Case Studies on Transport Policy 9 (2021) 1151–1159

Contents lists available at ScienceDirect

Case Studies on Transport Policy

journal homepage: www.elsevier.com/locate/cstp

Impact of fiscal incentives in the consumption of low emission vehicles

Jorge Urrutia-Mosquera *, Jorge Fábrega

Research Center in Social Complexity (CICS). Universidad del Desarrollo. Chile

ARTICLE INFO

Keywords:
Low emission vehicles
Economic incentives
Subsidy policy
Stated preference
Discrete choice model

ABSTRACT

Due to the high emissions produced by the transportation sector, one of the most implemented policies worldwide is the economic incentive to purchase electric and hybrid vehicles. The adoption of these policies in developing countries is scarce or null and there are no studies that investigate the impact of economic incentives in the potential demand for low emission vehicles. This paper covers this gap.

Using data from a stated preference experiment in Santiago of Chile, specifically built to collect individuals' preferences for incentives to low emission vehicles, a mixed logit model was estimated and results used to compute willingness to pay. In parallel, a contingent evaluation experiment was conducted to elicit individuals' willingness to pay under two specific policies, involving different ways to provide fiscal incentives. Results shows that individuals are more sensitive to autonomy and incentives in the case of electric vehicles in relation to conventional/hybrid type. Likewise, results show that for an exemption from VAT payment and any type of sales and purchase tax, 72% of individuals would be willing to purchase an electric vehicle, and 76% of individuals would be willing to purchase a hybrid vehicle, waiting for an adequate incentive policy for it.

1. Introduction

The problem of climate change has motivated the Nations members of the Framework Convention about climate change, to establish actions and public policies aiming to mitigate the effect of climate change, and in particular, to reduce the greenhouse gas emission produced by private cars. Several policies have been put in place to stimulate the adoption and use of electric and hybrid vehicles, as a way to reduce CO2 emission, MP2.5 concentrations and O3 produced by the private use of automotive ground. Countries such as Norway, United States, Netherlands, France, Japan, South Korea, Germany, and England, have been the pioneers in testing diverse policies and incentives including fiscal incentives, and have regularly monitored the diffusion of this market over the last decades. The situation is very different in the developing countries. In Latin America, in particular, there is no official data on the market share of electric and hybrid vehicles. However, newspapers in the most important countries of the region (Brazil, Chile, Argentina, Mexico and Colombia) report that the current market share is of the order of 0.00001%; an insignificant value compared to the United States and Europe where the lowest market share is of the order of 1.6%. Moreover, in Latin America, there is no evidence of a political agenda that encourages the adoption of this type of vehicles, with the exception of Mexico and Costa Rica that have incorporated government initiatives to exempt tax and VAT (Value-Added Tax) payment of electric and hybrid vehicles.

There is a particularly vast literature about the demand for low emission vehicles, a recent review can be found at Hardman (2019). Several studies, within this vast literature, have explicitly considered the effect of fiscal incentives in the adoption of electric and hybrid vehicles. These incentives refer to: subsidies to purchase price (Kwon et al., 2018; Diamond, 2009; Jenn et al., 2013; Jin et al., 2014; Fridstrøm and Alfsen, 2014; Assum et al., 2014; Ewing and Sarigöllü, 1998, 2000; Bjerkan et al., 2016; Wang et al., 2018), special taxes for electric and hybrid vehicles (Chandra et al., 2010; Gass et al., 2014; Assum et al., 2014; Tal and Nicholas, 2016; Bjerkan et al., 2016), gas tax (Horne et al., 2005; Caulfield et al., 2010; Bjerkan et al., 2016), subsidies to clean fuels and energy (Kwon et al., 2018; Irawan et al., 2018; Beresteanu and Li, 2011; Gallagher and Muehlegger, 2011; Fridstrøm and Alfsen, 2014a, 2014b; Bjerkan et al., 2016), taxes on specific emissions, tax reduction on the purchase of electric and hybrid vehicles, exemption for electric and hybrid vehicles from paying roads use fees, discount on the electric tariff, exemption for buyers of electric vehicles from paying driver's licenses (Brand et al., 2013; Wee et al., 2018; Bjerkan et al., 2016; Langbroek et al., 2016; Nanaki and Koroneos, 2016; Wang et al., 2017b), subsidies to charger installation (O'Neill et al., 2019; Kwon et al., 2018; Figenbaum and Kolbenstvedt, 2013; Wang et al., 2017a). Subsidies to

