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Road users' attitudes towards transforming a flat rate cordon toll to a congestion charging system: The case of Oslo, Norway

Marie Aarestrup Aasness [a,c], James Odeck [a,b,c,*]

[a] The Norwegian University of Science and Technology, 7491 Trondheim, Norway
[b] Molde University College, P.O. Box 2110, NO-6402 Molde, Norway
[c] Norwegian Public Roads Administration, PO Box 6706, 0609 Oslo, Norway

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ABSTRACT

The well-known Oslo cordon toll ring was transformed into a congestion charging scheme in 2017. The transformation implied higher toll rates during rush hours and lower rates during nonrush hours, and battery-driven electric vehicles (BEVs) were exempted from paying tolls as a means of enhancing the uptake of BEVs. This paper studies road users' attitudes towards the transformation that took place. The rationale is that studies examining road users' attitudes towards such transformations are lacking in the transportation literature. We use the results of a survey conducted a month after the transformation, and a question was added regarding users' attitudes towards the transformation. The dataset consists of 2005 responses. We use both descriptive statistics and logit-based regression analyses to assess the data. The results reveal that the average road user has a negative attitude towards the transformation, most likely because the transformation increased the travel cost for the average user. Our results add value to the literature and for researchers and policymakers who may want to consider similar transformations, and groups of users who need to be convinced of the usefulness of congestion charging are identified.

1. Introduction

The Oslo cordon toll ring is well-known in the literature of transportation for being among the first toll rings in the world to implement toll charges to supplement the scarce government funds in financing road infrastructure and other modes of transport, such as public transport and cycling and walking facilities (Bråthen and Odeck, 2009; Odeck and Bråthen, 1997, 2002, 2008; Odeck, Rekdal, and Hamre, 2003). From its inauguration in 1990 to October 2017, the Oslo cordon toll was a flat-rate toll charging scheme where tolls were charged 24 h a day. The system served its purpose well, and several roads, tunnels, public transport infrastructures, and cycling and walking facilities were built using the collected funds.

However, more road space using toll income has led to more traffic in the inner city over the years. The increase in road traffic in the inner city soon caused adverse effects, especially during rush hours when the traffic volume was at its highest, e.g., in terms of intolerable air pollution, which is a hazard to the health of a city's population, and congestion, which is a cost to road users in terms of increased travel time costs. Over the years, these adverse effects have become a matter of concern to the City Council of Oslo. In addition, studies have observed good results in, for instance, Singapore, London and Stockholm (Börjesson, Eliasson, Hugosson, and Brundell-Freij, 2012; Phang and Toh, 2004 and Santos, Button, and Noll, 2008). Therefore, in October 2017, the City Council of Oslo transformed its cordon toll scheme into a congestion charging scheme. The transformation entailed variable tolls where higher rates were charged during rush hours and lower rates during nonrush hours. The toll charging points remained as before the transformation. The transformation in Oslo's case is one of a kind since nowhere in the world, apart from the city of Bergen in Norway, has a flat-rate cordon tolling been converted to a congestion scheme to reduce the adverse effects that increased traffic causes. Similar to Oslo, Singapore was early in introducing a cordon toll system called the area licencing scheme (ALS) before being replaced by an electronic version called the electronic road pricing (ERP) system (Chin, 2005; Goh, 2002). The rates have been revised and the scope extended several times in both cities since the cordon toll systems were introduced (Olszewski and Xie, 2002, Chin, 2005, Oslo package 3-sekretariatet, 2015). Different from Oslo, Singapore introduced a congestion charging scheme from the start in 1975 (Chin, 2005). However, in 1975, the charging system was

* Corresponding author at: The Norwegian University of Science and Technology, 7491 Trondheim, Norway.
E-mail address: james.odeck@vegvesen.no (J. Odeck).

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introduced only for the morning peak, but in 1989, it was extended to the late afternoon and early evening period (16:30–18:00) as well (Olszewski and Xie, 2002). The results from Singapore show that the most dramatic effect on the traffic volume was the first introduction of road pricing in the form of the ALS in 1975 (Olszewski and Xie, 2002). Such high elasticity was never observed again (Olszewski and Xie, 2002). The Swedish cities Gothenburg and Stockholm also expanded their toll system and revised their charges (Börjesson and Kristoffersson, 2018). The results show that for the first time since the introduction of the toll system, the support among citizens fell (Börjesson and Kristoffersson, 2018). Therefore, in this special case, the research question addressed is as follows: (i) what are road users' attitudes towards such a transformation? There was not an option to reduce or remove the toll ring. Therefore, the question is about going from a flat-rate toll to a congestion charging scheme and whether users are negative or positive towards this transformation. In the case of Oslo, Presterud and Odeck (2018) found that the transformation worked according to its objectives of reducing the traffic level during rush hours when the adverse effects are at their highest level. The traffic level during rush hours was reduced by 5%, as forecasted.

The research question above is the question we address in this paper, and the rationale is that attitudinal studies on such a transformation will be value added to the literature of transportation economics and planning. For policymakers who may want to consider such a transformation, such a study may be informative, e.g., in terms of revealing the different groups of users expected to be negative or positive towards such a transformation.

The paper proceeds as follows. Section 2 is a short literature review of studies that addressed road users' attitudes towards congestion charging/road tolling worth mentioning in a study such as ours. Section 3 is a brief presentation of the Oslo cordon toll and the transformation. Section 4 describes the data. Section 5 describes the method used to assess the data. Section 6 presents the results and provides a discussion. Section 7 presents concluding remarks.

2. Brief literature review

The transportation literature has demonstrated that congestion charging is a powerful economic instrument that can help reduce congestion and thereby reduce the adverse effects that road congestion causes. Although congestion charging is also tolling, its main difference from cordon tolls meant for funding transportation infrastructures lies in its name; it entails higher tolls during congestion (rush hours) periods and fewer or no tolls during noncongestion (nonrush hours) periods. Congestion charging simply applies the economic law of demand, which states that when prices are high, there will be less demand for the good (car use) than when prices are low. Ceteris Paribus, the adverse effects of congestion, which are at their worst during rush hours, will be reduced if toll rates (fees) are high. Although economists have advocated congestion charging for decades, few cities have implemented it (Lindsey and Santos, 2020). Examples of how implemented congestion charging in cities helped reduce congestion include, e.g., Phang and Toh (2004) in the case of Singapore, Santos et al. (2008) in the case of London, and Börjesson et al. (2012) in the case of Stockholm.

The literature that has dealt with road users' attitudes towards road pricing has featured the following transitions from which the overall user's attitudes were inferred: (i) from no toll charging to complete congestion charging, (ii) no charging to hypothetical road pricing, and (iii) no toll charging to toll charging with flat toll rates meant for financial purposes. While acknowledging that many studies have dealt with attitudes in all three categories mentioned above but not of our focus category, we only briefly review a few of them. The reason is that the literature review is not the primary purpose of this paper. However, some relevant studies that have dealt with road users' attitudes towards road charges are relevant for our purpose.

One of the earliest studies to examine user attitudes towards a transition from no charges to hypothetical road pricing is Jones (1991). He reviewed public opinion surveys concerning users' attitudes towards road pricing in the UK. He found consistency between such studies to the extent that people living in urban areas with high congestion had higher support for road pricing, in addition to slightly higher support among younger people. The results also showed that the support for road pricing virtually doubles when it is presented as a package, where road pricing increases the possibilities to improve alternative modes and the urban environment, as in the case of Oslo.

