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Can the acceptance of a carbon tax be increased? The effect of tax revenue recycling and redistribution among households and companies

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DISCUSSION PAPERS

995

Discussion Papers No. 995, January 2023
Statistics Norway, Research Department

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Abstract:
Effective carbon taxation is essential to achieving the green transition. However, there is typically stiff opposition to carbon taxation due to perceived or actual adverse equity and other impacts. Hence, a better understanding of which factors, including the use of tax revenue, can increase acceptability is essential. To date, stated preference methods have rarely been used to analyse this issue and, when used, have focused only on households' acceptance. We conduct two identical national choice experiment surveys of Norwegian households and companies, respectively, including carbon tax levels and associated emission reductions and different revenue recycling options as attributes. We find that acceptance for higher tax levels increases among both groups if revenue finances climate mitigation measures. There is some heterogeneity among the groups with regard to using revenue to reduce different dimensions of inequality. Simulating policy options, we find acceptance for the highest carbon tax among both groups when revenue is used both to finance climate mitigation measures and to reduce rural-urban inequalities. This policy option points to an acceptable carbon tax close to an estimated level necessary for reaching the most ambitious climate target set by the Norwegian government. An effective carbon tax level can potentially be achieved in Norway with modest efficiency costs to alleviate inequality.

Keywords: Climate change; Carbon tax; Policy acceptance; Willingness to pay; Earmarking; Tax revenue

JEL classification: H23; Q48; Q58; R48
Acknowledgements: This work was supported by the Research Council of Norway, PLATON, grant no. 295789 and LandValUse, grant no. 319917. We thank Klaus Mittenzwei from Institute for Rural and Regional Research (Ruralis) for contributions to both population and company surveys, Fitwi Wolday and Tanu Priya Uteng from the Institute of Transport Economics (TØI) for inputs to the company survey, and Terje Skjerpen from Statistics Norway for valuable inputs on the manuscript.

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ISSN 1892-753X (electronic)

Sammendrag

Karbonprising er et viktig virkemiddel for grønn omstilling. Dog er det ofte ikke uten problemer å øke kostnaden på utslipp, blant annet på grunn av sterk mostand blant befolkningen og næringslivet som følge av ubeleilige fordelingseffekter. Derfor er det svært viktig å få en bedre forståelse av hvilke faktorer som kan øke aksept for karbonprising. Til nå har uttrykte preferansemetoder i liten grad blitt brukt til å vurdere hvordan ulike virkemidler påvirker aksept av karbonprising, og hvis så er tilfelle har forskningen utelukkende fokusert på husholdninger. En av fordelene med uttrykte preferansemetoder er at respondenter må gjøre en rekke vanskelige avveininger som resulterer i at de «tvinges» til å prioritere hvilke politiske virkemidler de foretrekker ved økt karbonskatt. I denne studien gjennomfører vi to identiske nasjonale valgeksperimentundersøkelser for både husholdninger og bedrifter, hvor valgeksperimentattributtene består av karbonskattesatser med reduksjon i utslipp og ulike former for øremerking av skatteinntektene. Vi finner blant annet at aksept for høyere karbonskattenivåer øker hvis inntektene øremerkes til å finansiere klimatiltak. Ved å simulere ulike politikk-scenarier med attributtene i valgeksperimentet finner vi videre at aksept for høyere karbonskattenivåer er størst blant både husholdninger og bedrifter når inntektene øremerkes både til å finansiere klimatiltak og redusere inntektsforskjeller mellom by og land. Dette politikk-scenariet gir en karbonskatt på omtrent samme nivå som det som er nødvendig for å nå myndighetenes mest ambisiøse klimamål. Derav er det tilsynelatende mulig å designe en policy som oppnår et samfunnsøkonomisk effektivt nivå på karbonskatten og som i tillegg stimulerer aksept blant både husholdninger og bedrifter.

1. Introduction

Under the Paris Agreement, many countries have set ambitious targets for reducing their greenhouse gas emissions (GHG) before 2030. A carbon tax is seen as an essential policy instrument for achieving them and contributing to the low-carbon transition (Stiglitz et al., 2017; Timilsina 2022). Carbon pricing makes emissions more costly for households and companies, aligns incentives across emission sources, and leads to cost-effective GHG reductions. However, many countries have experienced stiff domestic opposition to introducing carbon taxes or increasing them to more appropriate levels (Carattini et al., 2018). Much of this opposition can be explained in terms of the perceived or actual impacts of the tax (e.g., Douenne and Fabre, 2020), such as disproportionate impacts on rural, carbon-intensive, and/or poorer households and specific sectors or companies (Ohlendorf et al., 2021; Goulder et al., 2019; Berry, 2019; Cronin et al., 2019; Metcalf and Stock, 2020). Hence, there is a growing realisation that in order to be able to implement an effective (sufficiently high) carbon tax, a better understanding of its impacts and the factors that can increase its acceptability are needed (Klenert et al., 2018; Stiglitz et al., 2017; Carrattini et al., 2017; 2018; Dolšak et al., 2020; Zhang et al., 2022; Sun et al., 2021).

Suggestions to increase acceptability include public schemes that earmark all or parts of the tax revenue and redistribute it, for example, to alleviate inequity concerns and/or fund additional climate mitigation efforts (Carrattini et al., 2017; Kotchen et al., 2017). Recent surveys of the literature indicate that both of these uses of earmarked tax revenue may increase social acceptance for a tax (Köppl and Schratzenstaller, 2022; Maestre-Andrés et al., 2019; Drews and van den Bergh, 2016). Since few countries have tried such recycling schemes, there is still limited evidence of the actual effects on acceptability (Mildenberger et al., 2022).

While there is a surge of interest in understanding public preferences for and the acceptability of carbon taxes[1] through general attitude surveys, the research to date has focused almost exclusively on households, not companies. However, a better understanding of companies' concerns, the hurdles they face in responding to a tax, and the types of tax design and factors that may increase their acceptability and consequently the ability to achieve the low-carbon

[1] There is also an increasing interest in public preferences concerning taxation more generally, see e.g., de Bresser and Knoef (2022) and Stantcheva (2021).

transition, is crucial (Peñasco et al., 2021; Bumpus, 2015). While companies do not have the right to vote and are not (indirectly) involved in public decision-making the way citizens are, they are nevertheless important agents in the political economy of climate policymaking (Genovese and Tvinnereim 2020; Mildenberger 2020). Research on the climate behaviour of companies has to date mostly focused on specific technical/environmental processes, voluntary mitigation activities, management systems, and corporate social responsibility (Engler et al., 2021; Böttcher and Müller, 2016; Dahlmann et al., 2019; Damert and Baumgartner, 2018; Liu and Wang, 2017).

Further, research to date on carbon tax acceptability has included minimal use of stated preference (SP) methods (choice experiment – CE and contingent valuation – CV) that require survey subjects to prioritise and make explicit trade-offs between the different attributes of carbon tax design, potentially yielding valuable and more specific information for policymakers compared to traditional attitude surveys (Douenne and Fabre, 2020). When it comes to surveys of households, a few studies have applied CE methods to investigate trade-offs between different aspects of carbon taxes, such as environmental impact, earmarking of tax revenue for different purposes, fairness and equity, and economic and competitiveness effects (Carattini et al., 2017; Beiser-McGrath and Bernauer, 2019; Gevrek and Uyduranoglu, 2015; Sommer et al., 2022; Brännlund and Persson, 2012; Hammerle et al. 2021).[2] For companies, the only SP study of carbon tax we are aware of is Liu et al. (2015), a CE study of the carbon tax preferences of 200 companies in two Chinese provinces.[3] This study shows that a carbon tax with some relief for energy-intensive sectors, combined with earmarking of tax revenue for further climate mitigation efforts, would be preferable and realistic for these companies.

To contribute to this small and fast-growing literature, we conduct two concurrent national, representative surveys, of Norwegian households and companies, respectively. The two surveys have the same CE design and several other similar questions for exploring and comparing preferences. We use a hypothetical increase in the existing Norwegian carbon tax on fossil fuels

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[2] More general CE studies of preferences for climate and environmental policies include Svenningsen and Thorsen (2020), Andor et al. (2022) and Bergquist et al. (2020).

[3] There are, however, a few studies of company preferences for other climate mitigation measures than taxation, such as offsetting in Germany (Engler et al., 2021), emission trading schemes in China (Gao and Wang, 2021) and a Chinese sectoral crediting mechanism scheme for voluntary efforts (Gao et al., 2016).

as an instrument. This tax was first introduced in 1991, and in 2022 is EUR 0.18 (NOK 1.78) per litre of petrol for road traffic and EUR 0.20 (NOK 2.05) for mineral oil (including diesel), equivalent to EUR 76.9 and EUR 77.0 per tonne CO_2, respectively. Despite the early adoption of a carbon tax in Norway, the level is still too low and uneven across sectors compared to what is deemed necessary to reach the GHG targets (Fæhn et al., 2020; Wangsness and Rosendahl 2022), and increases have faced continued public and political opposition (Grimsrud et al., 2020).[4]

The objectives of this study are to (1) survey what households and companies consider significant hurdles to moving towards less dependence on fossil fuel in road transportation; (2) investigate acceptance by companies and households of carbon tax levels on fuel and different uses of tax revenue that aim to alleviate some of the known concerns and hurdles for acceptability discussed above, (3) explain the variation within and differences between the stated preferences of households and companies, and (4) derive implications for a more acceptable carbon tax policy design.

To our knowledge, this is the first study to combine SP data for households and companies in the same study of any climate policy. This approach is useful, since successful carbon tax implementation depends on having both companies and households on board. This may depend on finding conditions for common acceptance at the most effective level of a carbon tax. While close involvement of companies, e.g., in tax revenue recycling schemes, features prominently in the literature as part of the proposed solution to making carbon taxes work (e.g., Klenert et al. 2018), investigations and surveys of companies' preferences in this regard are almost non-existent.

The paper proceeds as follows. In section 2 we outline the conceptual framework and hypotheses, describe the design and administration of the household and company surveys, and explain the approach to econometric analysis. Section 3 first presents some descriptive results on the general views on carbon taxes and perceived barriers to reducing dependence on fossil fuels for the household/company. Then, we present the results of the choice experiment and analyse

[4] In addition, there is an annual tax on motorised vehicles where the tax rate increases with factors that increase vehicles' CO_2 emissions, such as weight and engine type. Since this tax is not related to actual use but rather to the ownership of the vehicle, we have not considered this tax in analysis.

which factors can explain the degree of acceptance. Finally, Section 4 discusses results, derives carbon tax policies that achieve high levels of acceptance among both households and firms, and concludes.

2. Material and methods

2.1 Conceptual framework and research hypotheses

We base our conceptual framework on the broad-based research conducted on social acceptability referred to above, combined with the more specific choice experiment (CE) method. The main idea is to measure tax preference and acceptability and hurdles to changing behaviour. This is done directly by means of survey questions and indirectly by obliging respondents to make trade-offs between different carbon tax levels and tax design features that may increase (or decrease) their preference for a higher tax. We then include several questions as controls to help explain variation in preferences. These include specific characteristics of the household or company – and the representative respondent – and include transport behaviour, hurdles experienced in adjusting to tax, etc., and several attitudinal questions. Finally, we analyse the degree of and variation in acceptability using econometric methods (detailed in section 2.3 below).