* Corresponding author at: Las Condes 7610658, Chile.
E-mail address: jurrutiam@udd.cl (J. Urrutia-Mosquera).

https://doi.org/10.1016/j.cstp.2021.06.003
Received 14 January 2021; Received in revised form 28 May 2021; Accepted 8 June 2021
Available online 12 June 2021

lease cars (Van Eck et al., 2019).

The most important findings from these works indicate that, for potential buyers of low emission vehicles, the most effective monetary incentives are the fiscal policies that affect car ownership, such as purchase subsidies and purchase tax reduction; and in the case of vehicle owners, the most effective monetary incentives are those oriented to the operation and use of the vehicle, such as discounts on the electric charge rate, exempt from the payment of the fees for using roads and highways to electric and hybrid vehicles. However, none of these studies investigate which mechanism is more attractive for the operationalization of the subsidy, they also do not consider the effect of the discounts offered by conventional vehicle sellers to maintain their markup quota, as a way to compete with the reduction of the price of low pollution vehicles. We believe that including these elements in the analysis helps to improve the understanding of consumer behaviour, and to shed light into the fiscal mechanisms that would be less expensive and more effective for governments, in terms of implementation, and that positively impacts potential demand of low emission vehicles.

Since monetary incentives impacts the purchase capability, several papers (Caulfield et al., 2010; Potoglou and Kanaroglou, 2007; Saarenpää et al., 2013; Sangkapichai and Saphores, 2009; Zhang et al., 2019) have tested if income affects the preference for low emission cars. However, none of these works have explicitly tested for income effect (i.e. if the marginal utility of income change with level of available income). In the context of low emission vehicles, at our best knowledge, Mabit and Fosgerau (2011), Jensen et al. (2014) and Rotaris et al. (2021), are the only ones who tested income effect, but they do not study explicitly the impact of incentives. None of these three studies found a significant income effect, maybe because their work is applied in Denmark, a wealthy country, o Italy and Slovenia, countries where there is a strong middle class. Studies on a different preference context showed that income effect can play an important role in developing countries.

All these studies on electric vehicles have been carried out in developed countries, as these are were the EV market started. Soto et al. (2018) is the only paper that studies electric vehicles (EV) and hybrid vehicles (HV) penetration in South America, but this does not include economic incentives and income effects. Its main finding indicates that users have a high sensitivity to the purchase price, the cost of refuelling and the need for a greater presence of fuel stations. In this work, we aim to contribute to this literature and share some light on the efficacy of different fiscal incentives and the counter effect of discount on conventional vehicles on the purchase of EV. This research is targeted specifically to developing countries. We use Chile as a case study and consider it a good example to understand the processes of adoption of low emission vehicles in other developing countries, as it is a country that has some of the important conditions for this process. For example, Chile has an excellent road network system and excellent transport infrastructure conditions. It is a country that enjoys a stable economic system and also has a high rate of motorization. It also has free trade agreements with the EE.UU., which is one of the largest manufacturers of electric vehicles. It is also a country with a per capita income that has ranged between 13,847 and 19,424 dollars, from 2017 and 2020. This fact makes it possible for its inhabitants to have the capacity to acquire this type of technology.

The study of fiscal incentives in developing countries opens up interesting research questions, due to the different level of economic wealth compared to US and European countries, and consequently different impact on a large segment of population with low income. Our study uses data collected in Santiago of Chile, the capital city of the country, which has the largest private automotive fleet in Chile. The city of Santiago suffers of high levels of pollution especially in the winter period; at this period restrictions on the circulation of private vehicles are implemented, in order to reduce the levels of particulate matter (MP2.5).