Another study in this category is Schade and Schlag (2003), who conducted a road pricing public acceptability survey in four European cities. Their findings relevant to our study found relatively low acceptability for road pricing. Furthermore, they found that 'social norms,' 'personal outcome expectations,' and 'perceived effectiveness' are positively related to the acceptability of pricing strategies. Another study that addressed users' attitudes towards hypothetical road pricing is Ison (2000). He used a national survey to examine the attitudes of key stakeholder groups concerning urban road pricing. Regarding the publicly acceptable (totally or somewhat acceptable) implementation of urban road pricing, only 11.4% viewed it as totally or relatively acceptable.

Regarding attitudes towards road pricing in cases where there was no toll to congestion charging, Eliasson, Hultkrantz, Nerhagen, and Rosqvist (2009) and Winslott-Hiselius, Brundell-Freij, Vagland, and Byström (2009) examined users' attitudes towards congestion charging during the full-scale congestion charging trial in Stockholm. Their studies concurred that users became more positive towards congestion charging during the trial compared to the previous situation. Winslott-Hiselius et al. (2009) concluded that it seems that the public attitude changed because personal experience gave a new understanding of the implications of charges for personal well-being.

Studies of users' attitudes towards toll charging when the transition is from no tolls to flat-rate tolls are more common in Norway than in the rest of the world. For instance, Odeck and Bråthen (1997 and 2008) and Odeck and Kjerkreit (2010) examined user attitudes in this context. Their results showed that most users were negative towards toll charging, but positive attitudes increased over the years. They explained that users eventually become positive after seeing the infrastructure provided by funds collected.

The literature reviewed above indicates that road users' attitudes towards toll charges and congestion charging are many in the transportation literature. However, there is only incidence in the literature where users' attitudes towards such a transformation have been assessed, i.e., Tvinnereim, Haarstad, Rødeseike, and Bugnion (2020). They, however, focused on the role of geographical variation in the case of Bergen, Norway. The present study uses Oslo as a case study. Given that Oslo is currently the capital city of battery electric vehicles (BEVs), how the attitudes of BEV users differ from those of conventional vehicle users is also examined.

3. The Oslo cordon toll and its transformation to congestion charging

To understand why studying users' attitudes towards transforming the Oslo cordon toll ring to a full-fledged congestion scheme, a brief account of its original intentions and the reasons that eventually led to its transformation to a congestion-charging scheme is in order.

The initial Oslo cordon toll ring was introduced in 1990 after being approved by the Oslo city council in coalition with the neighbouring County council of Akershus and finally by the Norwegian parliament in 1988. This initial Oslo cordon toll ring became known as Oslo Package 1. Its main aim was to enlarge road capacity and increase public transport in the larger Oslo area encompassing the neighbouring Akershus county. The underlying reasons behind its proposal were that the larger Oslo area experienced a tremendous increase in traffic growth in the 1970s and early 1980s, needing more road space. The increase in traffic volumes led to more road traffic-related problems, such as increased noise and pollution in the inner city and other dense dwellings, and jeopardized traffic safety. All these problems, it was thought, could be reduced by building more road space outside the dense population areas, e.g., tunnels under the city and bypasses outside the dense areas, and by building more public transport infrastructures that could help reduce road traffic (Oslo package 3 secretariate, 2015).

Given that government resources were scarce, cordon toll funding was suggested, where road users contributed 55% and the government contributed 45%. The idea behind the tolling concept, which had been practised elsewhere in Norway, e.g., in the second largest city of Bergen, was that road users would prefer to realize road improvements now by contributing rather than waiting for government funding an unforeseeable future (Odeck, 2019).

The cordon toll system implied that toll booths were installed on all road arteries entering Oslo city. All vehicles were charged a flat-rate toll throughout the day, which varied by two vehicle classes; passenger vehicles paid approximately half of the fee for heavy vehicles. In 2017, the city council of Oslo transformed its flat-rate cordon toll ring into a time and environmentally differentiated toll scheme (congestion charging). The motives were as follows: (i) toll fees were differentiated by time of day, where higher fees were changed during rush hours and lower fees were changed during nonrush hours, in addition to being differentiated by fuel. The higher toll during rush hours reduces the traffic levels and, hence, reduces the critical environmental problems during rush hours. (ii) The differentiation of toll charges was designed such that the total toll income would be the same as before the transformation such that the predecided objectives with the cordon tolling, i.e., the much-needed building of transportation infrastructure according to Oslo Package 3, would be met in time. Thus, the transformation was a reformation of Oslo package 3 to eradicate the externalities that high traffic volumes cause during rush hours, which, according to economic theory, can best be resolved using congestion charging.

Fig. 1 gives an overview of the cordon toll system before and after the transformation.

The blue line shows the cordon toll system, where all traffic entering the city centre through the grey marked road arteries was charged a flat-rate toll fee. The orange line shows extra toll charging points that were implemented to finance the three arteries that previously were not in the Oslo packages and where the toll fees were lower compared to the fees in the main cordon toll system. As is evident on the map, all traffic entering the city centre had to pay toll fees.

Next, Table 1 shows the real changes in toll fees from flat rates to congestion charging for passenger vehicles. Heavy vehicles are not considered in the questionnaire.[1] Note that battery electric vehicles (BEVs) did not pay at the time of the questionnaire survey. For gasoline/rechargeable hybrid vehicles, the toll rates increased by 23 and 51% for nonrush and rush hours, respectively. The increases for diesel-driven vehicles were 37 and 66%, respectively, for nonrush and rush hours. Thus, in addition to congestion charging, the authorities introduced a carbon element in the toll fees where diesel-driven vehicles were charged a higher rate than gasoline-driven vehicles because the former emits more carbon than the latter. The table shows that the difference in toll rates between the two vehicle categories was 0.5 Euros[2] for both nonrush and rush hours.

4. The survey data

The data used in this study were collected from an online questionnaire survey commissioned by the Norwegian Public Roads Administration (NPRA) to explore road users' attitudes towards the transformation that took place with regard to the Oslo toll charging scheme. The NPRA is in charge of the planning, funding, construction, and maintenance of national road infrastructure in Norway.

The NPRA further engaged Norstat (2017), which is a data collection company, to collect the data. The data were collected through a web-based panel survey to capture representative road users in a cost-effective manner. Online surveys are cost-efficient and can be conducted in a short period of time (Nayak and Narayan, 2019). However, there have been critics of the use of online surveys that some subgroups are often underrepresented. Such subgroups include elderly individuals, low-income and less educated, who do not have high-speed internet access at home. Recent statistics show that underrepresentation of these groups need not be the case. Statistics Norway (2020) showed that for the period 2016–2018, 96% of Norwegians were online at home. This indicates that online surveys are in line with technological developments, making it a highly reasonable way of reaching a representative sample of Norwegian adults.

The participants in the panel were randomly selected by telephone interviews beforehand. In this way, the web-based panel surveys may produce a higher response rate since the respondents who are already approached would likely provide answers. The dataset consists of 2005 responses The interviews were conducted in November 2017, three years before the COVID pandemic that led to shelter-in-place and close-down that reduced people's possibility of travelling. The sample is, therefore, representative of normal travel circumstances.

