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Research paper

Road users' attitudes towards electric vehicle incentives: Empirical evidence from Oslo in 2014–2020

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 8142, 0033, Oslo, Norway

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ABSTRACT

This paper examines participant attitudes towards battery electric vehicle (BEV) incentives. Our case study was conducted in the greater Oslo area. Oslo has ranked as the world capital of BEV usage since 2014. The Norwegian government currently leads the comprehensive use of BEV incentives to decarbonize road transport. The data set is from a questionnaire survey conducted annually between 2014 and 2020. A total of 6363 individuals divided equally into annual random samples were asked to express their attitudes towards the different BEV incentives in place in each year. Participants were aged 18 or older and were living in the larger Oslo area. Professional data collection companies used computer-assisted telephone interviews to conduct the survey. Generalized structural equation modelling (GSEM) was used to analyse the data. The sample was 49% women and 51% men, with a mean age of 51 years, ranging from 18 to 99 years old. People in greater Oslo increasingly disagree each year with beneficial BEV incentives such as toll exemptions, access to bus lanes without passengers and free public parking. However, internal combustion engine vehicle (ICEV) users are more likely to disagree than BEV users. The results provide new knowledge about attitudes towards BEV incentives from a longitudinal perspective.

1. Introduction

Among the European Union's associated members, road transportation accounts for 28.5% of final energy consumption and approximately 20% of total greenhouse gas emissions (European Environment Agency (EEA) 2020). Similar figures are found for the global road transportation sector (European Commission, 2022)). The road transportation sector has a relatively high percentage of energy use and consequently high greenhouse gas emissions. Governments across the globe have in the last decade looked for potential mitigation policies to reduce greenhouse gas emissions from road transport. Since the introduction of battery electric vehicles (BEVs), governments have offered incentives to promote BEV use as a means of reducing carbon emissions. These incentives mainly take the form of fiscal incentives such as reduced purchase price/yearly cost, direct subsidies such as reduced variable costs and user privileges such as reduced time costs or other relative advantages (see Table 1). Overall, these incentives impact road users socioeconomically by providing lower operational and travel time costs for their vehicle usage. Intuitively, the economic returns from purchasing and using BEVs compared to those from internal combustion engine vehicles (ICEVs) should increase BEV adoption among general car users. This seems to have been the case in Norway, where the share of BEVs in new passenger car registrations is by far the highest in the world. Toll exemptions seem to be one of the most important incentives (Aasness & Odeck, 2015; Bjerkan et al., 2016; Figenbaum & Nordbakke, 2019). The global top rankings of countries with the highest new BEV registrations are Norway (72%), followed by Sweden (45%) and the Netherlands (30%) (IEA, 2022), due to ambitious governmental support programs. By comparing the two top ranking countries, it is easier to understand the gap between them. Due to tax incentives to guide vehicle purchases in Norway, ICEV vehicles are much less expensive in Sweden. Furthermore, the tax system in Norway also makes BEVs cheaper to purchase than in their neighbouring country Sweden (Elbil.no, 2021). For instance, the Nissan Leaf has a starting price of €35787 in Sweden, but in Norway, the same vehicle costs €22507, a difference of €13280 in favour of Norway (Nissan.no, 2022, and Nissan.se, 2022).

In this paper, we add to the literature on the effectiveness of BEV incentives by examining road users' attitudes towards free public parking, the exemption from road tolls and access to transit lanes (bus transit, hereafter called transit) without passengers for BEV users. Our

* Corresponding author. The Norwegian University of Science and Technology, 7491, Trondheim, Norway.
E-mail address: marie.aasness@vegvesen.no (M.A. Aasness).

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Table 1
BEV buyer-related advantages. Source: IEAHEV, 2021.

Incentives	Intro year	BEV buyer-relative advantage	Future plans
Fiscal incentives: Reduction in purchase price/yearly cost gives competitive prices			
Exemption from registration tax	1990/ 1996	The tax is based on ICEV emissions and weight and is progressively increasing. Example ICEV taxes: VW Up €3000; VW Golf: €6000; larger vehicles even higher	To be continued unchanged at least until the end of 2021 and likely until the end of 2022.
VAT exemption	2001	Vehicles competing with BEVs are levied a VAT of 25% of the sales price	To be continued unchanged until at least the end of 2021 and likely until the end of 2022.
Reduced annual tax (formally a tax on vehicle insurance)	1996/ 2004	From 2021: BEVs and hydrogen vehicles €213, diesel/petrol: €297–307 (2021-figures).	TBD, last change was for 2021
Reduced company-car tax	2000	The company-car tax is 40% lower compared with ICEVs, but BEVs are seldom bought as company cars.	This incentive was up for revision in 2017/18 but remained in place.
Exemption from change in ownership tax	2018	Change in ownership tax: ICEVs 0–3-year-old vehicles +1200 kg: €660; 4–11-year-old: €398.	
Direct subsidies to users: Reduction in variable costs and help solving range challenges			
Reduced toll roads	1997	In Oslo, users save 60%, €360–600/year. In some places, savings exceed €1500.	Law revised so that rates for battery electric vehicles on toll roads and ferries are decided by local governments, up to a maximum rate of 50% of the ICEV rate. A national plan for toll infrastructure has been developed but is rather vague.
Reduced fares on ferries	2009	Similar to toll roads, saving money for those using car ferries.	
Financial support for normal charges	2009	Reduce investors' risk, reduce users' range anxiety, expand usage.	
Financial support for fast chargers	2011-	More fast-charging stations influences BEV kms driven & market shares.	ENOVA** has supported fast chargers along major corridors and in municipalities without chargers. City fast charging left to commercial actors.
Electricity tax: €0.0162/kWh. Much less than fuel taxes		Gasoline road use tax: €0.491/litre; Gasoline CO2-tax: €0.126/litre; Diesel: €0.362 +€0.145/litre respectively	Road use tax to be continued until it can be replaced by GPS road pricing.
User privileges: Reduction in time costs and providing users with relative advantages			
Access to transit lanes	2003/ 2005	Despite limitations, many BEV users save time driving to work in the transit lane during rush hours.	Local authorities have been given the authority to introduce restrictions if BEVs delay buses.
Free or reduced parking fees	1999	Users get a parking space, which is expensive, and save time.	Since 2017, local authorities can charge BEVs up to 50% of ICEV rates

*Implemented on 01.10.2017.

case study is located in the greater Oslo area, where BEV incentives have been in place since 1990. However, the purchase of BEVs had a sharp increase in the mid-2000s, probably because of new BEVs entering the market that could substitute for ICEVs such as the Nissan Leaf. Oslo has been ranked as the world capital of BEV usage since 2014. Furthermore, the Norwegian government is currently the front-runner in its ambition to use BEV incentives as a means of decarbonizing road transport. The data set used is from a questionnaire survey conducted annually in the 2014–2020 period. The research objective is to examine road user attitudes about BEV incentives in greater depth. To do so, a case study where BEV incentives are in place and are experienced by road users is chosen. Furthermore, the study uses longitudinal data to track changes in attitudes across years. Thus, the case study examines an ideal environment for tracking road users' attitudes towards BEV incentives while employing a rich data set. Such information provides useful insights, especially for policy makers in countries that are still in the innovator phase with limited incentives to offer. Furthermore, the study provides evidence for the Norwegian government of whether BEV incentives are necessary. In addition, it may be easier to make information campaigns about the adverse effects of the incentives for those who have the most positive attitude towards the incentives. Therefore, it may be easier to reduce the incentives with the worst adverse effects.

2. Literature review

Since the inception of government incentives to promote BEVs, several studies in the scientific literature have evaluated the effectiveness of such policies with observed and/or experimental data. Studies have shown that government incentives are likely effective in increasing the sales and usage of BEVs (i.e., Helveston et al., 2015; Wang et al., 2017; Jenn et al., 2018). However, Wang et al. (2018) did not find any significant positive effect of financial incentive policy on consumer intentions to adopt BEVs, contrary to their expectations (Wang et al., 2018). They reasoned that Chinese consumers are more concerned about convenience factors for BEV users, such as access to transit lanes, dedicated parking spaces and looser restrictions on the rules governing the use of vehicles by even- and odd-numbered licence plates, rather than financial incentives (Wang et al., 2018).

