, 2019).

Mozumder et al. (2011) estimated households WTP for renewable energy with different scenarios of provision of renewable energy supply, 10% and 20% respectively. Results indicate that 40% of the respondents had higher WTP for a higher share of renewable energy, with an increase of the monthly bills at 14%. Furthermore, they state that “Households who donate a higher percentage of their income to environmental causes are more likely to report a higher WTP for renewable energy in New Mexico” (Mozumder et al., 2011, p. 1122). In addition, altruism related to environmental causes, and household size results in positive WTP, however, income is only positive and significant for provision of 10% and not 20%. Furthermore, Koto

& Yiridoe (2019) investigate the expected WTP for wind power in Canada. Additionally, scope sensitivity, zero WTP, and protest responses are explored in detail. Results show that households are willing to pay 14% more per month for wind power development. They also find some evidence of scope sensitivity in the conditional means, however these values are not economically significant (Koto & Yiridoe, 2019, p. 86).

Mirasgedis et al. (2014) examines the “visual impact” (also referred to as “visual disamenities”) of wind farms. In addition to conducting a CV study, Mirasgedis et al. also conduct a literature review and meta-analysis of 10 studies on wind power and their visual impact. They find that the visual impact of wind farms increases with the number of turbines and production capacity. In other words, there is a certain amount of disutility caused by wind power. Furthermore, WTP to decrease the visual impact declines as distance to the wind farms increases; and increases as number of turbines and production capacity increases (Mirasgedis et al., 2014, pp. 299-300). This can be thought of as an example of scope sensitivity in wind power development. The respondents are given an opportunity to pay to decrease their disutility from the visual impact of wind power (e.g., by moving the turbines further away) while retaining the increased production of electricity. Overall, Mirasgedis et al. in their study and meta-analysis find positive WTP for reducing the visual impact of wind farms.

Similarly, Einarsdóttir et al. (2019) also examined the visual impact of wind power development and WTP, however this study differs from that conducted by Mirasgedis et al. (2014) by simply investigating the option of not developing an area. As such the question in Einarsdóttir et al. (2019) takes the form of an “all or nothing” situation where WTP is elicited to avoid wind power disutility entirely or if the development of the area in question should proceed. In other words, there is no discussion or consideration of sensitivity to scope in this case. They find that the overall mean WTP when accounting for respondents with a true zero WTP was 12 549 ISK. Only a few covariates were determined to be statistically significant such as gender, having previously visited the area, and some income ranges (Einarsdóttir et al., 2019, pp. 795, 799, 802).

3.4 Non-CV and wind power

In the context of non-CV and wind power, Dugstad et al. (2020) and Mattmann et al. (2016) included scope discussion, while Ladenburg & Dubgaard (2007), Firestone et al. (2008) and Ladenburg & Dubgaard (2009) did not discuss scope in their studies, however, results indirectly indicate sensitivity to scope. Mattmann et al. (2016) present a meta-analysis examining both CV and DCE studies, the remaining four studies are DCE studies estimating WTP.

Mattmann et al. (2016) presented a meta-analysis from 32 studies on the external effects related to wind power production. They find significant effects of visual direct externalities on welfare estimates, with positive effect on visual improvements and negative effects on visual deteriorations. The importance of biodiversity (of fauna and birds respectively) does not affect the welfare estimates. Mattmann et al. also find strong evidence for income effects on WTP. Furthermore, they find that sensitivity to scope holds for choice experiments (CE) studies and not for CV. The scope variables (small, medium, and large change) only depend on proportional externalities to the number of turbines causing the externality (Mattmann et al., 2016, p. 33). This is contrary to Mirasgedis et al. (2014), who makes no assumptions regarding of the proportionality of the disutility.

Dugstad et al. (2020) conduct a study of scope elasticities of WTP in discrete choice experiments, and as such is quite important for this thesis for its methodology, models, and insights into scope elasticities. They perform a literature review of a number of articles in the field of environmental valuation and derive from them estimates of elasticities. From this literature review they conclude that "explicit investigations of scope sensitivity in DCE studies seem uncommon", which seems to also be the case in CV studies. They also point out that "many studies assume unitary elastic scope sensitivities" ($E_{WTP} = 1$), and studies using non-linear models tend to find inelastic results which is "consistent with diminishing marginal utility from attribute improvements" (Dugstad et al., 2020, pp. 4, 17). Their findings indicate diminishing marginal utilities in a number of variables using quadratic and piecewise linear models. One specific variable pointed out by Dugstad et al. is that of familiarity (with wind power) which they find to affect WTP and scope sensitivity. Overall, they find positive WTP for avoiding negative externalities linked to wind power, but also a positive WTP for renewable energy production. They also report "substantial differences in WTP across attribute levels", furthermore "all scope elasticities are statistically significant" although relatively inelastic (ranging from 0.18 to 0.46). Finally, they conclude: "we deem these elasticity estimates to be of an adequate and plausible order of magnitude" (Dugstad et al, 2020, p. 17).

Ladenburg & Dubgaard (2007, 2009) investigated respondents' WTP for future offshore wind projects at various distances from shore in Denmark. Annual WTP per household for reducing visual disamenities in Ladenburg & Dubgaard (2007) was estimated to be 46, 96, and 122 EUR, for the wind project located at 12, 18, and 50 km, relative to 8 km. Respondents living near the "affected" area had far higher WTP estimates, indicating that the distance from the respondent to the wind power development influences the WTP. The results indicate sensitivity to scope as the WTP estimates is higher for having the wind projects located further from shore. Ladenburg & Dubgaard (2009) uses the same data as Ladenburg & Dubgaard (2007), expanding the analysis. Results in Ladenburg & Dubgaard (2009) indicate that frequent users of the coastal area have higher WTP for reducing disamenities when compared to with less frequent users. Additionally, frequent users, in comparison to less frequent users, have twice the WTP for moving the offshore wind projects further away from the shore. Moreover, it seems more acceptable to have wind projects closer to the shore where there is less recreational activity (Ladenburg & Dubgaard, 2009, p. 241). This is supported by Firestone et al. (2008), who also finds that 83,5% of respondents would visit a beach that they never have visited before with the intention of seeing offshore wind farms. Hence, wind power development can negatively affect frequent users of recreational coastal areas, and conversely attract new users to visit an area. In other words, wind power development can be both an economic good and a bad, which has a confounding effect. In this sense estimating scope sensitivity becomes more complicated.

Correspondingly, Westerberg et al. (2013) found WTP for the three listed tourism segments in the French Mediterranean to be negative for wind farm implantation at 5 or 8 km from the shore, especially with the French, retired, non-loyal tourists. This segment demanded compensation if wind farms were located 5 km from shore. They would nevertheless choose another resort without a wind farm, even if they were offered to stay for free. However, Westerberg et al. stated that "if accompanied by a coherent environmental policy and wind farm associated recreational activities", then the wind farms can be located at 5 km without revenue losses from the tourism sector (Westerberg et al., 2013, p. 179). Results in Landry et al. (2012) also indicate that North Carolina (NC) local tourists are hostile to wind farms located near the shore, however locating wind farms further from the shore has no impact on welfare. Overall, they find little impact of offshore wind power development on regional residents' visitation preferences in NC. The study cannot show evidence of significant sensitivity to scope by their distance attributes, which is the same case in the study by Brennan & Van Rensburg (2016). Interestingly, results in Brennan & Van Rensburg show that some respondents gain welfare when the number of turbines increases and setback distances are reduced, which lends support to the findings of Firestone et al (2008).

3.5 Other Articles of Interest

In this section we discuss a few articles of interest not related to oil spills nor wind power that nonetheless caught our attention during the discovery phase of this literature review. The articles selected for this section were not chosen in accordance with the first criterion as stated above. Instead, we opted to include these articles as we happened to come across them during our research and deemed them to be sufficiently relevant to this thesis (articles also included in *Appendix A*).

Søgaard et al. (2012) in an effort to examine scope insensitivity in CV studies conducted a survey on Danish men invited to a screening for cardiovascular disease. While overall the sample was found to be sensitive to scope at the sample-mean level, at the individual level more than half the respondents failed to show sensitivity to scope. At the respondent level 54% failed to show sensitivity to scope for a reduction in risk through a better screening programme (test 1), similarly 66% of respondents failed to show sensitivity to scope when offered a scenario with less travel costs (test 2). Furthermore, 58% of the respondents that passed test 1 went on to fail test 2, and 43% of respondents that passed test 2 had previously failed the first test for risk reduction. The authors argue this indicates that "the reasons for failing could be different for the two tests" (Søgaard et al., 2012, p. 401). WTP was also notably different when excluding the subsamples which failed the scope tests, with those respondents who passed the scope test for risk reduction valuing the base offer lower than the mean (by 49%), and valuing the better offer higher than the overall sample mean (by 41%).

Søgaard et al. (2012) argue that the failure rate being higher for test 2 than 1 indicates that the reason for scope insensitivity is not “a lack of sensitivity to small risk changes, as has been pointed out as a common cause” (Søgaard et al., 2012, p. 403). Among the potential reasons for scope insensitivity according to Søgaard et al. are cognitive limitations; emotional load, where the respondent relies on emotions in the valuation exercise; mental budgeting, where the respondents create their own mental budgets for specific uses (and subsequently deplete their mental budget at the first bidding opportunity); and regret theory (Søgaard et al., 2012, pp. 397, 404). They also examine some characteristics such as age and level of information, but do not draw any conclusions from their results other than indicating they “play a role” (Søgaard et al., 2012, p. 402). Finally, Søgaard et al. conclude that future studies should focus on understanding motives for stated preferences to better understand seemingly irrational responses leading to potentially imprecise estimates of WTP and welfare (Søgaard et al., 2012, p. 404).

Veisten et al. (2004) conducted a study on complex environmental amenities (bundles of endangered species) in which they investigated scope sensitivity. Estimate results found by Veisten et al. are as expected, with higher WTP as the scope of the bundle valued increases. Sub-samples were divided into different elicitation formats: open-ended questions with and without payment cards. This influenced the elicited WTP values, with more respondents stating values over 2% or household income as their WTP with the payment card format. These respondents also had fewer item non-responses than those without this format. Overall, the payment card format returned higher estimates of WTP (Veisten et al., 2004, p. 322). The authors conclude that elicitation format affect not only stated WTP, but also the statistical tests of scope sensitivity (Veisten et al., 2004, p. 328).

Veisten et al. (2004) conducted several tests of scope sensitivity, both internal and external, with different results. Some rejecting scope insensitivity, others providing mixed results, and some being unable to reject the null hypothesis that WTP varies with scope. Veisten et al. find that some respondents seem to truly be insensitive to scope. They add however, that “the behaviour of this minority of respondents did not have any dominating effect on the outcome of the scope tests”. In fact, the effect of elicitation format was greater, and the payment card format lead to more sensitivity to scope being found. (Veisten et al., 2004, p. 329). They conclude that “observed insensitivity to scope is due to flaws in survey design and amenity misspecification, not an inherent weakness of the method threatening its theoretical construct validity" (Veisten et al., 2004, p. 329). According to Veisten et al. there are several potential biases, and considerations one should make when conducting a CV study. These include the purchase of moral satisfaction (warm glow effect), mental accounting/budgeting, diminishing marginal utilities affecting scope sensitivity, baseline bias causing the respondent to use the valuation of the first good as an anchor (baseline) for valuing subsequent goods, etc. Veisten et al. also draw attention to the issue of the size of scope sensitivity. "One might still ask if rejecting the null hypothesis of insensitivity to scope is 'enough' to conclude that CV provides the correct estimates in relation to scope or size" (Veisten et al., 2004, p. 329). This is similar to the issue raised by Lazaro (2010), who questioned the validity of CV due to a lack of proportionality of WTP and damages described despite finding scope sensitivity.

3.6 Findings from the literature review

Through our literature review we have identified several important factors for our continued research. For example, a number of useful methods and models (such as employing piecewise model specifications) have been identified which will be implemented or otherwise guide our work on this thesis. Of particular interest for this thesis is the method of using elasticities as a measure of scope sensitivity as seen in Lopes & Kipperberg (2020), and Dugstad et al. (2020). Also of importance are the various confounding factors, biases, and considerations mentioned in the body of literature such as mental budgeting, warm glow, emotional responses, etc. See Lopes & Kipperberg (2020); Dugstad et al. (2020); Veisten et al. (2004); Søgaard et al. (2012); Firestone et al. (2008); León et al. (2014), etc. Finally, we have identified multiple potential variables from the reviewed literature which can be employed in our models such as socio-economic (e.g., income), and demographic attributes (e.g., age, gender), attitudes (environmental organisation membership), case specific factors (e.g., length of coastline spoiled, number of dead animals), distance, frequency of use of the area, knowledge/familiarity with the topic.

4. ENVIRONMENTAL VALUATION

In this chapter we will go through the theoretical foundations of environmental valuation, provide some information regarding the SP and CV empirical methods (such as common problems and biases of CV), and explain sensitivity to scope, and the scope elasticity approach.

4.1 Theoretical foundations

4.1.1 Total Economic Value

When valuating the environment, it is common practice to distinguish between use values and non-use values. Use values are connected to the consumer's direct or indirect consumption utility. By contrast, non-use values are connected to the consumer's satisfaction from the goods beyond use values. The sum of the two values gives us the total economic value (TEV) of environmental goods (Perman et al., 2011, p. 412). *Figure 1.* presents the conceptualization of TEV.

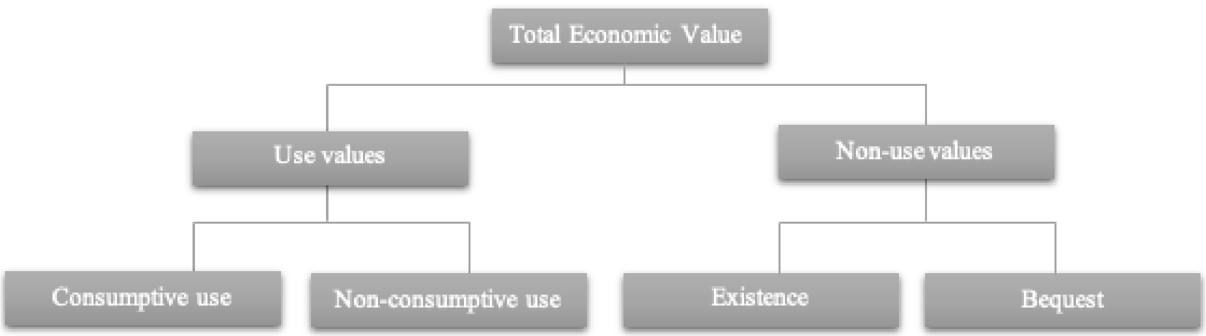

Figure 1: Standard classification of economic values.

TEV in the figure above are divided into use and non-use values as described, which then can be divided into two further categories. For use value the first is consumptive use, and this relates to direct use of an environmental good. In contrast, non-consumptive use relates to environmental goods that can be indirectly used or give individuals pleasure. On the other hand, non-use values can be divided into existence and bequest. Individuals may be proud of the existence of an iconic site even if they have not visited, and do not intend to visit the site. Lastly, bequest are values appear from concern for the interest of the future generation (Perman et al., 2011, pp. 412-413).

4.1.2 WTP and WTA

TEV is calculated by the sum of all relevant WTP and WTA. These measures typically represent an improvement or deterioration of value. Perman et al. (2011) states that:

> It is often assumed that individuals have the right to current levels of environmental quality. Viewed from this perspective, improvements in environmental quality should be valued using WTP questions whereas reduction in environmental quality should be valued using WTA questions. (p. 417)

However, CV studies typically use WTP questions regardless of the situation as WTA compensation is often more complex compared to WTP. When using WTA in practice, one can often observe more protest behavior in form of zero responses because they do not want to be paid off to accept an environmental damage or that the compensation should be infinitely large (Lindhjem et al., 2014, p. 28). This is also the case for the questionnaires used in this thesis, where respondents were asked about their WTP for avoiding oil spills in Lofoten and the Oslofjord.

In the socio-economic sense, the welfare loss is the amount a respondent (directly or indirectly) is willing to have their income reduced by. Meaning less to spend on other goods and services that benefit them, in order to avoid or reduce the environmental damage. The individual loss of benefit can be captured by the maximum WTP to avoid damages, and is defined by the indirect stated utility function (V) of the individual j (Lindhjem et al., 2014, p. 28):

Equation 1: Individual utility function

$$V_j(P_j^0, Y_j - WTP; Q_j^0, QUAL_j^0, SUB_j^0, H_j, I_j) = V_j(P_j^1, Y_j; Q_j^1, QUAL_j^1, SUB_j^1, H_j, I_j)$$

where *P* is a price vector for market goods, *Y* is household income, *Q* is a measure of the extent (quantity) of the damage (e.g., km of affected shoreline), *QUAL* is a measure of quality reduction, *SUB* is a measure of substitutes (for the lost marine and coastal ecosystem services), *H* are other characteristics of the household that is not income, and *I* is a measure of the information available to the respondent. Indexes 0 and 1 indicate before and after the damage has occurred, respectively. If we solve *equation 1* for WTP, we get (Lindhjem et al., 2014, p. 28):

Equation 2: WTP

$$WTP = f(P_j^0 - P_j^1, Q_j^0 - Q_j^1, QUAL_j^0 - QUAL_j^1, SUB_j^0 - SUB_j^1, H_j, I_j)$$

Equations 1, and *2* define WTP if we assume constant prices and available substitutes. Therefore, WTP is the amount that can be deducted from the household's income in the initial situation, as this is indifferent in relation to the situation where the oil spill and the environmental damage have occurred. Theoretically, a household should have higher WTP to avoid larger damages than a small damage, such as for higher values of Q and $QUAL$. This indicates scope sensitivity, which is a widely used measure of validity in stated preference methods, as emphasized by Arrow et al. (1993), see *section 4.3*.

4.2 Empirical methods

Empirical valuation methods can be divided into two broad categories: stated preference, and revealed preference. Choice experiments and contingent valuation are examples of stated preference methods. SP methods study hypothetical scenarios where it can capture both use and non-use values. By contrast, there is demand dependency, the travel cost method and hedonic pricing, which are examples of methods used in revealed preference. Revealed preference methods study actual observable behavior and capture use values (Perman et al., 2011, p. 415). For our thesis we look closely at SP and CV, and attempt to find determinants that can affect WTP and scope elasticity at the individual level. In addition, scope elasticity is discussed in this chapter (see *section 4.3.1*).

4.2.1 Stated Preference

SP methods use survey techniques to estimate WTP for improvements, or avoiding marginal loss (Tietenberg & Lewis, 2018, p. 78). Moreover, environmental valuation is based on data from surveys asking respondents hypothetical questions regarding their preferences for a change (improvement/deterioration) in the environment. Environmental value estimates are derived from their stated responses (Segerson, 2017, p. 21). Hence, the SP methods using multiple different hypothetical scenarios can be used to test for scope sensitivity.

4.2.2 Contingent Valuation

Contingent valuation (CV) is a survey-based valuation technique where respondents are asked about their maximum WTP or WTA for environmental goods, in a hypothetical scenario. As mentioned, CV is a stated preference method and can measure both use and non-use values. CV studies have been conducted in many countries for environmental protection, government departments, university research, etc. (Perman et al., 2011, p. 415). The payment vehicle is the method by which the questionnaire asks the respondent about their hypothetical WTP for a scenario. Commonly used payment vehicles include increasing local or national taxes as a one-time payment or an annual payment per household. The most common elicitation methods are bidding games, payment cards, dichotomous choice, and double-bounded dichotomous choice (Perman et al., 2011, pp. 416-17). The payment card method was used in the surveys which we employ in this thesis. A scenario is described to the respondent who is then presented with a "card", in this case a slider scale to select a specific amount of money from a number of options. However, Perman et al. questions this method as the scale used in the payment card may influence the respondent's decision. This view is supported by Lindhjem et al. (2014) where they argue respondents tend to centre their WTP on round, or middle numbers in the scale presented to them (Lindhjem et al., 2014, p. 32).

Relating to the "CVM debate" and following the Exxon Valdez oil spill, a NOAA panel of experts reviewed the CV method, and whether it provided reliable estimates for lost passive-use values. They concluded that the CV method has its value, but put forward a set of "best practice" guidelines for how CV should be carried out (Arrow et al., 1993). Moreover, reliability, and validity are two important topics in relation to SP methods. Perman et al. (2011) argue that when studies include "face validity" questions, it aims to examine whether the survey includes the proper question for the supposed scenario. They further stated that "results from surveys characterized by a large number of protest bids or no-response items should be viewed with skepticism" (Perman et al., 2011, p. 423). Similarly, Arrow et al. (1993) suggested for example in-person interviews, clear scenario descriptions, follow up questions, and use of referendum WTP questions. In addition, CV studies need to include "whether the CV technique is capable of providing reliable information about lost existence or other passive-use values" (Arrow et al., 1993, p. 5). These guidelines have been influential in shaping the recently conducted studies (e.g., Kling et al., 2012), and as mentioned in *section 2.1* the scope test has also become a standard practice for CV studies (Desvousges et al., 2012).