Throughout the questionnaire survey, respondents were asked to answer with reference to the previous trip that they made when applicable according to the question being addressed. This was for the purpose of making the respondents respond more objectively since the previous trip is thought to be the freshest trip in memory. The questions addressed to the respondents and, hence, the variables of relevance to our study are summarized in Table 2.

The first question (variable) in Table 2 is the independent variable to be explained. It asked the respondents what their attitudes towards the introduction of the congestion charging scheme in the Oslo cordon toll were. The responses were coded on a 5-point scale as follows:

1 = totally negative, 2 = negative, 3 = neither positive nor negative, 4 = positive and 5 = totally positive. The explanatory variables included were factors that are thought to affect attitudes towards the transformation. They included the respondents' socioeconomic characteristics, e.g., their age, gender, level of education and income; whether they experienced less congestion after the transformation or not; how much they were willing to pay to avoid congestion on their previous trip; whether they lived in Oslo (inside the cordon) or not; and whether their general experiences with congestion were negative or otherwise, as reported in Table 2. The table presents the variables, the questions asked to measure the variables in the questionnaire, and the measurement scales of the variables.

5. Method

Our dependent variable (Attitude) is categorical and ordered, where the different response categories were coded from 1 for totally negative to 5 for totally positive. The commonly used ordinary least squares (OLS) regression model assumes a continuous dependent variable. When the OLS model is used on an ordered dependent variable, it will result in violations of the OLS assumptions. Hence, the estimators will not give the best estimators (see, for instance, Winship and Mare, 1984, Hosmer Jr., Lemeshow, and Sturdivant, 2013 and Mehmetoglu and Jakobsen, 2017, Williams, 2021). Another approach is the multinomial model. Ignoring the ordinality and treating it as nominal, i.e., using a multinomial model, we would fail to use some of the information available. This increases the probability of using more parameters than needed and increases the probability of obtaining significant numbers (Williams, 2021). The real distance between the categories is unknown. The values

[1] For heavy vehicles, the changes in toll fees are found here: https://www.fjellinjen.no/privat/nyhetsarkiv/tids-og-miljodifferensierte-takster-i-oslo-article912-966.html.

[2] 1 Euro = 10 NOK in 2021/2022

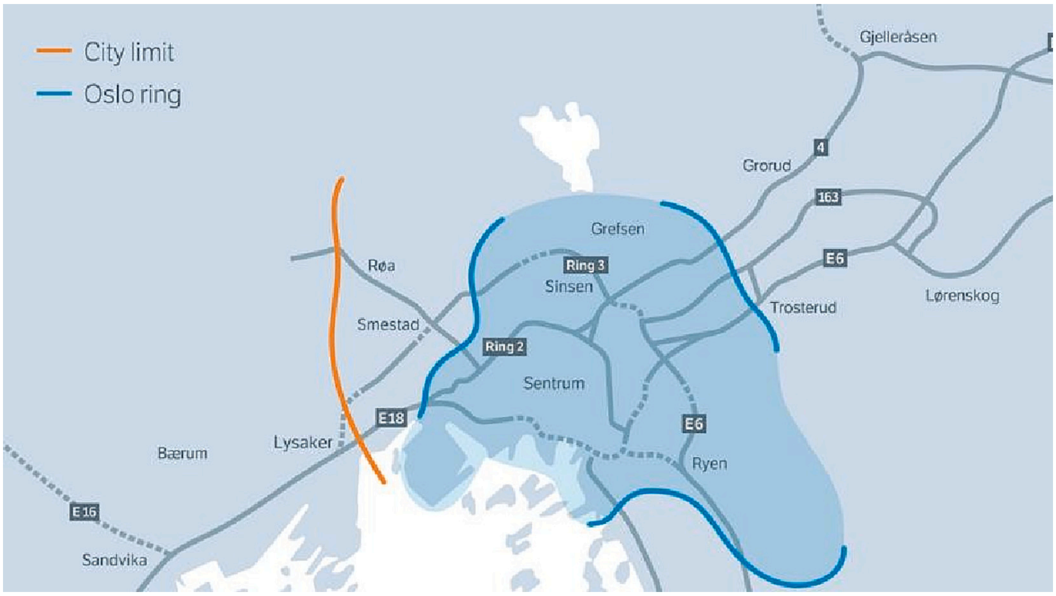

Fig. 1. Map of the cordon toll system in Oslo 2017. Source: Oslo package 3 secretariate.

Table 1
The tariffs for entering the toll cordon toll system before and after implementation of the congestion charging system. Heavy vehicles were not included in the questionnaire and analyses. Source: (Fjellinjen, 2017).

Vehicle type	Before (2016)	After (2017)		%Change	
	Flat rate	Non rush hours	Rush hours	Non rush hours	Rush hours
Gasoline/ rechargable hybrid	35	43	53	23	51
Diesel	35	48	58	37	66
	Before (2016) *In Euros*	**After (2017)**		**%Change**	
	Flat rate	Non rush hours	Rush hours	Non rush hours	Rush hours
Gasoline/ rechargable hybrid	3.5	4.3	5.3	23	51
Diesel	3.5	4.8	5.8	37	66

can now be ranked from low to high. The appropriate econometric method to use is an ordered logit model, commonly shortened as an OLOGIT model or ordered probit model and commonly shortened as the OPROBIT model (Long, 1997). In this paper, we opted for the OLOGIT model since the literature seems to prefer it over OPROBIT models; see, e.g., Quddus, Wang, and Ison (2010). Formally, the model with ordinal outcome variable Y and M categories can be written as follows (Liu and Fan, 2021; Train, 2003; Williams, 2021):

$$P(Y_i > j) = g(X\beta) = \frac{exp\left(\alpha_j + iX_i\beta\right)}{1 + \left[exp\left(\alpha_j + iX_i\beta\right)\right]}, j = 1, 2, \dots, M-1 \quad (1)$$

where Y is the attitudes towards the transformation to a congestion charging system, $X_{i.}$ represents a n*1 vector containing all the explanatory variables, α_j represents the cut $-$ off points for the jth cumulative logit, and β_is the estimated coefficient for the variables.

The probability for the different outcomes can be defined as follows:

$$P(y = j) = \begin{cases} P(Y = 1) = P(\text{ totally negative}) = P(\ y < \alpha_1) \\ P(Y = 2) = P(\text{ negative}) = P(\ \alpha_1 < y < \alpha_2) \\ P(Y = 3) = P(\text{ neither negative or positive}) = P(\alpha_2 \le y \le \alpha_3) \\ P(Y = 4) = P(\text{positive}) = P(\ \alpha_3 < y < \alpha_4) \\ P(Y = 5) = P(\text{totally positive}) = P(\ y > \alpha_4) \end{cases} \quad (2)$$

where cut-off points $\propto_1$ and α_{j-1} are estimated. When crossing a cut-off point, the observed category changes. The statistical analyses were performed using Stata MP 17. (StataCorp, 2021)

6. Results and discussion

The summary statistics of the variables included in the final model are shown in Table 3. This is to provide evidence that there are in fact variations in responses received, which calls for more rigorous statistical/econometric analyses.