The contribution of this investigation lies in three aspects. First, it evaluates the effect that subsidies on purchase price has on the preference for low emission vehicles, explicitly accounting for income effect. Second, it specifically evaluates the relative attractiveness between an exemption of VAT versus exemption of purchase tax, as well as the return of income taxes, for the adoption of electric and hybrid vehicles. Third, as far as we know, this is the first work of this kind in a country with a developing economy (like in Latin American).

The rest of this article is organized in the following way: Section 2 discusses the questionnaire and survey methodology. Section 3 presents the main modeling approach, the structure of the model and results. Section 4 presents the effects of two specific subsidy policies on the willingness to buy low-pollution vehicles. Section 5 presents an integral discussion of results while Section 6 summarizes the Conclusion and policy implications.

2. Data collection

2.1. Questionnaire and survey methodology

The data used in this study has been collected in the city of Santiago de Chile that is by far the largest city in the country. According to 2017 population census, the city houses a total of 6.310.000 people, compared to an overall population in Chile of 17.574.003 As a consequence of that, Santiago is also the city with the largest use of private vehicles in the country, with around 56% of the trips made by private vehicles, according to figures published in March 2016 by the Civil Identification Registry and the national statistical institute (Instituto Nacional de Estadística, 2017b).

The questionnaire used to collect the data is articulated in 6 parts. Section 1 included information about driving frequency (namely the number of times the car is used in a week), driving distance (i.e. the average daily distance travelled) and the main purpose the vehicle is used for. Section 2 contained the stated preference experiment and Section 3 information about the attractiveness of the fiscal policies for low emission vehicles. In section 4, respondents were asked to report their level of agreement or disagreement regarding a set of statements on environmental concerns or pro-environmental inclinations. Finally, Section 5 asked key socio-economic information, such as civil status and age, education level, size of the household and more importantly the respondent's income. This paper focuses on the stated preferences and the attractiveness of the fiscal policies.

The stated preference experiment (Section 2) consists of a choice among three alternatives: a conventional car (CV), and electric vehicle (EV) and a hybrid vehicle (HEV). Since this study focuses on the impact of incentives, the alternatives were described in terms of *purchase price*, *fiscal incentive* offered by the government (subsidy) for electric and hybrid cars and discount purchase for the conventional vehicles offered by dealers (these are not subsidies). We also included the driving range, because this has been found to be a key attribute in all studies on EV. Pilot tests were conducted initially including also fuel and electricity costs, charging network and time to charging the vehicles. In the pilot tests respondents were also explicitly asked to indicate which attributes they considered the most important in their choices. Results showed that the three attributes: purchase price, fiscal incentive/discount and range were by far the most important attributes. It was then decided to focus the experiment only on these attributes and describe the others before the experiment and kept them fixed across the choice tasks. Non-monetary attributes, such as the use of exclusive lanes or free parking spots, were not considered because those policies would not be realistic for the Chilean context, given that parking is operated by private companies. Table 1. Shows the levels of the attributes used in the survey. The values for the purchase price, incentives, and discounted purchase were presented in Chilean pesos. For 2017, one dollar was equivalent to 650 Chilean pesos on average.

The stated preference experiment was based on a fractional factorial experimental design, allowing for interactions and quadratic effects. The three attributes included in the design all had three levels. The values

Table 1
Attributes and levels of the discrete choice experiment.