Based on theoretical expectations and the findings of several general acceptance studies using the CE method, we derive a number of hypotheses linked to two main research questions (RQ) that we use the CE part of the data to analyse:

RQ1: Does acceptance for a carbon tax increase if the tax revenue is earmarked for a specific purpose?

H1.1: *Acceptance for a carbon tax increases if tax revenue is earmarked for climate mitigation measures.*

H1.2: *Acceptance for a carbon tax increases if the negative impact on the purchasing power of lower income groups is reduced through the distribution of the carbon tax revenue.*

H1.3: *Acceptance for a carbon tax increases if the negative impact on the purchasing power of the rural population is reduced through the distribution of the carbon tax revenue.*

H1.4: *Acceptance for a carbon tax by companies increases if the tax revenue is earmarked for reduced taxes on companies.*

This research question and the four hypotheses above explain the general acceptance for the attributes included in our CE. H1.3 addresses a specific concern related to the urban-rural divide in Norway and many other countries.

There might also be heterogeneity in acceptance among households and companies, which it is highly relevant to explore with our second research question:

RQ 2: Are there variations within and differences between the preferences of households and companies?

H2.1: *Households and companies that rely more on fossil fuels for transportation have a lower acceptance for a higher carbon tax on fossil fuels.*

H2.2: *Households worried about climate change have a higher acceptance for a higher carbon tax on fossil fuels.*

H2.3: *Households that worry about climate change have a higher acceptance for a carbon tax if the revenue is earmarked for funding climate mitigation measures.*

H2.4: *Companies with technological barriers to reducing* CO_2 *emissions have a lower acceptance for a higher carbon tax*.

One important aim with respect to policy implications is to derive combinations of tax attributes that create the highest common acceptance among households and companies at the most effective tax level.

2.2 The household and company surveys

We used both a general population survey and a survey of companies containing identical CE designs to gather the necessary data to test our hypotheses. In addition, the questions that led up to the CE were almost the same except for some adjustments to fit the context of a household or a company. At the beginning, both surveys asked the respondent to answer on behalf of their household/company. For SP surveys of citizens, this is a relatively standard procedure (Johnston et al. 2017). For company surveys, there is, to our knowledge, no standard practice to lean on[5]. We emphasised clearly in italics in the survey introduction to companies that the respondent should "*attempt to answer on behalf of their company*".[6]

Respondents in the general population survey then received two warm-up questions asking them to write freely about what they associated with "climate change" and measures to reduce climate change. Companies were not asked these questions to avoid making their survey too long. Both households and companies were then asked about their acceptance for a carbon tax on fossil fuels without earmarking of the tax revenue and whether they thought increasing the carbon tax on fossil fuels would reduce fossil fuel consumption and thereby GHG emissions. This question was a check on respondents' views on the effectiveness of carbon taxation for reducing fossil fuel consumption. Both surveys then asked about types of private transportation to learn more about the transport needs and costs of the household/company. Household respondents were asked about the number and type(s) of car (fossil, electric, hybrid, hydro, etc.) in the household and the annual mileage of each vehicle. Companies were asked what share of their total operating costs transport costs constituted. Respondents in both surveys were then presented with different levels of carbon tax per tonne of CO_2, along with the implied price increase per litre of fossil fuel (gas/diesel), before being asked about the effect the highest tax increase presented would have on their household economy/company profitability. The highest tax increase would be necessary to reach the government's most ambitious climate target and was estimated at the time of the

[5] There may be similar types of challenges involved in asking a respondent to represent the preferences of his or her household or the company he or she works for. While this may potentially be more problematic in a (large) company setting, in the SP literature on population surveys there is surprisingly little critical reflection on the complexities of household decision-making (Lindhjem and Navrud (2009) is one exception).

[6] Since the survey was carried out during the tail end of the Covid pandemic, we also acknowledged in the survey that many companies are struggling during the pandemic and that the respondent should attempt to consider a more normal situation when the pandemic is over.

survey to be NOK 6.41/litre (Fæhn et al., 2020). The response options were largely the same in both surveys, except that households did not have bankruptcy as an option. Bankruptcy is rarely used to handle household debt issues in Norway. The final question before the CE asked the respondent about how they would like the revenue from an increased carbon tax to be used. The respondents were then provided with four possibilities to spend the revenue on: (1) to fund public expenses in the same way as today, (2) to compensate consumers for loss of purchasing power, (3) to reduce corporate taxes, or (4) to use the revenue to fund government climate mitigation measures. The respondents were asked to distribute the tax revenue percentages on these four purposes so that they added up to 100 percent.

The second part of the survey contained the choice cards and standard follow-up questions, described in more detail below. After the choice experiment, the surveys' questions for households and companies diverged somewhat. Household respondents were asked whether they thought climate change was real, how concerned they were about climate change, and the barriers they experienced to reducing their transport-related CO_2 emissions. They were also asked a series of questions regarding their views on various climate policy measures and impacts. Finally, they were asked questions about the socio-demographics of the respondent and the household. After the choice experiments, companies were asked about the barriers they experience to reducing their use and dependence on fossil fuel-based transportation, increasing their use of rail for freight transport, and increasing their use of electric vehicles. Moving freight transport from road to rail is one of the measures proposed by the government to enable Norway to reach the goals set in the Paris agreement (Klimakur 2030, 2020). The survey of companies then ended with some questions regarding the characteristics of the respondent and their company.

The CE design had four attributes. Attribute 1 was the level of the carbon tax on fossil fuels along with the associated reduction of CO_2 emissions for road traffic. This reduction was estimated by modelling results from the SNOW-NO model[7] used in the Government White Paper "Klimakur

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[7] Statistics Norway's world model (SNOW) is a computable general equilibrium (CGE) model developed for studies of climate policy and emissions in the long run. SNOW-NO, also developed by Statistics Norway, is the SNOW model of the Norwegian economy. SNOW-NO is used for projections of GHG emissions by the Norwegian Ministry of Finance. See, e.g., https://www.ssb.no/nasjonalregnskap-og-konjunkturer/artikler-og-publikasjoner/energy-in-the-snow-model

2030”, which discusses measures to enable the Norwegian economy to reach the country’s climate goals (Klimakur 2030, 2020; Fæhn et al., 2020). The lowest level was the level at the time of the survey. The second attribute described the purpose for which the carbon tax revenue should mainly (60 percent or more) be used. The third and fourth attributes described how a share of between 0-20 percent of the overall carbon tax could be earmarked to level up general economic inequality in society and rural-urban inequality specifically. The levels for inequality adjustment were set at below 80 percent in order to explore preferences for moderate adjustment of income and rural inequalities. This choice was partly based on Goulder et al. (2019), who found that efficiency costs rise dramatically when targeted compensation extends beyond the lowest income quintiles.

Table 1 provides an overview of the attributes, variable names, and levels in the CE. We designed the CE using NGENE software[8]. The carbon tax was modelled as a continuous variable and the remaining variables were modelled as dummy variables. An example of a choice card is shown in Figure 1.

Table 1. Attributes and levels in the choice experiment

Attribute	Levels	Variable name
Carbon tax on fossil fuels and associated cost increase per tonne CO_2 equivalent (CO_2e) and percentage reduction in CO_2 emissions	- NOK 590 /ton, NOK 0/litre, 0 percent - NOK 1000/ton, NOK 1.09/litre, 15 percent - NOK 1500/ton, NOK 2.42/litre, 20 percent - NOK 2000/ton, NOK 3.75/litre, 25 percent - NOK 3000/ton, NOK 6.41/litre, 30 percent	Tax_litre
What should the revenue from the new carbon tax mainly be used for?	- General public expenses in the same way as today - Financing climate mitigation measures - Reducing the taxes faced by companies - One-off payment to Norwegian citizens—an equal amount for all	- Public - Climate - Companies - Citizens
The percentage of the new tax revenue that should be used to reduce income inequality resulting from the carbon tax	0 5 10 20	General_inceq
The percentage of the new tax revenue that should be used to reduce economic inequality resulting from the carbon tax between urban and rural areas	0 5 10 20	Rural_inceq

Note: The variable name defines the name of the variables used in the econometric analysis. The carbon attribute included information about carbon tax per tonne CO2e, per litre of fossil fuel at the gas station, and the expected contribution of the tax to reducing GHG emissions from road traffic in Norway.

[8] http://www.choice-metrics.com/

The data were collected using an Internet survey platform administered by a reputable survey company (TNS Kantar, ISO 26362 certified management of household Internet panel). The household data were collected in the last two weeks of August 2021. We only sampled companies with five or more employees to avoid a large share of companies that, in practice, are inactive. The company data collection also started in mid-August 2021 and continued until 24 September 2021. Both the household and the company survey were stratified to ensure as good representativeness of the population as possible[9]. The survey topic was not disclosed in email invitations to households or companies in order to minimise self-selection bias related to, e.g., environmentally conscious subjects.

The household survey was sent to 5,336 respondents. 2,248 respondents opened the survey, and 1,832 returned completed questionnaires (82 percent), yielding a response rate of 34 percent. The median time used to complete the survey was 23 minutes. The sample largely represents the Norwegian population of 18 years and older, except that the level of education is somewhat higher in the sample. There may be two reasons for this, as pointed out by the survey company: people tend to overreport their education level, and it is harder to reach respondents who have only completed compulsory education.

Figure 1. Example of a choice card used in the survey

No. 6	TODAY'S SITUATION	ALTERNATIVE A	ALTERNATIVE B
Carbon tax and estimated reduction in greenhouse gas emissions from road traffic	Today's tax of **NOK 590** per ton CO_2, i.e. no increased tax on fuel No further reduction in greenhouse gas emissions from road traffic	Increase in tax to **NOK 1000** per ton CO_2, i.e. **NOK 1.09** more per litre fuel **15 percent** reduction in greenhouse gas emissions from road traffic	Increase in tax to **NOK 3000** per ton CO_2, **NOK 6.41** more per litre fuel **30 percent** reduction in greenhouse gas emissions from road traffic
What the new government revenue should mainly be used for	Finance general public expenditures, in the same way as today	Finance general public expenditures, in the same way as today	Government financing of climate measures
Percentage of tax revenue used to reduce general economic inequity as a results of the increased carbon tax	0 percent	0 percent	10 percent
Percentage of tax revenue used to reduce economic inequity between urban and rural areas as a result of the increased carbon tax	0 percent	0 percent	5 percent
I CHOOSE:	○	○	○

[9] Households according to age, gender and place of residence. Companies according to number of employees in intervals of 5-9, 10-49 and 50+.