There are several types of biases and problems in CV. One prominent example of a common CV problem is amenity misspecification which can be defined as: "where the perceived good being valued differs from the intended good" (Mitchell & Carson, 1989, p. 237). Other problems associated with CV include: "part-whole" bias; hypothetical bias; insensitivity to scope; temporal embedding; and information bias. Any one of which could have an effect of the scope sensitivity in our thesis. “Part-whole” bias occurs when the value of a good is similar to the value for a more comprehensive good. Hypothetical bias occurs when respondents typically overstate WTP amounts because it a hypothetical scenario (overvaluation of the environmental good or services). Insensitivity to scope occurs when the respondents WTP is independent of the scale of the good being presented. Temporal embedding arises when respondents WTP do not vary due to the frequency of payments. Information bias arises when respondents WTP reflect deficiency of their knowledge (Perman et al., 2011, pp. 424-425). Another concern with the method has been the probability of biased answers, such for WTP and WTA. Many CV studies found higher values for a respondents WTA than for WTP, while the economic theory suggest that these should have been equal (Tietenberg & Lewis, 2018, p. 79-81). However, the NOAA panel recommended WTP instead of WTA because the former is more conservative (Arrow et al., 1993, p. 32). The survey method can also cause problems, the NOAA panel recommended in-person interviews, however the literature reviewed (in *Ch. 3*) indicates a large proportion of CV studies do not use in-person interviews, but other less reliable methods (e.g., phone interviews). Nevertheless, Lindhjem et al. (2014) argued that web-based surveys do not necessarily present imperfect answers (Lindhjem et al., 2014, p. 29).

The CV method has been criticized in the past, and some studies indicate that the method can potentially exaggerate “real” WTP (e.g., Seip & Strand, 1992), furthermore the respondents’ elicited WTP is not based on real transactions (e.g., Bishop et al., 2017). The method has also been criticized in the context of scope sensitivity (e.g., Kahnemann & Knetsch, 1992; Mitchell & Carson, 1989). Another potential problem with the CV method is the “warm glow” effect, where respondents give a value in order to feel good, and be recognized for good moral choices, rather than their true WTP for the presented scenario (Arrow et al., 1993, pp. 9-10, 26; Nunes & Schokkaert, 2003). This is also supported by Veistein et al. (2004), see literature review (*Ch. 3*). Carson et al. (2001) reflected on many of these issues mentioned above and concluded that “many of the alleged problems with CV can be resolved by careful study design and implementation” (Carson et al., 2001). Regarding scope sensitivity, Lazaro (2010) questions the CV method as WTP amounts are not proportional to described damages.

4.3 Sensitivity to scope

The basic assumption regarding sensitivity to scope is that the respondent's WTP is higher for greater quantities of a good or for preventing larger damages. The scope test intends to see whether WTP estimates are sensitive to the scope of the good or damages being valued. However, when a respondent is faced with different damage size in the same questionnaire ("internal scope test"), they may on average state higher WTP (but probably marginally decreasing WTP) in order to avoid larger damages compared to a small damage (Lindhjem et al., 2014, p. 28). In addition, two different issues have appeared: first, no statistically significant change in WTP estimates as the scope of the good or damages increases; secondly, the change in WTP estimates is statistically significant, but the sensitivity to scope is rather small. The latter issue raises questions in relation to whether estimates are economically significant (Amiran & Hagen, 2010, p. 298). For the purpose of estimating economic significance of sensitivity to scope, we will use the scope elasticity approach.

4.3.1 Scope elasticity

Scope elasticity is an approach of assessing scope sensitivity of WTP. Lopes & Kipperberg (2020) stated that "scope elasticity measures the percentage change in WTP associated with a percentage change in the magnitude of the good, and as such, can be utilized to assess the economic significance rather than the statistical significance of scope impacts" (Lopes & Kipperberg, 2020, p. 193). Results with negative elasticity indicate that changes to WTP move in the opposite direction of changes to the scope of the good. Zero elasticity signals no scope effect. Scope elasticities of one indicates proportional responsiveness, while elasticities between 0 and 1 are inelastic (less than proportional effect) (Dugstad et al., 2020, p. 5). In their study, Dugstad et al. constructed scope arc-elasticity of WTP ($\bar{E}_{WTP}$) (Dugstad et al., 2020, p. 7). This is also the method we will employ in our estimations of scope elasticities for this thesis. Scope arc-elasticity of WTP as used in Dugstad et al. ($\bar{E}_{WTP}$) can be defined as:

Equation 3: Scope arc-elasticity

$$\bar{E}_{WTP} \equiv \frac{\%\Delta WTP}{\%\Delta q} = \left(\frac{WTP^B - WTP^A}{(WTP^B + WTP^A)/2}\right) / \left(\frac{q^B - q^A}{(q^B + q^A)/2}\right)$$

Where q represents the size of the damages (small, medium, large and very large). In this case, length of affected coastline (km) is used as a proxy for the total scope of damages (as presented in the survey scenario for each oil spill size, see *Appendix B*: *fig. B.1* and *Appendix C*: *fig. C.1*). WTP^A and WTP^B is the respondent's willingness to pay for the different scenarios of q.

The scope elasticity approach has recently been used for instance by Amiran & Hagen (2010), Whitehead (2016), Burrows et al. (2017), Lopes & Kipperberg (2020) and Dugstad et al. (2020). For strictly convex neoclassical preferences, Amiran & Hagen (2010) implies scope elasticity between 0 and 1. Whitehead (2016) consider scope sensitivity when elasticities are higher and statistically different from zero. Moreover, Burrows et al. (2017) suggest values between 0.2 and 0.5 to be "scope elasticities in a range that, in our judgement, is plausible" (Burrows et al., 2017, p. 141). Lopes & Kipperberg (2020) used scope arc-elasticity and judge elasticities of 0.2 to be adequate and plausible. This is also the case in Dugstad et al. (2020) which implies significant scope elasticity for their results between 0.18 and 0.46.

5. METHODOLOGY

This chapter presents the survey design in both Lofoten, and the Oslofjord. Following with information on the regression model used, then a section on the variables used in the final models. This chapter ends with a section on data processing where we describe the data cleansing process, models, and datasets used in the analysis.

5.1 Survey Design – Lofoten

The survey creation process for the Lofoten survey began in 2012. The survey built on, and took inspiration from multiple oil spill studies conducted previously (Lopes & Kipperberg, 2020, p. 199). Lindhjem et al. (2014) developed a pilot study in order to explore the practical issues surrounding the survey, and aid in the purpose of acquiring reliable data. One such practical issue is ensuring that respondents properly understand the descriptions of damages presented in the survey in the manner the researchers intend. Respondents incorrectly understanding the situation as presented and thus valuing something other than what the researcher intended would be an example of amenity misspecification as mentioned in *section 4.2.2*. The data collection was done through a web-based survey conducted in April 2013 by NORSTAT, a survey sampling company in Norway. The second survey had almost identical information, questions, and structure compared to the first, and was completed in April 2020.

The data collected in 2020 is the one used in this thesis. As a response to the COVID-19 pandemic, the second survey included questions about the respondent's situation before and after the pandemic (more about this in *section 5.1.3*). As mentioned in *section 4.2.2*, Lindhjem et al. (2014) argued that web-based surveys do not necessarily present imperfect answers, even though the NOAA panel recommended in-person interviews.

5.1.1 Questionnaire

The survey starts with question regarding respondents' demographics, attitudes towards societal tasks and general use of the Lofoten area. Following with questions about personal experience with oil spills, the local ecosystem, and knowledge about 7 previous oil spills. It continues with a statement where experts believe that an oil spill from a ship accident will likely occur in the area in the next few years, if measures are not implemented. Oil spill scenarios of four different sizes (small, medium, large and very large) were described by a visual dispersion map and damage table (*Appendix B*: *figure B.1,* and *B.2*). Damages from the oil spills are described with, and without oil spill countermeasures in the form of bird and seal deaths, soiled coastline (km), and recovery time for safe seafood consumption. Later parts of the questionnaire ask questions about the respondents' WTP for the different scenarios. The questionnaire ends with the respondent's background information, and COVID-19 related questions.

5.1.2 WTP questions

Before the WTP questions, respondents were informed that each of the damage levels should be assessed in turn, and that they will start with the smallest damage level in order to avoid surprises, and give the respondents the opportunity to compare the extent of the damages in advance (Lindhjem et al., 2014, p. 31). The payment vehicle in the WTP questions takes the form of increased taxes for the household paid annually for the next 10 years which means less to spend on other goods and services that benefit them. One potential problem here is the possibility of respondents answering in protest because of opposition for higher taxes (Lindhjem et.al., 2014 p. 33). The WTP questions were in the form of a payment card with a slider scale where the respondent could move and choose their household WTP on a scale from "0 NOK" to "More than 15 000 NOK". They could also choose to answer "Do not know" (*Appendix B*: *figure B.3*). The questionnaire attempts to avoid round and centered WTP amounts with this slider scale. Including the options "do not know", and "more than 15 000

NOK”, there are 25 WTP options to choose from on the payment card. After the WTP question, the following question depends on what the respondents answer. If they were to answer “more than 15 000 NOK”, they also had to state a specific amount. If the respondents answered “0 NOK” or “Do not know”, they also had to specify the most important reason for their answer from a set of alternatives. This was done for each of the four oil spill scenarios.

5.1.3 Background information

The questionnaire ends with a section asking the respondents information about their background such as income, household income, occupation, education, whether they are members of an environmental organization, etc. The importance of this is to report respondents' characteristics to ensure the validity of the answers (Lindhjem et al., 2014, p. 32). Lastly, this section included questions about respondent's well-being before and after the COVID-19 pandemic occurred, if the WTP answers would have been different if this was before the pandemic, and whether the household's income would be affected due to COVID-19 compared to a normal situation (*Appendix B*: *figure B.4 – B.7*). These answers are based on the respondent's reported income and happiness responses, and not actual data from different years.

5.2 Survey Design and Questionnaire – the Oslofjord

The Oslofjord survey, and the Lofoten survey are almost identical in design, and questions posed to the respondents, although with some changes and differences between the two surveys such as site-specific questions. Data collection was handled by Norsk Gallup (*Appendix C*: *Figure C.1 – C.7*). The survey was based on all counties in Norway, however almost all respondents who completed the survey were located near the Osloford area. For this reason, the Oslofjord survey is a more reginal survey, while the Lofoten dataset is a national survey.

In-between the visual dispersion map and damage table, the Oslofjord included a slider scale where the respondents had to mark the loss of quality of life between 0 and 100 that the household would experience from the different sizes of oil spills and their damages. In contrast, the Lofoten survey included a figure where respondents could rank from 1 to 4 which of the environmental damages (damage to birds, seals, the coastal zone, and life elsewhere in the sea) were important, with 1 being the most important (*Appendix B*: *figure B.8*, and *Appendix C*: *figure C.8).*

Other differences where the questions regarding the respondents' WTP. For the Lofoten dataset, questions about WTP were based on annual payment for the next 10 years, while the payment vehicle in the Oslofjord dataset was a one-time payment from households for the different oil spill scenarios. Moreover, there were differences with the numbers used in the WTP question for the four different scenarios. The Oslofjord survey used the option "More than 12 000" NOK as the highest option on the slider scale, while the Lofoten survey used "More than 15 000" NOK. The options of NOK values presented on the scales were also different (see *Appendix B*: *figure B.3* and *Appendix C*: *figure C.3).*

5.3 Regression models

As the respondents were presented with 4 different oil spill scenarios (small, medium, large, and very large) in both the Lofoten and Oslofjord questionnaires it is possible to create 6 unique scope arc-elasticity measures for both surveys. These are: small - medium; small - large; small - very large; medium - large; medium - very large; and large - very large. Combining these measures provides the opportunity to examine the effects on the scope elasticities in each questionnaire as a whole by using panel data methods. By expanding the dataset so that each respondent now has 6 observations, the 6 individual-level arc-elasticities are placed in a vector which is used as the dependent variable (y) in the regression models. We utilize a generalized linear panel model, assuming homogeneous parameters ($\alpha_i = \alpha$ and $\beta_i = \beta$ for all i):

Equation 4: Generalized linear panel model

$$y_i = \alpha + \sum_{1}^{K} \beta_k x_{ki} + \epsilon_i$$

Where $i = 1, \dots, n$ is the index of each individual respondent, and $k = 1, \dots, K$ is the index of variables for the model. Here ϵ_i is the error term for each individual respondent. In our analysis specifically we use the package 'plm' in R, allowing us to create and analyze linear models for panel data. We use the estimation method 'between' (model = between) which "returns a vector containing the individual means … with the length of the vector equal to the number individuals" (Croissant & Millo, 2008, p. 104).

5.4 Variables

This section aims to shed some light on the variables used in our model estimations. Our analysis is a more semi-exploratory data analysis for ensuring valid results. This is an approach for investigating and understanding patterns, and errors in the datasets before making a selection on the variables (IBM, 2020). Prior to investigating the datasets, the literature review gave us an indication on which variables to include in our models, however due to the relatively sparse information on the topic of scope determinants on an individual level we decided to investigate broadly the effects of a wide range of potential variables on the scope elasticities. After examining the datasets, we discovered some interesting relationships, identified some potential issues and selected variables which we thought were best suited for this research. See *table 2* below for a complete list of variables used in both the Lofoten and the Oslofjord analyses. Additionally, we have grouped the variables into further categories: demographics/socio-economics, use/non-use, attitudes, COVID-19, knowledge/familiarity, and trust related variables. The results and discussion sections are written to conform with these groupings.

In accordance with Dugstad et al. (2020) who found that their piecewise model specifications were "more flexible and statistically superior", our models for the most part consist of dummy variables, however there are some continuous, and quadratic variables such as those for the respondent's age, household income, and distance variables. Our dependent variable is a vector of 6 observations of arc-elasticities for each respondent. Each elasticity is calculated using the same approach as Dugstad et al. (2020) in *Equation 3* (see *section 4.3.1*) on an individual level:

Equation 5: Individual scope arc-elasticity

$$E_{it} \equiv \frac{\%\Delta WTP_i}{\%\Delta q} = \left(\frac{WTP_i^B - WTP_i^A}{(WTP_i^B + WTP_i^A)/2}\right) / \left(\frac{q^B - q^A}{(q^B + q^A)/2}\right)$$

Here $i = 1, \dots, n$ is the index of each individual respondent, and $t = 1, \dots, 6$ is the specific elasticity between two scenarios B, and A (scenarios B, and A identify the different oil spill scenarios: small, medium, large, and very large). Where q represents damages caused by the oil spill scenarios measured in km of coastline spoiled. WTP_i^A and WTP_i^B is the respondent's reported WTP when presented with these damages. The reported WTP reflects the respondent's utility loss from the oil spill. Utility and WTP are both functions of factors such as income, prices, available substitutes, the specifics of the oil spill such as extent, and loss of quality of the affected good (area) among others. See *Equation 1* and *Equation 2* in *section 4.1.2*

Table 2: List of variables with descriptions

List of variables with descriptions

Variable name	Description	Type	Dataset
elasticities	Elasticity of respondents WTP responses	Dependent variable	Both
gender	Respondent's gender (1 = male)	Dummy	Both
age	Respondent's age	Quadratic	Both
college	Respondent has tertiary level education	Dummy	Both
HHInc_1000s	Household income in thousands (NOK)	Linear	Both
dist	Distance to Lofoten (km)	Quadratic	Lofoten
red_gas	Important reduce greenhouse gases	Dummy	Both
red_hosp_g	Important reduce hospital queue	Dummy	Both
new_roads	Important build new roads	Dummy	Both
spill_prev	Important prevent oil spills	Dummy	Both
old_care	Important provide care for the old	Dummy	Both
ocean_dist	Distance to ocean from house (km)	Quadratic	Both
visit_lofoten	Respondent has visited or lives in Lofoten	Dummy	Lofoten
num_trip	Number of trips respondent has made to Lofoten	Quadratic	Lofoten
env_org	Respondent is member of environmental organization	Dummy	Both
low_inc_cov	Respondent's household income negatively affected by covid	Dummy	Both
spill_fam	Respondent has familiarity with previous spills (at least 1)	Dummy	Both

spill_fam_2	Respondent has familiarity with previous spills (at least 4)	Dummy	Both
spill_fam_pers	Respondent has personally seen an oil spill on the shore	Dummy	Both
eco_fam	Respondent is familiar with local ecosystems	Dummy	Both
trst_results_used	Respondent's belief/trust in importance of questionnaire: will results be used to inform policy / decision making	Dummy	Lofoten
trst_more_tax	Respondent's belief/trust in credibility of questionnaire: oil spill counter measures will increase taxes if enacted	Dummy	Lofoten
eff_measures	Respondent's belief/trust in efficacy of oil spill counter-measures	Dummy	Both
likely_north	Respondent will likely travel to northern Norway soon	Dummy	Lofoten
likely_lofoten	Respondent will likely travel to Lofoten soon	Dummy	Lofoten
dis_oil_Lofoten	Respondent is strongly against oil exploration in Lofoten	Dummy	Lofoten
happiness_neg	Respondent's happiness has been negatively affected by covid	Dummy	Both
visit_oslofjorden	Respondent has visited the Oslofjord in last 12 months	Dummy	The Oslofjord
frequent_visits	Respondent has frequently visited the Oslofjord in last 12 months	Dummy	The Oslofjord

5.5 Data processing

This section presents the data processing for both datasets. We began with the Lofoten dataset and then replicated the process with the Oslofjord dataset, with only a few necessary changes in the approach to be able to compare the outputs. For both Lofoten and the Oslofjord datasets we created 3 models each: model 1 based on the full dataset with all respondents; model 2 is a 'trimmed' version with respondents removed from the analysis based on certain criteria related to their elicited WTP (income, protest answers), and the time spent on the questionnaire; model 3 is an even further trimmed version of model 2, removing respondents based on criteria related to their elasticity values (the dependent variable) (see *table 7*, and *table 8).*[3]

5.5.1 WTP and protest answers

Respondents whose WTP exceeded 2% of household income were removed from the analysis due to unrealistic levels of elicited WTP. A potential reason for respondents giving such high levels of WTP may be the 'hypothetical bias' as covered in *section 4.2.2*, where respondents overstate WTP amounts because they are presented with a hypothetical scenario. This may also be linked to the issue of 'warm glow'. One such example of a very high WTP is a respondent in the Lofoten dataset with a stated WTP for one oil spill scenario of 1.2 million NOK despite only having a household income of 650 000 NOK. This method of removing respondents based on unrealistic WTP has also been done in previous studies as such answers are not in line with economic theory (e.g., Veisten et al., 2004, p. 322; Lindhjem et al., 2014, p. 36). Respondents who refused to answer the question for household income were assigned an income equal to the mean of the other respondents' responses. A few respondents reported very high levels of income, as such they were removed from the calculation of the mean as outliers, but were not removed from the data or analysis generally.

Respondents who gave the answer "do not know" on the WTP elicitation questions were recoded to zero WTP. We cannot tell *a priori* if "0 WTP" answers are protest answers, or if the respondents' 'true' WTP is zero. Therefore, it is important to understand why respondents report "0 WTP" or "do not know" on the WTP questions, and then removing those answers identified as protest answers. If "0 WTP" and "do not know" answers are incorrectly removed

[3] Note: we use the phrase "models" throughout this thesis to refer to the analyses for both surveys. To clarify, the model specifications are the same for all three models in Lofoten, and also for all three models in the Oslofjord. The same variables are used across models, with only some differences between Lofoten, and the Oslofjord. What differentiates the models is their 'foundations', meaning the dataset used varies across models, with model 1 using the full dataset, and models 2, and 3 building on reduced datasets.

from the analysis, we are likely to overestimate the mean WTP of the sample. On the other hand, leaving all answers in the analysis by not removing protest answers will give a low estimate of WTP. However, those respondents who gave “0 WTP” or “do not know” responses were asked to justify their answer from a number of categories. We identified several of these categories as protest responses and removed these respondents, such as respondents who feel that the tax level is high enough or that the environment should not be measured in monetary terms (see *Appendix B*: *table B.1*, and *Appendix C*: *table.C.1*). Identifying and removing protest answers has also been done in previous studies (e.g., Koto & Yiridoe, 2019; Carson et al., 2003), as has recoding “do not know” answers as zero WTP (e.g., Loureiro and Loomis, 2013; Ahtiainen, 2007; Carson et al., 2003). This gives a more conservative estimate of WTP which Carson et al. (2003) states as an objective when using the CV method (Carson et al., 2003, p. 261).