Attribute	Type	Description (levels)		
Purchase price (CLP)	Continuous	Purchase price (CV)	Purchase price (EV)	Purchase price (HEV)
		$10,029,000	$13,290,000	$18,357,000
		$13,290,000	$24,049,100	$19,667,300
		$16,190,000	$25,759,700	$20,290,000
Discount purchase (CLP) Incentives (CLP)	Percentage	Discount purchase (CV). Discount rate	Incentives (EV). Subsidy rate	Incentives (HEV). Subsidy rate
		10%	30%	20%
		20%	35%	30%
		30%	40%	40%
Driving range	Continuous	Driving range (CV)	Driving range (EV)	Driving range (HEV)
		450 (Km)	199 (Km)	350 (Km)
		550 (Km)	250 (Km)	450 (Km)
		650 (Km)	280 (Km)	550 (Km)

have been defined based on the real values of the Chilean market. At the time the survey was carried out, the only electric and hybrid vehicles available in Chile were of average size (like Nissan Leaf, Yundai Ioniq or Toyota Prius). Purchase price and driving range in the experiment refer then to an average vehicle.

After completing the stated preference experiment, respondents were also asked (Section 3) to indicate their willingness ("very willing", "willing", "indifferent") to buy a hybrid or electric vehicle for two specific incentive policies:

Policy 1: refund of the value paid in the return of the income tax, that is, the difference between the cost of the commercial value of an electric vehicle versus a conventional one.

Policy 2: exemption of the VAT payment and any other type of tax on the purchase and sale of electric and hybrid vehicles.

The final survey was run between October and December 2017. Respondents were contacted in their homes, in workplaces and malls. Participation was on a voluntary basis; no incentives were given to participate. The only condition to be eligible was that respondents needed to be 30 years old or more, own a car or express the intention to buy a car in the next coming months and have a net monthly income of at least 800 thousand Chilean pesos (Equivalent to USD 1230). The final survey included 525 individuals. Of these, 23 were excluded from the analysis since presented incomplete information due to a technical problem or inconsistent information. Table 1 reports a summary of the main socio-economic characteristics of the sample and a comparison with the national figures.

2.2. Descriptive analyses

This section reports a descriptive analysis of the main information collected in the survey. Table 2 shows a summary of the socio-demographic characteristics of the sample and the socio-demographic characteristics of the population (Instituto Nacional de Estadística, 2017a). The sample is not representative of the population. By design, the largest proportion of individuals in the sample are young people (between 30 and 40), highly educated, with medium–high income. This condition in the sample was necessary for the public surveyed to have the purchasing power given the price of the three types of vehicles compared. Table 3 shows the statistics of the activities, for which survey respondents use the vehicle.

Figs. 2 and 3 show the frequency of renewal time and the frequency of vehicle use. 35% of the sample reported that they change cars after 3–4 years of usage and 38% after 5–6 years of usage, which means that 73% of the sample plans to renovate their vehicles after 3 to 6 years. Fig. 3 shows that the majority of the sample uses the vehicle 3–4 times a week, and males tend to use cars much more than females (73% of men versus 59% of women use cars more than 3 times a week).

Table 2
Socio-demographic characteristics.

	Sample	Chilean population[a]
Gender:		
Female	44%	51%
Male	56%	49%
Age		
30–40	47%	35%
40–50	24%	22%
50–60	21%	17%
More than 60	8%	26%
Educational level		
Incomplete secondary education	4%	18%
Complete secondary education	7%	36%
Incomplete university education	10%	11%
Complete technical education	15%	12%
Complete university education	50%	20%
Postgraduate studies	14%	3%
Average monthly net income		
678.3 $ US – 1204.7 $ US	29%	55%
1206.1 $ US – $20052.6 US	34%	27%
2054 $ US – 3435.6 $ US	24%	9%
3437.1 $ US – 5789.4 $ US	11%	6%
More than 5789.4 $ US	2%	3%

[a] Source: Own elaboration, from the Socio-economic survey CASEN 2017 and Income supplementary survey INE (national statistical institute).

Table 3
Trips characteristics in the sample.