The company survey was sent to 14,271 registered company email addresses (typically company emailbox) using the email contact-information maintained by the same survey company. Many of these email invitations did not make contact, probably due to spam or manual filtering. This is a common issue with company surveys (Bethlehem and Biffignandi, 2021). The web survey was opened but not fully completed by 1,163 and was completed by 600 companies. This yields a response rate of 4.2 percent of the total number of invitations but as high as 52 percent of the invitations that actually made contact. The median time used to complete the survey was 14 minutes, which is shorter than for the households as the company survey included fewer questions. Companies within the sectors “manufacturing” and “transporting and storage” were slightly overrepresented (by about 6 percent), and companies in the sectors “wholesale and retail trade” and “health” (10-13%) and “accommodation” (4%) were slightly underrepresented. Table A1 in the appendix shows the company sample by sector compared to available information on company employee numbers.

2.3. Econometric approach for CE analysis

The random utility framework (McFadden, 1974) models individuals’ discrete choices between different goods or alternatives, often defined by multiple attributes, such as in choice experiments. The individuals are assumed to make discrete choices that are utility maximizing. The foundation of the random utility model is Lancaster’s (1966) consumer theory, where an individual derives utility from the attributes of a good rather than from the good itself.

Both household and company respondents were presented with a set of four choice cards with three alternatives, including a do not know option.[10] We assume that a given respondent's utility function consists of a deterministic and an unobservable stochastic component. Given this assumption, the utility for the given respondent n choosing alternative i in choice situation t can be expressed as:

$$U_{int} = \sigma(-\alpha c_{nit} + \beta' x_{nit}) + \varepsilon_{nit}, \tag{1}$$

[10] “Don’t know” responses are treated as “missing values” in the econometric modelling.

where α and β are the preference parameters for the cost attribute and the non-monetary attribute x_{nit}, respectively. c_{nit} and x_{nit} are vectors representing the levels of the cost and non-monetary attributes, respectively, while ε_{nit} represents the stochastic component of the utility function and is an i.i.d. type I extreme value distributed error term, where the variance is constant $\pi^2/6$. The scale parameter (σ) can be specified as $\sigma = \exp(\lambda I_n)$, where I_n denotes an indicator variable equal to 1 if the respondent is in the household sample and zero otherwise (Swait and Louviere, 1993). The parameter λ is estimated and represents the relative scale parameter, fixed at 1 for the companies.[11] The multinomial logit model gives us the following probability of respondent n choosing alternative i in choice situation t:

$$\text{Prob}(i_{nt}|\alpha,\beta,c_{nit},x_{nit}) = \frac{\exp\big(\sigma(-\alpha c_{nit} + \beta' x_{nit})\big)}{\sum_j^J \exp\Big(\sigma\big(-\alpha c_{njt} + \beta' x_{njt}\big)\Big)}. \tag{2}$$

Let us define the sequence of choices as the vector y_n. The probability then becomes:

$$\text{Prob}(y_n|\alpha,\beta,c_n,x_n) = \prod_{t=1}^{T} \text{Prob}(i_{nt}|\alpha,\beta,c_{nit},x_{nit}). \tag{3}$$

The multinomial logit model assumes that all respondents have homogeneous preferences, which is a strict assumption. Instead, we allow for unobserved heterogeneous preferences, using a mixed logit specification in which the random parameters are specified as having a joint distribution. Let Θ_n denote a vector of all random preference parameters and Ω represent their means and variances-covariances. With the joint distribution of the random parameters given by the density function $f(\Theta_\text{n},\Omega)$, we get the following unconditional probability of the sequence of choices:

$$\text{Prob}(y_n|c_n,x_n,\Omega) = \int \prod_{t=1}^{T} \text{Prob}(i_{nt}|\alpha_n,\beta_n,c_{nit},x_{nit})\, f(\Theta_\text{n},\Omega) d(\Theta_\text{n}). \tag{4}$$

[11] This assumption applies when we analyse the choice experiment data for the pooled sample.

The integral is approximated using simulations, where the mixed logit model uses simulated maximum likelihood estimation (Train, 2009, p. 144). To estimate the mixed logit models, we use 2000 scrambled Sobol draws (Czajkowski and Budzinski, 2019) and the Apollo package in R (Hess and Palma, 2019). We assume that all random parameters follow a normal distribution with a complete correlation structure. A strictly negative log-normal distribution is the most common assumption for the monetary attribute in CE (Mariel et al., 2021). This requires all households and companies to experience disutility with an increased carbon tax. However, this is an unrealistic and inconvenient distributional assumption given the nature of our monetary attribute. On the one hand, people are expected to have a negative preference for an increased carbon tax on fuel because it reduces people's disposable income. On the other hand, the monetary attribute is bundled (i.e., perfectly correlated) with reductions in CO_2 emissions from road transportation. Research strongly indicates that people prefer reducing CO_2 emissions and are willing to pay for it (e.g., Grammatikopoulou et al., 2020). Hence we, along with Liu et al. (2015), specify the carbon tax rate preference parameter as being normally distributed, which means that people can have positive and negative preferences for an increased carbon tax and the corresponding reduction in carbon emissions. [12]

To test our hypotheses, we estimate a total of five mixed logit models. First, we estimate a pooled model, which includes both households and companies. Here, we estimate a relative scale parameter (denoted λ previously in this section) to test for differences in error variance between households and companies. We estimate one mixed logit model per sample. Finally, to explore preference heterogeneity, we estimate one mixed logit model per sample, in which we include covariates through interaction terms.

3. Results

We first present results related to general views on carbon taxes and perceived barriers to reducing dependence on fossil fuels for the household/company in order to find potential ground for increased tax acceptance among both companies and households.

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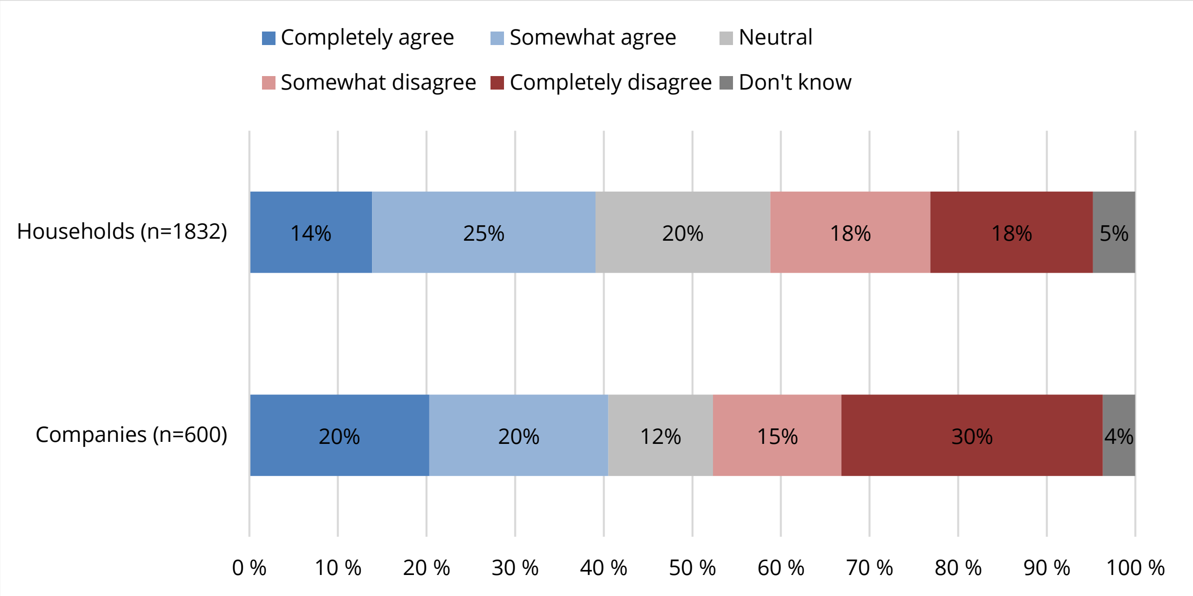
[12] In a preliminary analysis, we tried to estimate a model for the household and company samples in which the carbon tax attribute was assumed to be log-normally distributed, but we experienced convergence failure. This indicates that the assumption that all individuals experience disutility with a higher carbon tax is too strict.

3.1 Tax preferences and perceived transition barriers among households and companies

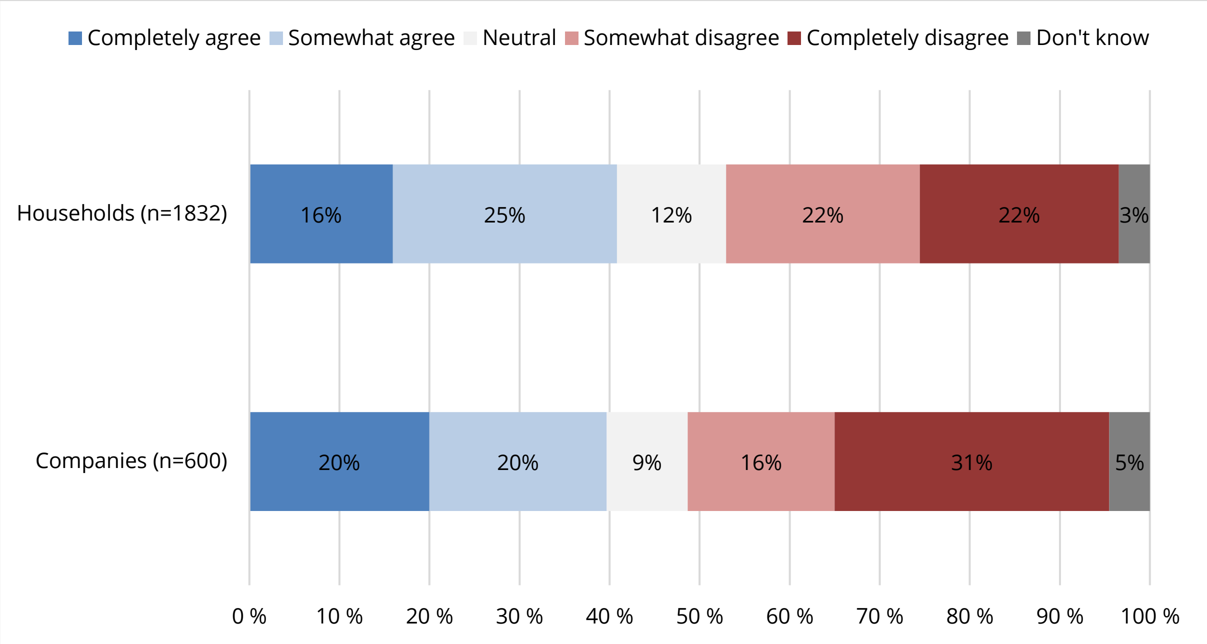
More companies (20 percent) than households (14 percent) completely agree that it is generally acceptable for the authorities to use carbon tax income to cover general public expenditure rather than earmarking the income for specific purposes. More companies (30 percent) completely disagree with this statement than households (18 percent) (see Figure 2). This indicates that companies are more polarised in their views on a carbon tax without earmarking than households. While this question does not ask about earmarking for climate mitigation measures specifically (H1.1), the answers to these questions suggest that earmarking of the carbon tax revenue can have a role in increasing the acceptance by both households and companies.