5.5.2 Time spent on the survey

The median time respondents spent on the two surveys was 16 minutes. We recon the time spent can give us an indication on how reliable answers were, as those respondents who complete the survey too quickly likely did not give appropriate attention to the questions asked. Therefore, we decided to remove respondents who took less than half of the median time to complete the survey, which is 8 minutes. The removal of these respondents, as well as those mentioned previously with unrealistic reported WTP levels, and those who gave protest responses is part of the procedure for creating model 2.

5.5.3 Elasticities

During the construction of our models and the dependent variable for the Lofoten dataset, we observed several negative elasticity values for some respondents and found this to be both interesting and somewhat illogical at the same time. Therefore, we wanted to see if the presence of these negative values would have an effect on the estimated results and decided to remove respondents with negative elasticities, thus creating model 3 which we estimate on a further reduced dataset. Upon discovery of similar elasticity results in the Oslofjord dataset, we saw an opportunity to examine and compare results across the two surveys. For comparison, see *table 7*, *table 8*, and *Appendix D*: *table D.1 – D.6*. In model 1, and 2 negative elasticities are included, in model 3 negative elasticities are excluded.

5.5.4 Finished models

We use a total of 6 models in this thesis, 3 for Lofoten, and 3 for the Oslofjord survey. Lofoten model 1 builds on the complete dataset with all 1010 respondents who completed the questionnaire. Model 2 is based on the observations of 734 respondents, and model 3 has 616 respondents. Similarly, in the Oslofjord data, model 1 has all 1041 respondents, and model 2 and 3 have 700 and 659 respondents respectively.

6. EMPIRICAL ANALYSIS

6.1 Descriptive Statistics

All respondents who completed the survey for Lofoten, and the Oslofjord survey are included in the first part of this chapter which provides relevant descriptive statistics related to the analysis. After processing the data (as mentioned above) some respondents were excluded from the analysis as shown in the results in *section 6.3*.

6.1.1 Lofoten Survey

Of the Lofoten dataset, 1010 of 2631 respondents completed the survey. The county with the most respondents is 'Viken' with 223 respondents (22%), which is fairly proportionate with the real population of 'Viken' and Norway. Not all of the counties are quite as proportionally represented in the survey however, 24% of the respondents live in the counties 'Troms og Finnmark' and 'Nordland' compared to roughly 9% of the actual population (see *figure 2*). As such the counties of Northern Norway are overrepresented in the dataset, and several of the southern counties are slightly underrepresented. Of the respondents from Nordland, 9 live in Lofoten. This is relatively representative of the population in Lofoten.[4]

[4] Of the data collected, 115 respondents are from Nordland county, of these 9 respondents (7,8%) are from Lofoten. Comparatively about 10% of the actual population in Nordland county live in Lofoten.

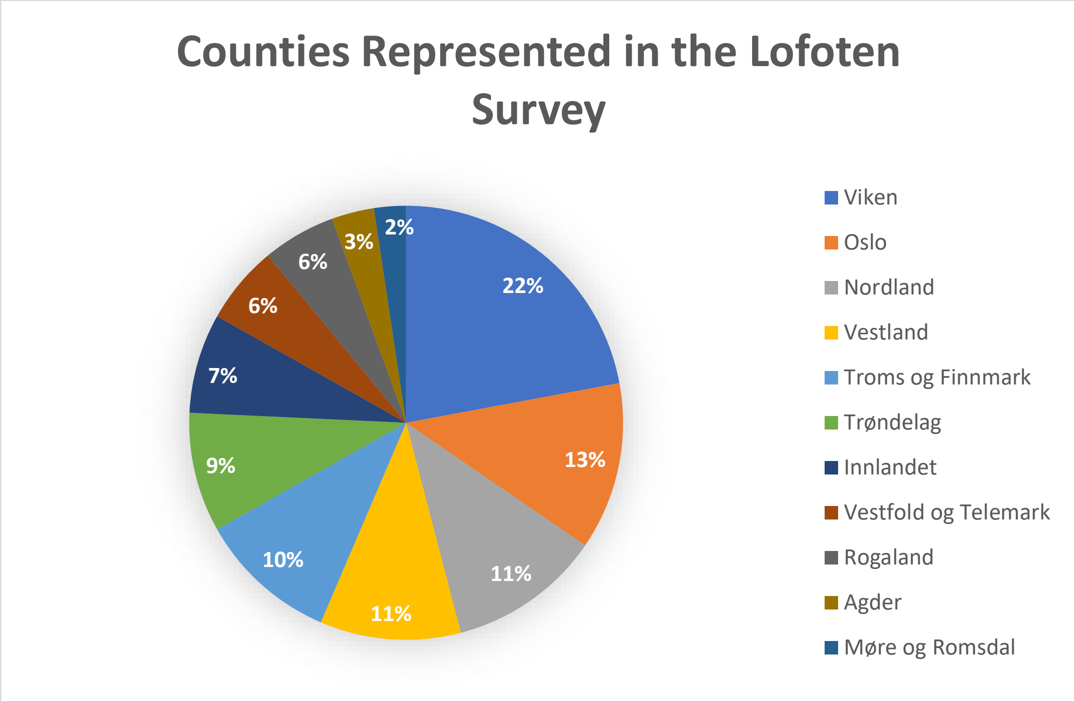

Figure 2: Counties represented in Lofoten dataset

6.1.1.1 Respondents Characteristics

The sample provides a wide range in terms of age. The mean age is 53.8 years, where the youngest respondent is 18 and the oldest respondent is 86. Out of this, 46.24% of the respondents are female. Of the sample, 7.3% are members of an environmental organization. There are some differences in the education level, where the largest group is those with tertiary education accounting for 60% of the sample. Approx. 41% of the sample have a bachelor's degree. The remaining 40% answered high school, junior high school, or elementary school as their highest completed education level. Furthermore, there are some variations in profession. The majority of respondents are employed, 41.2% working full-time, and 7.82% working part-time, 7.55% are students, 27.21% are retired, and 1.4% are unemployed. The remaining 14.82% are in other categories such as self-employed, military duty, maternity leave, etc. Numbers are provided in the *table 3* below.

Table 3: Characteristics of respondents in Lofoten and the Oslofjord surveys

Respondent Characteristics

	Lofoten	The Oslofjord
Mean and median age (years)	53.8 and 56	55.8 and 58
Female (%)	46.2	45.3
Higher Education (%)	60	51
Mean and median household income (NOK)	799 533 and 746 556	827 436 and 827 436
Member of environmental org. (%)	7.3	9
Employed full-time (%)	41.2	N/A

6.1.2 The Oslofjord survey

Of the Oslofjord dataset, 1041 of 2915 completed the survey. As mentioned earlier, the survey was based on all counties in Norway, however the respondents who completed the survey where almost all located in counties near the Oslofjord area. See *figure 3* for distribution of respondents across counties in the Oslofjord survey. As the overwhelming majority of respondents are from the counties of Eastern Norway, this survey can be categorized as a regional survey.

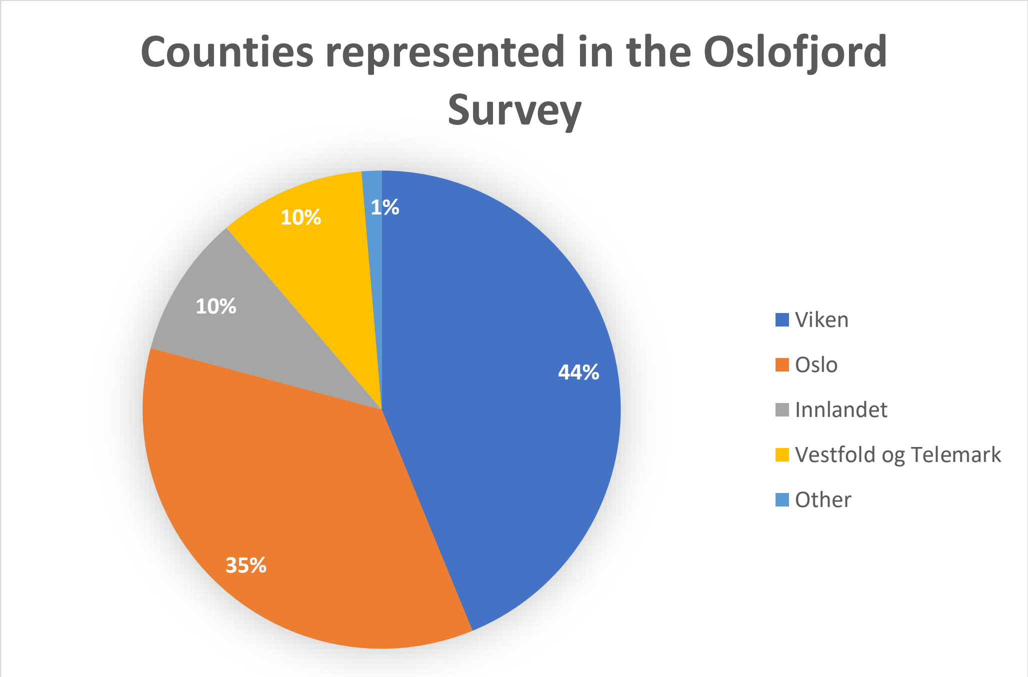

Figure 3: Counties represented in the Oslofjord dataset

6.1.2.1 Respondents Characteristics

As with the Lofoten dataset, the sample provides a wide range in terms of age, see *table 3*. The mean age is 55.8 years, where the youngest respondent is 18 and the oldest respondent is 89. Of 1041 respondents, 45.25% are female. Of the sample, 9% are members of an environmental organization. There are some differences in the education level, where the largest group is those with tertiary education accounting for 51% of the sample. Approx. 28.5% of the sample have a bachelor's degree. The remaining 49% answered high school, vocational school, junior high school, or elementary school as their highest completed education level. In comparison with the Lofoten survey, there are some small differences in the respondents' characteristics. The Oslofjord dataset did not have any equivalent questions for the respondent's profession, and therefore this is this listed as N/A in *table 3*.

6.1.3 WTP answers for both surveys

As mentioned in *section 5.5.1,* we removed those respondents who answered WTP amounts deemed too high for their level of income from some of our models. This section provides descriptive statistics for WTP of all respondents with no data cleansing having been performed, and no respondents having been removed. It should be noted however, that these WTP numbers include "do not know" answers recoded as 0 WTP.

For the small oil spill scenario, the mean WTP amount is 951 NOK for Lofoten, and 625 NOK for the Oslofjord. For the medium scenario, the mean WTP is 1136 NOK for Lofoten, and 857 NOK for the Oslofjord. For the large scenario, the mean WTP is 2616 for Lofoten, and 1249 for the Oslofjord. For the very large scenario, the mean WTP is 3023 for Lofoten, and 1729 for the Oslofjord, see *table 4,* and *figure 4* for comparisons. In the table below we included the median WTP, number of respondents that had 0 WTP, and how many of these respondents answered "do not know". The last column in the table is for those who answered more than 15 000 NOK in the Lofoten survey, and 12 000 NOK for the Oslofjord survey. There are some differences in the mean WTP numbers, however, it seems at a glance that the respondents are sensitive to the scope in the different oil spill scenarios for both surveys as the mean WTP increases for each scenario.

Table 4: WTP answers

WTP Answers - Lofoten / The Oslofjord

Oil Spill Scenario	Mean WTP (NOK)	Median WTP (NOK)	0 WTP (respondents)	Do not know (respondents)	WTP more than 15 000 / 12 000 NOK (respondents)
Small	951 / 625	300 / 200	237 / 276	154 / 119	0 / 2
Medium	1136 / 857	500 / 300	233 / 242	145 / 112	2 / 3
Large	2616 / 1249	700 / 500	221 / 231	141 / 116	2 / 5
Very Large	3023 / 1729	700 / 700	220 / 237	138 / 129	5 / 10

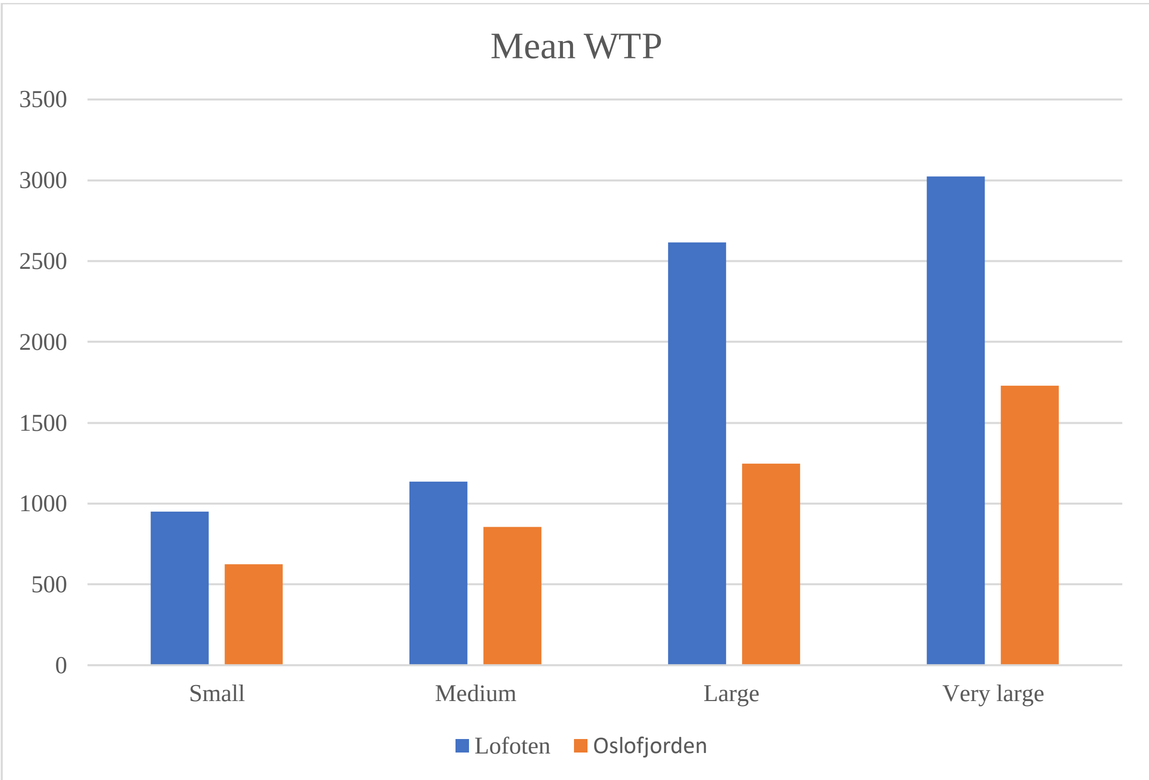

Figure 4: Mean WTP for Lofoten and the Oslofjord for all scenarios

6.1.4 Elasticities for both surveys

Each of our 6 models has its own elasticity characteristics due to the data cleaning process removing some of the respondents, causing the different models to build on different foundations. Furthermore, there are notable differences in the elasticity characteristics between the two surveys. This likely stems from a few factors; the two questionnaires utilized slightly different WTP elicitation methods, such as using different amounts on the payment cards, differing 'highest' standard values (Lofoten allows up to 15 000 NOK; the Oslofjord survey allows up to 12 000 NOK), and whereas the Lofoten survey uses annual recurring payments, the Oslofjord survey operates using a one-time payment. This difference in elasticity characteristics may also stem from the differences in environmental damages between the two locations. Due to the nature of the arc-elasticity equation (see *eq. 5* in *section 5.4*) each calculation has a maximum possible value. For example, should one of the elicited WTP values for an individual be equal to 0 in the calculation the numerator term for change in WTP ($\%\Delta WTP_i$) will simplify to be equal to 2. The denominator term on the other hand depends on the specific values (km of spoiled coastline) of the oil spill scenarios used in the calculations. The clearest example of this issue is the calculation of small-to-medium oil spill elasticity in the Oslofjord dataset:

Equation 6: Example of change in environmental damages in the Oslofjord

$$\left(\frac{q^B - q^A}{(q^B + q^A)/2}\right) = \left(\frac{30 - 20}{(30 + 20)/2}\right) = 0.4$$

In this case the highest possible value the arc-elasticity can take is $\frac{2}{0.4} = 5$, which is far higher than any possible value using the Lofoten data. See *table 5*, *figure 5*, and *figure 6* below for overview of maximum possible elasticities for all calculations in both Lofoten, and the Oslofjord datasets, as well as graphical presentations of elasticities for all respondents in both locations. To help with our analysis we have removed elasticities that hit the max possible values from the models 2, and 3 in both Lofoten and the Oslofjord. As we have a rule that the first models should be as unaltered as possible, all elasticities are retained in model 1 in both Lofoten, and the Oslofjord.

Table 5: Max Elasticities Lofoten, and the Oslofjord

Max Elasticities Lofoten and the Oslofjord

	Lofoten Max Elasticity	Oslofjord Max Elasticity
Small - Medium	1.400	5.000
Medium - Large	1.500	1.667
Small - Large	1.069	1.400
Large – Very Large	2.200	4.429
Medium – Very Large	1.162	1.375
Small – Very Large	1.025	1.235

Now we will examine the characteristics of the elasticities for the different models in both Lofoten and in the Oslofjord. Firstly, there are the models which use the complete datasets as the foundation for analysis (see *figure 5*, *figure 6*, and *Appendix D*: *table D.1* and *table D.4*). Lofoten model 1 has an average elasticity of 0.175 with approx. 8% of the calculated elasticities being negative, 46% equal to zero, and 47% being positive. In comparison the average elasticity in the Oslofjord model 1 is 0.460, where approx. 5% of elasticities are negative, 39% are zero, and 56% are positive. A simple two-sided t-test of the mean elasticities in these two models indicates that these means are significantly different. Running a test based on the complete combinatorial methods as proposed by Poe et al. (1997) and Poe et al. (2005) gives a significance level of 0.4781 when testing if $distribution1 > distribution2$ where *distribution1* is the complete set of individual level elasticities (6 per respondent) in the Oslofjord dataset, and *distribution2* is the complete set of individual level elasticities in Lofoten (6 per respondent).