	Male	Female
Main purpose the vehicle is used for		
	%	%
Shopping trips	29,2%	41,08%
Trips to work	53,66%	43,93
Travel for leisure	31,78%	35.96%
Long trips	26,79%	29,28%

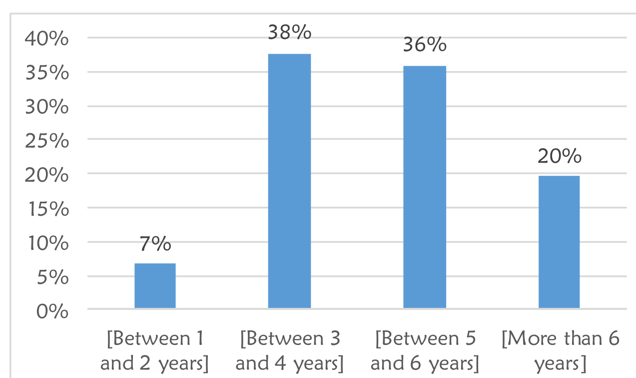

Fig. 2. Information on renewal time.

Figs. 4 and 5 show respondents' agreements to the two incentive policies tested. Results indicate that the second policy (exemption of the VAT payment and any other type of tax on the purchase and sale of electric and hybrid vehicles) seems to be more attractive than the first policy (return of the value paid in the income tax). 55% of the sample declared to be willing to purchase an EV (Fig. 4), and 63% (Fig. 4) a hybrid vehicle if policy 1 is implemented. If the policy is the exemption of VAT payment and any other type of taxes, instead, 72% (Fig. 5) of the sample declared to be willing to buy an electric vehicle and 76% (Fig. 5) a hybrid vehicle. This result is consistent with the psychological literature that reports that people prefer an immediate discount compared to

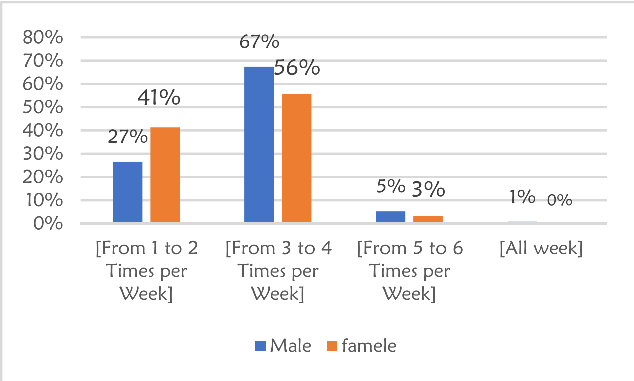

Fig. 3. Information on driving frequency.

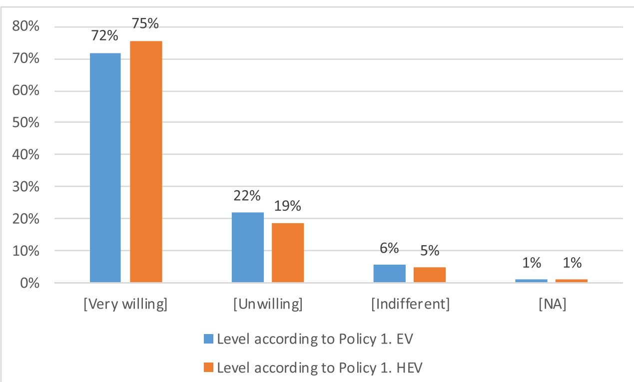

Fig. 4. Level according to Policy 1. EV and HEV.

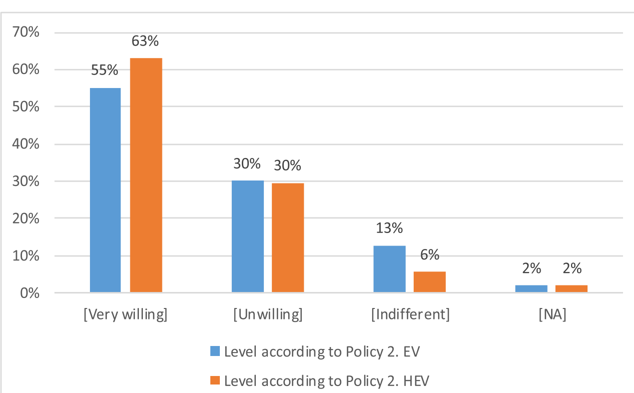

Fig. 5. Level according to Policy 2. EV and HEV.

the promise of a future discount.