For the dependent variable (ATTC), which measures the extent to which attitudes are negative or positive, the mean is 2.19 and below the average of 2.50. This indicates that the average attitude towards the transformation was a "negative" attitude. This is also evident when we look at the means of the different 5-point Likert scales, where the sum of "totally negative" and "negative" is 0.64. This implies that 64% of all the respondents had a negative attitude towards the transformation. This observation is an interesting result since it reveals that the average road user in the wider Oslo area had a negative attitude towards the transformation from a flat-rate toll to congestion charging scheme.

Regarding all the potential explanatory variables that were also classified into different scales, some interesting observations emerge. For instance, the willingness to pay to avoid congestion (WTP) has a mean of 8.8 NOK < 1 Euro. It is, however, difficult to determine whether this value is low or high since no information is available regarding time spent in congestion. The average time spent on trip (MINUTES) was 41.8 min, with a large standard deviation of 34 min. This implies that there is a wide variation in the number of minutes used on trips across respondents, which is an indication that the survey also captured respondents who live far away from the Oslo CBD. The sample consisted of 1013 (51%) men and 992 (49%) women. The mean age of the sample respondent was 48 years within the interval [18;91] years old.

The model described above is used to study attitudes towards a

Table 2
Summary of variables in the questionnaire.

Variables	Question asked	Code	
Attitudes towards congestion charging(ATTCC)	What is your attitude towards the tranformation to a congestion charging scheme in the Oslo cordon toll system? (With congestion charging we mean the time and environmentally differentiated toll)	1. Totally negative ….. 5. Totally positive	
willingness to pay to avoid congestion (WTP)	How much would you be willing to pay to avoid congestion on your previous trip?	Continuous variable in NOK	
Like to drive car (LIKECAR)	Do you like to drive a car?	1:Yes; 0: Otherwise	
Like to take bus (LIKEBUS)	Do you like to take a bus?	1:Yes; 0: Otherwise	
Like to take train (LIKETRAIN)	Do you like to take a train?	1:Yes; 0: Otherwise	
Age (AGE)	How old are you?	Continuous variable in year	
Gender (GENDER)	What is your gender?	1: Male; 2: Female	LTGB was not asddresssed!
Income (INCOME)	Is your houlseholdeincome less than 90100EUR	1:Yes; 0: Otherwise	
The length of last trip in min. (TRIPMINUT)	How long did your trip of reference last in minutes?	Continuous variable in minutes	
Do you have a university level of education(EDUC)	Do you have a higher education i.e. university/ college education?	1:Yes; 0: Otherwise	
Experience with congestion (EXP_CONGEST)	What is your experience with congestion?	1:Negative; 0:Otherwise	
Experience of less congestion after (EXPOST_CONGEST)	I experienced less congestion after congestion charging was implemented	0. Disagree, 1. Neutral, 2. Agree	
Live in Oslo (OSLO)	Do you live in Oslo?	1:Yes; 0: Otherwise	
Car ownership in houshold (CAR_OWNERSHIP)	How many cars do have in your household?	1, 2, 3 and 4	
Fuel type used (FUEL)	What type of fuel does your vehicle use?	1. Diesel, 2. Gasoline 3. Hybrid, 4. EV and, 5. I do not have a car	
Possibility to use other modes (POSS_OTHER_MODES)	Did you have the possibility to use a different mode?	1:Yes; 0: Otherwise	
Corridor used in the last trip (CORRIDOR)	Which road corridor did you drive/ use on your last trip?	1. E6 South corridor, 2. E18 West corridor, 3. E6 Northeast corridor 4. All others	
Travel purpose (TRAV_PURP)	What was your travel purpose	1.To/from work 2. Leisure 3. Buisness	
Parking access (PARK_ACC)	What was the situation with parking accessibility at your destination?	1. Very difficult, 2. Difficult, 3. Easy, 4. Very easy. 5. I have a permanent parking space	

Table 3
Descriptive statistics.

Variable		Obs	Mean	Std. Dev.	Min	Max
ATTCC		2005	2.19	1.42	1	5
	1. Totally negative	2005	0.50	0.50	0	1
	2. Negative	2005	0.14	0.35	0	1
	3. Neutral	2005	0.13	0.34	0	1
	4. Positive	2005	0.12	0.33	0	1
	5. Totally postive	2005	0.10	0.31	0	1
WTP		2005	8.80	21.58	0	200
LIKECAR		2005	0.68	0.47	0	1
LIIKEBUS		2005	0.30	0.46	0	1
LIKETRAIN		2005	0.53	0.50	0	1
AGE		2005	48.13	16.49	18	91
GENDER		2005	1.49	0.50	1	2
INCOME		2.005	0.51	0.50	0	1
TRPMINUT		2005	41.79	33.99	10	200
EDUC		2005	0.73	0.45	0	1
EXP_CONGEST		2005	0.53	0.50	0	1
EXPOST_CONGEST		2005	0.66	0.65	0	2
OSLO		2005	0.56	0.50	0	1
CAR_OWNERSHIP		1851	2.20	0.77	1	4
FUEL		1806	1.98	1.08	1	5
POSS_OTHER_MODE		2005	1.50	0.56	1	3
CORRIDOR		2005	2.23	1.36	0	4
TRAV_PURP		2005	0.65	0.59	0	2
PARK_ACC		1442	3.63	1.06	1	5

transformation to congestion charging on an ordinal scale, and the variables affecting attitudes are described and discussed in this section.

Many model-building strategies exist; however, purposeful selection has become a standard method for the selection of variables in logistic regression (Stavseth, Clausen, and Røislien, 2020). To select the variables in the model, we used a model-building strategy called purposeful selection, which can be summarized in 7 steps (Hosmer Jr. et al., 2013). Step 1: We fit a univariate regression model for each covariate (independent variable). Step 2: To fit the first multivariate model, we include all covariates that were significant at the 0.25 level in the univariate regression model in step 1. Step 3: We check whether the covariates removed in step 2 are needed. We compare the coefficients from the first multivariate model to those of the smaller model. Step 4: The covariates that were not significant in the univariate analyses are included one by one in step 3. The next step is to check whether the assumption that the model is linear in the logit for each continuous covariate holds. By making a smoothed scatter plot of the logits and the continuous variable age, we can see whether the assumption of linearity holds. The advantage of smoothed scatter plots is that if they look linear, the assumption of linearity is likely fulfilled (Hosmer Jr. et al., 2013). Step 6: We explore the possible interactions among the covariates. Only one significant interaction term is found. The final step is to investigate the model fit.

To test the quality of the model, several postestimation tests are conducted. First, a multicollinearity test is conducted. Multicollinearity indicates high correlations or high interrelations between the independent variables. The tolerance value (*1/VIF*) of each X-variable is the proportion of its variance that is not shared with the other X-variables. If the tolerance value is <0.2, the estimated coefficient becomes less stable. (Mehmetoglu and Jakobsen, 2017). In our model, the tolerance values were >0.2 ($1/VIF > 0.2$), so we conclude that we did not find high multicollinearity between the independent variables.