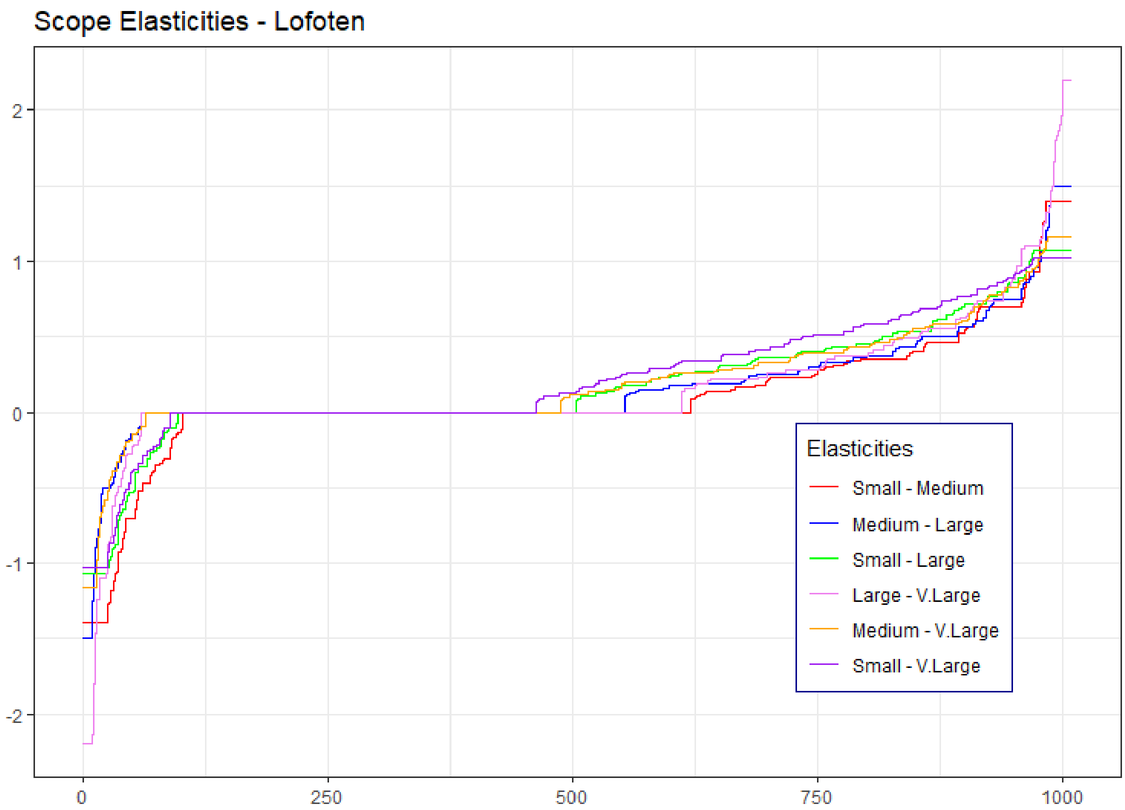

Figure 5: Graphical visualization of elasticity in Lofoten

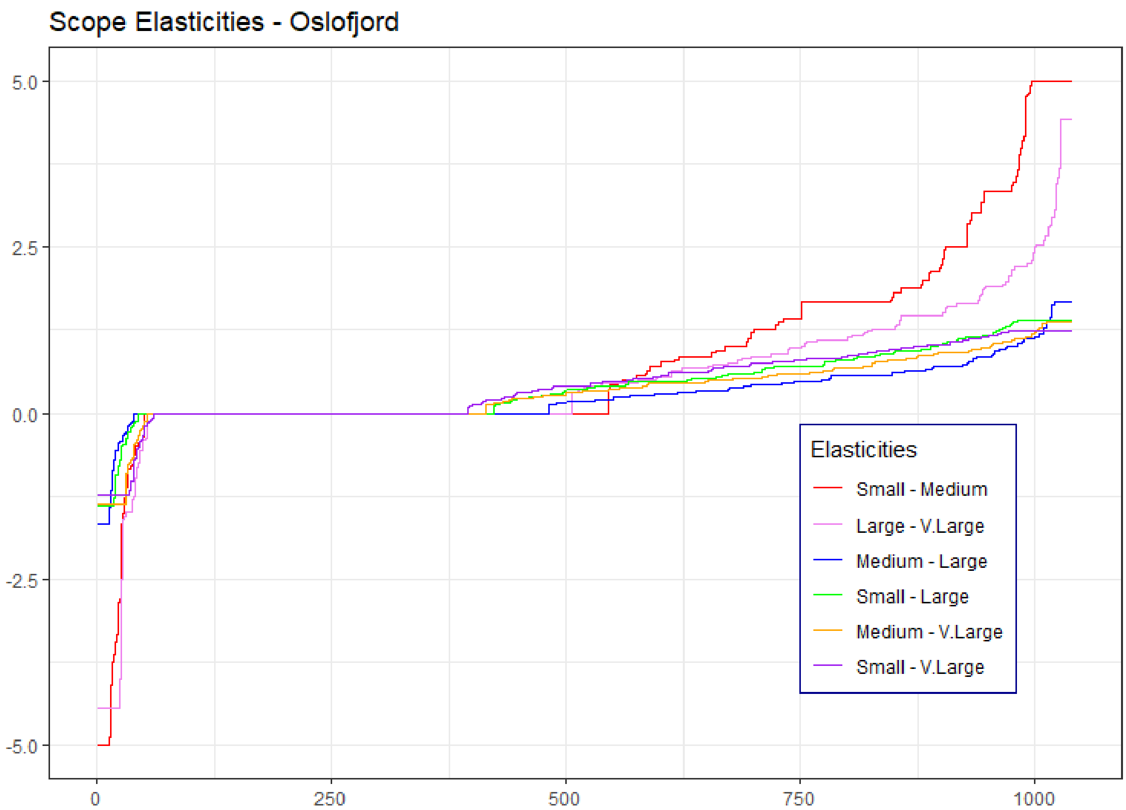

Figure 6: Graphical visualization of elasticity in the Oslofjord

Now we should examine the models from which respondents have been removed based on protest answers, unrealistic WTP amounts, etc. (see *Appendix D*: *table D.2*, and *table D.5*). Lofoten model 2 has an average elasticity of 0.203 where approx. 7% of the elasticities being negative, 39% are zero, and 54% are positive. In comparison the average elasticity in model 2 for the Oslofjord is 0.535, where approx. 2% are negative elasticities, 31% are zero, and 67% are positive. Again, a two-sided t-test on the mean elasticities will give significant results for the two being different. The combinatorial test in this case returns a significance level of 0.4002 when comparing the two distributions. In both the Lofoten data, and the Oslofjord data the average elasticities have increased due to the data cleansing process. There are also fewer zero elasticities, and negative elasticities, with a corresponding increase in positive elasticities.

Finally, there are the models which exclude those respondents with negative elasticities (see *Appendix D*: *table D.3*, and *table D.6*). Lofoten model 3 has an average elasticity of 0.247, approx. 42% of the elasticities are zero, and 58% are positive. The Oslofjord model 3 has an average elasticity of 0.569, where approx. 31% of elasticities are zero, and 69% are positive. A t-test on the means of the elasticities once again gives significant results for the two being different, whereas a combinatorial test returns a significance level of 0.4106 when testing if the Oslofjord distribution is higher than that of Lofoten.

When comparing the characteristics of the elasticities in the two datasets the mean elasticities are generally higher for the Oslofjord respondents. However, it should be noted that some of this difference likely stems from the issue of calculating arc-elasticities as we discussed in the beginning of this section. The Oslofjord survey also has fewer negative elasticities, and fewer zero elasticities overall, although the ratios are fairly similar. In both cases we see a decrease in negative elasticities, and zero elasticities due to the data cleansing process. Correspondingly there is an increase in average elasticities from model 1, to model 2, to model 3 in both Lofoten, and the Oslofjord. Detailed summaries of the elasticities across both surveys can be found in *Appendix D: table D.1 – D.6.*

6.2 Hypotheses

Based on the literature review and the data, we formulated four hypotheses (see *table 6*). When deciding whether to reject the null hypothesis or not, we need to assess the relevant facts, and conduct statistical tests before we make any conclusions. In the case of hypotheses linked to variables included in the models, we need to look at the sign, and the significance (p-value) of its estimated coefficient, the standard error, the magnitude of the coefficient, and we also need to consider the statistical measures of the overall model. Once all these considerations have been made, we can conclude by rejecting the null or not based on the supporting evidence.

Table 6: Hypotheses

Hypotheses and Research Question	
Research Question:	
WTP to avoid oil spills: Who are sensitive to the scope of the damage	
Hypotheses:	
Hypothesis 1	Household income positively influences scope elasticity for avoiding oil spills
Hypothesis 2	When there are more non-use values in play, one can expect less sensitivity to scope
Hypothesis 3	Membership of an environmental organization will positively affect scope elasticity for avoiding oil spills
Hypothesis 4	Iconic sites (Lofoten) will have different scope elasticities compared to non-iconic sites (the Oslofjord)

Hypothesis 1 suggest that household income will affect scope elasticity for avoiding oil spills. In our analysis household income measured in thousands NOK is included as a variable in the regression models. There is a lack of previous studies which have examined the effects of income on scope sensitivity on an individual level, as such there is not much information on which to build in this area. Some previous studies that have looked at income effect on WTP and found positive effects of income on WTP (e.g., Carson et al., 2003; Mattmann et al., 2016; Koto & Yiridoe, 2019). On the other hand, Casey et al. (2008) looked at WTP in subsistence level societies and found sensitivity to scope. Based on the previous results of studies on income effects on WTP, we believe income should positively affect scope sensitivity. This hypothesis can be formulated with parameters in the following way:

$$H_0: \beta_{HHInc} = 0$$

$$H_1: \beta_{HHInc} > 0$$

Hypothesis 2 suggest less sensitivity to scope when where are more non-use values in play. At an individual level, we expect that respondents who have never been to either area will have lower sensitivity to scope. According to Ladenburg and Dubgaard (2009) users of coastal areas have higher WTP to move wind power projects further from shore, and stronger preferences for the area in question. Based on the relationship between use/non-use values and WTP in previous studies (see *Ch. 3*), we hypothesize that a similar relationship can be found between use/non-use values and scope sensitivity. Variables for visitation and use of the Lofoten, and the Oslofjord areas are therefore included in the analysis. This hypothesis can be formulated with parameters in the following way:[5]

$$H_0: \beta_{Non-use} = 0$$

$$H_1: \beta_{Non-use} < 0$$

Hypothesis 3 suggests that membership of an environmental organization will affect scope elasticity for avoiding oil spills in Lofoten, and the Oslofjord area. Being a member of an environmental organization is included in the variables used for the analysis. Respondents who are members of these organizations are often against petroleum activities, and the use of petroleum in industry and transport, and often have higher WTP for environmentally friendly scenarios (e.g., Liu et al., 2009). Based on the expected higher WTP of members of environmental organisations, we similarly expect higher estimated elasticities for these respondents. This hypothesis can be formulated with parameters in the following way:

$$H_0: \beta_{env\_org} = 0$$

$$H_1: \beta_{env\_org} > 0$$

Lastly, Hypothesis 4 suggests that iconic sites (Lofoten) will have a statistically different scope elasticity than non-iconic sites (the Oslofjord). This hypothesis depends on the assumption that Lofoten is an iconic site, and simultaneously the Oslofjord is not iconic. As pointed out in Lopes and Kipperberg (2020) in response to their findings of inelastic WTP to avoid damages in Lofoten, Norwegians view Lofoten as "an exceptional coastal area when it comes to natural

[5] Note there is not one variable for use/non-use values, the use of $\beta_{Non-use}$ in this case is purely for illustration purposes. When considering this hypothesis later on we will consider several different variables and their model results.

and cultural amenities”. They further reason that “exposing it to … an oil spill could be seen as fundamentally damaging: once the Lofoten Archipelago is *soiled,* its non-market economic value is *spoiled* – the size of the oil spill may not matter so much” (Lopes & Kipperberg, 2020, p. 213). Building on this logic, we can expect that iconic areas will have lower scope elasticities, as any damage at all to such areas is unacceptable, and respondents will therefore expend all their budget to avoid any and all damages regardless of size. The relationship between iconic, and non-iconic areas can be explored by comparing the estimated mean elasticity for Lofoten (E_L) and the Oslofjord (E_O). This hypothesis can be formulated as follows:

$$H_0\colon\ E_L = E_O$$

$$H_1\colon\ E_L < E_O$$

6.3 Results

This analysis has been conducted using a semi-exploratory method, we have constructed a total of 6 models for this thesis. 3 for Lofoten, and 3 for the Oslofjord survey. For both datasets, model 1 builds on the complete dataset with respondents who completed the questionnaire. Model 2 removes respondents based on protest answers, time spent on the survey, and unrealistic WTP. Model 3 removes respondents with negative elasticities. Our dependent variable is a vector of 6 observations of arc-elasticities for each respondent.

6.3.1 Lofoten dataset

For elasticity of WTP in Lofoten, *table 7* provides an overview of the model results. The models’ R^2 ranges from a low of 0.145 in model 1 to a high of 0.189 in model 2. The f-statistics for the Lofoten models are as follows: 3.149 for model 1; 3.143 for model 2; and 2.148 for model 3. All f-statistics are significant at the 1% level, indicating overall significance for the models despite the low R^2 levels. The estimated constant is significant in all models, however with varying degrees of significance (from 10% to 5% significance levels).

Table 7: Elasticity of WTP in Lofoten

Elasticity of WTP - Lofoten

	Dependent variable:		
		Elasticity	
	(1)	(2)	(3)
age	-0.009	-0.013**	-0.010*
	(0.006)	(0.006)	(0.006)
age2	0.0001	0.0001*	0.0001
	(0.0001)	(0.0001)	(0.0001)
gender	0.050*	0.064**	0.048*
	(0.027)	(0.027)	(0.027)
college	0.062**	0.063**	0.052*
	(0.026)	(0.028)	(0.028)
HHInc_1000s	0.00002***	0.0001***	0.0001***
	(0.00001)	(0.00003)	(0.00003)
num_trip	-0.019	-0.053**	-0.018
	(0.014)	(0.026)	(0.031)
num_trip2	0.0004	0.003	0.001
	(0.001)	(0.003)	(0.003)
ocean_dist	0.0005	-0.001	0.00000
	(0.001)	(0.001)	(0.001)
ocean_dist2	-0.00000	0.00000	0.00000
	(0.00001)	(0.00001)	(0.00001)
dist	0.00005	0.00003	0.0001
	(0.0001)	(0.0001)	(0.0001)
dist2	-0.00000	-0.00000	-0.00000
	(0.00000)	(0.00000)	(0.00000)
likely_lofoten	0.039	0.010	-0.008
	(0.032)	(0.032)	(0.032)
likely_north	0.008	0.001	0.027
	(0.030)	(0.030)	(0.031)
env_org	0.095**	0.100**	0.086**
	(0.045)	(0.045)	(0.043)
red_gas	0.099***	0.059**	0.055*
	(0.028)	(0.029)	(0.029)
red_hosp_q	-0.018	0.011	0.004
	(0.029)	(0.030)	(0.030)

new_roads	0.010	-0.006	0.007
	(0.029)	(0.031)	(0.032)
spill_prev	-0.023	-0.008	-0.010
	(0.029)	(0.031)	(0.031)
old_care	-0.029	-0.042	-0.006
	(0.029)	(0.030)	(0.031)
dis_oil_Lofoten	0.044	0.054^{*}	0.047^{*}
	(0.027)	(0.028)	(0.028)
spill_fam	0.084^{**}	0.059	0.049
	(0.042)	(0.043)	(0.045)
spill_fam_2	-0.029	-0.060^{**}	-0.040
	(0.027)	(0.028)	(0.028)
spill_fam_pers	-0.030	-0.035	-0.015
	(0.031)	(0.031)	(0.031)
eco_fam	-0.021	0.005	0.011
	(0.029)	(0.031)	(0.031)
trst_results_used	-0.012	-0.0002	0.015
	(0.028)	(0.029)	(0.029)
trst_more_tax	0.020	0.041	0.027
	(0.024)	(0.026)	(0.026)
eff_measures	0.031	0.009	0.006
	(0.025)	(0.027)	(0.027)
low_inc_cov	0.009	0.017	-0.0005
	(0.027)	(0.028)	(0.027)
happiness_neg	-0.004	-0.011	-0.014
	(0.030)	(0.033)	(0.033)
Constant	0.288^{*}	0.385^{**}	0.329^{**}
	(0.153)	(0.156)	(0.148)
Observations	568	421	342
R^2	0.145	0.189	0.166
Adjusted R^2	0.099	0.129	0.089
F Statistic	3.149^{***} (df = 29; 538)	3.143^{***} (df = 29; 391)	2.148^{***} (df = 29; 312)
Note:			*p<0.1; **p<0.05; ***p<0.01

6.3.1.1 Demographics/ socio-economic variables

Firstly, we will examine the demographic and socio-economic variables included in the models. The results for model 2 and 3 indicate the first term of the 'age' variable has a negative impact on the elasticity, at a 10% level of significance in model 3, and a 5% level of significance estimation in model 2, furthermore model 2 has a positive (albeit small) effect for the quadratic term (age2). A simple calculation tells us that according to model 2 scope elasticity falls as age increases, until it reaches a minimum at 65 years of age, after which it will once again increase from the minimum. This effect cannot be observed in the other models, and model 1 does not show any significance of the age variable at all. The dummy variable 'gender' (1 = male) is significant in all three models, being significant at the 10% level in models 1, and 3, and at a 5% significance level in model 2. The positive estimated coefficient indicates that men generally have higher elasticities than women, i.e., are more sensitive to scope. The dummy variable 'college', denoting whether or not a respondent has a tertiary level education, is similarly moderately significant (at a 10% level) in model 3, and fairly significant (at a 5% level) in model 1, and 2. The sign of the estimated coefficients for tertiary education is positive, indicating more sensitivity to scope in respondents with higher education. The variable 'HHInc_1000s' indicates the respondent's household income denoted in thousands NOK. This variable is highly significant (1% significance level), and has a positive coefficient in all 3 models indicating that household income has an observable (though small) effect on the respondent's scope sensitivity. The magnitude of the effect of household income on scope elasticity varies between the models and is quite a bit smaller in model 1 than in models 2, and 3. According to models 2 and 3 an increase in household income of 100 000 NOK would lead to an increase of 0.01 of the dependent variable, a fairly small increase.

6.3.1.2 Use/non-use variables

Secondly, let us consider the group of variables indicating use/non-use of the Lofoten area. Here the variable indicating the number of trips (num_trip) made to the Lofoten area is significant at the 5% level in model 2 only, and negatively affects elasticity. No interaction with the quadratic term of the variable can be observed. Neither the variable for distance to Lofoten (dist) from the respondent's home county, nor the variable for distance to the ocean (ocean_dist) from the respondent's house can be found to have any effects in our models here. Likewise, there is no observable effect of whether the respondent has any plans of travelling to either Lofoten (likely_lofoten) or Northern Norway (likely_north) in the near future.

6.3.1.3 Attitude variables

Next, we ought to inspect the variables related to various attitudes of the respondents and their effects on the dependent variable. We believe it is safe to assume that membership in an environmental organisation indicates certain attitudes towards protection of natural areas, and as such this variable (env_org) is grouped as an attitude variable in this analysis. In all three models this variable is significant at the 5% level and positively affects scope elasticity. The size of the coefficient is fairly consistent across all models ranging from 0.086 to 0.1, implying that membership of an environmental organisation positively affects the respondent's scope elasticity, supporting hypothesis 3 (see *section 6.2*). The respondents were asked to rate the importance of certain societal tasks, these tasks were: reducing greenhouse gas emissions (red_gas); reducing hospital queues (red_hosp_q); build new roads (new_roads); improve preparedness for oil spills on the coast (spill_prev); and improving care for the elderly (old_care). Each task was rated on a scale of importance from 'not at all important' to 'very important'. Of these variables only reducing greenhouse gas emissions (red_gas) could be found to have any significant impact on the dependent variable, however the level of significance varies between the models (significant at the 10% level in model 3, at the 5% level in model 2, and at the 1% level in model 1). The magnitude of the coefficient varies a bit, being higher in model 1 than in 2, and 3. The results imply that respondents who find the reduction of greenhouse gas emissions 'very important', or 'quite important' are more sensitive to the scope of the damages. Interestingly no results could be found indicating an effect of the attitude towards improving the preparedness for oil spills along the coast. Finally, the dummy variable indicating respondents who are strongly against oil exploration in Lofoten (dis_oil_Lofoten) is significant at the 10% level, and positive for models 2, and 3. Indicating, perhaps not surprisingly, that those respondents who wish to protect the Lofoten area from oil exploration also are more sensitive to the scope of damages caused by spills.

6.3.1.4 Familiarity/knowledge variables

We will also examine the variables indicating familiarity or knowledge regarding the topic of the questionnaire. The respondents were early on asked if they had heard of previous oil spills, mostly in Norway, but not exclusively. A list of 7 spills was presented to the respondents who indicated whether they had heard of the spills before. The first variable for familiarity with oil spills (spill_fam) indicates whether the respondent had heard of at least one of the listed spills. This variable has a positive coefficient and is significant at the 5% level in model 1, no effects can be established in models 2, and 3. The second variable for familiarity with oil spills (spill_fam_2) indicates whether a respondent has heard of at least 4 of the listed spills, and interestingly has a negative estimated coefficient significant at the 5% level in model 2. No other effects can be established for this variable in models 1, and 3. The variable indicating whether a respondent has personally experienced the effects (seen damages) of an oil spill on the coast cannot be found to have any effect in our models. Likewise, the variable denoting respondents who know the local ecosystem of Lofoten 'fairly well' or 'very well' (eco_fam) also does not show any significant results in our models.

6.3.1.5 COVID-19/trust related variables

Towards the end of the questionnaire, the respondents were asked a set of questions regarding their beliefs and trust in the premises of the survey as well as a few questions regarding the effects of the COVID-19 pandemic on the respondent and their responses. None of the variables indicating whether the respondent believe that that the Norwegian Coastal Administration is likely to use the survey results for decision-making (trst_results_used), or that any changes to oil spill prevention / preparedness programmes will lead to higher taxes (trst_more_tax), or the trust that any measures put into place will be effective at preventing oil spills (eff_measures) can be found to have any effect on the dependent variable according to our models. Respondents' belief that their income will be negatively affected by the COVID-19 pandemic (low_inc_cov) also does not show any impact on the scope sensitivity. Neither does the dummy variable indicating the respondent's level of happiness in life has been negatively affected by COVID-19 (happiness_neg).