Figure 2. Responses to the statement: "It is generally acceptable for the authorities to use tax and fee income to cover general public expenditure, rather than earmarking the income for specific purposes"



More companies (20 percent) than households (16 percent) completely agree that a tax on fossil fuels would reduce fossil fuel consumption and, thereby GHG emissions (Figure 3). Again, views are more polarised among companies than households: 31 percent of companies completely disagree, while only 22 percent of the households completely disagree with this statement. It is somewhat unexpected that such a large percentage of companies operating in markets completely disagree with this statement, which essentially expresses the law of demand. One reason may be that companies experience barriers to transitioning from fossil fuels. Companies within the sectors of transport, merchandise trading and construction most frequently completely disagree with this statement, and this finding supports H2.1 for companies. Notably, more than half of transport companies responded, “completely disagree”, indicating that this sector faces larger hurdles than other sectors. The fact that these sectors are less accepting of the carbon tax suggests that the data support both H2.1 and H2.4, that dependence on fossil fuels and technological barriers reduce acceptance. As further support for H2.1, the data suggest that resistance is greater among companies that used a higher share of their operating spending on transport (see Figure A1 in appendix). H2.4. is further supported by the fact that smaller companies with fewer employees and lower revenue are also overrepresented in the response category “completely disagree” (see Figure A2 in the appendix).

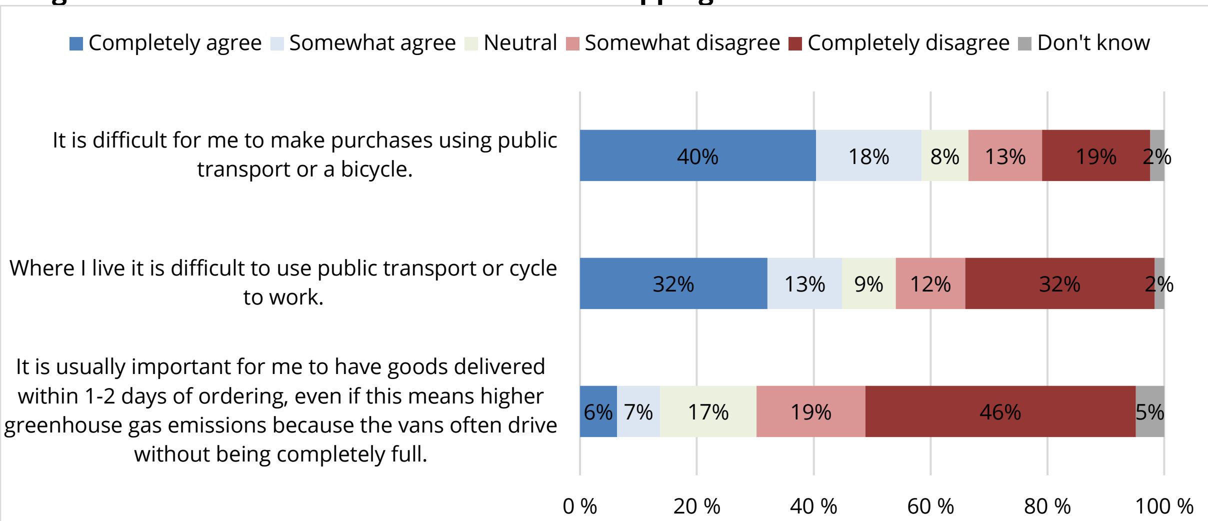
Figure 3. Responses to the question of whether the respondent disagrees/agrees with the statement that “increased tax on fossil fuels reduces fuel consumption, thereby reducing greenhouse gas emissions”



Most companies and households are concerned that higher fossil fuel prices will affect them negatively economically, and there is quite a similar distribution of answers (see Figure A3 in the appendix). As many as eight percent of companies stated they would go bankrupt if the fossil fuel price were to increase to the level required for the most ambitious climate policy, NOK 6.41 per litre, or EUR 0.64 per litre.

The reason households and companies do not believe they will reduce their fossil fuel consumption despite higher prices could be that alternative means of transportation are unavailable/limited or too costly in terms of time or money. As regards the presence of barriers to reducing household consumption of fossil fuels (H2.1), we find that 40 percent of households find it challenging to make purchases without using a car and that 32 percent find it difficult to travel to work without using a car (Figure 4). As for goods ordered from stores, 46 percent of households completely agree, and 19 percent somewhat agree that they do not mind waiting some days to receive the goods if this contributes to reducing the GHG emissions associated with shipping.

Figure 4. Households' self-reported barriers to using alternative transportation to a car. The biggest barrier appears to be making purchases followed by travelling to work. For goods ordered online or by other means, most households are willing to wait to receive the good to reduce GHG emissions related to shipping



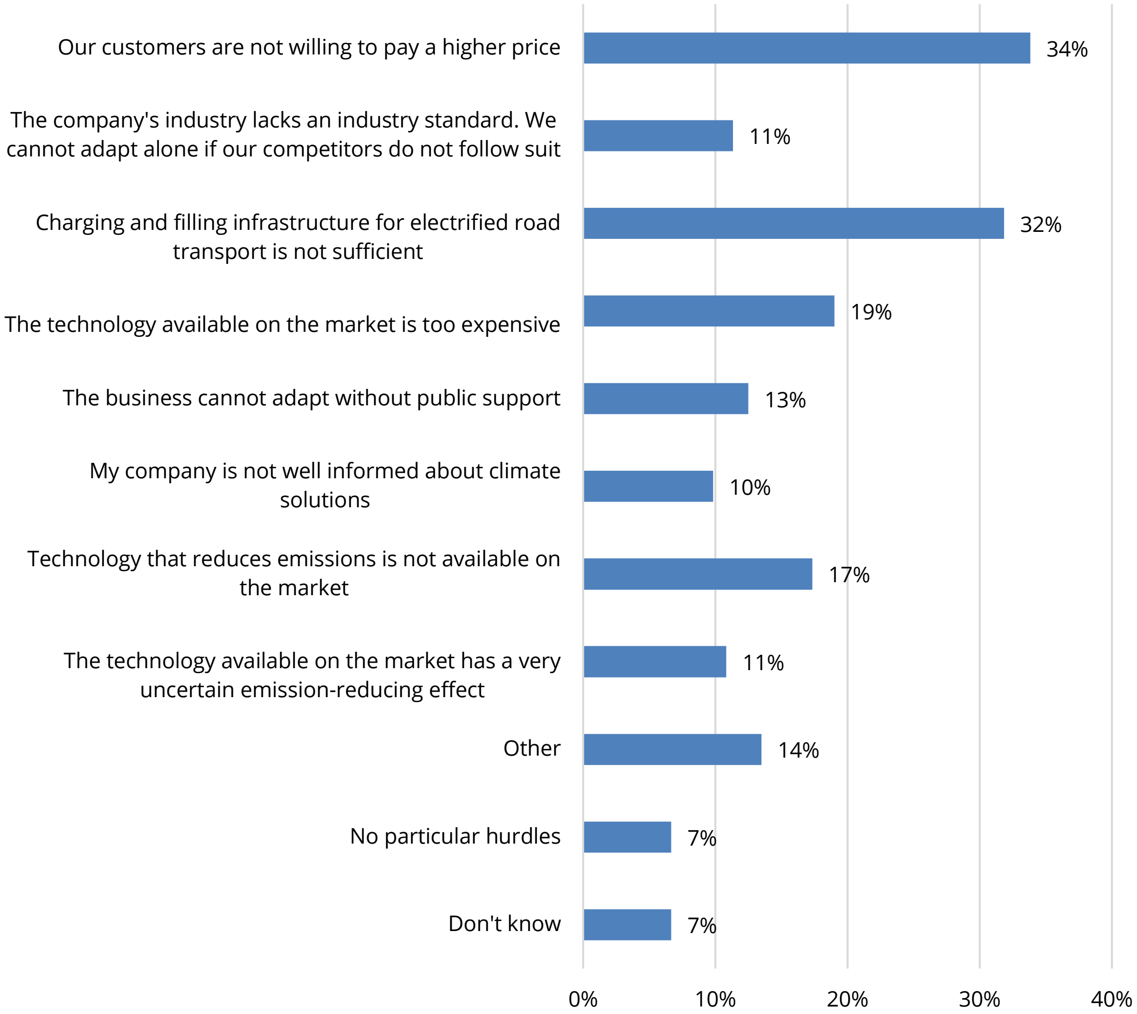
Companies were also asked what they consider the most important hurdles to reducing GHG emissions. The survey questionnaire provided several response options, and respondents were asked to indicate all the options that apply to their company. Figure 5 shows the percentage of companies that chose a particular option.[13] About one-third of companies did not think consumers would be willing to pay a higher price, and 11 percent thought an industry standard could help reduce emissions.

Indicating the existence of various technical barriers that may affect acceptance (H2.4), about one-third of companies (32 percent) considered the charging and filling infrastructure for electrified transport to be insufficient, and 19 percent also considered the technology currently

[13] Note: As companies could choose more than one option, the percentages in this graph will not add up to 100 percent.

available on the market to be too expensive. Similarly, 13 percent of companies thought they would need government funding to reduce their GHG emissions, and 10 percent considered that they were not well informed about climate solutions. In addition to the question of cost, there are also concerns that the necessary technology is unavailable on the market (17 percent) and that the available technology has a very uncertain emission-reducing effect (11 percent). These responses indicate a need to invest in R&D to reduce the technical barriers that companies face. In addition, industry standards can help companies that invest in technology that reduces GHG emissions to compete in the market.

Figure 5. "Does your company experience hurdles to reducing greenhouse gas emissions (indicate all that apply)". Responses from (n=600) companies. Percentage of companies that chose the particular response option



To reduce GHG emissions, the government has proposed increased use of railways for goods and freight transport as a climate-mitigating measure. The survey also asked companies to indicate the most significant obstacles they would face if they were to increase the volume of goods and freight transported by rail. Respondents could check all alternatives that apply. The results are reported in Figure 6.

One of the three main reasons holding companies back from using rail transport is that the railway is too far away from where the company requires transport (32 percent). 27 percent of companies answer that the company's transport requires greater flexibility than rail can offer, and that rail transport takes too long (10 percent). Finally, 29 percent of companies indicated that they do not consider rail transport applicable to their company. These results may be fairly typical for Norway since the rail network is limited due to the low population density and challenging geography (mountains and fjords).

Both households and companies were asked how they would prefer the revenue from a carbon tax on fossil fuels to be used, as this may have a bearing on their tax acceptance. The respondents were given four options: financing of climate mitigation measures; financing of general government spending, in the same way as today; some compensation to households for lost purchasing power; and tax reduction for companies. The results are shown in Figure 7. On average, households preferred that 38 percent of the revenue be used to finance climate mitigation measures supporting H1.1, 33 percent be used to finance general government spending, 19 percent be used to compensate households supporting H1.2 and H1.3, and only 10 percent should be used to reduce corporate taxes. Companies, on the other hand, would (naturally) like the majority of the tax revenue to be used to reduce corporate taxes (30 percent) supporting H1.4 and responded that almost an equal share of the revenue should be used to finance climate mitigation measures (28 percent) supporting H1.1 and to financing general government spending (27 percent). Companies only wanted 16 percent of the tax revenue to be used to compensate households for lost purchasing power supporting H1.2 and H1.3. Overall, this means that both households and companies are in favour of the tax revenue from a carbon tax on fossil fuel being used to finance climate mitigation measures supporting H1.1 and to finance general governmental spending in the same way as today. There also appears to be agreement that a share of the tax revenue (between 16 and 19 percent) could be used to compensate households for lost purchasing power, supporting H1.2 and H1.3. There is a reasonably large difference between companies and households in terms of how much they prefer to allocate to reducing corporate taxes.