3. Stated preference of type of engine

3.1. Modelling approach

For the choice of the type of engine (electric, hybrid or conventional), given the nature of the choice experiment, where respondents are asked to choose one option over a set of 3 mutually exclusive alternatives, in multiple scenarios, we used a typical mixed logit model with panel effect (ML) that allows accounting for intra-observation correlation (Train, 2009) in a discrete choice context. Mixed Logit models ground on the theory of random utility (McFadden, 1981) that assumes that an individual q, choosing among a finite set of j alternatives will evaluate all the characteristics of each alternative and will choose the option that provides her/him the highest utility. The evaluation of the alternative might be different among individuals depending on their socio-economic characteristics (SE) and other factors that are unknown to the modeler and/or to the respondents themselves. Consequently, the utility function for the alternative j in the situation of election t can be written as:

$$U^t_{jq} = ASC_j + \beta_j ATV^t_{jq} + \delta SE_q + \gamma_j (ATV^t_{jq} * SE_q) + \eta_{jq} + \varepsilon^t_{jq} \quad (1)$$

Where ASC_j is the alternative specific constant, $\beta_j, \delta, \gamma_j$are vectors of coefficients associated with the characteristics of the alternatives (ATV^t_{jq}) and the socio-economic characteristics (SE_q) of the individuals.η_{jq} is a random term distributed normal (Mabit and Fosgerau,2011), with mean zero and standard deviation σ_j, that takes into consideration the panel correlation. ε^t_{jq} is the error component, identical and identically distributed EV1 among scenarios and individuals. The probability of choosing the sequence of alternatives $j = \{j_1, \cdots, j_T\}$ is the integral of logit probability LP (η) conditional on the random term η:

$$P_{jq} = \int LP(\eta) d(\eta) \quad (2)$$

Where$LP(\eta)$, is the conditional mixed logit probability of the choice sequence of the different vehicle alternatives evaluated at the parameters(η), and it takes the following form:

$$LP_{jq} = \prod_t \frac{\exp(U^t_{jq}(\eta_{jq}))}{\sum_k \exp(U^t_{kq}(\eta_{jk}))} \quad (3)$$

3.2. Models results

The results of the estimated Mixed Logit (ML) models are presented in Table 4. The first two models (ML1 and ML2) differ in the way we tested the incentives. Since the incentive and the discount are expressed in terms of % to be applied to the purchase price, we first tested if what respondents evaluated was the price minus the amount of the discount/incentive (ML1) or the amount of the discount/incentive separated from the actual price of the vehicle (ML2).

Results show that model ML2 is significantly superior (both Akaike and BIC measures are lower) to model ML1, meaning that the economic incentives are not seen only as a net reduction in the purchase price, but the type of incentive received also has a significant impact in the choice of low emission vehicles. Both models include the squared of the price attributes. This allows testing the presence of income effect. Following Jara-Díaz and Videla (1989) and Cherchi and Ortúzar (2006) if the price squared is significant and positive, this is the first indication of income effect, because the marginal utility of the price in absolute value decreases as the price increases. As we can see, none of the two specifications confirm the presence of income effect. In both cases the price squared is significant but not positive.

Like Rotaris et al. (2021), Jensen et al. (2014) and Mabit and Fosgerau (2011), we did not succeed in testing the income effect with our quadratic way of specifying the purchase price. We attribute this to the socio-economic characteristics of the sample. By sample design, the individuals considered were people with high incomes due to their purchasing power. We believe that in the case of Chile, this may have been a determining factor in the results we obtained. This is something we hope to test in a future study with a more socio-economically diverse sample.

The third model includes the price as it was presented in the stated preference experiment, simply linear (not squared) but tested if income affects specifically the marginal utility of the discount/incentive. It includes a term that is the discount divided by income. This has a negative coefficient, meaning that the marginal utility for the discount/incentive diminishes as income increases. The model includes other significant

Table 4
Model estimation result.