6.3.2 The Oslofjord dataset

For elasticity of WTP in the Oslofjord area, *table 8* provides an overview of the model results. The models' R^2 range from a low of 0.079 in model 1 to a high of 0.121 in model 3. The f-statistics for the Oslofjord models are as follows: 3.915 for model 1; 3.772 for model 2; and 3.991 for model 3. All f-statistics are significant at the 1% level, indicating overall model significance. The estimated constant is significant in all models, in this case also varying in significance (from 10% to 1% significance levels).

Table 8: Elasticity of WTP in the Oslofjord

Elasticity of WTP - Oslofjord

	Dependent variable:		
	Elasticity		
	(1)	(2)	(3)
age	-0.011	-0.001	0.001
	(0.008)	(0.008)	(0.007)
age2	0.0001	-0.00001	-0.00002
	(0.0001)	(0.0001)	(0.0001)
gender	0.102^{***}	0.079^{**}	0.091^{**}
	(0.039)	(0.037)	(0.036)
college	0.028	0.072^{*}	0.058
	(0.040)	(0.038)	(0.038)
HHInc_1000s	0.0002^{***}	0.0002^{***}	0.0001^{***}
	(0.0001)	(0.00005)	(0.00005)
ocean_dist	-0.004^{***}	-0.002^{*}	-0.002
	(0.001)	(0.001)	(0.001)
ocean_dist2	0.00002^{**}	0.00001	0.00001
	(0.00001)	(0.00001)	(0.00001)
visit_oslofjorden	0.049	0.053	0.044
	(0.049)	(0.048)	(0.047)
frequent_visits	-0.138^{**}	-0.051	-0.031
	(0.055)	(0.051)	(0.051)
env_org	0.026	0.014	0.040
	(0.067)	(0.059)	(0.058)
red_gas	0.025	0.049	0.042
	(0.042)	(0.040)	(0.039)
red_hosp_q	-0.095^{**}	-0.074^{*}	-0.068^{*}
	(0.044)	(0.041)	(0.041)
new_roads	-0.058	-0.061	-0.108^{**}
	(0.051)	(0.052)	(0.051)
spill_prev	-0.002	0.025	0.010
	(0.041)	(0.038)	(0.038)
old_care	0.031	0.002	0.007
	(0.044)	(0.041)	(0.041)
spill_fam	-0.038	-0.096^{*}	-0.080
	(0.052)	(0.050)	(0.049)

spill_fam_2	0.012	0.040	0.059
	(0.043)	(0.041)	(0.040)
spill_fam_pers	0.039	0.046	0.014
	(0.047)	(0.043)	(0.042)
eco_fam	0.078	0.025	0.038
	(0.049)	(0.045)	(0.045)
eff_measures	0.049	0.086**	0.081**
	(0.038)	(0.037)	(0.036)
low_inc_cov	-0.002	0.019	0.077*
	(0.042)	(0.040)	(0.040)
happiness_neg	0.106**	0.079*	0.087**
	(0.045)	(0.045)	(0.044)
Constant	0.574***	0.357*	0.321*
	(0.206)	(0.196)	(0.192)
Observations	1,025	689	649
R^2	0.079	0.111	0.121
Adjusted R^2	0.059	0.081	0.090
F Statistic	3.915*** (df = 22; 1002)	3.772*** (df = 22; 666)	3.911*** (df = 22; 626)
Note:			*p<0.1; **p<0.05; ***p<0.01

6.3.2.1 Demographics/socio-economic variables

We will once again examine the groupings of the variables similarly to the Lofoten results in *section 6.3.1*, beginning with the demographic and socio-economic variables. In this case the variable for the respondents age does not show any significant results in any of the 3 models. The variable for the respondent's gender (where 1 = male) is highly significant at the 1% level in model 1, and significant at the 5% level for models 2, and 3. Similarly to the results using the Lofoten dataset, the estimated coefficients are positive, indicating that men have higher scope elasticities than women, although the magnitude of the estimated coefficients is higher for all models in the Oslofjord area compared to Lofoten. The variable indicating the respondent having tertiary level education is significant at the 10% level only in model 2, and is not significant in either model 1, or 3. The estimated coefficient is positive, indicating tertiary education has some effect sensitivity to scope according to model 2. Similarly to results from Lofoten, the variable for household income (denoted in 1000s NOK) is highly statistically significant at the 1% level in all three models, and has positive estimated coefficients. In this case the magnitude of the coefficients is more similar, ranging from 0.0001 to 0.0002, indicating an increase in household income of NOK 100 000 would increase average scope elasticity by 0.01 to 0.02.

6.3.2.2 Use/non-use variables

There are three variables indicating use/non-use values in the Oslofjord dataset. Firstly, the variable for distance to the ocean from the respondent's house (ocean_dist) is statistically significant at the 1% level in model 1, and at the 10% level in model 2. No statistically significant effect can be observed in model 3. The quadratic interaction term of this variable (ocean_dist2) is only significant in model 1 (at the 5% level). Model 1 has a negative coefficient for the first term, and a positive coefficient for the quadratic term indicating that the dependent variable scope elasticity decreases as distance to the ocean increases, until it reaches a minimum at 100km, and once again begins to increase from the minimum. The dummy variable indicating a respondent has visited the Oslofjord in the last 12 months (visit_oslofjorden) cannot be found to have any statistically significant effect in any of the models. The variable indicating a respondent has made frequent visits to the Oslofjord for recreation is significant only in model 1. The variable is significant at the 5% level and negative, indicating that respondents who visit frequently are less sensitive to scope according to model 1. No such effects can be determined from models 2, or 3.

6.3.2.3 Attitude variables

Next, we will examine the effects of the variables related to the various attitudes presented by the respondents in the questionnaire. Unlike the Lofoten survey, the variable for membership in an environmental organisation (env_org) cannot be found to have any impact of the dependent variable in any of the models. This contradicts our findings from the Lofoten dataset, and does not support hypothesis 3 (see *section 6.2*). Of the attitude variables where respondents rated societal tasks on a scale of importance from 'not at all important' to 'very important' only the variable for reducing hospital queues (red_hosp_q), and building new roads (new_roads) could be found to have any statistically significant effects. The variable for reducing hospital queues is significant at the 10% level in models 2, and 3, and significant at the 5% level in model 1. In all three models the estimated coefficient is negative. The variable for the importance of building new roads is significant at the 5% level only in model 3, and has a negative estimated coefficient.

6.3.2.4 Familiarity/knowledge variables

Let us examine the variables indicating a respondent's familiarity or knowledge of oil spills, and of the local ecosystem. Only the variable for familiarity with at least one oil spill of a list of 7 (spill_fam) can be found to be statistically significant. The variable is significant at the 10% level in model 2, and has a negative estimated coefficient. No further effects can be found in models 1, and 3. The variable for knowledge of several of these oil spills (spill_fam_2) is not statistically significant in any of the models. Neither is the variable for having personally experienced oil spill damages on the coast (spill_fam_pers), nor the variable for familiarity with the local ecosystem (eco_fam).

6.3.2.5 COVID-19/trust related variables

Finally, we should again consider the variables related to the respondent's beliefs, and trust in the premises of the survey, as well as those related to the COVID-19 pandemic. Unlike the Lofoten questionnaire the respondents were not asked quite the same questions in this instance, and as such only the variable denoting trust in the effectiveness of the proposed counter-measures (eff_measures) is included in the Oslofjord models as there were no reasonable substitutes for the variables used in the Lofoten models indicating trust that results of the survey would be used, or that the measures would lead to higher taxes. The variable for trust in the efficacy of the proposed oil spill counter measures (eff_measures) is significant at the 5% level in both models 2, and 3. The estimated coefficients are both positive, indicating that those respondents who believe the measures will be effective have higher scope elasticities, and are thus more sensitive to the scope of the damages. The variable for respondents who believe that their household income will be negatively affected by the COVID-19 pandemic (low_inc_cov) is significant at the 10% level in model 3, and has a positive estimated coefficient indicating these respondents are more sensitive to scope. No other effects can be observed in models 1, or 2. The last variable of the Oslofjord models indicates respondents whose level of happiness in life has been negatively affected by the COVID-19 pandemic (happiness_neg). This variable is significant at the 10% level in model 2, and at the 5% level in models 1, and 3. The sign of the estimated coefficients is positive, which further indicates that the effects of the ongoing pandemic could have impacted the sensitivity to the scope of damages.

7. DISCUSSION

7.1 Discussion of Results

Our models have several significant coefficients estimates, however which variables are significant is not entirely consistent between the Lofoten and the Oslofjord datasets (see *table 7*, and *table 8*). One example of inconsistency between the two datasets is the age variable which is (partially) significant in Lofoten, but not significant in any models in the Oslofjord analysis. In this section we will discuss some of these discrepancies, compare the results of the different variable groupings, and discuss some of the findings of particular importance such as those related to the hypotheses as laid out in *section 6.2*. We will also attempt to relate our findings to the literature reviewed in *chapter 3*.

7.1.1 Findings from demographics/socio-economic variables

In the introduction to *chapter 3*, we postulated that “factors that affect WTP could also influence sensitivity to scope”. This assumption was in large part the foundation for the selection of the variables included in our models. Demographic and socio-economic variables are commonly used in regression analyses as control variables, or as central variables to the research, depending on the focus of the research. In our study, these variables are perhaps the single most important grouping of variables, and the household income variable is of particular interest. The results of the demographic variable for the age of respondent are not consistent across models or surveys. The Lofoten analysis model 2 indicates a quadratic relationship, model 3 does not, and model 1 finds no effect at all. In the Oslofjord analysis the results are not significant for this variable. These mixed results cast doubt on whether or not age can truly be said to affect scope elasticity or not, however there is some indications that scope elasticity decreases with age. Gender on the other hand is one variable which is consistently significant across both surveys and all models. These results indicate that men are more sensitive to scope than women. One possible explanation for this is that women may have consistently higher WTP for all scenarios (leading to lower elasticities), which is in line with previous literature (e.g., Einarsdóttir et al., 2019, p. 799; Soto Montes de Oca & Bateman, 2006, p. 9). Tertiary education is significant in all three models, and positive in the Lofoten data, yet only shows significant results in model 2 in the Oslofjord data.

7.1.2 Findings from the income variable

Findings in previous literature indicate that wealthier households tend to have higher WTP (e.g., Carson et al., 2003, p. 276; Soto Montes de Oca & Bateman, 2006, p. 13; Mozumder et al., 2011, p. 1122), and are more willing to participate in paying to prevent the degradation of the environmental good being valued (e.g., Koto & Yiridoe, 2019, p. 85; Lee et al., 2018, p. 8). Lopes & Kipperberg (2020) found no effect of income on sensitivity to scope, only on the respondent's WTP (Lopes & Kipperberg, 2020, p. 22). In our analysis, household income is highly significant across all models in both surveys. However, the variable has a fairly small impact on the dependent variable overall, requiring large differences in income (100 000 NOK) for relatively small increases (0.01 to 0.02) in scope elasticity. The results do seem to definitively support our first hypothesis that scope elasticity is affected by income. Apart from a lower value in Lofoten model 1, the magnitude of the coefficient of household income is similar across the board which further corroborates the relationship between income and scope sensitivity. Regarding hypothesis 1, we believe we can reject the null hypothesis in this instance. Household income does positively influence scope elasticity for avoiding oil spills.

7.1.3 Findings from use/non-use variables

As for the use/non-use variables, these variables were largely non-significant in the Lofoten models, with the exception of the variable denoting the number of trips made to Lofoten in model 2, which suggested a negative relationship between use-values and scope elasticities. The results of use/non-use variables using the Oslofjord data suggests a similar relationship between use-values and scope elasticities in the variable for frequent recreational visits to the Oslofjord. These findings contradict our expectation that higher use-values would be linked to higher elasticities (see *section 6.2*). Scope elasticities may be lower for frequent users due to these respondents having a higher mean WTP. For example, respondents who frequently visited the Oslofjord had on average 51-73% higher mean WTP than the full sample. Similar observations were also made by Ladenburg & Dubgaard (2009) and Mattmann et al. (2016). Once again, these scope elasticity results are found in only one of the three models providing mixed or weak results overall. Results also show some evidence that those respondents who live closer to the sea have higher scope elasticities than those further away, a relationship which could not be established in the Lofoten data. We should also consider the possibility that some of the impact of use/non-use values does not show in the variables used in the models yet may be expressed as differences in the elasticities of the different locations. The Oslofjord can be assumed to have naturally higher use values as it is a more densely populated region, furthermore this data is based on a local/regional survey. Lofoten can be assumed to have more non-use values at play as this data was collected by a survey on the national level, and the region itself is less populated. Mean elasticities are generally higher using the Oslofjord data, however it is difficult to determine if this is due to differences in use/non-use values or due to some other cause such as the issues raised regarding the calculation of arc-elasticities in the section detailing elasticities in the Oslofjord, and Lofoten (*section 6.1.4*). Overall, we have mixed results for the effects of use/non-use values and their impact on sensitivity to scope (hypothesis 2). Therefore, we cannot with certainty reject the null hypothesis.

7.1.4 Findings from attitude variables

Regarding attitude variables the results are again mixed, with none of the variables being significant in both locations. Whereas in Lofoten we find significant results for those respondents who value reducing greenhouse gas emissions, and who don't wish to see oil extraction in the Lofoten archipelago, in the Oslofjord area only the variables for reducing hospital queues, and building new roads can be found to have any statistical significance. Crucially, the variable for membership in an environmental organisation is significant in all three models using the Lofoten dataset, and not at all significant in any of the models using the Oslofjord dataset. Results from previous studies like those of Liu et al. (2009) and Mozumder et al. (2011) have found links between donations to environmental causes, membership of environmental organisations, and higher WTP values. As such we wished to examine whether any relationship could be established with scope sensitivity. Had this study been based entirely on the Lofoten dataset, a case could have been made for membership of an environmental organisation affecting scope sensitivity, however the results from the Oslofjord dataset confound the results somewhat in this instance. Regarding hypothesis 3 then, we have mixed results, and cannot definitively reject the null hypothesis, however the results strongly suggest a relationship may be present.

7.1.5 Findings from knowledge/familiarity variables

Our variables concerning knowledge or familiarity with oil spills, and local ecosystems are largely non-significant in both the Lofoten, and the Oslofjord analysis, with none of the variables being significant in more than one model per location. Moreover, what results were found in our models are contradictory between the analyses. Lopes & Kipperberg (2020) examined the relationship between prior experience with oil spills and could not find any effect on WTP estimates nor scope inference. Our results for scope elasticity are somewhat in-line with these findings. As such we cannot draw any conclusions regarding the impact of these variables with only weak indications of relationships between dependent and independent variables which are further confounded by contradicting results.

7.1.6 Findings from COVID-19/trust related variables

The results related to trust variables and COVID-19 are mixed, all variables in this category are non-significant in the Lofoten analysis. In the Oslofjord analysis results of models 2, and 3 indicate that respondents who believe that the proposed measures against oil spills will be effective have higher elasticities. Some respondents may see the survey, and its scenarios as purely hypothetical and thus non-consequential. This 'hypothetical bias' is one of the criticisms of the CV method. Not finding significant results for these trust related variables may be a sign of good survey design ("face validity") however, indicating that there are not significantly different answers from respondents who do not believe in the premises of the survey, and those that do. Regarding COVID-19 results from the Oslofjord analysis indicate that respondents who report being negatively affected (in income or happiness) by the ongoing pandemic are more sensitive to scope. León et al. (2014) argues that emotions affect WTP, specifically that respondents are more likely to report WTP values on either extreme of the spectrum. Our findings seem to support this, indicating that changes in happiness affects scope sensitivity. Søgaard et al. (2012) indicates 'emotional load' may be a cause of scope insensitivity, which our findings seem to contradict. Nonetheless our finding that COVID-19 has negatively affected happiness, which also impacted scope sensitivity of respondents is interesting and suggests that not only logic, but also emotions may factor into WTP in environmental damage valuations. While comparable results could be found in the Lofoten analysis, we argue this nevertheless indicates that the COVID-19 situation has noticeably affected respondents and their scope sensitivity. As such, analysis results based on a survey conducted in a time of non-normalcy may not be completely transferable, and may not apply in normal societal/economic conditions.

7.1.7 Findings from the elasticities in Lofoten and the Oslofjord

Finally, we will compare the estimated elasticities between Lofoten and the Oslofjord. Hypothesis 4 states that iconic sites (like Lofoten) should have different scope elasticities when compared to a non-iconic site (the Oslofjord area). Note that declaring Lofoten as an iconic location, and that the Oslofjord is not iconic is partially based on the perceptions of the authors, and should be considered as a limiting factor. Hypothesis 4 is based on this premise. To reiterate the findings presented in *section 6.1.4* concerning the scope elasticities of both Lofoten and the Oslofjord, we find that the estimated mean elasticities are consistently higher in the Oslofjord analysis than in Lofoten, and there are fewer elasticities equal to zero or with a negative sign in the Oslofjord. As far as hypothesis 4 is concerned this is a good sign, however there may be other factors affecting the scope elasticities other than the iconic or non-iconic nature of the survey location. As discussed in *section 7.1.3* which concerns use/non-use values, differences in elasticities may also be an expression of differences in use/non-use values between the locations that do not show in the selected variables in the regression models. Furthermore, there are subtle differences between the surveys, in the questions asked, and in the methods used. While these survey designs are very similar, which allows us to compare the results in the first place, we cannot rule out the possibility that minor differences between the questionnaires can be expressed as differences in elasticities. Finally, there is the computational issue of the arc-elasticities caused by the differing sizes of oil spill scenarios between the locations, and the nature of the arc-elasticity equation leading to very different maximum values for the elasticities. All these issues combined mean we cannot isolate the effect of an area being iconic or not, and properly compare the results. The results hint at a relationship between iconic areas and scope elasticity, and may be used as an indication to that effect, yet we should not conclusively reject the null hypothesis in this case.

7.2 Limitations

Both surveys were conducted during the COVID-19 pandemic. As such questions were added to control for the effects of the pandemic. The results indicate that changes to the respondent's well-being and income affects scope sensitivity. This could impact results compared to the period before the pandemic. As the time period of the survey falls in a time of extraordinary societal and economic conditions, the results may not reflect on a "normal" economic condition in Norway, and may in the worst-case scenario not be applicable once the situation normalizes.

As mentioned in *section 4.2.2*, the NOAA panel recommends in-person interviews in CV studies. Lindhjem et al. (2014) argues that web-based surveys do not necessarily give less useful answers. Web-based surveys may reduce the probability of issues related to warm-glow effects where the respondents may give inaccurate WTP answers in order to be seen as a good citizen, or morally upright. Both the Lofoten, and the Oslofjord surveys were web-based, and we should be aware of the potential issues this may cause.

We opted to use arc-elasticity as a measure of scope sensitivity in order to have a unit free measure of sensitivity that was simple to calculate, and easily interpreted. Yet we should be aware that this measure is not without its limitations. As explained in detail in *section 6.1.4* there are issues related to the calculation of arc-elasticity based on the specific values in a scenario which make the interpretation of the results more difficult. We recommend when conducting similar analyses to be aware of the limitations and benefits of the potential measures of scope sensitivity such as arc-elasticity, point-elasticity, or other measures, and choose accordingly. One must be aware of, and keep in mind the limitations when conducting an analysis, and when interpreting results.

A further limitation is that of adequacy of scope. There is no agreed upon standard for what level of scope sensitivity is ‘adequate’. Whether estimated scope elasticities (specifically inelastic estimates) are adequate is a question of some contention, as pointed out by Amiran and Hagen (2010): “the question becomes whether a very low degree of sensitivity to scope can be consistent with rational choice in the context of neoclassical consumer theory” (Amiran & Hagen, 2010, p. 299). Lopes and Kipperberg (2020) used the same Lofoten data find elasticities ranging from 0.18 to 0.41. Dugstad et al. (2020) in a study on WTP and renewable energy find elasticities ranging from 0.18 to 0.46, which the authors deemed “to be of an adequate and plausible order of magnitude” (Dugstad et al., 2020, p. 17). In other words, there is precedence for finding similarly inelastic measures of scope sensitivity, yet we should keep in mind the fact that using elasticities as a measure of scope sensitivity is a relatively new approach, and no standard value for adequacy of scope has been determined. This issue is further compounded if level of elasticity is highly impacted by the issues related to calculating arc-elasticities.