Second, to test the important parallel regression assumption for ordinal logistic regressions, also called the proportional odds assumptions for ordinal logit models (Long and Freese, 2014), a Brant test is used. The parallel regression assumptions imply that $\beta_1 = \beta_2 = \ldots\ldots = \beta_{J-1}$. To the degree that the parallel regression holds, the estimated $\beta\hat{}_1$

$= \hat{\beta}_2 = \ldots\ldots = \hat{\beta}_{J-1}$ should be close. A significant test statistic provides evidence that the parallel regression assumption has been violated. The total model is not significant. However, three of the categories of the covariate “less congestion” are significant at the 5% level. Therefore, we also calculate a generalized structural equation model (GSEM) with the same covariates. The GSEM is a more flexible model and does not need those requirements (Mehmetoglu and Jakobsen, 2017). We obtained exactly the same results, which should occur if the model is calculated properly. It is important to note that parallel assumptions are often violated with larger samples (Williams, 2021). Considering the latter two aspects, we have a reasonable level of confidence that attitudes towards converting the flat-rate toll to a congestion charging scheme are related to the independent variables in the model, and the model has an acceptable fit. The results for the ordered logistic regression model described are given in Table 4.

Table 4 tells us that we have 1669 units in our analysis. The model chi-square is 572 with 23 degrees of freedom. This is highly significant ($p < 0.001$) and tells us that the independent variables in the model have a significant effect on attitudes towards the transformation from flat-rate toll to congestion charging in Oslo. The log-likelihood Chi test tells us that there is a significant improvement of the model compared to a null model, with only intercept included. The Mc Fadden R^2 is 0.13. Table 4 also shows the direction of the effect for the covariates, how significant the variables are, and the test statistics already mentioned. To interpret the results in a more intuitive way, the marginal effect is calculated (see Table 5) to find the average predicted probabilities (Long and Freese, 2014).

Table 4
Ordered logistic regression model for attitudes towards congestion charging in Oslo.

Explanatory variables	Coef.	Std. Err.	z	$P > \lvert z \rvert$	[95%	Conf. Interval]
WTP	0.011	0.002	5.130	0.000	0.007	0.016
LIKECAR	−0.639	0.109	−5.870	0.000	−0.852	−0.426
LIKETRAIN	1.146	0.175	6.540	0.000	0.803	1.490
AGE	−0.018	0.003	−5.610	0.000	−0.025	−0.012
EDUC	0.623	0.122	5.100	0.000	0.383	0.862
EXP_CONGEST	−0.419	0.101	−4.140	0.000	−0.618	−0.221
CAR_OWNERSHIP						
2	−0.426	0.178	−2.400	0.016	−0.774	−0.079
3	−0.744	0.194	−3.830	0.000	−1.125	−0.363
4	−0.967	0.289	−3.350	0.001	−1.534	−0.401
EXPOST_CONGEST						
1. Neutral	1.720	0.169	10.200	0.000	1.390	2.051
2. Agree	2.387	0.268	8.890	0.000	1.860	2.913
FUEL						
Gasoline	0.227	0.116	1.960	0.050	0.000	0.454
BEV	0.521	0.176	2.950	0.003	0.175	0.867
Hybrid	0.414	0.169	2.450	0.014	0.083	0.745
Do not have a car	−0.316	0.326	−0.970	0.333	−0.955	0.324
CORRIDOR						
E18 West corridor	−0.047	0.181	−0.260	0.795	−0.403	0.308
E6 South corridor	−0.333	0.189	−1.760	0.078	−0.702	0.037
E6 Northeastern Corridor	−0.337	0.180	−1.870	0.061	−0.690	0.016
Other trips	−0.185	0.180	−1.030	0.303	−0.538	0.168
LIKETRAIN#EXPOST_CONGEST						
1 1	−0.552	0.222	−2.490	0.013	−0.988	−0.117
1 2	−0.327	0.336	−0.970	0.330	−0.985	0.331
/cut1	0.045	0.293			−0.530	0.620
/cut2	0.886	0.294			0.310	1.462
/cut3	1.721	0.295			1.142	2.299
/cut4	2.864	0.301			2.273	3.454
Test statistics						
Number of obs	1669					
Log likelihood	−1943					
LR chi2(23)	572					
Pseudo R^2	0.13					

Consider first whether fuel type will have an impact on the attitude towards the transformation to congestion charging. Recall that the dependent variable is an ordinal variable on a five-point scale, from very negative to very positive towards the transformation to congestion charging. When congestion charging was implemented in 2017, BEV users did not pay a toll in the cordon toll system, and the vehicles using diesel are still paying the most. Therefore, it is interesting to investigate whether fuel impacts the attitude towards the transformation to congestion charging (variable FUEL). Users driving gasoline, hybrid or BEV had a significantly higher likelihood of having a positive attitude towards congestion charging than diesel users. Studies show that one of the main reasons people purchase and use BEVs is that they are toll exempt (e.g., Bjerkan, Nørbech, and Nordtømme, 2016). Therefore, it is natural that those who benefit from the toll exemption also are less negative towards the change. After congestion charging was implemented, the benefit for BEV users increased greatly. Importantly, BEV users were exempted from the toll when the congestion charging scheme was implemented. Note that since 2019, BEV users have also paid tolls, but the tolls are only a small share of what conventional vehicle users pay.

Consider next the variable “EXPOST_CONGEST”, which represents those who state that they experienced less congestion after the transformation to congestion charging on a 3-point scale. In other words, the variable addresses whether the respondents agree or disagree that the transformation to congestion charging influenced the traffic level. Those who agree that the congestion charging scheme had an effect on congestion are also more positive towards the change and hence are more willing to pay for reducing congestion and the associated emissions. The variable “EXPOST_CONGEST” also had a significant interaction term with “LIKETRAIN”, which can be illustrated in Fig. 2.

Fig. 2 illustrates that there is a higher likelihood of having a totally negative attitude towards the transformation if the respondents did not experience any effect of congestion charging. Furthermore, those who do not like a train (dark blue line) have an even higher likelihood of having a totally negative attitude than those who like a train (red line).

Those who agree that congestion charging had an effect on congestion are 50 percentage points less likely to have a totally negative attitude towards the transformation to congestion charging than those who disagreed that they experienced less congestion after the transformation. The results are reasonable. Those who experienced less congestion after the transformation to congestion charging are less likely to have a totally negative attitude towards the transformation to congestion charging. This finding shows that “real life experience” helps people understand that congestion charging reduces congestion, which also corresponds to the findings in Stockholm (Börjesson et al., 2012; Schade and Schlag, 2003; Winslott-Hiselius et al., 2009). One major reason why people oppose congestion charging is the uncertainty about its effectiveness (Gu, Liu, Cheng, and Saberi, 2018). People are more likely to misunderstand the scheme if they do not experience the effect (i.e., Gaunt, Rye, and Allen, 2007).

The next variable to consider is”CAR_OWNERSHIP”, i.e., whether the number of vehicles in the household will impact the attitude towards the transformation. Table 4 illustrates that the coefficient is increasing after how many cars the household has (0,4–1) compared to those with only one vehicle. Those who have a household with two vehicles are 11 percentage points more likely to have a very negative attitude ($p <$ 0,05); however, those with three or four vehicles are 18 and 24 percentage points (p ⟨0,001), respectively, more likely to have a totally negative attitude towards the transformation compared to those who

Table 5
Marginal effect of the ordered logistic regression model.