Variable	ML 1		ML 2		ML 3	
	Estimates	Robust *t*-test	Estimates	Robust *t*-test	Estimates	Robust *t*-test
ASC_EV	−9.87	−1.96	−44.3	−2.08	−20.9	−2.85
ASC_HV	3.440	2.58	2.570	1.67	1.390	1.36
Price – Incentive/discount	−0.794	−3.26				
(Price – Incentive/discount) ˆ2	−0.0097	−2.07				
Price			0.174	1.05		
Priceˆ2			−0.039	−2.05		
Range (CV)	0.729	1.8	0.371	1.27	0.658	1.83
Range (EV)	5.770	2.87	10.70	2.06	6.650	2.98
Range (HV)	0.892	2.12	0.565	1.62	0.832	2.16
Discount (CV)			0.206	2.07	0.205	3.24
Incentive (EV)			0.488	1.91	0.334	3.09
Incentive (HV)			0.224	2.1	0.238	3.22
Commuting Trips	−1.380	−2.83	−1.480	−2.04	−1.590	−2.94
Long-Trip	0.573	2.26	0.640	1.84	0.597	2.34
Renovation-Time	0.496	2.05			−0.702	−0.92
Systematic heterogeneity						
Incentive (EV) X infrequent trips					−0.069	−2.38
Incentive (HV) X infrequent trips					0.016	1.94
Incentive (EV) X renovation 3–4 years					0.059	1.93
Incentive (HV) X renovation 3–4 years					0.033	1.29
Incentive (EV) / Income × 100					−0.409	−2.22
Incentive (HB) / Income × 100					−0.321	−2.96
SIGMA_PANEL_CV	−1.09	−1.71			−1.220	−2.13
SIGMA_PANEL_EV	8.36	2.49			10.40	2.96
SIGMA_PANEL_HV	−3.93	−2.77			−3.850	−2.68
Model Fit						
Final log likelihood:	−4354.5		−4307.7		−4283.2	
Akaike Information Criterion:	8735.008		8647.38		8608.34	
Bayesian Information Criterion:	8818.414		8750.03		8743.07	
N. of draws	500		500		500	

interaction with incentives and discounts. In particular, respondents who plan to change their car within two years are more sensitive to incentives/discount. Respondents who travel once or twice a week are less sensitive to incentives for electric vehicles and more for hybrid vehicles. We note that all the linear effects are significant and with the right sign. This result is consistent with the results of the literature base referenced in this study. In particular the economic incentive (subsidy of purchase), in case of electric and hybrid vehicles and the discount in the case of conventional vehicles, have a positive effect. The price has of course a significant negative effect, while the range has a significant positive effect. For the EV is 10 times higher than for the conventional cars, and 8 times higher for the HV.

3.3. Trade-offs between attributes

Table 5 shows the trade-offs between attributes computed using model ML2. The trade-off between an attribute and the price represents the willingness to pay for an improvement in that attribute. Since our specification includes incentives/discount, the willingness to pay computed refers to the full price (i.e. before any incentives or discount).

As indicated in (Ewing and Sarigöllü, 2000, 1998; Bunch et al., 1993), range is one of the attributes most valued by potential buyers of electric and hybrid vehicles. In the Chilean context, the same result is obtained. As shown in table 5, potential buyers of electric vehicles have a higher willingness to pay for this attribute, compared to potential consumers of hybrid and conventional vehicles. This result is consistent with the findings reported in (Hidrue et al., 2011; Hackbarth, and Madlener, 2013). In contrast to these two works, the magnitude of the willingness to pay for the increased driving range of 1 km in an electric vehicle is much smaller in the Chilean context. The difference is in the order of 9 dollars less. In the case of hybrid vehicles, the willingness to pay for the increased driving range of 1 km is very similar to the values reported in these studies and is around 16.82 dollars per km.

Table 5
Willingness to pay $UD.