While the literature has investigated the effectiveness of government BEV incentives, there is yet another related issue that has not been adequately addressed. Few scholars have examined car users' attitudes towards BEV incentives, especially where such incentives are already in place. Such a study would indicate to policy makers which segments of the car user market to target with BEV incentives to achieve a wider acceptance of a gradual reduction in these economic benefits. Several studies have investigated the extent to which government BEV incentives are effective and how those incentives can contribute to BEV adoption. Such works are divided into (i) studies that used observed data, (ii) studies that used survey data/experimental data to infer how effective such incentives are and how they can contribute to the adoption of BEVs and (iii) studies that specifically looked at how effective Norwegian BEV incentives have been while using either (i) or (ii) above as a point of departure. Here, we provide a review of some studies in each of the categories named above.

Regarding the first category of studies, which used observed data to infer the effectiveness of BEV incentives, Jenn et al. (2018) used actual data from the US to investigate the impact of BEV incentives there. They found, among other things, that for every 1000 dollars offered in BEV purchase rebates, the sales of BEVs increased by 2.6%. Sierzchula et al. (2014) investigated the factors that influence the adoption of both BEVs and plug-in hybrid electrical vehicles (PHEVs) by using sales data from 30 countries. They found that financial incentives and charging infrastructure were significant factors explaining national market shares of electrical vehicles. Austmann (2021) conducted a comprehensive literature review of studies that examined drivers who adopted electrical vehicles (EVs) and focused on actual market data. Austmann (2021) found six different categories, namely, the "*Automobile sector, Incentives Socioeconomic/Sociodemographic, Infrastructure/Geography, Energy prices, Development EV and Psychological*". The development EV category includes all variables that address the vehicle type itself. Psychology includes norms, attitudes, moral values and behaviour and seems to be underexplored (Austmann, 2021). The present study adds to the literature about attitudes, which Austmann (2021) found to be underexplored. Furthermore, Austmann (2021) found that socioeconomic factors such as age impacted the adoption of EVs.

Among the studies in the second category that used survey/experimental data to infer the effectiveness of BEV policies, Wang et al. (2017) conducted a discrete choice experiment in the context of China. They found that the policies that enhanced BEV acceptance and hence were most effective were exemptions from vehicle purchase and driving restrictions. Discounts and free access to BEV charging stations also positively impacted the acceptance of BEV policies. Another similar study was conducted by Helveston et al. (2015). Using data from choice-based conjoint surveys from 2012 to 2013 for China and the US, they assessed consumer preferences for ICEV, PHEV, and BEV technologies. Specifically, and relevant for our study, they found that despite similar incentives in the two countries, Chinese consumers were more willing to accept BEVs than their US counterparts. The reason was assumed to be that two-thirds of Chinese car buyers are first-time buyers. Thus, the ability to take long trips has not yet been established. Driving range expectations may therefore not be as problematic as in the US. Furthermore, China has a major intercity train system that is a very good alternative for longer trips, which is a less accessible alternative in the U.S. (Helveston et al., 2015). Their study implied the potential for BEV adoption in China, although that adoption would not necessarily mean a reduction in greenhouse emissions since coal is still the main part of electricity production in China (EIA, 2022). Several studies have found that policy instruments such as public charging points increase the adoption of BEVs (e.g., Egnér & Trosvik, 2018; Haustein et al., 2021). However, the driving range stress is likely to decrease as the driving range of BEVs increases. Many BEVs already have a range of over 500 km (Electric Vehicle, 2022). Haustein et al. (2021) found that information campaigns are important for the adoption of BEVs. Additionally, one result was the lack of knowledge among ICEV users about BEV attributes (i.e., the price, driving range, maintenance costs, and number of chargers at work, home and along highways). The present study could make it easier to create a more targeted information campaign.

The third category of studies examined the effectiveness of the Norwegian BEV policy in particular. There are many such studies because Norway is a world leader in this area. Figenbaum et al. (2015) investigated the experiences and opportunities for BEVs in Norway. They explored explanations for the developments in BEV usage in Norway by means of a narrative approach. They observed that increased BEV purchases and usage in Norway resulted from a long-lasting interaction between private enterprises, public authorities, and nongovernmental organizations combined with economic incentives that encouraged the purchase and use of BEVs. In addition, they remarked that the Norwegian government's support for the expansion of BEV battery charging stations would further enhance the purchase and usage of BEVs in the future. Their narrative has been supported by sales data, as the purchase and use of BEVs in Norway is constantly increasing. Zhang et al. (2016) examined the impact of car specifications, prices, and incentives for BEVs in Norway. They used BEV sales data for 2011–2013 and applied the random coefficient discrete choice model in their analyses. They found improvements in BEV technology, road space allotted and road toll waivers for BEV users. Additionally, the density of battery charging stations significantly impacted the demand for BEVs. Their findings therefore support those of, e.g., Figenbaum et al. (2015). Deuten et al. (2020) tested and analysed electric car incentive scenarios in the Netherlands and Norway. Their point of departure was to explore past and future BEV sales shares using a powertrain technology transition market agent model (PTTMAM). Their general findings indicated that emission regulation targets for manufacturers are necessary to prompt a transition from the sale of ICEVs to BEVs. Only strong incentives resulted in a significant sales share of BEVs in the Netherlands and Norway. Notably, their study did not concern BEV user subsidies but vehicle manufacturer regulations.

Perhaps the most closely related study surveyed motorists in New Zealand about their attitudes towards and perceptions of plug-in electric vehicles (BEVSs and PHEVs) (Broadbent et al., 2021). Furthermore, the popularity and awareness of incentives for both plug-in electric vehicles and ICEV users were investigated (Broadbent et al., 2021). They identified the factors that affect plug-in electric vehicle adoption. The results showed that the "strongest barriers [among New Zealand motorists] to plug in electric vehicles purchase were vehicle range, ICEV driver perceptions that plug in electric vehicles are expensive, inconvenience relating to charging and the unknown value proposition of batteries" (Broadbent et al., 2021).

The above literature review shows some examples of the three categories of i) studies that used observed data, (ii) studies that used survey data/experimental data to infer how effective such incentives are and how they can contribute to the adoption of BEVs and (iii) studies that specifically looked at how effective Norwegian BEV incentives have been while using either (i) or (ii) above as a point of departure. However, car users' attitudes towards BEV incentives, especially where incentives for BEV usage are already in place, as in Norway, have not been adequately studied in the literature. This observation corroborates the necessity of the present study as a contribution to the literature on road users' attitudes towards BEV incentives.

3. Norwegian BEV incentives

The incentive package in Norway is meant to induce car users to prefer BEVs over ICEVs as a means of decarbonizing road transport.

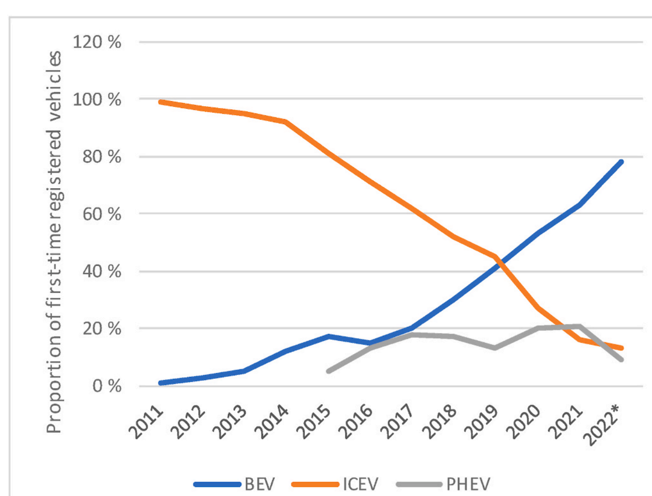

Fig. 1. The graph shows the proportion of first-time registered vehicles in Norway by fuel type over time. *Until March 2022. Source: NRPA, 2022.

Fig. 1 shows the proportion of first-time registered vehicles in Norway by fuel type over time. In March 2022, almost 80% of first-time registered vehicles were BEVs (NPRA, 2022). The proportion of first-time registered BEVs has increased sharply in recent years, while the share of ICEVs has decreased.

Many of the incentives in Norway date back to the 1990s. The BEV incentives are summarized in Table 1.