Explanatory variables	Cut points	dy/dx	Std.Err.	z	P > z	[95%	Conf. Interval
WTP							
	1: Totally negative	−0.003	0.001	−5.13	0.000	−0.004	−0.002
	2:Negative	0.001	0.000	4.48	0.000	0.000	0.001
	3: Neither negative or positive	0.001	0.000	4.83	0.000	0.001	0.001
	4: Positive	0.001	0.000	4.88	0.000	0.001	0.001
	5: Totally positive	0.001	0.000	4.82	0.000	0.000	0.001
LIKECAR							
	1: Totally negative	0.158	0.027	5.97	0.000	0.106	0.210
	2:Negative	−0.025	0.004	−5.62	0.000	−0.033	−0.016
	3: Neither negative or positive	−0.049	0.009	−5.63	0.000	−0.066	−0.032
	4: Positive	−0.051	0.010	−5.23	0.000	−0.070	−0.032
	5: Totally positive	−0.034	0.007	−4.88	0.000	−0.048	−0.021
AGE							
	1: Totally negative	0.005	0.001	5.62	0.000	0.003	0.006
	2:Negative	−0.001	0.000	−4.71	0.000	−0.001	−0.001
	3: Neither negative or positive	−0.001	0.000	−5.24	0.000	−0.002	−0.001
	4: Positive	−0.001	0.000	−5.35	0.000	−0.002	−0.001
	5: Totally positive	−0.001	0.000	−5.24	0.000	−0.001	−0.001
EDUC							
	1: Totally negative	−0.151	0.029	−5.29	0.000	−0.208	−0.095
	2:Negative	0.036	0.009	4.23	0.000	0.020	0.053
	3: Neither negative or positive	0.047	0.009	5.04	0.000	0.029	0.066
	4: Positive	0.042	0.008	5.32	0.000	0.026	0.057
	5: Totally positive	0.026	0.005	5.29	0.000	0.016	0.036
EXP_CONGEST							
	1: Totally negative	0.104	0.025	4.170	0.000	0.055	0.153
	2:Negative	−0.021	0.005	−3.860	0.000	−0.031	−0.010
	3: Neither negative or positive	−0.032	0.008	−4.030	0.000	−0.048	−0.017
	4: Positive	−0.031	0.008	−4.010	0.000	−0.046	−0.016
	5: Totally positive	−0.020	0.005	−3.910	0.000	−0.030	−0.010
EXPOST_CONGEST							
	Neutral						
	1: Totally negative	−0.338	0.025	−13.77	0.000	−0.386	−0.290
	2:Negative	0.077	0.009	8.76	0.000	0.059	0.094
	3: Neither negative or positive	0.103	0.010	10.55	0.000	0.084	0.122
	4: Positive	0.096	0.009	10.26	0.000	0.078	0.115
	5: Totally positive	0.062	0.007	8.81	0.000	0.048	0.076
	Agree						
	1: Totally negative	−0.503	0.032	−15.89	0.000	−0.565	−0.441
	2:Negative	0.049	0.012	3.99	0.000	0.025	0.073
	3: Neither negative or positive	0.134	0.011	12.23	0.000	0.113	0.156
	4: Positive	0.176	0.018	9.53	0.000	0.140	0.212
	5: Totally positive	0.144	0.021	6.79	0.000	0.103	0.186
LIKETRAIN							
	1: Totally negative	−0.212	0.025	−8.40	0.000	−0.261	−0.162
	2:Negative	0.042	0.007	6.31	0.000	0.029	0.055
	3: Neither negative or positive	0.065	0.009	7.45	0.000	0.048	0.083
	4: Positive	0.063	0.009	7.39	0.000	0.046	0.080
	5: Totally positive	0.041	0.006	6.87	0.000	0.029	0.053
CAR_OWNERSHIP							
	2 cars						
	1: Totally negative	0.106	0.043	2.45	0.014	0.021	0.190
	2:Negative	−0.011	0.003	−3.31	0.001	−0.017	−0.004
	3: Neither negative or positive	−0.032	0.013	−2.51	0.012	−0.057	−0.007
	4: Positive	−0.037	0.017	−2.22	0.026	−0.069	−0.004
	5: Totally positive	−0.026	0.013	−2.08	0.037	−0.051	−0.002
	3 cars						
	1: Totally negative	0.184	0.047	3.91	0.000	0.092	0.276
	2:Negative	−0.029	0.007	−4.16	0.000	−0.042	−0.015
	3: Neither negative or positive	−0.056	0.014	−3.94	0.000	−0.085	−0.028
	4: Positive	−0.059	0.017	−3.41	0.001	−0.093	−0.025
	5: Totally positive	−0.040	0.013	−3.11	0.002	−0.065	−0.015
	4 cars						

(*continued on next page*)

Table 5 (*continued*)

Explanatory variables	Cut points	dy/dx	Std.Err.	z	P > z	[95%	Conf. Interval
	1: Totally negative	0.236	0.067	3.51	0.000	0.104	0.369
	2:Negative	−0.044	0.018	−2.47	0.013	−0.079	−0.009
	3: Neither negative or positive	−0.073	0.021	−3.49	0.000	−0.114	−0.032
	4: Positive	−0.072	0.021	−3.50	0.000	−0.112	−0.032
	5: Totally positive	−0.048	0.014	−3.32	0.001	−0.076	−0.019
FUEL							
	gasoline						
	1: Totally negative	−0.056	0.029	−1.96	0.050	−0.112	0.000
	2:Negative	0.012	0.006	1.94	0.053	0.000	0.025
	3: Neither negative or positive	0.018	0.009	1.95	0.051	0.000	0.035
	4: Positive	0.016	0.008	1.94	0.052	0.000	0.032
	5: Totally positive	0.010	0.005	1.93	0.054	0.000	0.020
	BEV						
	1: Totally negative	−0.130	0.044	−2.98	0.003	−0.215	−0.044
	2:Negative	0.022	0.006	3.58	0.000	0.010	0.034
	3: Neither negative or positive	0.040	0.014	2.98	0.003	0.014	0.067
	4: Positive	0.040	0.015	2.68	0.007	0.011	0.070
	5: Totally positive	0.027	0.011	2.52	0.012	0.006	0.048
	hybrid						
	1: Totally negative	−0.103	0.042	−2.45	0.014	−0.185	−0.021
	2:Negative	0.019	0.007	2.83	0.005	0.006	0.033
	3: Neither negative or positive	0.032	0.013	2.45	0.014	0.006	0.058
	4: Positive	0.031	0.014	2.27	0.023	0.004	0.058
	5: Totally positive	0.020	0.009	2.17	0.030	0.002	0.038
	do not have a car						
	1: Totally negative	0.075	0.075	1.00	0.316	−0.071	0.221
	2:Negative	−0.022	0.024	−0.90	0.368	−0.069	0.026
	3: Neither negative or positive	−0.023	0.023	−1.01	0.313	−0.068	0.022
	4: Positive	−0.019	0.018	−1.06	0.287	−0.053	0.016
	5: Totally positive	−0.011	0.010	−1.09	0.274	−0.031	0.009
CORRIDOR							
	E18 West corridor						
	1: Totally negative	0.012	0.045	0.26	0.795	−0.077	0.101
	2:Negative	−0.002	0.006	−0.26	0.792	−0.014	0.011
	3: Neither negative or positive	−0.004	0.014	−0.26	0.795	−0.031	0.024
	4: Positive	−0.004	0.015	−0.26	0.796	−0.033	0.025
	5: Totally positive	−0.003	0.010	−0.26	0.797	−0.022	0.017
	E6 South corridor						
	1: Totally negative	0.083	0.047	1.77	0.077	−0.009	0.174
	2:Negative	−0.016	0.009	−1.82	0.069	−0.033	0.001
	3: Neither negative or positive	−0.026	0.015	−1.76	0.078	−0.055	0.003
	4: Positive	−0.025	0.015	−1.71	0.087	−0.054	0.004
	5: Totally positive	−0.016	0.010	−1.67	0.094	−0.035	0.003
	E6 Northeastern Corridor						
	1: Totally negative	0.084	0.045	1.88	0.061	−0.004	0.172
	2:Negative	−0.016	0.008	−2.00	0.045	−0.032	0.000
	3: Neither negative or positive	−0.026	0.014	−1.87	0.061	−0.054	0.001
	4: Positive	−0.025	0.014	−1.79	0.073	−0.053	0.002
	5: Totally positive	−0.016	0.009	−1.74	0.081	−0.035	0.002
	Other trips						
	1: Totally negative	0.046	0.045	1.03	0.303	−0.042	0.134
	2:Negative	−0.008	0.007	−1.09	0.278	−0.022	0.006
	3: Neither negative or positive	−0.014	0.014	−1.03	0.303	−0.042	0.013
	4: Positive	−0.015	0.014	−1.01	0.314	−0.043	0.014
	5: Totally positive	−0.010	0.010	−0.99	0.320	−0.029	0.009