Figure 6. "What are your company's biggest obstacles to increasing the volume of goods and freight transported by rail? (check all that apply)", n = 600

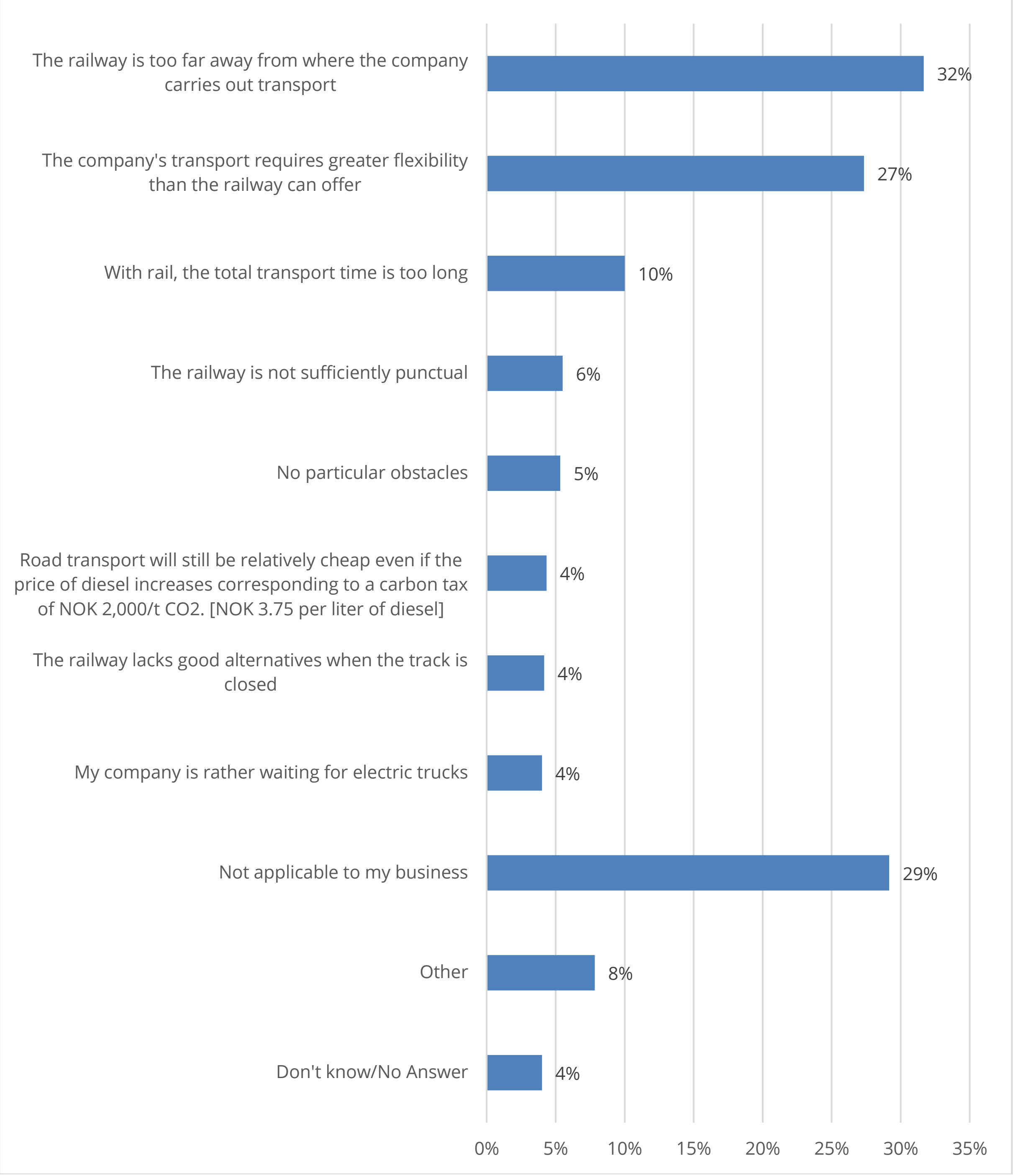
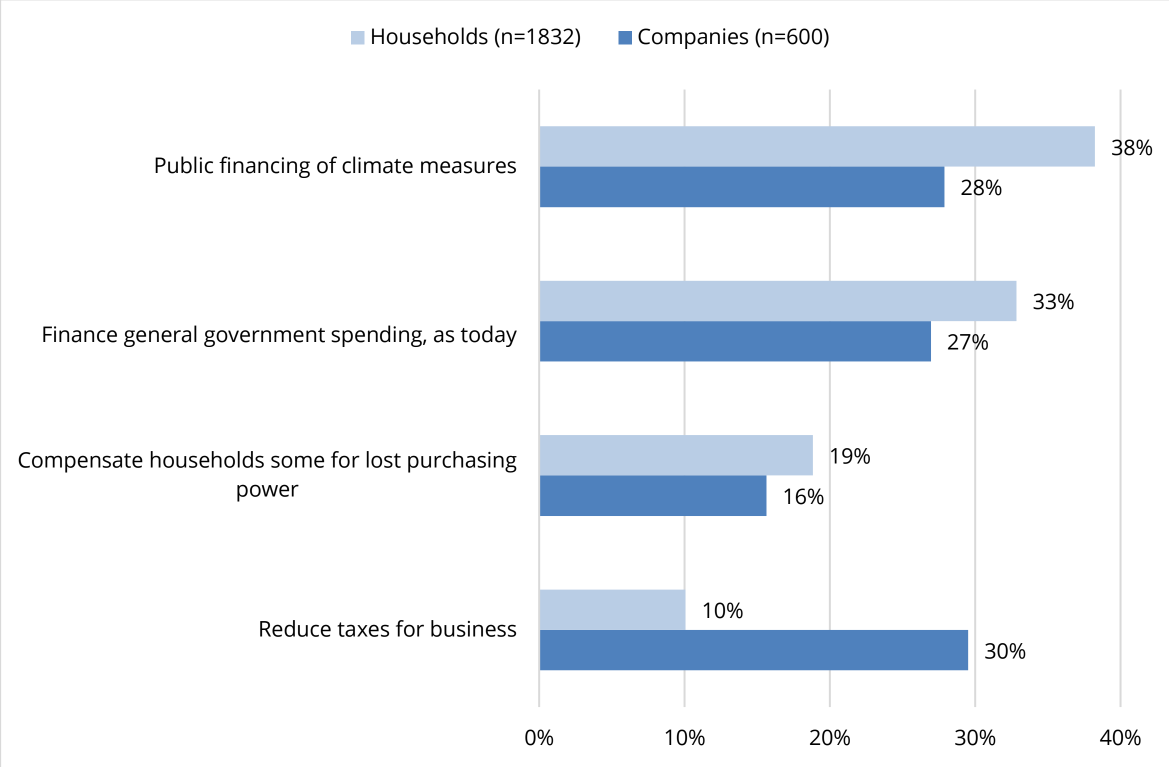


Figure 7. Respondents from both households and companies were asked how they would prefer the tax revenue from an increased carbon tax on fossil fuels to be used



3.2 Estimation results from the choice experiment

Table 2 displays the main results of the CE part in the survey, where households and companies are obliged to make trade-offs between different levels of carbon taxes and the government's use of the revenue. The three models, POOLED, HH, and COMP, are estimated by means of mixed logit models for the pooled, household, and company samples, respectively. From POOLED, the overall sample has a negative preference for increasing the carbon tax. If the revenue from an increased carbon tax were to be used for purposes other than to finance general government spending, as is the case today, then the overall sample has a positive preference for using the revenue to finance climate mitigation measures and reduce urban-rural and general income inequalities, but a negative preference for compensating companies through reduced taxes and distributing the revenue from the carbon tax equally to all Norwegian citizens. This is consistent with the summary statistics reported in Figure 7. Significant estimates of standard deviations indicate heterogeneous preferences for all the attributes. The relative scale parameter is positive, significant, and less than 1. Hence, the household sample has a lower error variance than the company sample, indicating more randomness in household choices, as might be expected. A likelihood ratio test statistic for parameter equality between the three models is rejected at the 1% level, indicating that there is a significant difference between households and companies in preferences for the attributes.

From HH, we see that households have a negative preference for a higher carbon tax. This can be explained by the negative effect of a higher carbon tax on household disposable income. However, the different revenue recycling schemes may increase households' acceptance for a higher carbon tax. Households have a positive preference for using the tax revenue to finance climate mitigation measures, reduce rural-urban inequalities and reduce general income inequalities. On the other hand, households have a negative preference for increasing the carbon tax and using the carbon tax revenue to reduce (other) taxes faced by companies. Taking the ratio of the significant non-market preference parameters and the cost preference parameter allows us to derive households' mean WTP for the different non-market attribute levels. Households are, on average, willing to accept an increase of NOK 3.53/l in carbon tax if the revenue is used to finance climate mitigation measures instead of general public expenses, as it is today. Thus, acceptance for a carbon tax increases when it is earmarked for climate mitigation measures, consistent with H.1.1. On the other hand, households demand a carbon tax reduction of NOK 1.63/l of fuel if the revenue is used to reduce other corporate taxes. Such a recycling scheme reduces acceptance for the carbon tax by households and signals a conflict line with companies, which typically prefer lower taxes. Households are willing to accept an increase of NOK 0.18/l per percentage point of tax revenue used to reduce general and rural-urban income inequalities. This is consistent with H.1.2 and H.1.3.

In COMP, we see the same tendency as in HH for a negative preference for a higher carbon tax. The higher carbon tax will reduce companies' revenue. However, various recycling schemes may also increase companies' acceptance for a higher carbon tax. Like the household sample, the companies also show a positive preference for earmarking the carbon tax revenue to finance climate mitigation measures instead of general government expenses as is the case today. The WTP for an increased carbon tax with the revenue to be used to finance climate mitigation measures is NOK 1.67/l, which is around half of households' WTP. This is also in line with H.1.1. The companies also have a positive preference for using the carbon tax revenue to reduce rural-urban inequalities. They are willing to accept an increase of NOK 0.11/l of fuel in the form of a carbon tax for each percentage point of the revenue used to reduce rural-urban inequalities. This is also in line with H.1.3. In contrast to households, and as expected, companies have a positive preference for using the tax revenue to reduce corporate taxes. Their WTP for the increased carbon tax is NOK 1.35/l. This supports H.1.4. Companies have a negative preference for distributing the tax revenue equally among all Norwegian citizens. They demand a reduction in the carbon tax equivalent of NOK 3.04/l to avoid this.