BEVs and other zero-emission cars have no purchase or registration taxes or value added tax (VAT), which a recent study found to be the most important factor to speed up the market uptake of BEVs in Norway (Østli et al., 2022).

In addition to lower annual and purchase taxes, BEV users have reduced variable costs and user privileges, such as reduced road tolls, reduced fares on ferries, free or reduced parking charges and access to transit lanes. In Oslo, the maximum parking charge for BEV users is 20% of what petrol and diesel cars pay (City of Oslo, 2021). BEV users have access to transit lanes. However, restrictions on the BEV use of transit lanes have been introduced by authorities where there is risk of congestion for public transport. Toll exemptions and discounts are an important reason why Norwegians are increasingly choosing BEVs (Figenbaum and Nordbakke, 2019; Bjerkan et al., 2016). The government mandates that BEV users pay a maximum of 50% of what petrol car users pay in tolls at existing toll stations (Ministry of Transport, 2017). Municipalities and county-level authorities determine the rates at individual toll stations; therefore, there are local variations.

The Oslo cordon toll system has several purposes. Tolls contribute to financing transport solutions, to zero growth in passenger car transport, to the transition to BEVs and to reducing congestion and greenhouse gas emissions (Bruvoll et al., 2020). However, some of these effects are contradictory. For example, BEV benefits can increase traffic and congestion (Bruvoll et al., 2020). At the same time, exemptions and reduced tariffs for BEVs reduce toll revenues and thus undermine their contribution to financing public transport, cycle paths and other measures to improve the urban environment (Bruvoll et al., 2020).

In summary, compared with the use of ICEVs, the use of BEVs is associated with lower taxes and more benefits. BEV owners can save €2000–3500 per year compared with ICEV owners due to much lower energy costs, local incentives and competitive sale prices resulting from tax exemptions (Figenbaum and Nordbakke, 2019).

4. Method and data

The data used in this study are based on an annual survey conducted since 1989. The Oslo cordon toll system was opened on 1 February 1990. Since 1989, an annual survey has been carried out among the populations of Oslo and Viken (formerly Akershus) about their attitudes towards various aspects of the toll stations. The main purpose of this series of reports and the annual survey is to uncover any behavioural and attitudinal changes over time (NPRA, 2020). However, in 2014, three questions were included asking to what extent citizens agreed or disagreed with the following BEV incentives: exemption from tolls, free public parking and access to transit lanes without passengers. These three questions are the dependent variables in this study. Hence, this study investigates road users' attitudes towards free parking, exemption from tolls and access to transit lanes without passengers from 2014 to 2020 (NPRA, 2020).

The annual survey includes a random and representative sample of approximately 1000 respondents living in Oslo and nearby municipalities (corresponding to old Akershus) who are aged 18 years or older (NPRA, 2020). Any biases in the net sample are statistically weighted according to publicly available statistics with regard to gender, age and geography (NPRA, 2020). Geographic weighting means that there is a proportional distribution of respondents from Oslo and Akershus. The sample comprised 49% women and 51% men. The mean age was 51 years, with a range of 18–99 years old. The surveys in 2014–2019 were carried out in February, May, August and November. The survey in 2020 was carried out in February, June, September and November. Annually, 250 interviews were conducted in each of the four rounds. The reason for this division into four waves is a desire to capture any seasonal variations in the results, in addition to obtaining results that to a greater extent reflect the average in attitudes throughout the year. By road user, we mean those who are above 18 years old. Ninety percent of the participants have a driver licence, but we also take into consideration passengers and those who cycle and walk. The data collection was conducted in the form of computer-assisted telephone interviews by professional data collection companies (Norfakta Markedsananlyse AS and Opinion). They are known to use well-grounded research methods to collect reliable data about any desired topic. They recruit most of their survey respondents from the previous research panels that they maintain. A total of 69% had studied at the university level, and approximately 14% had a BEV. Note that the share of BEVs is increasing, from 3% in 2014 to 25% in 2020. The participants received no compensation for taking part. The data were anonymized according to the European Union General Data Protection Regulation. The questionnaire included questions about whether the participants agreed to implement measures to reduce congestion and pollution. Such measures could include traffic congestion tolls and environmental tolls based on the vehicle type. Moreover, questions about whether they are satisfied with walking and cycling facilities and whether they use BEVs were included. Furthermore, socioeconomic data such as age, whether they have children, and the extent to which environmental concerns influence attitudes towards incentives were gathered. Important variables are described in Table 2a.

To select the variables in the model, we used a model building strategy called purposeful selection that can be summarized in 7 steps (Hosmer et al., 2013). One benefit of purposeful selection is that the analyst has full control of the method. "Purposeful selection has become a standard method of selection of variables in logistic regression" (Stavseth et al., 2020).

Respondents were asked the three following questions: "Do you agree or disagree that BEVs should have free public parking? Do you agree or disagree that BEVs should have access to transit lanes (without passengers)? Do you agree or disagree that BEVs should be exempted from tolls?" The possible responses were 1 = "disagree", 0 = "agree", or 2 = "do not know". Therefore, this is a discrete choice problem and not a case where the endogenous variable is continuous, for instance, in the case of ordinary least squares (OLS). The model has different categories but no natural order; accordingly, a multinomial approach is preferred. However, when we analysed the data, there were too few people in the category of those who "do not know" whether they agree or disagree with the exemption of BEVs in the Oslo cordon toll system. This affects our statistical analysis, as "a skewed distribution of the dependent variable can easily lead to problems, so it is better to have a 50/50 distribution than 5/95" (Melmehtoglu & Jakobsen, 2017). The correctness of the logit estimates depends on the sample size. In this case, less than 2% of respondents answered that they did not know for each of the dependent variables, while the two other categories that approve or disapprove of the BEV incentives share the last 98%. Especially if we do have fewer than 200 observations, this would create a problem of biased estimates (Melmehtoglu & Jakobsen, 2017), as is the case here for each dependent variable. Therefore, we omit this category from the calculations to obtain a more robust model. The dependent variable is thus binary; a person either agrees (=0) or disagrees with the incentives (=1). The variables included are based on the purposeful selection procedure for the dependent variable toll exemption as a standard binary logit model. The logit of Y is a linear function of the X variables. It can be formulated as follows (Hosmer et al., 2013, Mehmetoglu & Jakobsen, 2017):

$$L = \beta_0 + \beta_1 x_1 + \ldots\ldots + \beta_{k-1} x_{k-1} \quad (1)$$

where L is the total logit of Y, Y is the dichotomous variable, and k is the number of parameters in the model (the constant parameters and all the

Table 2a
Summary of important variables in the questionnaire.