have only one vehicle, controlling for all the other variables. The same tendency does in the opposite direction; the more cars they have, the less likely they are to have a positive attitude towards the transformation to a congestion charging scheme. It is logical that those who have several vehicles are also more likely to drive more and hence are more affected by congestion charging. Car availability and car use are found to be the most decisive travel-related factor for users' attitude towards congestion charges (Eliasson and Jonsson, 2011). Furthermore, less frequent car users are found to more strongly support road pricing systems (Jones, 1991).

CORRIDOR represents which corridor they drove on their previous journey. Corridor E6 South and North East are more likely to have a negative attitude (−0,3 p ⟨0,1) than city centre trips. E6 South and North East are 8 percentage points more likely to have a very negative attitude compared to those who drive in the city centre, controlling for all the other variables. On the other hand, they are less likely to have a positive attitude towards the transformation compared to those who drove in the inner city, controlling for all the other covariates. This indicates that those who are not affected by the toll (city centre) are less likely to have a very negative attitude towards the transformation to congestion charging. Note that the E18 west corridor does not have a significant difference, which is a corridor with much traffic and congestion (NPRA, 2021). Similar effects in Stockholm have been shown (Eliasson and Jonsson, 2011).

The socioeconomic factors with significant effects include age and education. Age seems to cause a significantly higher likelihood of having a negative attitude towards the transformation to congestion charging. However, the marginal coefficient is very small, most likely because

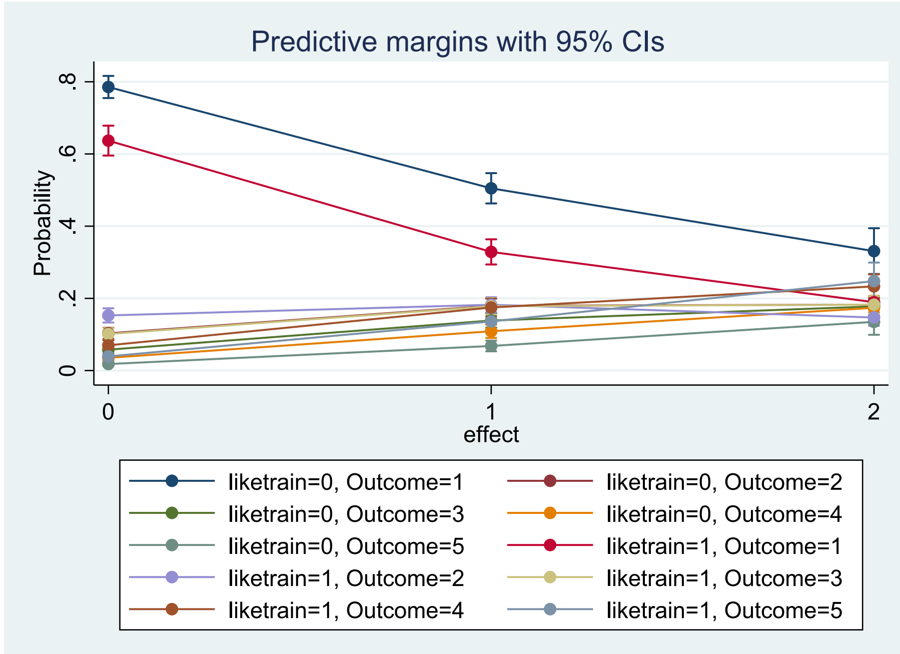

Fig. 2. Probability of the different outcomes of attitudes for the variables EXPOST_CONGEST and LIKETRAIN.

there is not much change in one year. Hence, it is more intuitive to illustrate the effect using a marginal plot; see Fig. 3.

Fig. 3 illustrates the likelihood of having a negative attitude towards the transformation to congestion charging. This shows that older people have a higher likelihood of having a negative attitude with the transformation to congestion charging than younger people. This result corresponds with the results of other studies (Jones, 1991; Sun, Feng, and Lu, 2016; Tvinnereim et al., 2020)

A higher educational level causes a significantly higher likelihood of having a positive attitude towards the transformation to congestion charging (EDUC coefficient = 0,6 and p ⟨0,01), see Table 3), which is also supported by previous research (Tvinnereim et al., 2020). For people with higher education at the university level, holding everything else constant, and an increase in education (in this case from 0 to 1), the likelihood of having a totally negative attitude towards the transformation to congestion charging decreases by 15 percentage points compared to those without education at the university level. Tvinnereim et al. (2020) suggested that the strong effect of education could be

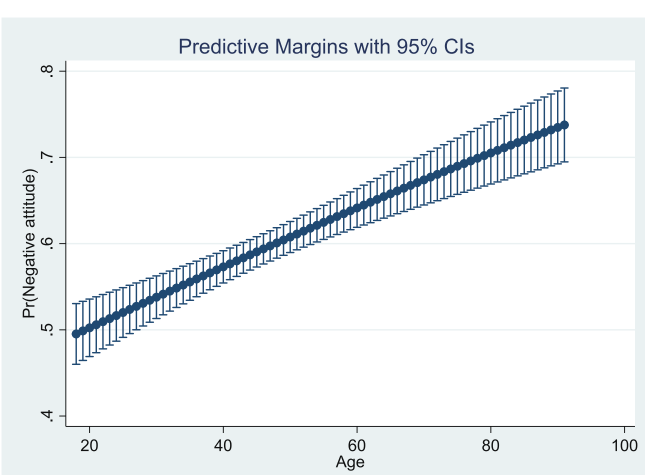

Fig. 3. Marginal plot of the likelihood of having a negative attitude towards transformation to congestion charging, measured by age.

explained by either greater flexibility in work hours or stronger trust in the ability of experts to solve practical problems such as congestion.