7.3 Suggestion for future work

The limitation of this thesis can give valuable opportunities for improvements for future work on this topic. The thesis was written using data collected during the COVID-19 pandemic, and this period of time does not reflect the "normal" economic conditions in Norway. Therefore, results may differ if surveys are conducted after the pandemic and/or when the economy is more stable. As the surveys used in this thesis have also been used previously, research could also be conducted using both the old data from 2013, and the newly collected data from 2020 to compare elasticity results over time. This would be particularly helpful in determining the validity of results in the 2020 data with regards to the effects of COVID-19, which we listed as a limitation in *section 7.2*. Collecting new data in the future could provide even more information regarding the nature of scope sensitivity and elasticities.

We recommend further studies of a similar mode to be conducted in order to examine the relationships we have found in other places and scenarios. We found mixed results relating to use/non-use values, attitudes, and for some demographic variables. Further study is required to determine whether any effect on scope sensitivity can be established in these areas. Of particular interest is also the effect of household income on the respondent's scope sensitivity. While our results indicate a relationship between the two, further studies to reaffirm (or disprove) this relationship are recommended. Another area of interest is the effect of emotions on WTP, and by extension scope sensitivity. We found some indications that a negative change in overall happiness leads to changes in scope elasticity. Further study of this phenomenon could prove quite interesting.

8. CONCLUSION

The aim of this thesis was to investigate what determines sensitivity to the scope of damages caused by oil spills on an individual level. We examine the results of two CV method surveys conducted in 2020 on Norwegians' WTP to avoid oil spills in coastal areas, one focusing on the iconic, and ecologically diverse Lofoten, and the other focusing on the more densely populated Oslofjord area. This thesis uses a generalized linear panel model, and arc-elasticities as a measure of sensitivity to the scope of damages, in order to answer the research question as presented in *Ch. 1*, and *Ch. 6, section 6.2*.

Constructing significant scope sensitivity has been seen as an essential validity check for SP methods (e.g., Kahnemann and Knetsch, 1992; Mitchell and Carson, 1989; Arrow et al., 1993; Kling et al., 2012; Whitehead, 2016; Dugstad et al., 2020; Lopes & Kipperberg, 2020). Our sample mean elasticities range from 0.17 to 0.25 in Lofoten, with the highest proportion of negative elasticities being 8%, and highest proportion of zero elasticities being 46%. In the Oslofjord the sample mean elasticities range from 0.46 to 0.57, with the highest proportion of negative elasticities being 5%, and the highest proportion of zero elasticities being 39%. These findings are not dissimilar from the findings of Søgaard et al. (2012) who found that a significant proportion of respondents (more than half) failed to show sensitivity to scope on an individual level, and Veisten et al. (2004) who found that some respondents seemed to be "truly insensitive to the scope of environmental amenities" (Veisten et al., 2004, p. 329). We found the occurrence of negative elasticities somewhat peculiar in relation to oil spill scenarios, and as such decided to investigate whether the removal of these values would have an impact on the estimates. We did not find that these negative elasticities altered the results of the model estimations in any noteworthy manner. The estimates of sample mean elasticities are in line with Burrows et al. (2017), who suggests sensitivity to scope when elasticities are between 0.2 and 0.5. Additionally, our estimates are also consistent with suggestions of adequate scope sensitivity made by Amiran & Hagen (2010), Whitehead (2016), Lopes & Kipperberg (2020) and Dugstad et al. (2020) (see *section 4.3.1*, and *section 7.2*). Based on these findings, we deem our scope elasticity estimates to be adequate and plausible. Results of two-sided t-tests performed on the elasticity distributions show statistically significant differences between Lofoten and the Oslofjord, however tests based on complete combinatorial methods provide more mixed results.

The results of our regression analyses show several significant determinants at an individual level such as household income, gender, and membership of environmental organisations. Many of the determinants included in the analysis vary in significance across models, and locations. Basing the analysis of the same variables on multiple models and locations provides a method of testing the validity of our results. Perhaps the most theoretically significant result of our analysis is the positive relationship between income and scope sensitivity (hypothesis 1). A relationship which was consistently present in all our models and fairly consistent in magnitude across locations. Other demographic variables are also shown to be significant, although there are some mixed results across models and locations. Regarding use/non-use values the model results were largely non-significant, with some exceptions providing mixed, and weak results for a few variables. We do not reject the null hypothesis in the case of hypothesis 2 on the grounds of mixed, weak, and contradictory results for the relationships between use/non-use values and scope elasticity. As for attitude variables the results are mixed between Lofoten, and the Oslofjord, with different variables being significant in the former, but not the latter, and vice versa. Overall mixed results with some indications of significant relationships between dependent and independent variables. Particularly relevant is membership of environmental organisations (linked to hypothesis 3) which is significant in Lofoten but not in the Oslofjord analysis. There is a strong indication of a relationship in one survey analysis, however based on the combined considerations of both locations we could not fully reject the null hypothesis. Regarding differences between iconic and non-iconic locations, we cannot adequately establish a difference in elasticities being caused by a location's iconic status, further research into this topic is recommended. In the case of hypothesis 4, we do not reject the null hypothesis.

Finally, we must recognize certain limitations of our research, as well as make a few concluding remarks regarding future research. While this thesis examined data of both Lofoten, and the Oslofjord in order to strengthen the validity of the results, the research has been conducted on data collected in an unusual time period, as such results may not be entirely representative of normal conditions, more research using data from a 'normal' time period is recommended to ensure the validity of results. On the other hand, our findings related to the impact of COVID-19 on happiness indicate that emotions, and overall happiness may be important in environmental valuation exercises as this affects the respondents' WTP, and ultimately their sensitivity to scope. The use of arc-elasticity as a measure of scope sensitivity has its own limitations for interpreting results. Future research into scope sensitivity should consider carefully the nature of the different potential elasticity or scope sensitivity measures. We recommend more research be conducted into scope sensitivity at the individual level. The number of studies conducted in this manner are limited, and further research into this topic could prove valuable in fields using non-market valuation methods. Better understanding of the intricacies of the respondents' WTP and their sensitivity to scope could function as a validity check, and provide more accurate results in future studies, and valuation exercises. Improving the quality of CV studies could for example help the Norwegian Coastal Administration and the government determine appropriate levels of taxation in order to avoid oil spills in Norwegian coastal areas. As seen in *Ch. 2*, oil spills can be very damaging to the environment, and can cause significant societal losses. Understanding the processes and determinants of a respondent's WTP, and scope sensitivity in a valuation setting may allow for improved survey design in studies using CV and DCE methods, thus improving the validity of results, as well as the reliability of non-market valuation methods, and the applicability of their findings.

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Appendix A: Literature table

Study reference	Research focus	Context	Scope discussion	Study conclusions	Scope relevant attributes
Ahtiainen (2007)	WTP for improvements in the oil spill response capacity	CV Oil spill	No	Respondents value nature in the area and ecosystem higher than its recreational use value	Demographics
Alvarez et al. (2014)	Recreational fishing losses from Deepwater Horizon	Non-CV Oil spill	No	WTP for oil spill prevention varies by fishing mode and anglers fishing from private boats and shore	Income Use variables
Brennan & Van Rensburg (2016)	Preferences on wind farm externalities in Ireland	DCE Wind power	No	Respondents are willing to make trade-offs for wind farms further away from their residents and wind farms with lower heights.	Individual and wind farm characteristics
Casey et al. (2008)	WTA environmental risks of oil transport on the Amazon	DCE Oil spill	Yes	Subsistence level communities in the Amazon required additional compensation beyond direct damages compensation to accept risks of oil transport, suggesting non-use values should be accounted for. Size, and frequency of oil spills significantly impact WTA Duration is not significant (with caveats)	Size of spill Frequency of spill Duration of spill Demographics Socio-economic characteristics
Carson et al. (2003)	Lost passive use values from the Exxon Valdez oil spill	CV Oil spill	Yes	Some evidence of scope sensitivity Income positively correlated with WTP Attitudes toward environment determine WTP Belief that Oil company should pay negatively affects WTP 4.87 – 7.19 BN USD lost passive use values	Demographics socio-economic characteristics respondent's beliefs about issue
Dugstad et al. (2020)	Scope elasticity New renewable energy production and new wind power installations	Non-CV Wind power	Yes	1. Investigation of sensitivity to scope is uncommon in DCE 2. Studies often assume unitary elasticities 3. Non-linear methods tend to find inelastic scope sensitivity	Attribute presentation

Study reference	**Research focus**	**Context**	**Scope discussion**	**Study conclusions**	**Scope relevant attributes**
Einarsdóttir et al. (2019)	WTP for preservation Wind farm in Iceland	CV Wind power	No	Only 28% expressed WTP and genuine mean WTP was 12,549 ISK.	Demographics
Firestone et al. (2008)	Offshore wind power in Delaware	CE Wind power	Yes	WTP is $21, $37 and $91 for moving wind turbines from 0,9 miles to 20 miles. Offshore wind turbines have a more negative impact on those who live close to the coastline, compared to those living inland.	Demographics
Koto & Yiridoe (2019)	Wind energy in Atlantic Canada	CV Wind power	Yes	Demographics effects the likelihood of participation. Results indicate sensitivity to scope.	Demographics Socio-economic characteristics Attitudes Home Province
Lazaro (2010)	Compensation preferences WTP to avoid future oil spills in Spain	CV Oil spill	Yes	Signal of sensitivity to scope because answers to compensation question indicate that respondents will pay significantly more to avoid larger environmental damages.	Socio-economic characteristics
Ladenburg & Dubgaard (2007)	WTP for visual reduction from offshore wind farms in Denmark	Non-CV Wind power	Yes	Significant preference for reducing the visual disamenities from offshore wind farms. WTP varies across different km of the farm location.	Subgroups Socio-economic characteristics
Ladenburg & Dubgaard (2009)	Preferences regarding offshore wind farms	Non-CV Wind power	Yes	Users of the coastal zone have stronger preferences and higher WTP for reduction of visual disamenities, compared to non-users.	Recreational value Use values vs non-use values
Landry et al. (2012)	Coastal recreation impact of wind turbines in North Carolina	CE Wind power	No	Telephone survey support offshore wind farms. The internet survey show that NC residents are hostile to wind farms close to shore and indicate no negative impact on wind farms further from shore.	Site characteristics

Study reference	Research focus	Context	Scope discussion	Study conclusions	Scope relevant attributes
Lee et al. (2018)	WTP for reducing oil spills in Korean rivers (ROK)	CV Oil spill	No	Statistically significant mean WTP: KRW 6188 (USD 5.28) Education and income increase WTP House owners and men have lower WTP	Income Gender Education House ownership status
León et al. (2014)	Impact of emotions on valuation of damages after oil spills	CV Oil Spill	No	"emotional reactions are important characteristics of human decision making that significantly explain heterogeneity across the sample of participants in a constructed market for the valuation of oil spill prevention programs" "the emotional reactions of individuals should be modeled accordingly in order to improve the validity of non-market valuation assessments across heterogeneous populations."	Socioeconomic characteristics Emotional responses
Liu et al. (2009)	Valuation of oil spill prevention	Non-CV Oil spill	No	1. Environmental attributes generate significant impact. 2. Monetary attribute has significant impact on the utility of the respondent. 3. An individual with more adults in the household, member of an environmental organization and higher monthly income prefer more costly but environmentally friendly option.	Monetary attributes Individual characteristics
Lopes & Kipperberg (2020)	1. Scope insensitivity in previous research 2. Scope insensitivity in WTP for preventing oil spills in Arctic Norway	CV Oil spill	Yes	1. Scope insensitivity in 13 different CV studies. Few studies have presented explorations of scope in specific case analysis 2. WTP over four different oil spill scenarios to be statistical difference in avoidance of a small vs. a very large oil spill (1086 and 1869 NOK)	Confounding effects
Loureiro et al. (2009)	Environmental values lost due to the Prestige oil spill.	CV Oil spill	No	WTP was based on a parametric and non-parametric approach, where the latter approach gives the highest mean WTP.	Social and demographic variables Protest responses

Study reference	Research focus	Context	Scope discussion	Study conclusions	Scope relevant attributes
Loureiro & Loomis (2013)	Passive use values, WTP, and preferences on international (EU) level.	CV Oil spill	No	WTP is higher in the country in which the accident occurred (Spain) Despite distance from the affected area WTP is positive and significant in other countries (Austria & UK).	Demographics Effectiveness Concern (for issue) Altruism
Mattmann et al. (2016)	Meta-analysis on wind power externalities	Metanalysis Wind power	Yes	Positive effect of visual impacts in the social science literature. Results indicate strong income effects and sensitivity to scope.	Population characteristics
Mirasgedis et al. (2014)	Valuing negative impacts of wind power in Greece	CV Wind power Meta-analysis	Yes	WTP for mitigation of visual impact of wind farms increases with number of turbines/capacity WTP for mitigation of visual impact of wind farms decreases as distance to wind farm increases.	Trust in govt. Professional status Expenses Attitudes to climate Information Source of information
Mozumder et al. (2011)	WTP for a renewable energy program in New Mexico	CV Wind power	Yes	The demographic profile indicates positive WTP on renewable energy. Results indicates scope sensitivity for an incremental share of renewable energy from 10% to 20%.	Socio-demographic characteristics Attitudes
Søgaard et al. (2012)	Examine scope insensitivity in CV	CV Non-oil spill Scope sensitivity Health and risk mitigation	Yes	Sample overall sensitive to scope More than 50% of individual respondents were not sensitive to scope Potential determinants for insensitivity were tested but a relationship could not be established. Exception: more detailed information was positively associated with WTP, but negatively associated with scope sensitivity.	Level of information Emotional load Monetary budget restraints Mental budget restraints Individual level determinants

Study reference	Research focus	Context	Scope discussion	Study conclusions	Scope relevant attributes
Van Biervliet et al. (2006)	Non-use losses on different oil spill scenarios in the Belgian Coast	CV Oil spill	Yes	A significant welfare loss will occur if there is no oil spill assessment. Losses were estimated to be EUR 120-606 million. No order-effect or scope-effect, but both influences the WTP.	Social attitudes
Veisten et al. (2004)	Scope insensitivity, complex environmental amenities, bundles / sub-samples	CV Wind power Scope sensitivity	Yes	WTP elicitation procedure influenced WTP and scope sensitivity. Percentage of equal stated WTP for different goods varied from 14-35% Some respondents may be truly insensitive to scope Insensitivity to scope may be due to amenity misspecification or flawed survey design Overall positive conclusion regarding CVM	Survey design Individual level determinants
Westerberg et al. (2013)	Tourists' preferences for wind power in France.	CE Wind power	Yes	Segment one: Demand a price reduction on vacation rebate of 29 EUR. Segment two: willing to pay additional 43 EUR for having wind farms 12 km from shore. Segment three: Demanding compensation up to 265 EUR when the wind farm is 5 km from shore.	Socio-demographic

Appendix B: Lofoten Questionnaire

Figure B.1: Table describing damages of oil spills in Lofoten, with and without new measures

	Med tiltak	Uten tiltak			
	Dagens tilstand	**Liten miljøskade**	**Middels miljøskade**	**Stor miljøskade**	**Svært stor miljøskade**
Skade på fugl					
	Området er viktig hekke-, trekk- og overvintringsområde for sjøfugl. Har vært nedgang i sjøfugl siste år, men bestander i hovedsak i god forfatning	Fuglebestandene i hovedsak i god forfatning I alt **1500** døde fugl	Lomvi lokalt utrydningstruet Øvrige bestander tilbake til normalt etter **1** år I alt **15 000** døde fugl	Bestanden av krykkje og lomvi lokalt utrydningstruet Øvrige bestander tilbake til normalt etter **2** år I alt **50 000** døde fugl	Bestanden av krykkje og lomvi utrydningstruet i Norge Øvrige bestander tilbake til normalt etter **4** år I alt **120 000** døde fugl
Skade på sel					
	Området er viktig for sel. Selbestandene i god forfatning	Selbestandene i god forfatning I alt **30** døde sel	Selbestandene i god forfatning I alt **100** døde sel	Bestanden av selarten steinkobbe lokalt utrydningstruet I alt **500** døde sel	Bestanden av selarten steinkobbe utrydningstruet i Norge Øvrige arter tilbake til normalt etter 4 år I alt **1000** døde sel
Skade på kystsone					
	Rikt ravinelandskap og dypvanns koraller Området er viktig for rekreasjon og friluftsliv for fastboende og tilreisende	**5** km kystsone bestående av *svaberg og strender* tilsølt med olje Påvirker landbasert og vannbasert friluftsliv Berørte områder kan brukes som normalt etter **6** måneder	**30** km kystsone bestående av *svaberg og strender tilsølt med* olje Påvirker landbasert og vannbasert friluftsliv Berørte områder kan brukes som normalt etter **1** år	**150** km kystsone bestående av *svaberg og strender* tilsølt med olje Påvirker landbasert og vannbasert friluftsliv Berørte områder kan brukes som normalt etter **3** år	**400** km kystsone bestående av *svaberg og strender* og fiskevær tilsølt med olje Påvirker landbasert og vannbasert friluftsliv Berørte områder kan brukes som normalt etter **5** år
Skade på annet liv i sjøen					
	Området er viktig gyte- og internasjonalt viktig oppvekst- og beiteområde for flere fiskeslag	Kan høstes som før Trygt å spise sjømat Gyte- og oppvekstområder for fisk ikke påvirket	Kan høstes som før Trygt å spise sjømat Gyte- og oppvekstområder for fisk tilbake til normalt etter **1** år	Fisk, skalldyr, skjell og tang bør ikke spises før **3** år etter utslippet Gyte- og oppvekstområder for fisk tilbake til normalt etter **3** år	Fisk, skaldyr, skjell og tang bør ikke spises før **5** år etter utslippet Gyte- og oppvekstområder for fisk tilbake til normalt etter **5** år

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Figure B.2: Visualization of a small, medium, large and very large oil spill

Kartet nedenfor viser Vestfjorden/Lofoten-området, det vil si havområdet og kysten som ligger mellom ytterspissen av Lofoten i nord-vest, Bodø i sør og Lødingen i nord-øst. Et mulig punkt for en skipsulykke er vist som en rød prikk. Sirklene/skraveringen viser hvor langt oljen kan spre seg.

Har du de siste 12 månedene benyttet noen av områdene markert på kartet som ville bli skadet av dette oljeutslippet til fritidsaktiviteter?

Du kan krysse av for flere alternativer

- ☐ Ja, berørt område for liten miljøskade
- ☐ Ja, berørt område for middels miljøskade
- ☐ Ja, berørt område for stor miljøskade
- ☐ Ja, berørt område for svært stor miljøskade
- ○ Nei, har ikke benyttet noen av de berørte områdene

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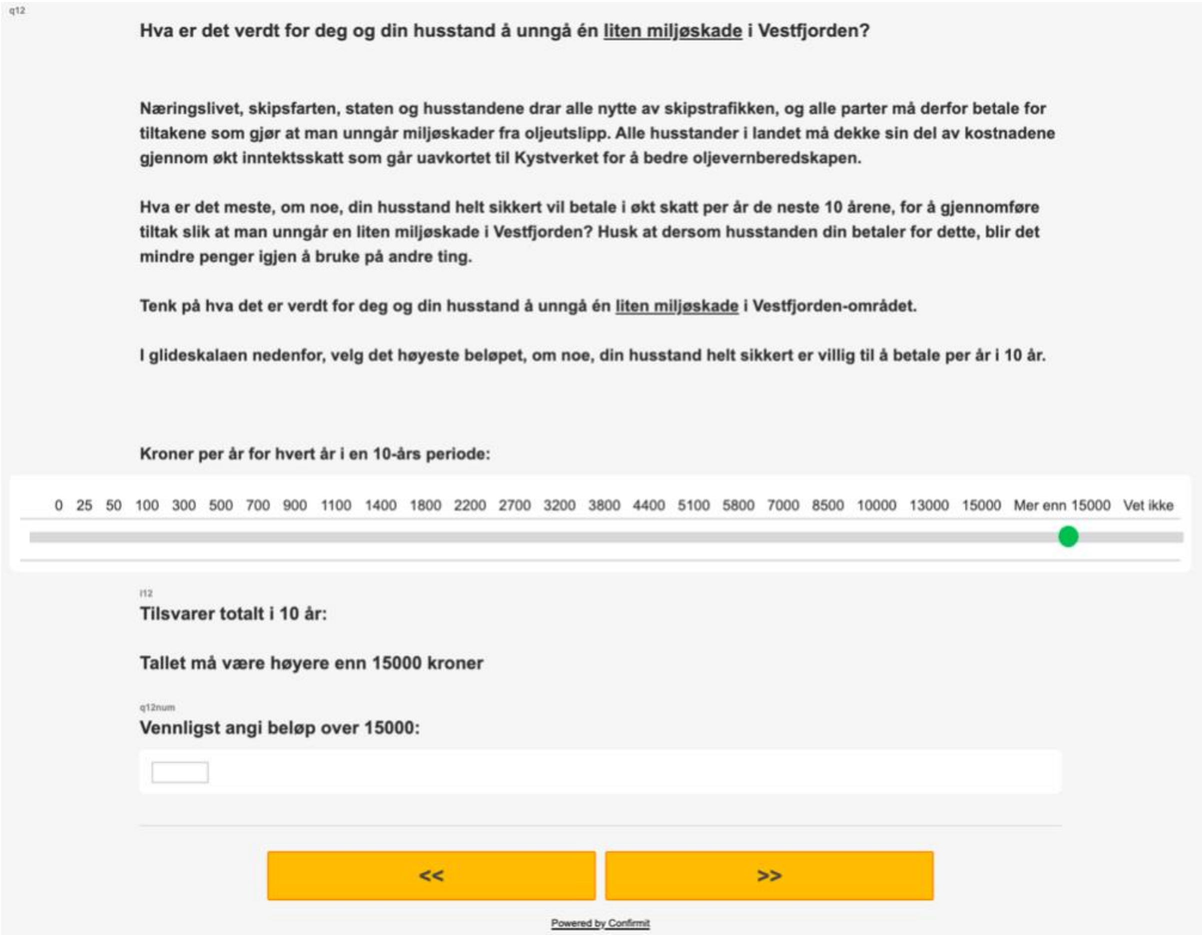
Figure B.3: WTP question for a small oil spill



q12

Hva er det verdt for deg og din husstand å unngå én liten miljøskade i Vestfjorden?