Variable	Question asked	Code
Free public parking	Do you agree or disagree that BEVs should have free public parking?	1:disagree; 0:agree
Access to transit lanes without passengers	Do you agree or disagree that BEVs should have access to transit lanes (without passengers)	1:disagree; 0:agree
Exemption from toll	Do you agree or disagree that BEVs should be exempted from toll?	1:disagree; 0:agree
Age	How old are you?	Continious variable in year
Gender	what is your gender	1.female; 0; male* otherpossibilities was not an option.
Uni	Do you have education at university level?	1:yes; 0; otherwise
Highincome	Householdincome more than 1 mill NOK	1:yes; 0; otherwise
Household size	How many people live in the household in total, including all adults and children?	Continious variable in year
Chidren 0–6 years	Do you have chilrdren in the group 0–6 years old?	1:yes; 0; otherwise
Children 7–15 years	Do you have chilrdren in the group 7–15 years old?	1:yes; 0; otherwise
Children 16–19 years	Do you have chilrdren in the group 16–19 years old?	1:yes; 0; otherwise
Vehicles #	Does the household have a car, and if so, how many cars?	on a scale from 0 to 5
BEV	Do you have a BEV?	1: yes; 0; otherwise
Congestion	For better accessibility during rush hour and less pollution where the price is higher during rush hour and lower outside rush hour can be implemented*. Do you .	1:agree.2:disagree.3:do not know
Pollution	To reduce pollution, a tariff system where the price is higher for cars that pollute a lot, and lower for cars that pollute little, can be introduced*. Would you:	1:agree.2:disagree.3:do not know
Measures to reduce pollution	Do you think it is right or wrong to introduce measures that reduce pollution from car traffic during periods of poor air quality?	
Professional driver	Are you a professional driver, or do you drive a daily or weekly car to work on service assignments (for example to meetings, customers and the like	1:yes; 0: Otherwise
Area	Do you live in Oslo?	1:yes; 0: Otherwise
Finance Public transport	Part of the income from the toll ring in Oslo and between Oslo and Bærum today goes to the public transport system in Oslo and Akershus. The goal is faster development of the public transport service than with only ordinary allocations. The investment will, among other things, increase capacity, speed and multiple departures. Do you think it is right or wrong for road users who drive a car to pay for improvements to the public transport system in this way?	0:right; 1: wrong, 2; Do not know
Fuel	What type of fuel do your vehicle have?	1. Diesel,2. Gasoline 3. Hybrid,4. BEV 5. Do not have a car
Mode possibilities	Did you have the possibility to use antoher mode	1:Yes; 0: Otherwise
Satiesfied bike facilities	How satiesfied are you with the bike facilities in Oslo and Akershus?	0:Dissatisfied; 1: Satiesfied, 2: Do not know.
Satiesfied walking facilities	How satisfied are you with the facilities for walking in Oslo and Akershus?	0:Dissatisfied; 1: Satiesfied, 2: Do not know.
HowSaiesfiedPT	How satisfied are you with the standard of public transport in Oslo \ Akershus?	1:Very dissatiesfied; 2: Quite dissatisfied; 3:. Prettu satisfied,4. Very satiesfied, 5. do not know.
HowSatiesfiedMainroad	How satisfied are you with the standard of the main road network in Oslo and Akershus?	1:Very dissatiesfied; 2: Quite dissatisfied; 3:. Prettu satisfied,4. Very satiesfied, 5. Do not know.
Travel less with toll	How much do you agree or disagree with the statement: Tolls in the Oslo area means that you travel less by car	1: Disagree; 2:Agree; 3: Other/do not know
Attitudetoll_beforetoll	Do you think the introduction of tolls in the Oslo area was a very negative, quite negative, quite positive or very positive measure?	1:Very negative; 2: Quite negative; 3: Quite positive; 4: Very positive; 5: Do not know \ unanswered
Attitudetoll_afterInfo	The tolls are used together with public funds for measures in Oslo and Akershus within road construction and public transport Based on how the income has been used so far, what do you think about the introduction of tolls in the Oslo area?	1:Very negative; 2: Quite negative; 3: Quite positive; 4: Very positive; 5: Do not know \ unanswered
Mode	What type of transport mode did you use the last time you traveled to work	1: Public transport; 2: Private car as driver; 3: Private car as a passenger; 4:Other
Tollring_to_work	Do you usually have to pass toll booths in the Oslo area when you travel to and from work? (include all transport modes)	0:Yes; 1:No, 2; Do not know
Pay_toll	Does your job pay in full or in part the expenses you have for toll passes in the Oslo area?	1: Yes, completely; 2: Yes, in part; 3: No. 4:Not sure \ do not know
Inside/outside tollring	Do you live inside or outside the toll ring?	1:Inside; 2: Outside; 3: Unanswered \ do not know
Year	1:2014; 2:2015; 3:2016; 4:2017; 5:2018; 6:2019; 7:2019	1:2014; 2:2015; 3:2016; 4:2017; 5:2018; 6:2019; 7:2020

X variables).

However, we are investigating a case where we have three endogenous variables, namely, access to transit lanes, the exemption from tolls and free public parking. Therefore, after including the variables in the final model as just defined in equation (1), the model is expanded by using a model technique that can handle a large number of both endogenous and exogenous variables at the same time (Golob, 2003). The model technique is called structural equation modelling. However, the dependent variables are discrete; hence, a generalized structural equation modelling (GSEM) approach with a logistic distribution family is used. A GSEM with one dependent variable should be identical to the already mentioned logistic regression. However, when adding two more endogenous variables, the structural equation model estimates the three regression models simultaneously. It can be defined in the same way as the logit model as follows:

$$\left.\begin{aligned} L_1 &= \beta_{10} + \beta_{11}x_1 + \ldots\ldots + \beta_{1k-1}x_{k-1} \\ L_2 &= \beta_{20} + \beta_{21}x_1 + \ldots\ldots + \beta_{2k-1}x_{k-1} \\ L_3 &= \beta_{30} + \beta_{31}x_1 + \ldots\ldots + \beta_{3k-1}x_{k-1} \end{aligned}\right\} \quad (2)$$

where L is the total logit of the three different dichotomous variables, specifically, the exemption from tolls, free public parking, and access to transit lanes without passengers. All the equations have the different parameters estimated but take the same X variables. Only significant covariates were kept in the final model for the three equations. The estimation is performed with maximum likelihood in the same way as the logit models. Statistical software StataCorp (2021) was used to analyse the data.

5. Results and discussion

In this section, the results from the regression analysis are presented and discussed. The descriptive statistics for the variables included in the final model are described in Table 2b. The table shows, for instance, that approximately half of the participants disagree with the exemption from tolls, but 60–70% disagree with free public parking and access to transit lanes without passengers.

The model described in section 4 is used to investigate which factors affect attitudes towards toll exemptions, free public parking and access to transit lanes for BEV users. It is possible to compare the results of the GSEM with only one dependent variable with those of a binary logit model (Mehmetoglu & Jakobsen, 2017).

The results for the binary logistic regression model (only one dependent variable: toll exemption) indicate that we have 4684 units in our analysis. The chi-square value for the model is 973 with 38 degrees of freedom. This is highly significant ($p < 0.001$) and implies that the independent variables in the model have a significant effect on attitudes towards BEV incentives. The log likelihood chi test indicates that the model is a significant improvement compared with the one for the null hypothesis with only the intercept included. The McFadden R2 is 0.15.

To test the quality of the model, 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 less than 0.2, then the estimated coefficient becomes less stable (Mehmetoglu & Jakobsen, 2017). In our model, the tolerance values are greater than 0.2 (1/VIF>0.2), and we thus conclude that there is no high level of multicollinearity between the independent variables.

The results of the model are shown in Table 3, which identifies 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 to find the average predicted probabilities (Long & Freese, 2014). The results are presented in a different subsection depending on the impacts examined.

5.1. The effect of age and time

The dependent variables are whether the respondent agrees or disagrees with the exemption of BEVs from road tolls, free public parking, and access to transit lanes in the 2014–2020 period. This indicates their attitudes towards the incentives and whether they are positive or negative. The coefficients for age and year are significant and positive ($p < 0.001$, Table 4). The effect of age and time, with everything else held constant, is illustrated in Fig. 2 below.

Fig. 2 illustrates that the older respondents are, the more likely they are to have a negative attitude towards the BEV incentives studied. This is the case for all years, but attitudes are also more likely to become negative over time. For example, opinion in the youngest group is much less likely to be negative in 2014 than in 2020. All the years are compared to the base outcome in 2014. The coefficient for years is increasing (0.4–0.5 in 2015 to 1.3–1.9 in 2020). The average predicted probability calculated is shown in Table 4.

A person is almost 40 percentage points more likely to disagree with toll exemptions in 2020 than in 2014, with all other variables held constant (see Table 4).

A person is approximately 33 percentage points more likely in 2018–2020 to disagree with access to transit lanes without passengers for BEV users than in 2014, with all other variables held constant.

Similar trends are also found for free public parking. In 2020, a person is almost 30 percentage points more likely to disagree with free public parking than in 2014. The results therefore give a clear signal that the citizens of the Oslo region probably have a greater acceptance of reducing BEV incentives in 2020 than in 2014. Status quo bias is found to be an important factor in explaining attitudes towards congestion charging (Börjesson et al., 2016), as people prefer their current situation. Still, status quo bias may be only a partial explanation. During the time studied, the BEV incentives were reduced. However, disagreement started to decrease in 2015 and 2016. Hence, status quo bias is not the sole reason for this result. BEV users only started to pay a symbolic sum in the Oslo cordon toll system in 2019. In other places, they still are exempted from it. When congestion charging was introduced (2017), BEV users did not pay tolls. However, to a larger extent, people may have later agreed that it was reasonable that BEV users should pay, because the gap between ICEVs and BEVs became much larger. BEV users were exempted from parking in public places until 2017, at which point local communities could charge a maximum of 50% of the usual parking fee.