Those who like to drive cars (LIKECAR) are more likely to have a negative attitude towards the transformation ($-0{,}6$ with $p < 0{,}001$). For instance, the likelihood of having a totally negative attitude will be 16 percentage points higher than those who do not like to drive a car, controlling for all the other variables ($p < 0{,}001$). The result corresponds with the results of previous research regarding cars. On the other hand, those who like trains are more likely to have a positive attitude. For instance, those who like a train (LIKETRAIN) have a 21 percentage point lower likelihood of having a totally negative attitude towards the transformation to congestion charging compared to those who do not like to take the train. Hence, the results indicate that those who probably drive more have a higher likelihood of having a negative attitude, and those who like public transport such as a train have a higher likelihood of having positive attitudes.

The next variable to consider is “EXP_CONGEST”, where the participants in the survey should respond whether they had a negative or neutral experience in congestion in their previous trip in congestion. Those who had a negative experience in congestion were also more likely to have a negative attitude towards the transformation. This result indicates the importance of information campaigns. It would be more likely that those who have negative experience with congestion would have a positive attitude towards congestion charging if they knew it would reduce the traffic level. However, only 31% of the participants were willing to pay anything to avoid congestion. The willingness to pay (WTP) is also a significant variable ($p < 0{,}001$), but since it is a continuous variable measured in NOK, it is more intuitive to illustrate the effect in a marginal plot.

Fig. 4 illustrates the likelihood of having a totally negative attitude towards the transformation. Those who were willing to pay also had a lower likelihood of having a totally negative attitude towards the transformation to a congestion charging scheme. This result is logical since those who are willing to pay to reduce congestion should be more positive towards a congestion charging scheme that aims to reduce congestion.

This study focuses on attitudes towards the transformation from a flat-rate toll system that has existed since 1990 to a congestion charging system that was implemented in 2017. Few cities have implemented

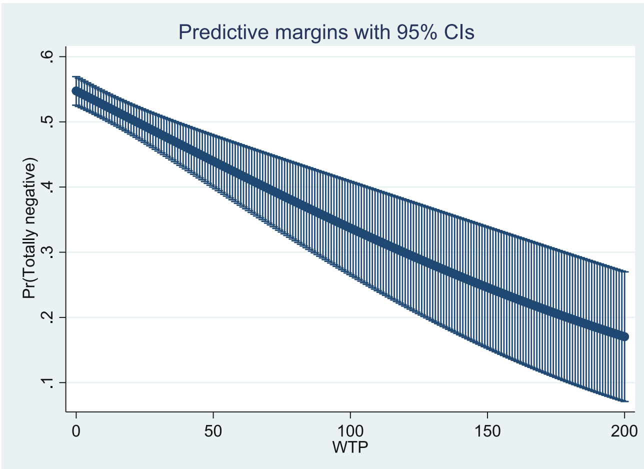

Fig. 4. Marginal plot of the likelihood of having a totally negative attitude towards transformation to congestion charging, measured in willingness to pay.

congestion charging (Lindsey and Santos, 2020), and more information is needed to make people accept it. Limited studies in the literature have examined how people react to such a transformation (Tvinnereim et al., 2020). Many studies confirm that public attitudes change after personal experience with congestion charging (i.e., Eliasson et al. (2009), Winslott-Hiselius et al. (2009)) and flat-rate tolls (Odeck and Bråthen (1997 and 2008) and Odeck and Kjerkreit (2010)); therefore, this study provides new information since citizens are familiar with toll charging. Furthermore, due to ambitious governmental support programs of BEV incentives in Norway, the transformation included an environmental aspect that included exemption of toll for all BEVs when the transformation was adopted. Compared to a diesel car user, a BEV user had an approximately 13 percentage point lower likelihood of having a very negative attitude towards the transformation to congestion charging compared to a user who used diesel as fuel. The results show that those who will probably be most affected (those with several vehicles, ICEV users, those who like to drive a car, those who drive outside the inner circle in Oslo (the inner circle is exempted from toll)) but also those without higher education and older people should be informed about the benefits with a congestion charging scheme.

7. Concluding remarks

The Oslo cordon toll system with flat rates was converted to a congestion charging scheme after almost three decades with flat rates. This study focuses on attitudes towards this transformation from a flat-rate to a congestion charging scheme rather than how it worked. The transformation implied a higher toll during rush hours and lower rates during nonrush hours. A questionnaire survey was conducted in the larger Oslo area to determine factors affecting road user attitudes towards this transformation. The major strengths of the study are that (i) limited studies have examined such a transformation, (ii) it uses a case study where road users are familiar with tolls, and (iii) it uses a case study where BEV incentives have been in place and are experienced by road users, and exemption of tolls has been an important incentive (Bjerkan et al., 2016). It will provide useful insight and implications for planning future transformations of flat-rate toll charges to congestion charging schemes in other cities. By experiencing the effect that congestion charging has on traffic levels, more people may accept congestion charging. Hence, future research could expand the analyses from a longitudinal perspective.

The findings of the survey demonstrate that there are more people who have a negative attitude towards the transformation to congestion charging in the Oslo cordon toll system than there are people in favour of the transformation. The factors found to influence attitudes towards congestion charging are as follows: willingness to pay, whether the respondents like to drive a car, whether they like trains, age, educational level, whether they have had a negative experience with congestion, whether they agree that they experience less congestion with congestion charging, fuel type and geographic area. The direction of the impact of these factors on attitudes towards the transformation to congestion charging is explained in the results section. The results correspond with those of previous research. For example, a previous study has shown that residents who resided in a charging zone and who were college educated, of working age, or believed that they saved time as a result of the toll system were more in favour of the system, which corresponds with the findings of the present study (Zheng, Liu, Liu, and Shiwakoti, 2014). Furthermore, the results have been supported by several other studies (Börjesson et al., 2012; Eliasson and Jonsson, 2011; Gu et al., 2018; Shatanawi, Abdelkhalek, and Mészáros, 2020). Users of conventional cars have significantly more negative attitudes towards the transformation to congestion charging schemes than BEV users, as expected. Oslo is the capital city of BEVs, and BEV users were exempted from congestion charging in 2017. The huge economic benefits for BEV users, such as the exemption of tolls, are the main reason for the sharp increase in the purchase and use of EVs (i.e., Aasness and Odeck, 2015; Bjerkan et al., 2016; Figenbaum and Nordbakke, 2019). Decision-makers and planners should provide information targeted to those groups that are more likely to have negative attitudes towards transformation to congestion charging, and information about the effects of congestion charging should be highlighted. Those who do not think congestion charging has an effect are much more likely to have a totally negative attitude towards the transformation to congestion charging.

One of the limitations of this study is that we do not have data to compare the results years after implementation, when the citizens of Oslo are more familiar with congestion charging and not just a flat toll rate. It would also be interesting to investigate whether more information about how congestion charging is working in other countries in the questionnaire would change some of the most negative attitudes, as they did in Sweden (i.e., Börjesson et al., 2012). The problem with congestion has decreased during the COVID-19 pandemic, and it would be interesting to investigate how this decrease has affected attitudes towards congestion charging. Another limitation is that the results cannot be copied by other cities since the results are affected by the underlying dataset, which is expected to be different among cities. However, the method approach used in this study can be replicated with other similar circumstances.

CRediT authorship contribution statement

Marie Aarestrup Aasness: Conceptualization, Methodology, Software, Writing – original draft, Writing – review & editing, Data curation. **James Odeck:** Methodology, Writing – review & editing, Supervision.

Declaration of Competing Interest

We confirm that we have no conflict of interest

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