Næringslivet, skipsfarten, staten og husstandene drar alle nytte av skipstrafikken, og alle parter må derfor betale for tiltakene som gjør at man unngår miljøskader fra oljeutslipp. Alle husstander i landet må dekke sin del av kostnadene gjennom økt inntektsskatt som går uavkortet til Kystverket for å bedre oljevernberedskapen.

Hva er det meste, om noe, din husstand helt sikkert vil betale i økt skatt per år de neste 10 årene, for å gjennomføre tiltak slik at man unngår en liten miljøskade i Vestfjorden? Husk at dersom husstanden din betaler for dette, blir det mindre penger igjen å bruke på andre ting.

Tenk på hva det er verdt for deg og din husstand å unngå én liten miljøskade i Vestfjorden-området.

I glideskalaen nedenfor, velg det høyeste beløpet, om noe, din husstand helt sikkert er villig til å betale per år i 10 år.

Kroner per år for hvert år i en 10-års periode:

0 25 50 100 300 500 700 900 1100 1400 1800 2200 2700 3200 3800 4400 5100 5800 7000 8500 10000 13000 15000 Mer enn 15000 Vet ikke

i12

Tilsvarer totalt i 10 år:

Tallet må være høyere enn 15000 kroner

q12num

Vennligst angi beløp over 15000:

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Figure B.4: Questions controlling for COVID-19 – Well-being before

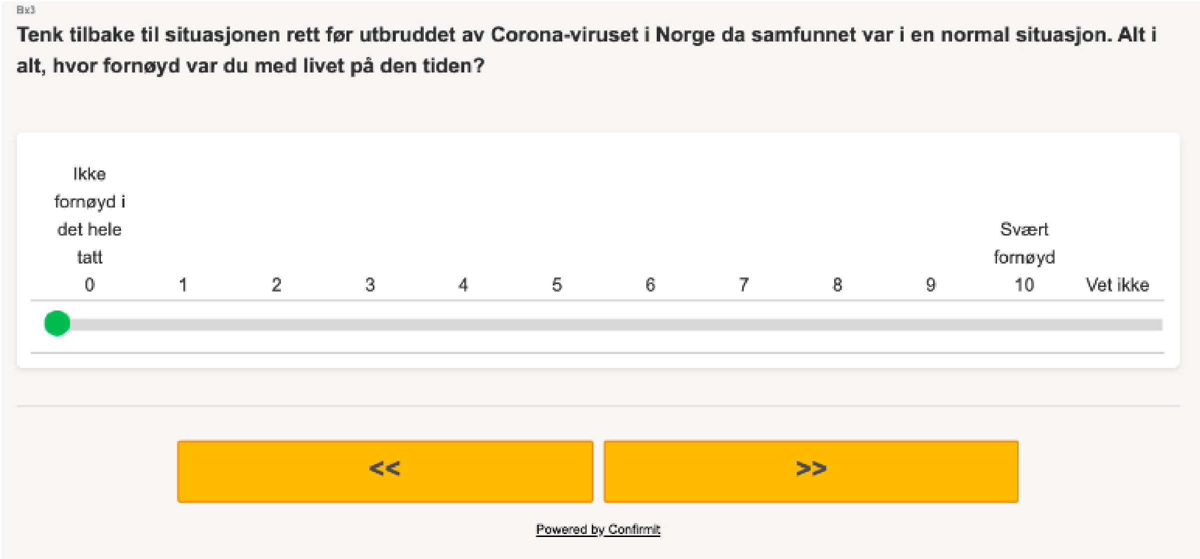


Figure B.5: Questions controlling for COVID-19 – Well-being after

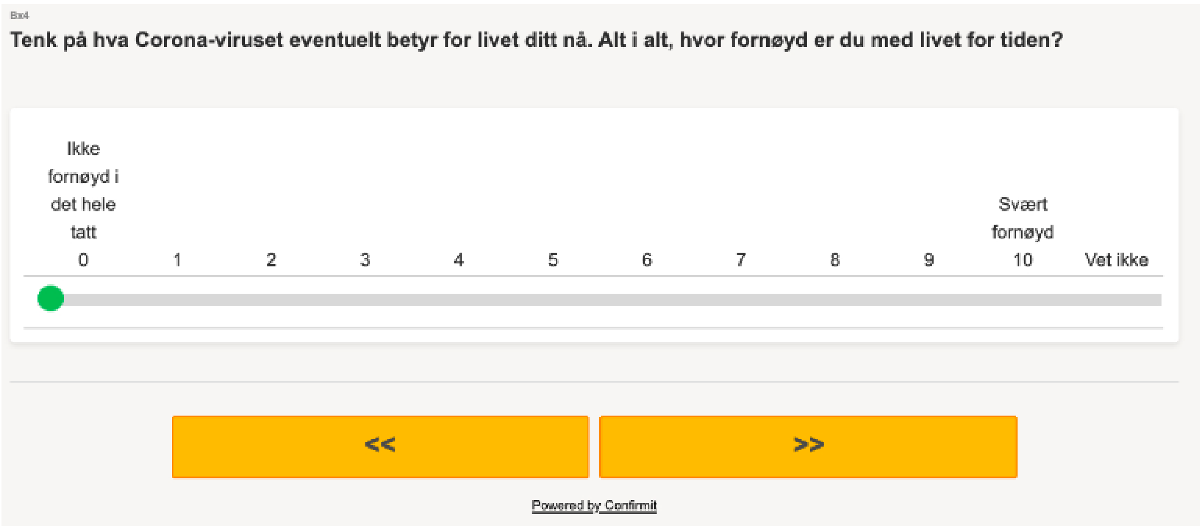
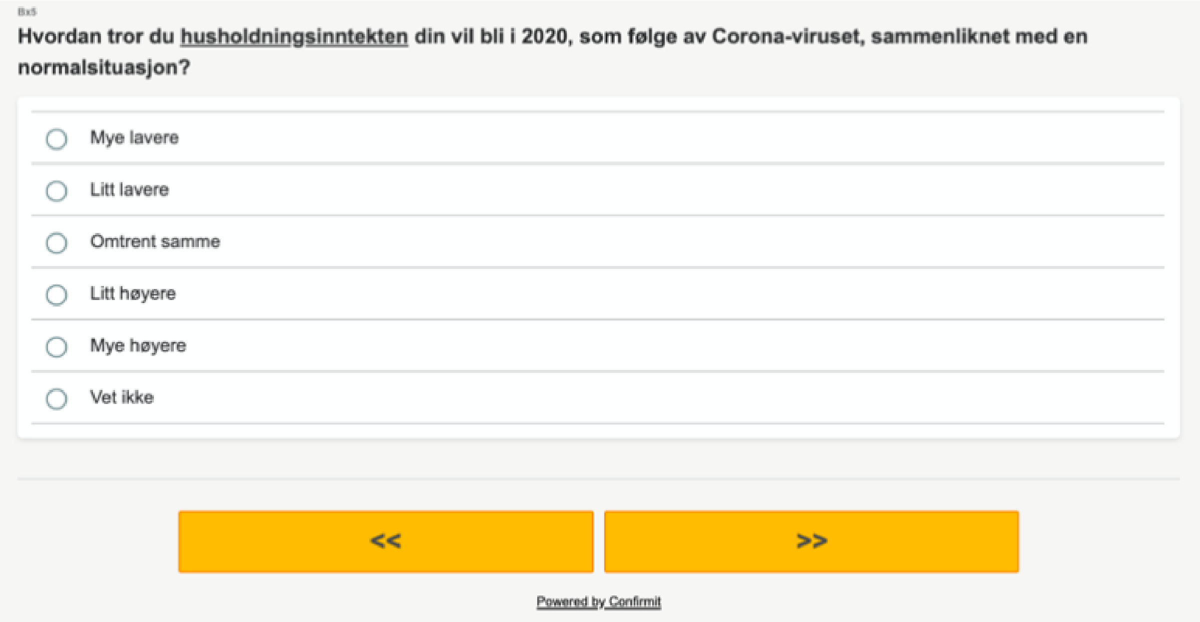


Figure B.6: Questions controlling for COVID-19 – Households Income


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

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Figure B.7: Questions controlling for COVID-19 – WTP


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

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Figure B.8: Rank the most important environmental damages

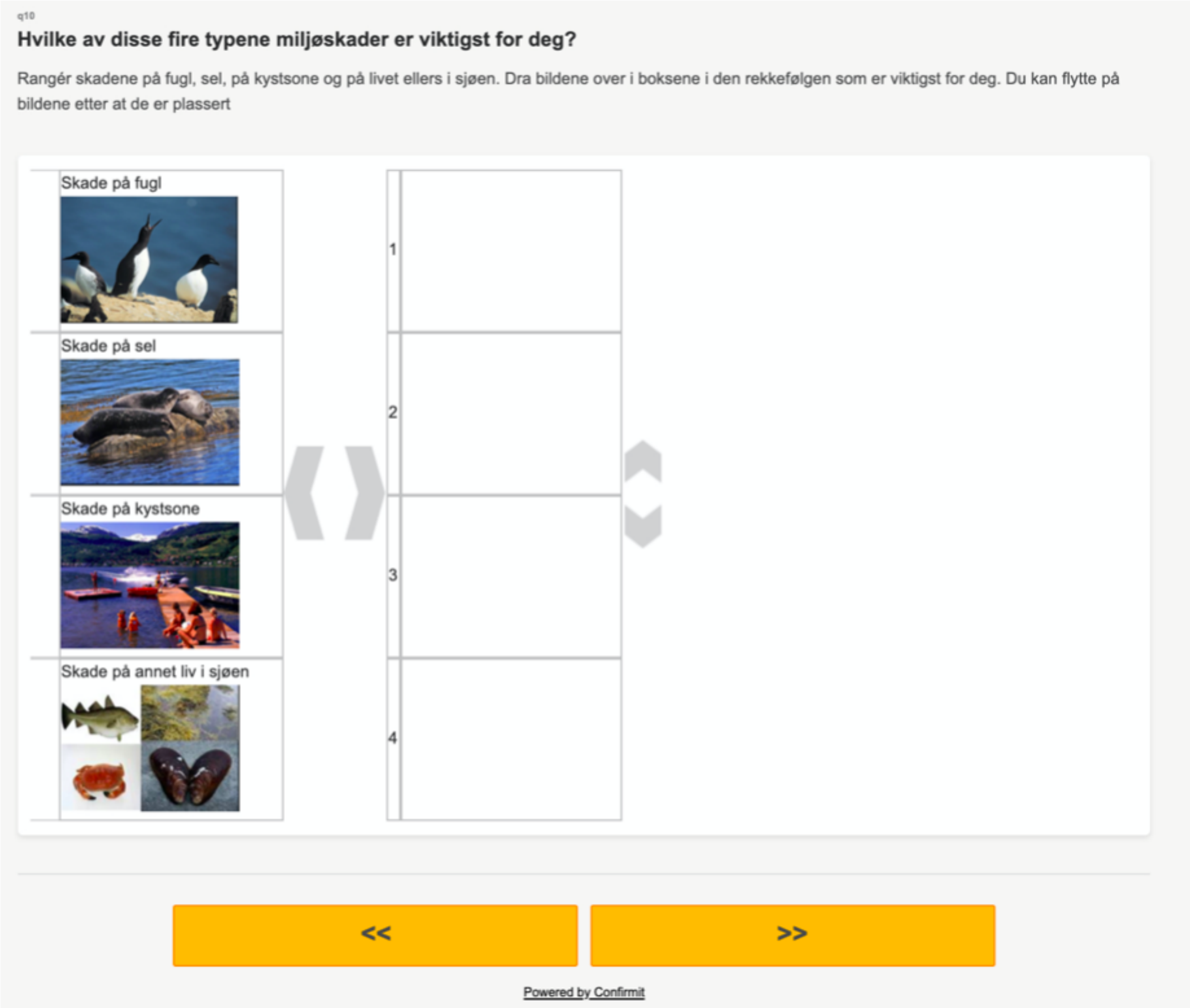

Figure B.9: Questionnaire alternative in Lofoten

qNewB

Hva er den viktigste grunnen til at du oppga at din husstand ikke er villig til å betale noe for å unngå miljøskader fra oljeutslipp eller ikke vet hvilket beløp du skal oppgi?

Kryss av for den grunnen som var viktigst for deg.

- ○ Dagens beredskap er bra nok
- ○ Det var for vanskelig å komme fram til et beløp
- ○ Skattenivået er allerede høyt nok
- ○ Min husstand har ikke råd til å betale for dette
- ○ Jeg ville betalt for tiltak i andre kystområder
- ○ Jeg føler det ikke er riktig å veie miljøet i penger
- ○ Hva jeg sier vil ikke påvirke om tiltakene gjennomføres eller ikke
- ○ Det er rederiene og skipsnæringen som bør betale
- ○ Jeg mener andre samfunnsoppgaver bør prioriteres først
- ○ Jeg stoler ikke på at pengene vil gå til det riktige formålet
- ○ Jeg tror ikke det vil skje oljeutslipp i dette kystområdet
- ○ Jeg mener at penger kan omfordeles eller brukes mer effektivt
- ○ Jeg vil ikke betale før jeg vet hva det koster
- ○ Andre grunner, spesifiser:
- ○ Usikker/ vet ikke

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Table B.1: Identified protest answers in Lofoten

Identified protest answers in Lofoten

Questionnaire alternative	Protest answer
The preparedness today is good enough	Protest
It was difficult to select an amount	
The tax level is high enough	Protest
My household cannot afford to pay for this	
I would pay for measures in other coastal areas	
I do not feel it is right to weigh the environment in monetary terms	Protest
What I say will not affect whether the measures are implemented or not	Protest
It is the shipping companies and the shipping industry that should pay	Protest
I think other societal tasks should be prioritized first	Protest
I do not trust that the money will go to the right purpose	Protest
I do not think that there will be oil spills in this coastal area	Protest
I believe that money can be redistributed or used more efficiently	Protest
I do not want to pay before I know what it costs	Protest
Other reasons, specify	
Unsure/do not know	

Appendix C: The Oslofjord Questionnaire

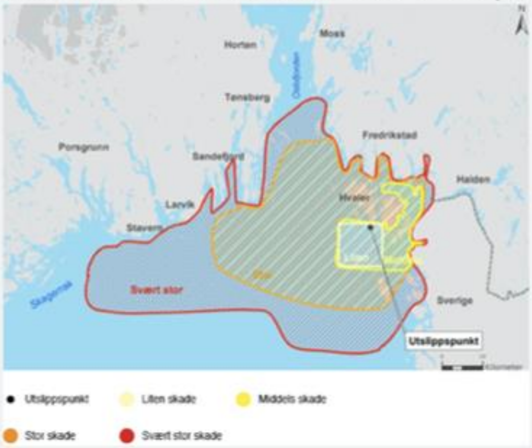
Figure C.1: Table describing the damages of an oil spill in the Oslofjord, with and without new measures

	MED NYE TILTAK	UTEN NYE TILTAK			
	Uten miljøskade	**Liten miljøskade** Tilsvarer utslipp av 20 tonn diesel	**Middels miljøskade** Tilsvarer utslipp av 200 tonn bunkersolje	**Stor miljøskade** Tilsvarer utslipp av 2000 tonn bunkersolje	**Svært stor miljøskade** Tilsvarer utslipp av 20 000 tonn råolje
Skade på sjøfugl 	Området er viktig for sjøfugl som ærfugl, skarv, lakse-and, gråmåke, svaner, og sårbare sjøfugl som sjøorre, teist og fiskemåke	**200** døde sjøfugl **Ubetydelig** påvirkning på sjøfuglbestandene	**3000** døde sjøfugl Bestander av vanlige og sårbare sjøfugl vil ta seg opp igjen etter **1 år**	**7000** døde sjøfugl Bestander av vanlige og sårbare sjøfugl vil ta seg opp igjen etter **2 år**	**15 000** døde sjøfugl Bestander av vanlige og sårbare sjøfugl vil ta seg opp igjen etter **3 år**
Skade på sel 	Viktig yngleområde for sel Selbestanden er i god forfatning	**20** døde sel **Ubetydelig** påvirkning på selbestanden	**40** døde sel Selbestanden vil ta seg opp igjen etter **1 år**	**80** døde sel Selbestanden vil ta seg opp igjen etter **2 år**	**120** døde sel Selbestanden vil ta seg opp igjen etter **5 år**
Skade på liv i sjøen 	Området er viktig gyte- og oppvekstområde for fisk og annet liv i havet Beiteområde for flere bestander	**Ubetydelige** skader på livet i sjøen	**Liten** skade på livet i sjøen Trygt å spise fisk og skalldyr etter **1 år**	**Noe** skade på livet i sjøen, spesielt lokale bestander Trygt å spise fisk og skalldyr etter **1-2 år**	**Større** skade på livet i sjøen, spesielt lokale bestander Trygt å spise fisk og skalldyr etter **1-2 år**
Skade på kystsone 	Svært viktig friluftsområde	**20 km** kystlinje forurenset Området kan brukes som normalt etter mindre enn **1 år**	**30 km** kystlinje forurenset Området kan brukes som normalt etter **2 år**	**120 km** kystlinje forurenset Området kan brukes som normalt etter **3 år**	**190 km** kystlinje forurenset Området kan brukes som normalt etter **5 år**

Figure C.2: Visualization of a small, medium, large and very large oil spill in the Oslofjord

Spredning av olje som gir liten, middels, stor og svært stor miljøskade.
Kartet nedenfor viser et område i Oslofjorden der det er mye skipstrafikk, og der eksperter mener at det kan skje skipsuhell som gir oljeutslipp. Den svarte prikken viser et slikt utslippspunkt. Sirklene viser hvilket område ekspertene mener oljen vil spre seg over. Alvorlighetsgraden er avhengig av hvor stort utslippet er, som vist i miljøskadetabellen. Det er en viss usikkerhet knyttet til skadeomfanget, blant annet fordi vær- og strømforhold kan variere. Oljespredningen og de mulige skadene er angitt ut fra den beste kunnskapen vi har i dag.

Har du brukt området som blir berørt av "svært stor skade" (rød linje) til fritidsaktiviteter de siste 12 månedene?



Nei, aldri brukt området	Nei, men brukt det tidligere	Ja, nå og da	Ja, ofte

Figure C.3: WTP question

Hva er det verdt for deg og husstanden din å unngå én liten miljøskade i Oslofjordområdet?

Vis i figuren nedenfor det meste, om noe, husstanden din helt sikkert er villig til å betale i en øremerket engangsskatt for nye tiltak for å unngå én liten miljøskade i Oslofjordområdet.