Those who have children from 0 to 6 years old are approximately 4–7 percentage points less likely to disagree with the three incentives investigated here ($p < 0.1$) than those who do not have children in that age range, with everything else held constant. Those with children from 7 to 15 years old are 4–5 percentage points less likely to disagree with the exemption from tolls and free public parking than those without

Table 2b
Descriptive statistics for the variables included in the final model.

Variable	Obs	Mean	Std. dev.	Min	Max
Exemption from tolls	6363	0.51	0.50	0	1
Free public parking	6363	0.62	0.48	0	1
Access to transitlanes without passengers	6363	0.67	0.47	0	1
Age	6363	50.92	16.44	18	99
BEV	5640	0.14	0.34	0	1
Pollution	6363	1.67	0.75	1	3
Measures to reduce pollution	6363	1.23	0.50	1	3
Finance public transport	6363	1.38	0.57	1	3
Satiesfied with walking facilities	6363	0.88	0.43	0	2
Satiesfied with bike facilities	6363	0.80	0.80	0	2
Travels less with toll	6363	0.58	0.63	0	2
Children 0–6 years	5123	0.17	0.37	0	1
Chrildren 7–15 years	5123	0.23	0.42	0	1
Year	6363	2016.99	2.00	2014	2020

Table 3
Results from the generalized structural equation model.

		Coef.	Std. Err.	z	P > z	[95% Conf.	Interval]	Coef.	Std. Err.	z	P > z	[95% Conf.	Interval]	Coef.	Std. Err.	z	P > z	[95% Conf.	Interval]
Endogenous variables			*Exemption from tolls*							*TransitWITHOUTpassenger*							*Free public parking*		
Age		0.028	0.002	11.73	0.000	0.023	0.033	0.021	0.002	8.9	0.000	0.016	0.025	0.024	0.002	10.16	0.000	0.020	0.029
Finance public transport																			
	Wrong	0.274	0.078	3.51	0.000	0.121	0.426												
	Do not know	0.230	0.165	1.39	0.164	−0.094	0.553												
BEV		−1.731	0.106	−16.39	0.000	−1.938	−1.524	−1.312	0.093	−14.07	0.000	−1.495	−1.129	−1.524	0.096	−15.85	0.000	−1.713	−1.336
Pollution																			
	Against	0.326	0.100	3.25	0.001	0.129	0.523	0.257	0.077	3.36	0.001	0.107	0.407	0.561	0.078	7.15	0.000	0.407	0.715
	Do not know	0.299	0.129	2.32	0.021	0.046	0.552	0.159	0.096	1.65	0.099	−0.030	0.347	0.408	0.096	4.25	0.000	0.220	0.597
Agreereducepollution																			
	Wrong	0.318	0.094	3.37	0.001	0.133	0.503							0.248	0.096	2.58	0.010	0.060	0.437
	Do not know	0.375	0.182	2.07	0.039	0.019	0.731							0.181	0.186	0.97	0.332	−0.184	0.545
Satiesfied walking facilities																			
	Satiesfied	−0.231	0.094	−2.46	0.014	−0.416	−0.047												
	Do not know	−0.137	0.187	−0.73	0.465	−0.503	0.230												
Satiesfied bike facilites																			
	Satiesfied	0.490	0.212	2.31	0.021	0.075	0.905							0.680	0.205	3.33	0.001	0.279	1.081
	Do not know	0.475	0.213	2.22	0.026	0.056	0.893							0.668	0.213	3.13	0.002	0.250	1.086
Travellesswithtoll																			
	Agree	−0.308	0.096	−3.19	0.001	−0.497	−0.119	−0.168	0.070	−2.39	0.017	−0.305	−0.030	−0.113	0.070	−1.61	0.107	−0.251	0.025
	Do not know	0.039	0.234	0.16	0.869	−0.420	0.497	−0.076	0.160	−0.48	0.634	−0.389	0.237	−0.039	0.160	−0.25	0.806	−0.354	0.275
Children 0-6years		−0.185	0.094	−1.98	0.048	−0.369	−0.002	−0.274	0.090	−3.06	0.002	−0.450	−0.098	−0.314	0.090	−3.47	0.001	−0.492	−0.137
Children 7–15years		−0.144	0.078	−1.85	0.065	−0.297	0.009							−0.226	0.077	−2.95	0.003	−0.376	−0.076
Year																			
2015		0.541	0.160	3.37	0.001	0.226	0.855	0.506	0.115	4.41	0.000	0.281	0.731	0.413	0.154	2.69	0.007	0.112	0.714
2016		0.663	0.169	3.93	0.000	0.333	0.994	0.411	0.113	3.62	0.000	0.189	0.634	0.436	0.162	2.69	0.007	0.119	0.754
2017		0.847	0.176	4.81	0.000	0.502	1.192	1.054	0.120	8.76	0.000	0.818	1.290	1.083	0.173	6.24	0.000	0.743	1.423
2018		1.220	0.186	6.57	0.000	0.856	1.583	1.462	0.130	11.29	0.000	1.208	1.716	1.205	0.183	6.6	0.000	0.847	1.563

(*continued on next page*)

Table 3 (*continued*)

		Coef.	Std. Err.	z	P > z	[95% Conf.	Interval]	Coef.	Std. Err.	z	P > z	[95% Conf.	Interval]	Coef.	Std. Err.	z	P > z	[95% Conf.	Interval]
Endogenous variables			*Exemption from tolls*							*TransitWITHOUTpassenger*							*Free public parking*		
2019		1.328	0.190	6.99	0.000	0.955	1.700	1.555	0.129	12.02	0.000	1.302	1.809	1.516	0.191	7.93	0.000	1.142	1.891
2020		1.887	0.204	9.26	0.000	1.488	2.287	1.593	0.132	12.04	0.000	1.334	1.852	1.647	0.204	8.09	0.000	1.248	2.046
Pollution#Lesstravelwithtoll																			
	Against#1	0.476	0.154	3.08	0.002	0.173	0.779												
	Against#2	−0.015	0.368	−0.04	0.968	−0.736	0.706												
	Do not knowt#1	0.062	0.193	0.32	0.746	−0.316	0.441												
	Do not know#2	0.258	0.401	0.64	0.519	−0.527	1.043												
Satiesfiedbikefacilities#Year																			
	1#2015	−0.099	0.296	−0.33	0.739	−0.678	0.481							−0.491	0.289	−1.7	0.089	−1.056	0.075
	1#2016	−0.159	0.286	−0.56	0.578	−0.720	0.401							−0.377	0.281	−1.34	0.180	−0.927	0.174
	1#2017	−0.158	0.289	−0.55	0.583	−0.724	0.407							−0.555	0.289	−1.92	0.055	−1.121	0.012
	1#2018	−0.522	0.297	−1.76	0.079	−1.105	0.060							−0.866	0.293	−2.95	0.003	−1.440	−0.291
	1#2019	0.066	0.292	0.23	0.820	−0.505	0.638							−0.552	0.292	−1.89	0.058	−1.124	0.019
	1#2020	−0.297	0.302	−0.98	0.325	−0.889	0.295							−0.437	0.302	−1.45	0.148	−1.030	0.155
	2#2015	−0.297	0.305	−0.97	0.331	−0.894	0.301							−0.564	0.306	−1.85	0.065	−1.163	0.035
	2#2016	−0.184	0.298	−0.62	0.536	−0.768	0.400							0.065	0.307	0.21	0.831	−0.535	0.666
	2#2017	−0.685	0.300	−2.29	0.022	−1.272	−0.098							−0.977	0.304	−3.22	0.001	−1.572	−0.382
	2#2018	−0.149	0.309	−0.48	0.631	−0.754	0.457							0.024	0.328	0.07	0.941	−0.618	0.666
	2#2019	−0.236	0.322	−0.73	0.464	−0.867	0.395							−0.714	0.328	−2.18	0.029	−1.356	−0.072
	2#2020	−0.647	0.324	−2	0.046	−1.281	−0.012							−0.555	0.334	−1.66	0.097	−1.210	0.100
_cons		−2.172	0.205	−10.62	0.000	−2.573	−1.771	−0.962	0.150	−6.4	0.000	−1.257	−0.668	−1.586	0.177	−8.95	0.000	−1.934	−1.239
Number of obs		4684																	
Log likelihood		−8121																	

Table 4
Marginal results from the generalized structural equation model.