Table 2. Mixed logit models without interaction terms

	POOLED		HH		COMP	
Attribute variable	Coef.	SD	Coef.	SD	Coef.	SD
Climate	0.705***	1.594***	0.783***	1.434***	0.493***	2.010***
	(0.101)	(0.188)	(0.115)	(0.234)	(0.202)	(0.355)
Companies	-0.147*	1.485***	-0.362***	1.578***	0.400**	0.187
	(0.114)	(0.205)	(0.133)	(0.238)	(0.208)	(0.343)
Citizens	-0.199*	2.127***	0.037	1.826***	-0.901***	0.414
	(0.149)	(0.206)	(0.162)	(0.263)	(0.370)	(1.329)
General_inceq	0.030***	0.085***	0.040***	0.075***	0.006	0.090***
	(0.006)	(0.015)	(0.007)	(0.032)	(0.012)	(0.030)
Rural_inceq	0.038***	0.055***	0.039***	0.057***	0.031***	0.008
	(0.006)	(0.016)	(0.007)	(0.021)	(0.011)	(0.097)
Tax_litre	-0.264***	0.795***	-0.222***	0.710***	-0.296***	0.763***
	(0.037)	(0.074)	(0.033)	(0.052)	(0.056)	(0.082)
Relative scale	0.901***					
parameter (λ)	(0.092)					
Willingness to pay						
Climate	2.671***	6.043***	3.530***	6.470***	1.666***	6.793***
	(0.513)	(1.087)	(0.710)	(1.399)	(0.713)	(1.749)
Companies	-0.557	5.628***	-1.634***	7.117***	1.350**	0.630
	(0.447)	(1.007)	(0.671)	(1.416)	(0.674)	(1.175)
Citizens	-0.754	8.062***	0.168	8.237***	-3.045**	1.398
	(0.584)	(1.287)	(0.728)	(1.531)	(1.383)	(4.538)
General_inceq	0.114***	0.323***	0.182***	0.338***	0.020	0.303***
	(0.025)	(0.068)	(0.037)	(0.146)	(0.039)	(0.118)
Rural_inceq	0.142***	0.207***	-0.178***	0.258***	0.106***	0.028
	(0.027)	(0.063)	(0.036)	(0.100)	(0.036)	(0.328)
Log-likelihood value	-5897.810		-4076.700		-1788.270	
No. of observations	6856		4704		2152	
AIC	11851.62		8207		3631	
BIC	12042.94		8382		3784	
Adj. Pseudo R-square	0.213		0.206		0.2322	

Note: *p<0.1, **p<0.05, ***p<0.01. Standard errors in brackets (). SD = Standard deviation. Standard errors for WTP are derived using the Delta-method.

3.3 What can explain acceptance among households and companies?

The results in Table 2 present the average preferences of households and companies but, as shown, the significant parameters of the standard deviations indicate that preferences are heterogeneously distributed. We therefore estimate one more model per sample, in which we include interaction terms between attributes and explanatory variables, consistent with the stated hypotheses in Section 2.[14]

The interaction model for households (HH_INT) is displayed in Table 3 and the model for companies (COMP_INT) in Table 4. We can see that those households that drive most with their fossil fuel cars have a more negative preference for a higher carbon tax. [15] This is consistent with H.2.2. Households that drive most with fossil fuel cars will suffer most financially given a higher carbon tax. As we see in Figure A.3 in the Appendix, a significant share will be negatively impacted by a higher carbon tax. Households that drive most with fossil fuel cars also have a more negative preference for earmarking the revenue for equal distribution among Norwegian citizens and using it to reduce general income inequalities. Households with a university education (three years or more) have a more positive preference for a higher carbon tax, with the revenue earmarked for financing climate mitigation measures and reducing rural-urban and general income inequalities. Women also have a more positive preference for redistributing some of the revenue to reduce rural-urban inequalities and to finance climate mitigation measures. One might expect women to be more positive about using the revenue to finance climate mitigation measures, as research indicates that women are more concerned about climate change than men (McCright, 2010). Women have a more negative preference for earmarking the revenue for equal distribution among Norwegian citizens. Households that are worried about climate change have a more positive preference for increasing the carbon tax and earmarking the revenue to finance climate mitigation measures. This is consistent with H.2.2 and H.2.3 and results from a meta-analysis of determinants of public opinion about climate change taxes and laws by Bergquist et al. (2022). Bergquist et al. (2022) find that stronger climate change concerns are associated with increased social acceptance for climate laws and regulations. From our results, we can also see that households that are concerned about climate change have a more positive preference for using the revenue for equal distribution among Norwegian citizens and to reduce general and rural income inequalities. Using a municipal centrality index developed by Statistics Norway (Høydahl, 2020)[16], we can see that households that live in an

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[14] Household income is not included as an explanatory variable because of missing values.

[15] Some households have more than one fossil fuel car. Their total driving distance is then the aggregate distance driven by the number of cars owned and used.

[16] The centrality index is a measure of the centrality of each municipality in Norway. The index is based on access to workplaces and services for each of the country's more than 13 500 "grunnkrets", which is the

increasingly central municipality have a more negative preference for earmarking the revenue for financing climate mitigation measures, paying all Norwegian citizens an equal amount as compensation for the tax increase, reducing the taxes faced by companies, and reducing rural-urban inequalities. These are interesting and potentially important results, suggesting that policymakers should recognise and take account of rural-urban differences in preferences relating to carbon tax policies to encourage acceptance.

Table 3. The mixed logit interaction model for households (HH_INT)

Attribute variable	reference	km fuel	hhinc	worried climate	univ.	age	female	index centrality
Climate	1.110*	-0.093	0.128	1.454***	0.376**	-0.006	0.372**	-0.115*
	(0.806)	(0.075)	(0.217)	(0.228)	(0.211)	(0.005)	(0.200)	(0.083)
Company	0.799	-0.013	-0.039	-0.044	0.037	0.003	-0.100	-0.150**
	(0.856)	(0.078)	(0.239)	(0.238)	(0.236)	(0.006)	(0.221)	(0.090)
Citizens	1.485*	-0.173**	-0.054	1.182***	-0.106	0.000	-0.392*	-0.182*
	(1.091)	(0.102)	(0.293)	(0.297)	(0.284)	(0.007)	(0.274)	(0.114)
General_inceq	-0.022	-0.012***	-0.011	0.073***	0.002	0.000	0.007	0.003
	(0.049)	(0.005)	(0.013)	(0.013)	(0.013)	(0.000)	(0.012)	(0.005)
Rural_inceq	0.086**	-0.003	0.006	0.050***	0.026**	0.000	0.029***	-0.011**
	(0.046)	(0.005)	(0.013)	(0.013)	(0.013)	(0.000)	(0.012)	(0.005)
Tax_litre	-0.703***	-0.040**	0.059	0.566***	0.125**	0.000	0.067	0.020
	(0.220)	(0.019)	(0.060)	(0.063)	(0.058)	(0.001)	(0.055)	(0.023)

Notes: *p<0.1, **p<0.05, ***p<0.01. Log-likelihood value = -3901.550, no. of observations = 4704, AIC = 7941.100, BIC = 8386.580, adjusted pseudo R-square = 0.23. Standard errors in brackets ().

In COMP_INT, we can see that companies have a more negative preference for increasing the carbon tax if transportation costs account for 25 percent or more of the total operating costs. This is consistent with H.2.1 and Figure 3, where about 50 percent of transport companies completely disagreed that a higher carbon tax would reduce GHGs. Companies with higher transportation costs will suffer more financially from a higher carbon tax and have higher technological barriers. As shown in Figure A.3 in the appendix, a significant share of companies will be negatively impacted by a higher carbon tax. Companies with higher transportation costs also have a more negative preference for using the revenue to reduce general income

basic statistical unit at the lowest administrative level in Norway. Such access is defined as the number of workplaces and services a resident in a given grunnkrets can reach within 90 minutes commuting. Both workplaces and services are weighted according to the commuting distance, with closer workplaces and services given higher weights. The data are then aggregated at the municipality level using the grunnkrets' population level as a weight. Finally, the index is normalized and assigns each municipality a value between 0 and 1000, where 1000 is the highest degree of centrality. This value is assigned to Oslo, the municipality of Norway's capital. The remaining municipalities are ranked relative to Oslo. We matched this data with respondent postal codes.

inequalities, make a one-off, equal payment to all Norwegian citizens, and finance climate mitigation measures. Companies with higher revenue have a more positive preference for using the revenue from an increased carbon tax to reduce other corporate taxes.

The size of the companies is particularly important for explaining preference heterogeneity. The more employees the companies have, the more positive their preference for increasing the carbon tax and using the revenue to finance climate mitigation measures, reduce urban-rural and general income inequalities, and make a one-off equal payment to all Norwegian citizens. Companies that experience technical barriers to reducing CO_2 emissions have a more positive preference for using the revenue from a higher carbon tax to reduce other corporate taxes, make a one-off, equal payment to all Norwegian citizens, and reduce urban-rural inequalities. This fits well with the fact that transportation companies and others that are more dependent on freight transport are less receptive to a non-earmarked carbon tax—as discussed in Section 3.1 (see also Figure A1 in the appendix). Companies located in more central municipalities have a more positive preference for increasing the carbon tax and using the revenue to finance climate mitigation measures and reduce general income inequalities. This stands in contrast to households that live in an increasingly central municipality.

Table 4. The mixed logit interaction model for companies (COM_INT)

Attribute variable	reference	fuel	revenue	employees	technical barriers	index centrality
Climate	0.484 (0.484)	-1.345** (0.632)	-0.035 (0.040)	0.002*** (0.001)	0.406 (0.365)	0.318** (0.179)
Company	-0.960** (0.548)	-0.316 (0.655)	0.086** (0.045)	0.000 (0.000)	0.969*** (0.411)	0.012 (0.191)
Citizens	-0.794 (0.713)	-1.199* (0.862)	-0.067 (0.057)	0.001* (6.0917e-04)	0.874** (0.523)	0.003 (0.245)
General_inceq	0.018 (0.029)	-0.050* (0.034)	-0.002 (0.002)	3.986e-05* (2.738e-05)	0.011 (0.021)	0.025*** (0.010)
Rural_inceq	-0.009 (0.026)	0.012 (0.031)	0.000 (0.002)	6.802e-05* (2.835e-05)	0.055*** (0.019)	-0.005 (0.009)
Tax_litre	-0.274** (0.131)	-0.403** (0.178)	0.002 (0.011)	2.1171e-04** (1.1076e-04)	-0.044 (0.099)	0.073* (0.048)

Notes: *p<0.1, **p<0.05, ***p<0.01. Log-likelihood value = -1742.580, no. of observations = 2152, AIC = 3599.160, BIC = 3922.590, adjusted pseudo R-square = 0.239. Standard errors in brackets ().

4. Discussion and conclusion

In this study, we contributed to the small but fast-increasing literature on using SP methods to measure social acceptance for climate policies by conducting two concurrent national representative surveys of Norwegian households and companies, respectively. We used a choice experiment to elicit carbon tax acceptability, testing different forms of revenue recycling schemes. The two surveys had the same CE design and several similar questions for exploring and comparing companies' and households' preferences.