Husk at dersom husstanden din betaler for dette, har dere mindre penger igjen til å bruke på andre ting.
Flytt markøren til ønsket beløp.
Engangsbeløp i kroner:

1/1

0

0	10	50	100	200	300	400	500	700	900	1100	1300	1500	1800	2200	2700	3200	3800	4400	5500	7000	8500	12000	Mer enn 12000	Vet ikke

NORSK GALLUP

Figure C.4: Questions Controlling for COVID-19 – Well-being before

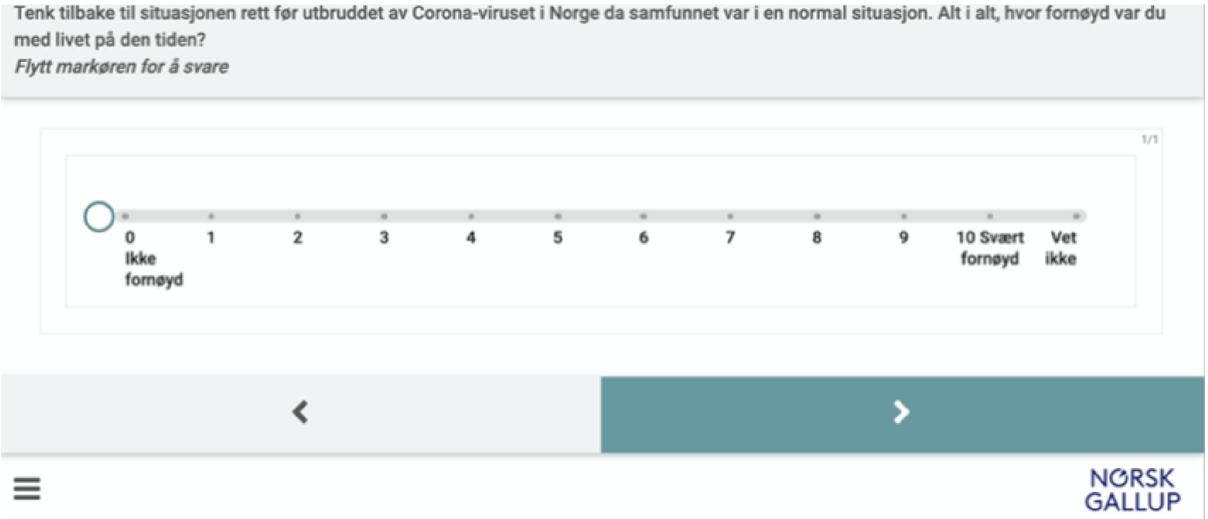


Figure C.5: Questions Controlling for COVID-19 – Well-being after

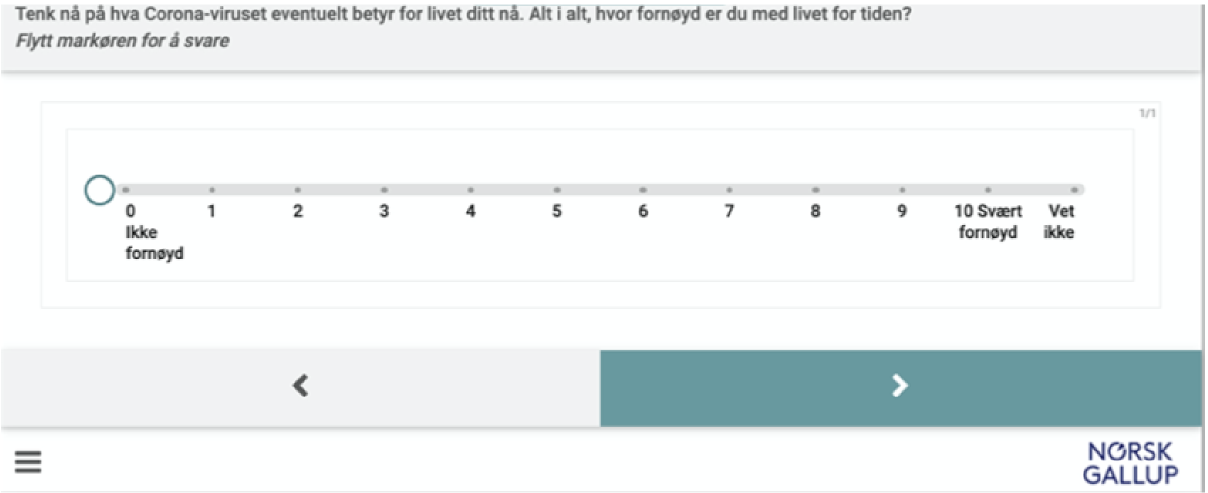
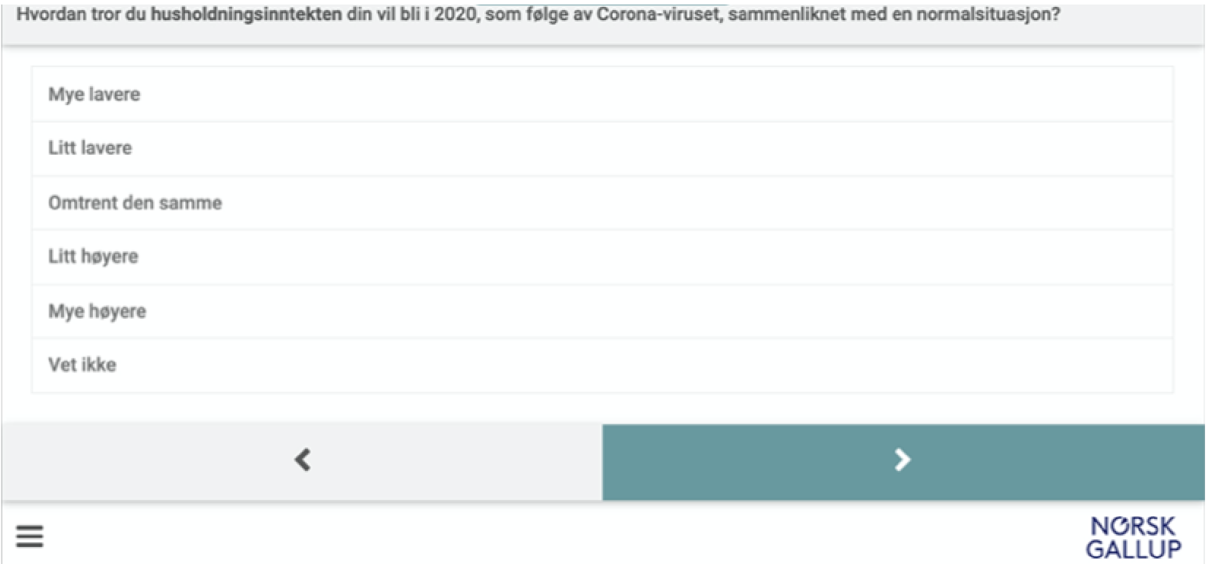


Figure C.6: Questions Controlling for COVID-19 – Households Income


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

Mye lavere

Litt lavere

Omtrent den samme

Litt høyere

Mye høyere

Vet ikke

NORSK GALLUP

Figure C.7: Questions Controlling for COVID-19 – WTP


Tenk tilbake på spørsmålene i denne undersøkelsen, om betalingsvillighet for å unngå miljøskader fra oljeutslipp.
Ville du oppgitt de samme beløpene 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

NORSK GALLUP

Figure C.8: Loss in quality of life the household would experience for each oil spills in the Oslofjord

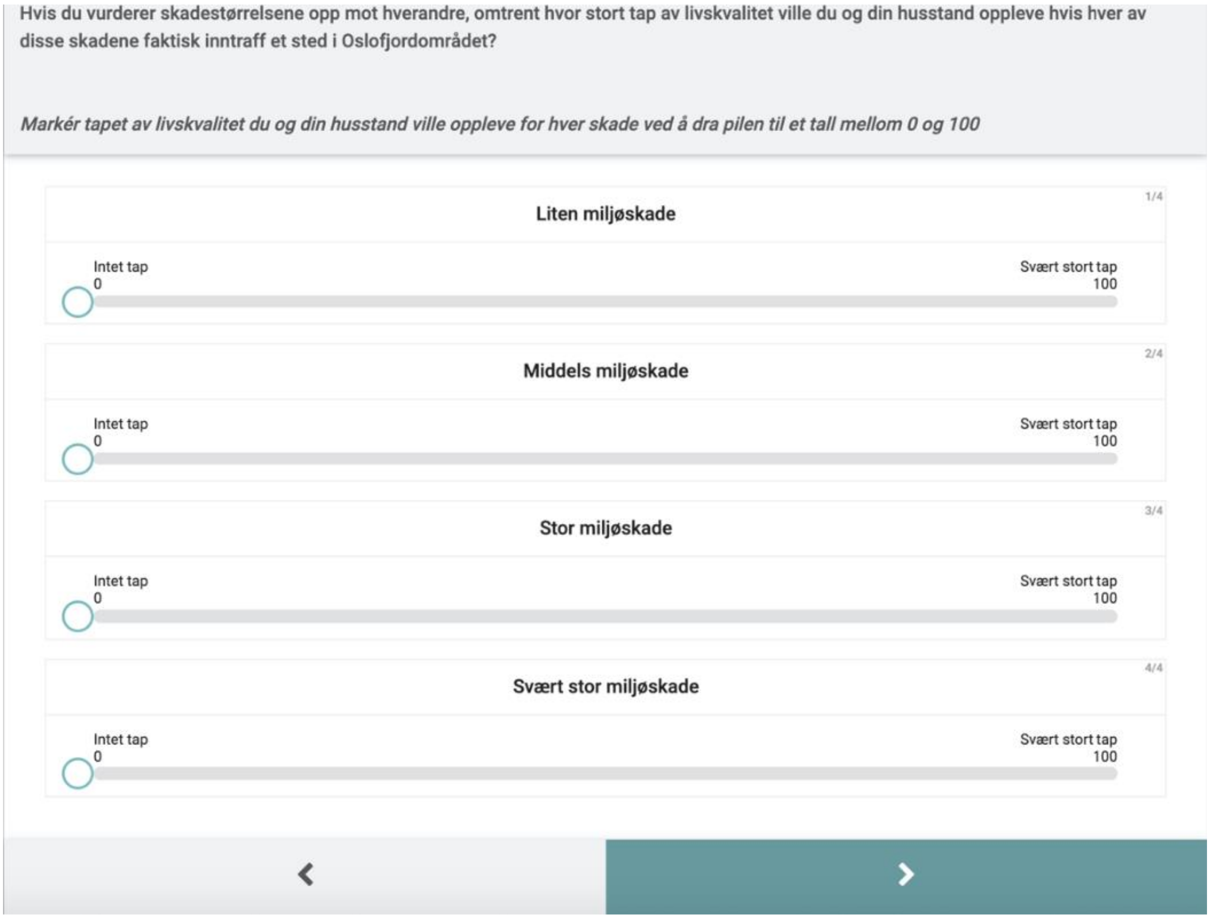
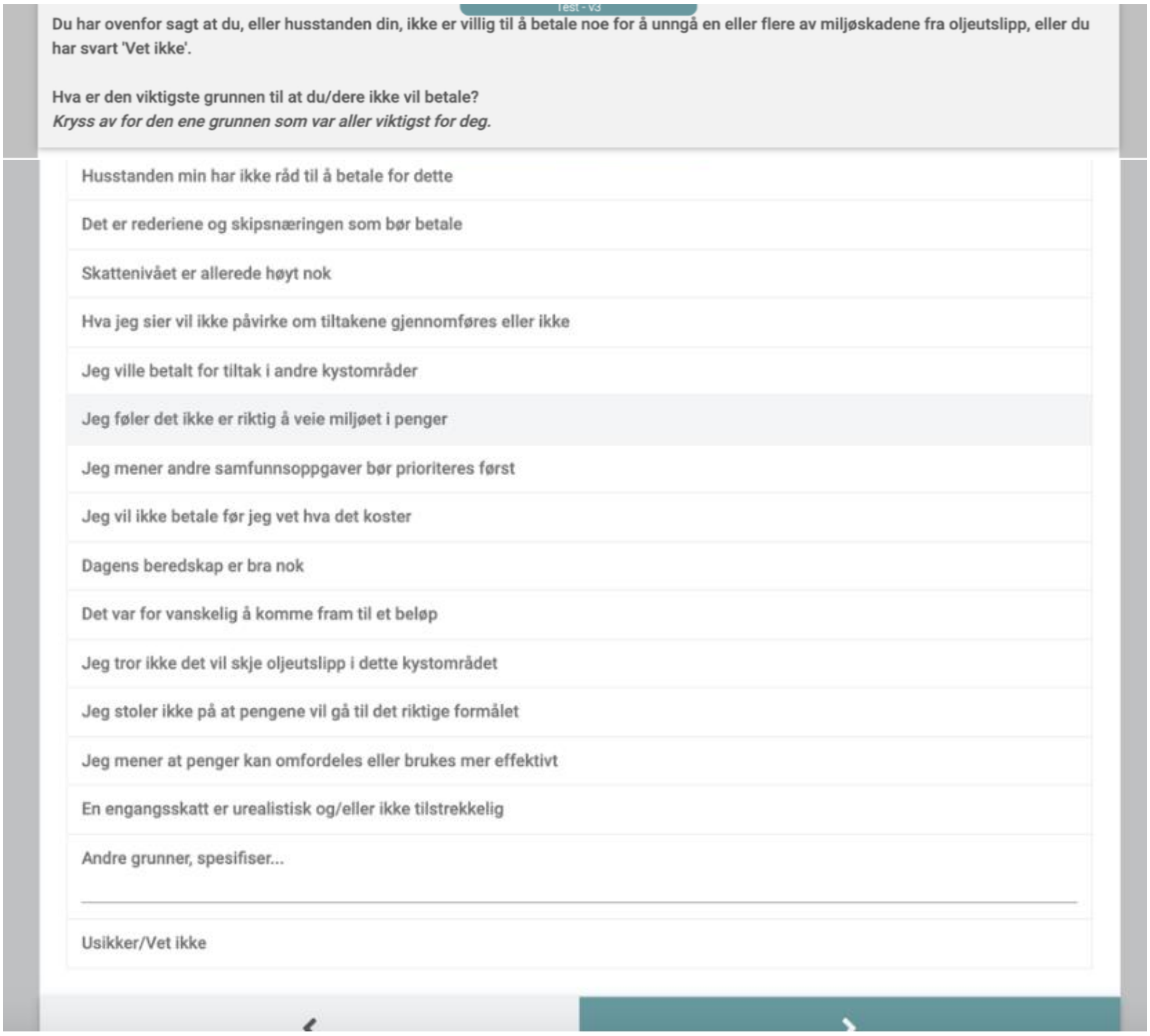


Figure C.9: Questionnaire alternative in the Oslofjord



Du har ovenfor sagt at du, eller husstanden din, ikke er villig til å betale noe for å unngå en eller flere av miljøskadene fra oljeutslipp, eller du har svart 'Vet ikke'.

Hva er den viktigste grunnen til at du/dere ikke vil betale?
Kryss av for den ene grunnen som var aller viktigst for deg.

- Husstanden min har ikke råd til å betale for dette
- Det er rederiene og skipsnæringen som bør betale
- Skattenivået er allerede høyt nok
- Hva jeg sier vil ikke påvirke om tiltakene gjennomføres eller ikke
- Jeg ville betalt for tiltak i andre kystområder
- Jeg føler det ikke er riktig å veie miljøet i penger
- Jeg mener andre samfunnsoppgaver bør prioriteres først
- Jeg vil ikke betale før jeg vet hva det koster
- Dagens beredskap er bra nok
- Det var for vanskelig å komme fram til et beløp
- Jeg tror ikke det vil skje oljeutslipp i dette kystområdet
- Jeg stoler ikke på at pengene vil gå til det riktige formålet
- Jeg mener at penger kan omfordeles eller brukes mer effektivt
- En engangsskatt er urealistisk og/eller ikke tilstrekkelig
- Andre grunner, spesifiser...
- Usikker/Vet ikke

Table C.1: Identified protest answers in the Oslofjord

Identified protest answers in the Oslofjord

Questionnaire alternative	Protest answer
My household cannot afford to pay for this	
It is the shipping companies and the shipping industry that should pay	Protest
The tax level is high enough	Protest
What I say will not affect whether the measures are implemented or not	Protest
I would pay for measures in other coastal areas	
I do not feel it is right to weigh the environment in monetary terms	Protest
I think other societal tasks should be prioritized first	Protest
I do not want to pay before I know what it costs	Protest
The preparedness today is good enough	Protest
It was difficult to select an amount	
I do not think that there will be oil spills in this coastal area	Protest
I do not trust that the money will go to the right purpose	Protest
I believe that money can be redistributed or used more efficiently	Protest
A one-time tax is unrealistic and/or insufficient	Protest
Other reasons, specify	
Unsure/do not know	

Appendix D: Results and Summary Statistics

Table D.1: Summary Lofoten Elasticities Model 1

Summary Lofoten Elasticities Model 1 - n = 1010

	Min	Median	Mean	Max	Negative	Zero	Positive
Small - Medium	-1.400	0.000	0.103	1.400	10%	51%	39%
Medium - Large	-1.500	0.000	0.168	1.500	6%	49%	45%
Small - Large	-1.069	0.085	0.181	1.069	10%	40%	50%
Large - Very Large	-2.200	0.000	0.166	2.200	6%	55%	40%
Medium - Very Large	-1.162	0.116	0.202	1.162	6%	42%	52%
Small - Very Large	-1.025	0.141	0.228	1.025	9%	37%	54%
Averages			0.175		8%	46%	47%

Table D.2: Summary Lofoten Elasticities Model 2

Summary Lofoten Elasticities Model 2 - n = 734

	Min	Median	Mean	Max	Negative	Zero	Positive
Small - Medium	-1.324	0.000	0.127	1.267	9%	46%	45%
Medium - Large	-1.250	0.150	0.186	1.370	5%	42%	53%
Small - Large	-0.956	0.181	0.212	1.011	8%	33%	59%
Large - Very Large	-2.102	0.000	0.193	1.907	6%	48%	46%
Medium - Very Large	-0.983	0.194	0.231	1.082	6%	34%	60%
Small - Very Large	-0.868	0.256	0.269	1.007	7%	29%	63%
Averages			0.203		7%	39%	54%

Table D.3: Summary Lofoten Elasticities Model 3

Summary Lofoten Elasticities Model 3 - n = 616

	Min	Median	Mean	Max	Negative	Zero	Positive
Small - Medium	0.000	0.000	0.188	1.267	0%	52%	48%
Medium - Large	0.000	0.150	0.202	1.300	0%	46%	54%
Small - Large	0.000	0.245	0.268	1.011	0%	37%	63%
Large - Very Large	0.000	0.000	0.229	1.907	0%	51%	49%
Medium - Very Large	0.000	0.243	0.261	1.082	0%	35%	65%
Small - Very Large	0.000	0.342	0.334	1.007	0%	31%	69%
Averages			0.247		0%	42%	58%

Table D.4: Summary the Oslofjord Elasticities Model 1

Summary Oslofjord Elasticities Model 1 - n = 1041

	Min	Median	Mean	Max	Negative	Zero	Positive
Small - Medium	-5.000	0.000	0.828	5.000	5%	48%	48%
Medium - Large	-1.667	0.185	0.272	1.667	4%	43%	54%
Small - Large	-1.400	0.360	0.401	1.400	4%	36%	60%
Large - Very Large	-4.429	0.375	0.513	4.429	5%	43%	51%
Medium - Very Large	-1.375	0.344	0.335	1.375	5%	35%	60%
Small - Very Large	-1.235	0.412	0.412	1.235	6%	32%	62%
Averages			0.460		5%	39%	56%

Table D.5: Summary the Oslodjord Elasticities Model 2

Summary Oslofjord Elasticities Model 2 - n = 700

	Min	Median	Mean	Max	Negative	Zero	Positive
Small - Medium	-4.888	0.714	0.882	4.934	3%	40%	57%
Medium - Large	-1.423	0.263	0.300	1.637	2%	34%	64%
Small - Large	-1.278	0.467	0.451	1.387	3%	27%	71%
Large - Very Large	-3.623	0.543	0.652	3.691	2%	36%	62%
Medium - Very Large	-0.917	0.458	0.414	1.360	2%	25%	73%
Small - Very Large	-1.078	0.533	0.513	1.233	2%	22%	76%
Averages			0.535		2%	31%	67%

Table D.6: Summary the Oslofjord Elasticities Model 3

Summary Oslofjord Elasticities Model 3 - n = 659

	Min	Median	Mean	Max	Negative	Zero	Positive
Small - Medium	0.000	0.769	0.947	4.934	0%	42%	58%
Medium - Large	0.000	0.278	0.313	1.637	0%	35%	65%
Small - Large	0.000	0.467	0.481	1.387	0%	27%	73%
Large - Very Large	0.000	0.554	0.690	3.543	0%	37%	63%
Medium - Very Large	0.000	0.458	0.436	1.360	0%	25%	75%
Small - Very Large	0.000	0.603	0.544	1.233	0%	22%	78%
Averages			0.569		0%	31%	69%