Variables		dy/dx	Std.Err.	z	P > z	[95% Conf.	Interval]
Age							
	Exemption from tolls	0.007	0.00	11.69	0.000	0.006	0.008
	Free public parking	0.006	0.00	10.22	0.000	0.004	0.007
	TransitWITHOUTpassenger	0.004	0.00	8.94	0.000	0.003	0.005
0. No children 0–6years		(base	outcome)				
1. Children 0–6 years							
	Exemption from tolls	−0.046	0.02	−1.97	0.048	−0.092	0.000
	Free public parking	−0.074	0.02	−3.40	0.001	−0.117	−0.031
	TransitWITHOUTpassenger	−0.060	0.02	−2.97	0.003	−0.100	−0.020
0. No children 7–15 years		(base	outcome)				
1. Children 7–15 years							
	Exemption from tolls	−0.036	0.02	−1.86	0.063	−0.074	0.002
	Free public parking	−0.053	0.02	−2.91	0.004	−0.088	−0.017
	TransitWITHOUTpassenger						
2014.year		(baseoutcome)					
2015.year							
	Exemption from tolls	0.102	0.03	3.55	0.000	0.046	0.158
	Free public parking	0.029	0.03	0.96	0.335	−0.030	0.089
	TransitWITHOUTpassenger	0.125	0.03	4.45	0.000	0.070	0.180
2016.year							
	Exemption from tolls	0.134	0.03	4.77	0.000	0.079	0.189
	Free public parking	0.082	0.03	2.76	0.006	0.024	0.140
	TransitWITHOUTpassenger	0.102	0.03	3.65	0.000	0.047	0.157
2017.year							
	Exemption from tolls	0.150	0.03	5.26	0.000	0.094	0.205
	Free public parking	0.162	0.03	5.53	0.000	0.105	0.219
	TransitWITHOUTpassenger	0.248	0.03	9.16	0.000	0.195	0.301
2018.year							
	Exemption from tolls	0.245	0.03	8.29	0.000	0.187	0.303
	Free public parking	0.220	0.03	7.45	0.000	0.162	0.277
	TransitWITHOUTpassenger	0.323	0.03	12.31	0.000	0.271	0.374
2019.year							
	Exemption from tolls	0.312	0.03	10.68	0.000	0.254	0.369
	Free public parking	0.266	0.03	9.34	0.000	0.210	0.322
	TransitWITHOUTpassenger	0.338	0.03	13.13	0.000	0.287	0.388
2020.year							
	Exemption from tolls	0.387	0.03	13.57	0.000	0.331	0.442
	Free public parking	0.302	0.03	10.77	0.000	0.247	0.358
	TransitWITHOUTpassenger	0.343	0.03	13.27	0.000	0.293	0.394
0: ICEV		(baseoutcome)					
1.BEV	Exemption from tolls	−0.384	0.02	−21.22	0.000	−0.419	−0.348
	Free public parking	−0.363	0.02	−17.15	0.000	−0.405	−0.322
	TransitWITHOUTpassenger	−0.308	0.02	−14.01	0.000	−0.351	−0.265

children in that age group, with all other variables controlled for ($p < 0.1$). People with small children may be more likely to drive during rush hours to pick up their children (especially those under 6 years old, who are not allowed to go home alone). Therefore, they may have a greater benefit from BEV incentives than those who may have higher flexibility in their work hours. A recent study also found that couples with children are largely overrepresented among BEV owners (Fevang et al., 2021). The same study also found that BEV owners tend to be in the 25–44 age group. Hence, it is natural that young people and those with children would be less negative towards BEV incentives, since they are likely to obtain the benefits of the incentives.

5.2. *The impact of fuel type on attitudes towards BEV incentives*

The next variable considers whether BEV users have a different attitude than ICEV users; see the marginal results in Table 4. The variable “BEV” is also significant ($p < 0.001$) and suggests that a BEV user is 31–38 percentage points less likely to disapprove of the economic benefits of BEVs than ICEV users. This is logical since they receive these economic benefits, which is one reason why people buy BEVs (Bjerkan et al., 2016; Figenbaum and Nordbakke, 2019). However, Fig. 3 shows that although BEV owners are still less likely to have a negative opinion, the share of those who disagree with the economic benefits is increasing. Fig. 3 shows the probability of disagreement of the three incentives. The red line identifies those who have a BEV, and the blue line identifies those who do not. Recall that the share of BEVs is increasing, from 3% in 2014 to 25% in 2020. There is a jump in the likelihood of ICEV users disagreeing with BEV incentives in 2017. The reason is likely the introduction of congestion tolls, which were implemented in the study area in 2017. Congestion tolls indicate a higher toll during rush hour, which increases costs for ICEV users, while BEV users were still exempted from the toll. During rush hour, the toll increased by approximately 50% for petrol vehicles and almost 60% for diesel vehicles (Fjellinjen, 2022).

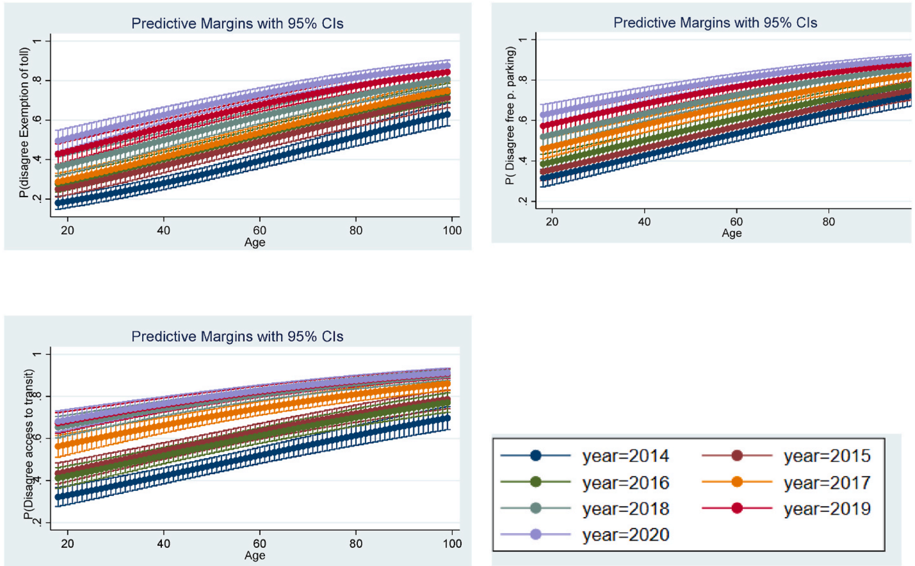

Fig. 2. Probability of disapproving of the incentives studied in 2014–2020.

5.3. Impact of environmental concerns

This section represents environmental concerns divided into the three variables of “finance public transport”, “pollution” and “measures to reduce pollution”. See the marginal results in Table 5.

The participants in the questionnaire were informed of the following: “Part of the income from the toll ring in Oslo and between Oslo and Bærum today goes to the public transport system in Oslo and Akershus. The goal is faster development of the public transport service than with only ordinary allocations. The investment will, among other things, increase capacity, speed and multiple departures”. Thereafter, they were asked “Do you agree or disagree that road users who drive a car should pay for improvements to the public transport system in this way?” The variable “finance public transport” represents this question as a dummy variable, where the possible answers are “agree”, “disagree” or “do not know”. “Agree” is the reference category. This variable is excluded from the regression for access to transit lanes and free public parking because it is nonsignificant. Compared to those who agreed that tolls should be used on public transport, those who disagreed were 7 percentage points ($p < 0.05$) more likely to be negative towards toll exemptions for BEV users.

The variable “pollution” represents whether the participants agree or disagree with a toll system based on vehicle-generated pollution. This is a dummy variable, where “agree” is the reference category. Those who disagree with such a system are also 13 percentage points more likely to disapprove of toll exemptions and free public parking and 5 percentage points more likely to disagree with access to transit lanes without passengers than those who agree with such a system.

The variable “measures to reduce pollution” represents those who agree as a reference category that measures to reduce pollution, i.e., environmental speed limits, should be implemented. Environmental speed limits are used to reduce local pollution by, for instance, reducing the traffic speed limit from 80 km/h to 60 km/h in the winter (Lopez-Aparicio et al., 2020). Those who disagree or do not know are 5–8 percentage points ($p < 0.05$) more likely to disapprove of free public parking and the exemption from tolls for BEVs than those who approve of the implementation of measures that reduce pollution when all other variables are controlled for.