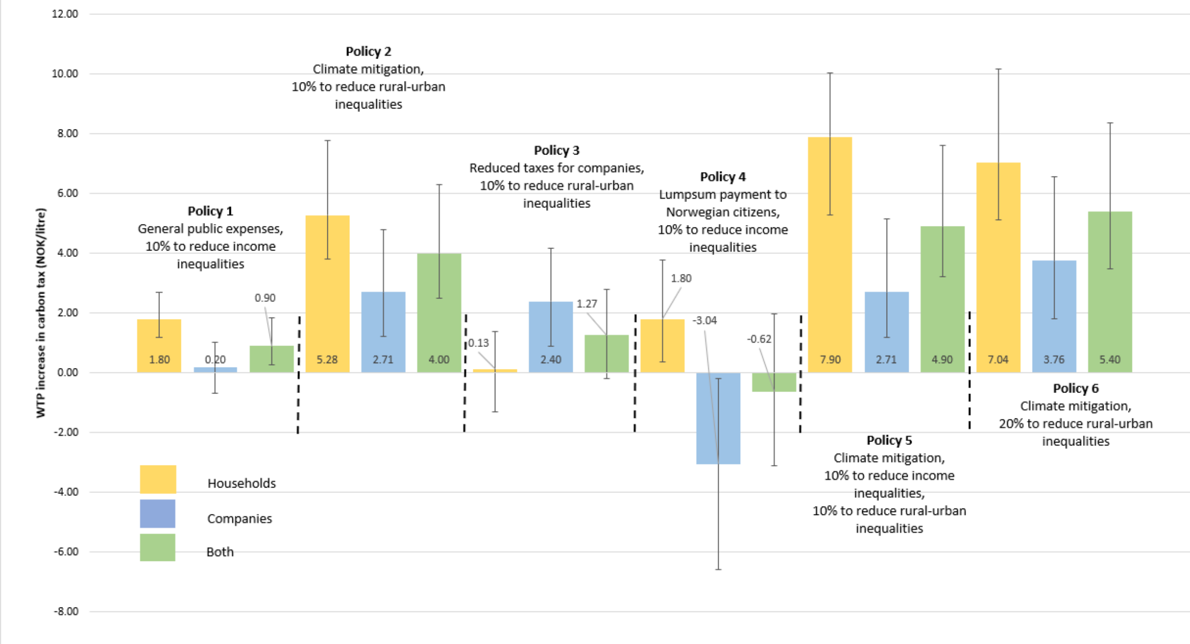
From the more descriptive results, we find that companies face technological hurdles to reducing GHG emissions; the technology is either unavailable or too costly to use. Increased research and development (R&D) could be a means of reducing these hurdles. However, R&D is often underfinanced due to well-known imperfections in market development and diffusion (Greaker and Popp, 2022). It may also take a long time before companies can reap the benefits of R&D, if at all. At the same time, both households and companies are in favour of using between 28 and 38 percent of carbon tax revenue on climate mitigation measures. Thus, one solution that could simultaneously contribute to reducing two externalities would be to use about 1/3 of the tax revenue from the carbon tax for R&D, which could lower the hurdles to companies' reducing their GHG emissions. However, when the respondents had to make trade-offs between different levels of carbon taxes and the government's use of the revenue in the CE, their preferences became clearer.

We find strong support for our defined hypotheses. Both households and companies have a negative acceptance for a further increase in the carbon tax. This is to be expected, as a higher carbon tax will reduce households' disposable income and companies' revenue. However, the results show that acceptance for a higher carbon tax may increase if the policymakers earmark the revenue for certain measures. Acceptance by both households and companies increases if the revenue is used to finance climate mitigation measures. Household acceptance increases further if some revenue is used to reduce general income inequalities. However, as companies do not have a significant preference for this measure, other options are more acceptable. For both households and companies, acceptance for a higher carbon tax increases if some revenue is used to reduce urban-rural inequalities. Acceptance by companies increases if the revenue is used to reduce other taxes that the companies face. On the other hand, this is the option least preferred by households. Likewise, household acceptance increases if the revenue is used to make an equal lump-sum payment to all Norwegian citizens. However, this is the option least preferred by companies.

We find broad support in the literature for acceptance for environmental taxes depending on tax revenue recycling schemes. For example, using a CE, Carattini et al. (2017) find that people have a positive preference for lump-sum redistribution of revenue ensuing from a higher energy tax and a negative preference for environmental recycling. In contrast, we find that both households and companies prefer environmental/climate recycling to a lump-sum redistribution. Gevrek and Uyduranoglu (2015) also use a CE and find that acceptance for a higher carbon tax increases among the public if the revenue is earmarked for environmental policies. Similarly, Brännlund and Persson (2012) use a CE to find that acceptance for a higher carbon tax increases if the policy positively affects willingness to invest in new GHG emission reduction technologies. Consistent with our results for households, Kotchen et al. (2017) and Beiser-McGrath and Bernauer (2019) find that using the revenue from a carbon tax to reduce corporate taxation reduces people's acceptance. In contrast to our results and those of Gevrek and Uyduranoglu (2015), Beiser-McGrath and Bernauer (2019) find that using the revenue to fund programmes for low-income households actually *reduces* acceptance in the USA (but has no significant effect in Germany).

An appealing aspect of the CE method is that we can use policy package simulations to evaluate how different combinations of WTP for attribute levels impact social acceptance. Using our CE results, we simulate six different policy packages. The results are displayed in Figure 8 (and Table A.2 in the Appendix, where √ indicating the attribute «activated»).

Figure 8. Results of policy package simulations



Note: The WTP estimates in this table reflect willingness to accept an increase on today's carbon tax level. 95 percent confidence interval in brackets, estimated using the Krinsky Robb method with 10 000 simulations

The policy option that yields the lowest social acceptability is number 4. In this option, households have a positive WTP because the revenue from a higher carbon tax is used to pay an equal lump-sum payment to all Norwegian citizens and reduce general income inequalities. However, companies have a negative preference for the lump-sum payment and hence demand a reduced carbon tax if the option is implemented. Policy option 6 generates the most socially acceptable policy for both households and companies because the revenue from a higher carbon tax is used to finance climate mitigation measures and reduce rural-urban inequalities. Policy option 6 implies that 20 percent of the revenue is used to reduce urban-rural inequalities ensuing from a higher carbon tax, and the rest is used to finance climate mitigation measures. Similarly, the acceptable increase in the carbon tax is NOK 7.04/l by households and NOK 3.76/l by companies. The mean WTP for the two groups combined for policy option 6 is thus NOK 5.40/l. If the policymakers instead decide to implement policy option 5, where 10 percent of the revenue is divided equally between reducing general and rural-urban income inequalities, the average WTP goes slightly down to NOK 4.90/l. Choosing policy option 6, either the minimum WTP of the two groups (NOK 3.76/l) or the average (NOK 5.76/l), would imply a carbon tax close to the level necessary for reaching the most ambitious climate target set by the government (6.41 NOK/litre), as estimated by Fæhn et al. (2020).

The main point arising from the policy package simulations is that considering levels of acceptance among households and companies simultaneously increases the chance of implementing higher, effective carbon tax levels. There are policy options that clearly generate a discrepancy between households and companies in their acceptance for carbon tax increases, a potential source of conflict and political stalemates. In our case, the results show that companies and households concur to a certain extent on the most socially acceptable policy option.

Our analysis is a first step towards integrating acceptability concerns among both households and companies into carbon tax design. Further research is required on both the conceptual and practical level (e.g., how to operationalize rural-urban dimensions). For decades, there has been a large research effort in environmental economics on the “double dividend effect”, whereby environmental tax revenue is used to reduce other taxes in the economy (Goulder et al., 1995; Kirchner et al., 2019). However, since sufficiently high environmental taxes have proved almost impossible to implement in practice, these potential efficiency gains remain “pies in the sky” in economists’ models. In some cases, it may be possible to achieve “first best” by reducing market imperfections in both R&D and carbon pricing by using carbon tax revenue to subsidize R&D and increase acceptance for the tax by households and companies at the same time. This may also reduce the hurdles companies state that they face to reducing emissions. However, as we and an increasing number of other studies have shown, other uses of the tax revenue may typically (also) be required to achieve sufficient acceptability, for example, the alleviation of distributional concerns. In such cases, there will inevitably be a trade-off between efficient carbon tax levels and equity (Goulder et al., 2019).

An example of important future research would be to combine economic modelling of the effects of the different carbon tax and revenue recycling designs (such as Hänsel et al. 2022 and Goulder et al. 2019) with what we increasingly know about how tax attributes influence the degree of acceptability among the general public and companies. These two research traditions have followed two separate tracks to date. Such integrated research would make the economic modelling more policy-relevant by focusing on the most realistic tax designs and the acceptability research more specific regarding tax attributes and better grounded in the thorough analysis of efficiency, equity, and GHG emission effects across the economy. Such research would also be necessary for a better understanding of the temporal aspects of tax designs. For example, Stavins (2020) points out that it may make sense to phase in higher tax levels over time, both because of acceptability concerns and in order to help reduce households' and companies' transition costs.

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Appendix A: Additional figures and tables

Table A.1 Descriptive statistics for companies in the sample

Sector	Population (5+ employees)	Percent	Sample (5+ employees)	Percent
Agriculture. forestry & fishing	1401	1.4 %	17	2.8 %
Mining and quarrying	482	0.5 %	5	0.8 %
Manufacturing	5722	5.7 %	71	11.8 %
Power supply	512	0.5 %	9	1.5 %
Water supply; sewerage. waste management	784	0.8 %	8	1.3 %
Construction	11080	11.0 %	79	13.2 %
Wholesale and retail trade	24007	23.9 %	82	13.7 %
Transport and storage	4071	4.1 %	59	9.8 %
Accommodation and food service activites	5975	5.9 %	11	1.8 %
Information and communication	3048	3.0 %	26	4.3 %
Financial and insurance activities	1137	1.1 %	8	1.3 %
Real estate activities	1448	1.4 %	4	0.7 %
Professional. scientific and technical activities	5833	5.8 %	57	9.5 %
Administrative and support service activities	4145	4.1 %	29	4.8 %
Public administration and defence; compulsory social security	3327	3.3 %	30	5.0 %
Education	4982	5.0 %	23	3.8 %
Human health and social work activities	17579	17.5 %	24	4.0 %
Arts. entertainment and recreation	2039	2.0 %	26	4.3 %
Other service activities	2856	2.8 %	32	5.3 %
Activities of households as employers	0	0.0 %	0	0.0 %
International organisations and bodies	6	0.0 %	0	0.0 %
Unknown	26	0.0 %	0	0.0 %
Total	100460		600	

Figure A1 Agreement with the statement "Increased tax on fossil fuels reduces fuel consumption thereby reducing greenhouse gas emissions" plotted against the company's transportation costs as a share of operating costs