The results from the three variables described above indicate that those who disagree that environmental travel policies, such as the use toll on public transport and toll charges based on vehicle-generated pollution, should be implemented are more likely to disapprove of BEV benefits. The implied intent of the BEV incentives is to make people change vehicles from ICEVs to BEVs. Thus, the results indicate that those with greater environmental concerns are more likely to be positive towards BEV incentives. Environmental concerns are found to be important for early adopters of BEVs (Bjørge et al., 2022). However, the characteristics of BEV owners in Norway are becoming more similar to those of other car owners (Fevang et al., 2021).

5.4. Impact of satisfaction with soft modes and whether tolls impact travel habits

This section represents those who are satisfied with soft modes encouraging active mobility, such as walking or cycling, and whether tolls impact their travel habits. See the marginal results in Table 5. Those who are satisfied with walking facilities in the greater Oslo area show a significant opinion only for the dependent variable “road toll exemption”. The variable was originally a 5-point scale from very dissatisfied to very satisfied. The fifth alternative was “do not know” (see Table 2a). To simplify the alternatives and presentations in this study, we combine very dissatisfied and quite dissatisfied responses and quite satisfied and very satisfied responses. As a result, we obtain three different groups, namely, dissatisfied as the reference category, satisfied and do not know. Those who are satisfied with the walking facilities are 6 percentage points less likely to disapprove of toll exemptions compared to those who are dissatisfied with the walking facilities. The category “do not know” does not significantly differ from the reference category in the respondents’ disagreement of toll exemptions.

Similar to the variable “walking facilities”, the variable satisfied with bike facilities is reduced to a three-point scale. Compared with those who are dissatisfied with the cycle path network in the larger Oslo area, those who are satisfied are 8 percentage points more likely ($p < 0.05$) to disagree with toll exemptions and 5 percentage points more likely ($p < 0.05$) to disagree with free public parking, while those who do not know are 5 and 7 percentage points more likely ($p < 0.05$) to disagree with toll exemptions and free public parking, respectively, with everything else held constant. This result is logical, as walking is rarely a substitute for a vehicle, but a bicycle can be a substitute for a vehicle for a variety of distances. However, there is also a significant interaction term between how satisfied people are with bike facilities and the year (see Table 3, $p < 0,1$). For the dependent variable exemption from tolls, the interaction term is significant only in 2018 for those who are satisfied with bike facilities and in 2017 for those who do not have any opinion about the

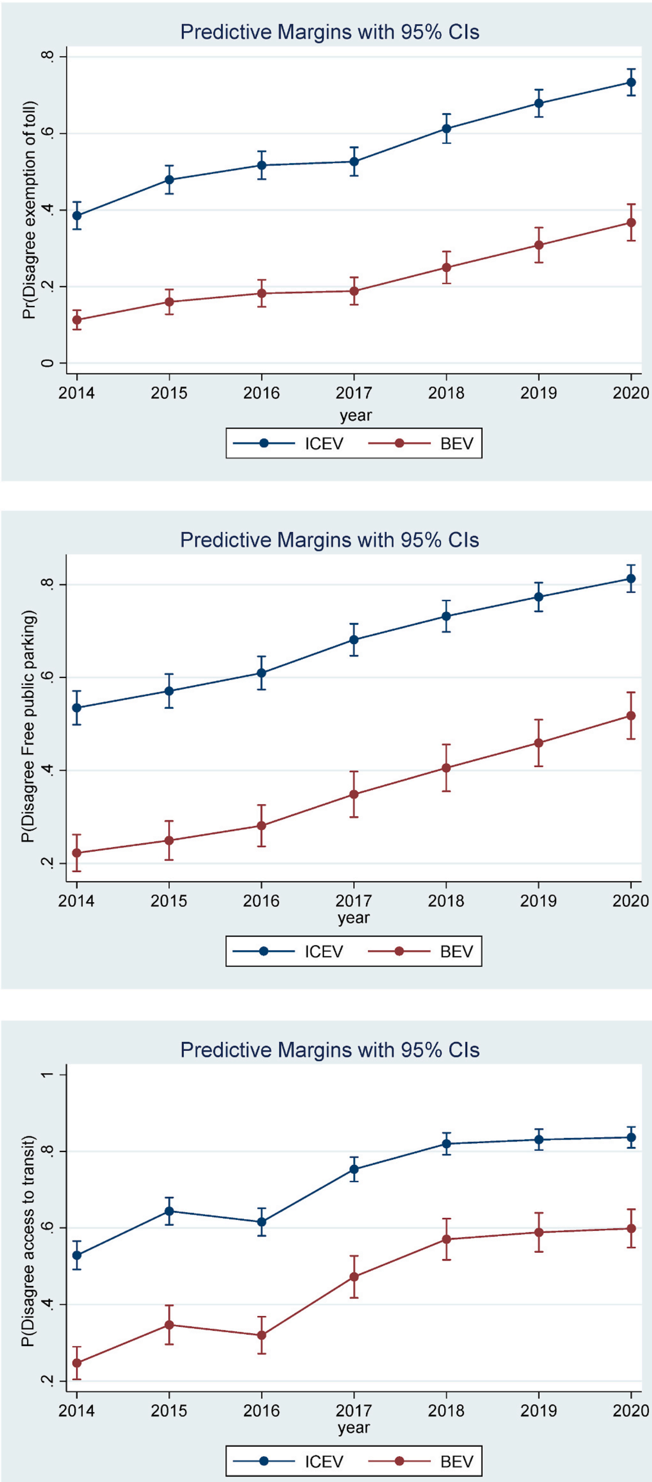

Fig. 3. Probability of disagreement with toll exemptions, free public parking and access to transit lanes without passengers for BEV users and ICEV users.

bike facilities. Compared to the benchmark outcome (dissatisfied with bike facilities in 2014), the results of other groups are less likely to be negative towards the exemption from tolls. Furthermore, from 2017 to 2019, those who were satisfied with bike facilities were less likely to be negative towards free public parking than those who were dissatisfied in the benchmark year of 2014. Those who do not know what they think about bike facilities are also less likely to be negative towards free public parking in 2017, 2019 and 2020 compared to those who are not satisfied with the bike facilities in the benchmark year 2014. The reason may be that in 2018, the congestion toll system had already been implemented for a year, and local communities could take parking charges for BEVs; therefore, people may have changed their travel habits after a year.

Those who report that they travel less with the Oslo cordon toll system are 3–4 percentage points ($p < 0.1$) less likely to disagree with BEV incentives than those who report that they do not travel less with the Oslo cordon toll system. This result is logical because those who change travel patterns because of a toll are more strongly affected by the toll. BEV users are less affected by tolls since they pay less; thus, those who have changed their travel patterns may support BEV incentives to a greater extent. The variable is also significant as an interaction term with the variable "pollution". The results are shown in Fig. 4. Fig. 4 illustrates that those who disagree with the toll system based on vehicle-generated pollution are also more likely to have a negative attitude towards the exemption from tolls, as already discussed in section 5c. Furthermore, this illustrates that those who state that they travel less because of tolls are also more likely to disagree with the toll system based on vehicle-generated pollution.

This study examines road users' attitudes towards BEV incentives by employing a rich data set. It provides evidence of decreasing support for incentive policies; for instance, the opinions of citizens in the larger Oslo area towards toll exemptions are approximately 40 percentage points more likely to be negative in 2020 than 2014, with all the other variables controlled for. We see the same tendency with the other two incentives. This is important for the Norwegian government to know when considering reducing incentives. The study confirms that information campaigns are important and indicates that, for instance, younger people are more likely to be in favour of such benefits.

6. Concluding remarks and policy implications

Many studies have investigated the extent to which government BEV incentives are effective and how those incentives can contribute to BEV adoption. However, few if any studies have examined car users' attitudes towards BEV incentives and mapped the development of these attitudes over time.

The present study is a case study of the greater Oslo area; Oslo has been ranked as the world capital of BEV usage since 2014. Furthermore, the Norwegian government is currently a front-runner in terms of its comprehensive use of BEV incentives as a means of decarbonizing road transport. The data set used is from an annual questionnaire survey conducted each year for the period of 2014–2020. Respondents were asked to express their attitudes towards the different BEV incentives in place.

The study was intended to help decision makers identify the factors that affect attitudes towards the three economic benefits for BEV users of free public parking, access to transit lanes without passengers, and exemption from tolls in the greater Oslo area. There is already an ongoing discussion in Norway about reducing these incentives. This study shows the changes over the years 2014–2020 in Oslo citizens' attitudes towards individual economic benefits. If the government gives clear signals of why and how these economic benefits change, it may be easier for the people to accept the reduction in incentives offered. The battery price is falling (Bloomberg, 2021); hence, the relative price difference between BEVs and ICEVs is decreasing. The information derived from this study could then be used to inform those groups of road users who are the most positive towards the incentives about adverse effects of the incentives. Furthermore, such information would be valuable for other countries considering incentives to promote the purchase and use of BEVs. Similar studies also found that BEV users highlighted the driving characteristics, silence and exciting technology as incentivizing (Ingeborgrud & Ryghaug, 2019). Several of the incentives were perceived as a bonus and not perceived as necessary to engender the purchase of a BEV, except for those with the least comfortable vehicle (Buddy), which also indicates that BEV users should

Table 5
Marginal results from the generalized structural equation model.

Variables		dy/dx	Std.Err.	z	P > z	[95% Conf.	Interval]
1.Agree finance public transport		(baseoutcome)					
2.Disagree finance public transport							
	Exemption from tolls	0.068	0.02	3.53	0.000	0.030	0.106
	Free public parking	–	–	–	–	–	–
	TransitWITHOUTpassenger	–	–	–	–	–	–
3. Do not know_ finance public transport							
	Exemption from tolls	0.057	0.04	1.40	0.161	−0.023	0.137
	Free public parking	–	–	–	–	–	–
	TransitWITHOUTpassenger	–	–	–	–	–	–
1.Pollution		(baseoutcome)					
2.Pollution							
	Exemption from tolls	0.131	0.02	6.87	0.000	0.093	0.168
	Free public parking	0.127	0.02	7.36	0.000	0.093	0.161
	TransitWITHOUTpassenger	0.054	0.02	3.40	0.001	0.023	0.086
3.Pollution							
	Exemption from tolls	0.084	0.02	3.62	0.000	0.039	0.130
	Free public parking	0.095	0.02	4.39	0.000	0.052	0.137
	TransitWITHOUTpassenger	0.034	0.02	1.68	0.094	−0.006	0.074
1.Measures to reducepollution		(baseoutcome)					
2.Disagree with measures to reduce pollution							
	Exemption from tolls	0.079	0.02	3.40	0.001	0.033	0.125
	Free public parking	0.056	0.02	2.66	0.008	0.015	0.096
	TransitWITHOUTpassenger	–	–	–	–	–	–
3. Do not know							
	Exemption from tolls	0.093	0.04	2.11	0.035	0.007	0.179
	Free public parking	0.041	0.04	1.00	0.319	−0.039	0.121
	TransitWITHOUTpassenger	–	–	–	–	–	–
1.Dissaiesfied walking facilities		(baseoutcome)					
2.Satiesfied walking facilities							
	Exemption from tolls	−0.058	0.02	−2.48	0.013	−0.103	−0.012
	Free public parking						
	TransitWITHOUTpassenger						
3.Do not know							
	Exemption from tolls	−0.034	0.05	−0.73	0.466	−0.125	0.057
	Free public parking						
	TransitWITHOUTpassenger						
1.Dissatiesfied bike facilities		(baseoutcome)					
2.Satiesfied bike facilities							
	Exemption from tolls	0.081	0.02	4.18	0.000	0.043	0.119
	Free public parking	0.050	0.02	2.76	0.006	0.014	0.085
	TransitWITHOUTpassenger	–	–	–	–	–	–
3. Do not know							
	Exemption from tolls	0.040	0.02	1.86	0.063	−0.002	0.083
	Free public parking	0.064	0.02	3.17	0.002	0.024	0.103
	TransitWITHOUTpassenger	–	–	–	–	–	–
1.Travel less with toll		(baseoutcome)					
2.Travel less with toll (Agree)							
	Exemption from tolls	−0.034	0.02	−1.96	0.050	−0.069	0.000
	Free public parking	−0.026	0.02	−1.61	0.108	−0.058	0.006
	TransitWITHOUTpassenger	−0.036	0.01	−2.38	0.017	−0.065	−0.006
3.Travel less with toll (do not know)							
	Exemption from tolls	0.019	0.04	0.48	0.633	−0.059	0.097
	Free public parking	−0.009	0.04	−0.24	0.807	−0.081	0.063
	TransitWITHOUTpassenger	−0.016	0.03	−0.47	0.638	−0.082	0.050

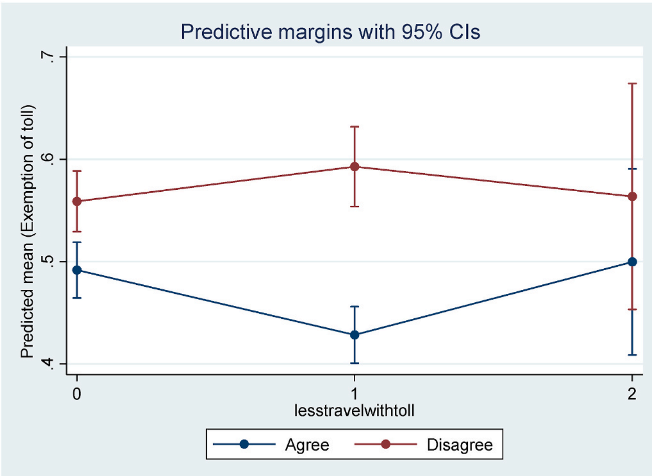

Fig. 4. Probability of disagreement with toll exemptions measured for the variables less travel with tolls and the variable “pollution”.

not be treated as a homogenous group (Ingeborgrud & Ryghaug, 2019). People living in greater Oslo are starting to disagree with beneficial BEV incentives such as those already mentioned. BEV users are significantly less likely to disagree with the incentives than ICEV users; however, the share who disagree is increasing. As individuals grow older, they become more likely to disagree with the incentives and perhaps are likely to be less tolerant that the government funds such incentives. Children also tend to matter; those with children under 15 years old are less likely to disagree with the incentives. This corresponds with other studies. Socioeconomic characteristics such as age and having children in the household also impact the adoption of BEVs (Austmann, 2021; Fevang et al., 2021). Naturally, those who obtain the benefits of incentives will be less negative towards them. Those who are satisfied with the cycle path network also have a higher probability of disagreeing with the incentives. Environmental concerns are found to be important for early adopters of BEVs (Bjørge et al., 2022). The results indicate that those with greater environmental concerns are more likely to be positive towards BEV incentives. However, the characteristics of BEV owners in Norway are becoming more similar to those of other car owners (Fevang et al., 2021). Policies from the Norwegian government have consistently obtained their intended results, i.e., an increase in BEV market share over growth in ICEVs. It may be time to wind back such policies. The market is mature, and spending on such policies is becoming less acceptable to the public; the purchase price relative to ICEVs is also coming down (Bloomberg, 2021), and these incentives will no longer be needed in the near future in Norway.

7. Limitations and further research

One of the limitations of this study is that people traveled less in 2020 due to the coronavirus pandemic; hence, their attitudes in that particular year may have been influenced. Furthermore, it would be interesting to investigate whether the pandemic has changed attitudes. For instance, Oslo citizens recommended not taking public transport during lockdown, which may have increased the demand for BEVs. Another limitation of the study is that the results cannot be assumed to be generalizable due to the different socioeconomic compositions of cities/countries. In addition, Norway is quite unique in regard to its BEV purchase and user incentives. These factors have led to the world’s largest share of BEVs per capita in recent years. It is therefore difficult to compare Norway with other countries. The dependent variables could have had a larger Likert scale to differentiate them more. However, the results may be seen as evidence that such strong incentives are not necessary even for users as the market matures. Nonetheless, the incentives have, as already mentioned, led to a sharp increase in purchases and use. Therefore, they may have been necessary in the short run, but it may be time to reduce them in Norway.

CRediT authorship contribution statement

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

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