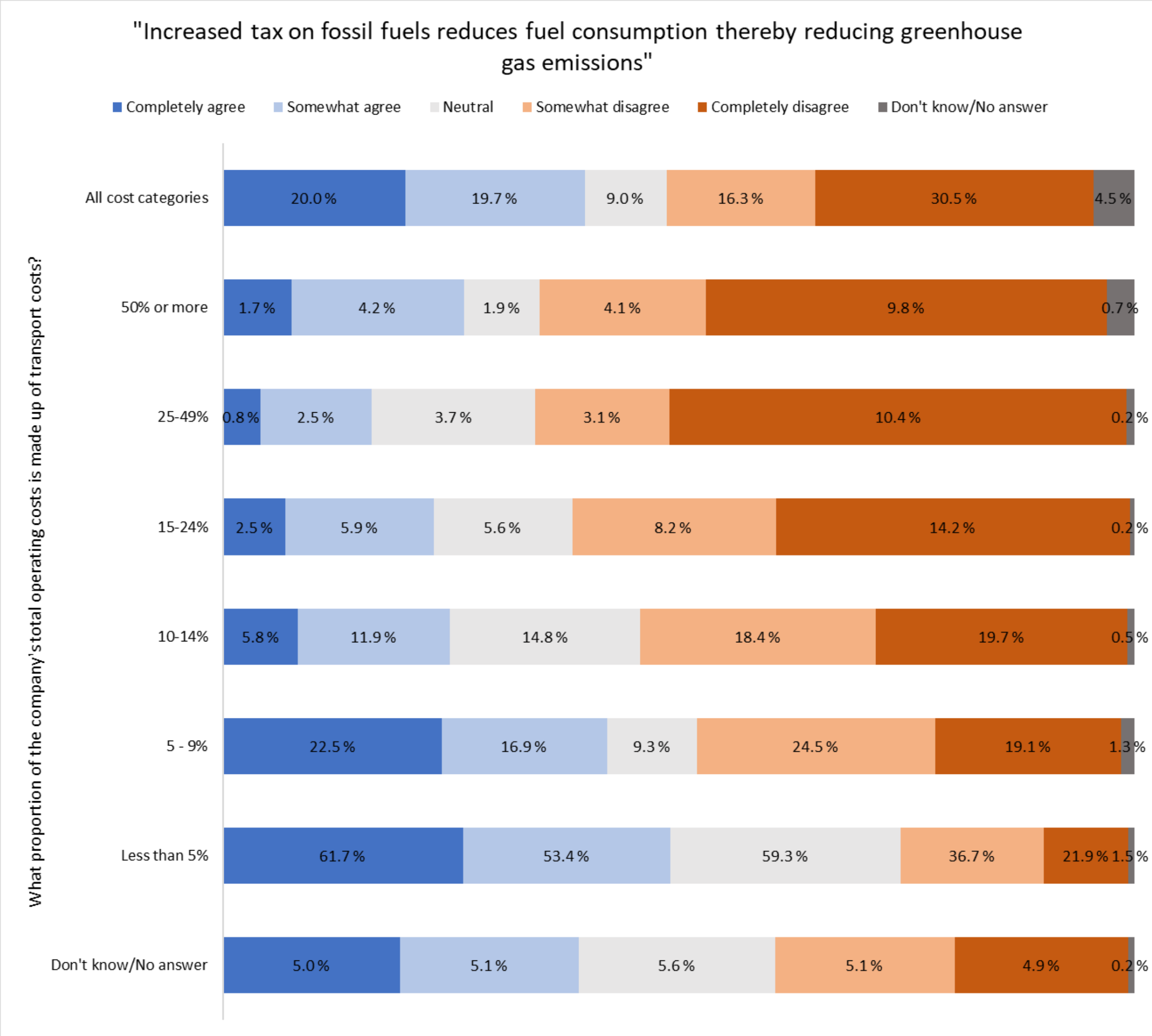

Figure A2 Agreement with the statement "Increased tax on fossil fuels reduces fossil fuel consumption thereby reducing greenhouse gas emissions" and median total revenue and average number of employees for each response category

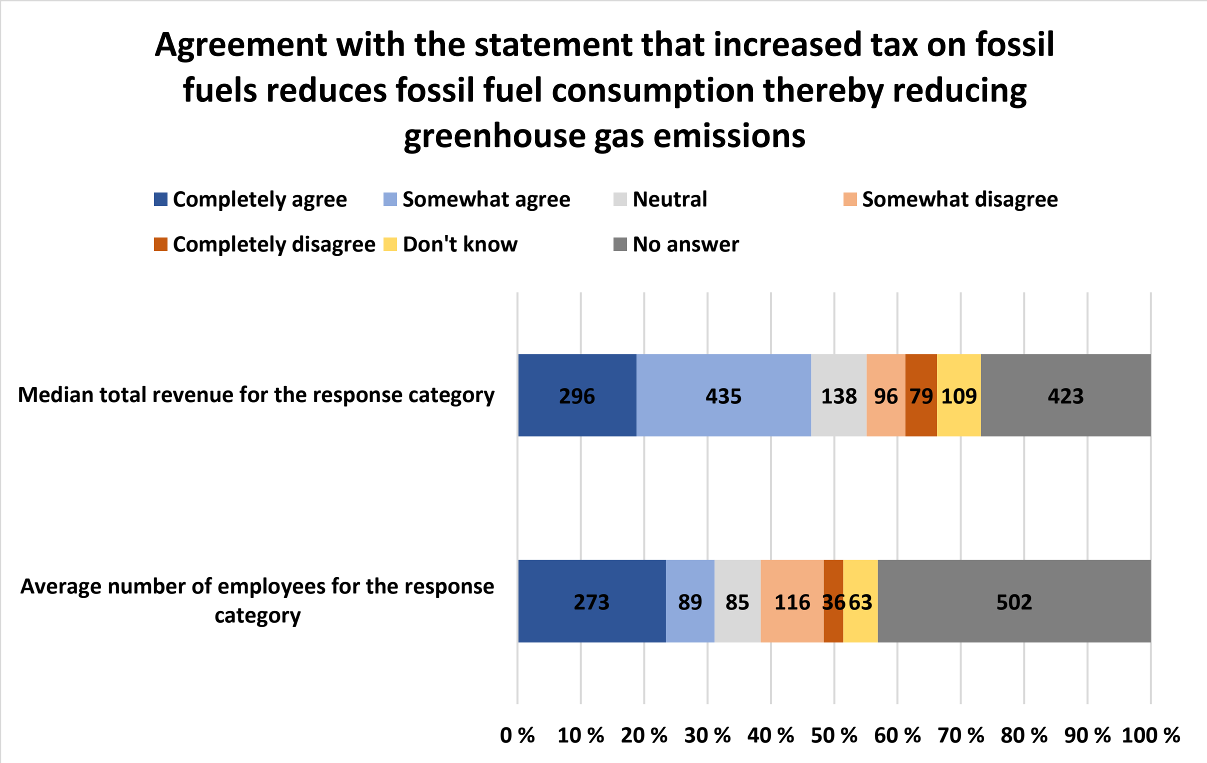

Figure A3. "If the price of fossil fuels increases by 0.64 euro per litre of petrol/diesel compared with today's price. how do you think this will impact your company's profitability/household economy?"

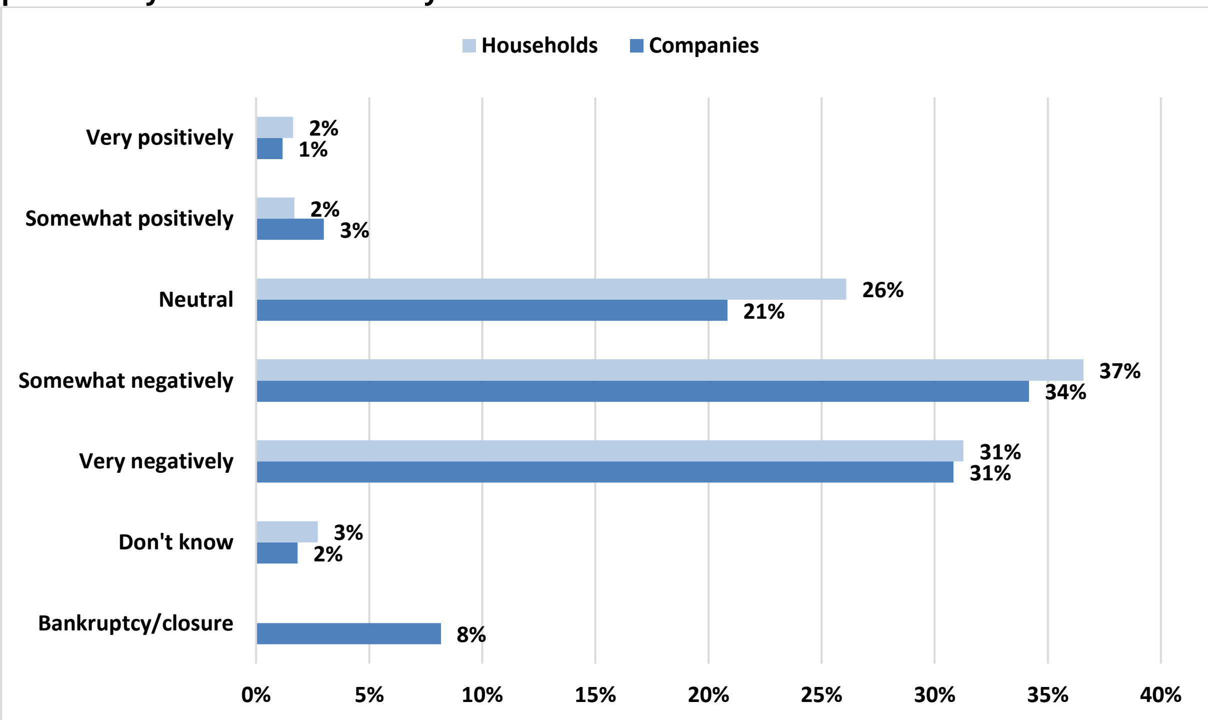

Table A.2. Results of policy package simulations

Attribute	Policy 1	Policy 2	Policy 3	Policy 4	Policy 5	Policy 6
General public expenses	√					
Climate mitigation		√			√	√
Reduced taxes for companies			√			
Lump-sum payment to Norwegian citizens				√		
10 percent used to reduce general income inequalities	√			√	√	
10 percent used to reduce rural-urban inequalities		√	√		√	
20 percent used to reduce rural-urban inequalities						√
WTP increase in carbon tax households (NOK/litre)	1.80 (1.18. 2.69)	5.28 (3.81. 7.77)	0.13 (-1.29. 1.39)	1.80 (0.36. 3.78)	7.09 (5.28. 10.05)	7.04 (5.14. 10.16)
WTP increase in carbon tax companies (NOK/litre)	0.20 (-0.67. 1.02)	2.71 (1.20. 4.80)	2.40 (0.91. 4.18)	-3.04 (-6.56. -0.18)	2.71 (1.19. 5.16)	3.76 (1.83. 6.57)
WTP increase in carbon tax combined. i.e.. mean of the two (NOK/litre)	0.90 (0.26. 1.86)	4.00 (2.51. 6.29)	1.27 (-0.19. 2.79)	-0.62 (-3.10. 1.98)	4.90 (3.24. 7.61)	5.40 (3.49. 8.37)

Note: The WTP estimates in this table reflect willingness to accept an increase on today's carbon tax level. 95 percent confidence interval in brackets. estimated using the Krinsky Robb method with 10 000 simulations.