ML 2	
Range (CV, km/$US)	13,229
Range (EV,km/$US)	21,458
Range (HV,km/$US)	16,875
Long-Trip (Number of trips/$US)	19,167

4. Agreement to subsidy policies

4.1. Modelling approach

To measure the impact of two specific subsidy policies on the willingness to buy low-pollution vehicles, we used ordered probit models, where P_q is the probability that individual q is very willing, willing or indifferent to buy a low pollution vehicle as a function of their SE characteristics. The model assumes the form:

$$P_q(A=1)=\Phi\left(A_q\left(SE_q,\eta_A\right)\right) \tag{4}$$

$$P_q(A=2)=\Phi\left(A_q\left(SE_q,\eta_A\right)\right)-\Phi\left(A_q\left(SE_q,\eta_{A-1}\right)\right)$$

$$P_q(A=3)=1-\Phi\left(A_q\left(SE_q,\eta_{A-1}\right)\right)$$

where η_A are thresholds defined respectively as: very willing; this corresponds to $P_q(A=1)$; willing, this corresponds to $P_q(A=2)$; and indifferent, this corresponds to $P_q(A=3)$. The two policies tested were: (1) refund of the amount paid in the return of the income tax, (2) exemption from VAT and any other type of tax. Different models were estimated for the willing to buy a BEV and a HEV, the variable available for purchase and as explanatory variables the socio-economic characteristics of the individuals and variables associated with the use of the vehicle.

4.2. Models results

Table 6 reports the results of the estimation of the Probit models.

4.2.1. TPW, based on the two subsidy policies.

An ordered probit model is estimated to measure the willingness-to-pay for low-pollution vehicles according to two possible subsidy policies Indicated in 4.1. In the model, the response variable (dependent variable) is the degree of preference for a particular option and the explanatory variables are the socio-economic characteristics of the individuals and variables associated with the use of the vehicle.

The response variable has three ordered categories. Individuals were

Table 6
Predicted probabilities and marginal effects from the estimated ordered probit model.

Variable	Policy No. 1 for EV		Policy No. 1 for HV		Policy No. 2 for EV		Policy No. 2 for HV	
	Value	Marginal Eff TPW	Value	Marginal Eff TPW	Value	Marginal Eff TPW	Value	Marginal Eff TPW
Predicted Probabilities	Pr (A = 1) = 0.5462		Pr (A = 1) = 0.5789		Pr (A = 1) = 0.7012		Pr (A = 1) = 0.7354	
Civil status								
Married	–	–	−0,258(-4,7)	−4,4%	–	–	−0,109(-1,7)	−0,7%
Divorced	−0,853 (-3,7)	−11%	−0,469(-6,2)	−7%	−0,54(−6,1)	−3%	−0,528(-5,9)	−2,5%
Other	–	–	−1,308(-5.6)	–11%	–		−1,087(-4,5)	−3,2%
Widower	−0,161(-3,1)	−8%	−0,285(-2.0)	4,7%	−0,536(-2,6)	−3,3%	−0,305(-1,8)	−1,7%
Age								
40 to 49 years old	0,106(2,1)	12%	0,218(4,0)	3,3%	3,10(5,2)	2,9%	0,353(5,5)	1,9%
50 to 59 years old	–	–	0,219(3,5)	4%	–	–	0,572(7,8)	3%
More of 60 years old	–	–	0,311(3,4)	5,1%	0,249(2,5)	2,2%	0,492(4,7)	3%
Academic background								
Incomplete Sec Edu	−0,446(-2,7)	−12%	0,606(3,3)	13%	−0,420(-2,4)	−8,2%	0,859(3,9)	9%
Sec Edu	–	–	0,590(3,1)	13%	–	–	–	–
Incomplete Education T/U	−0,655(-4,2)	−17%	–	–	−0,640(3,9)	−11%	0,371(1,7)	2,4%
Complete Technical Education	−0,308(-2,0)	−9%	0,396(2,3)	8%	−0,863(-5,3)	−13%	–	–
University Education	−0,790(-5,3)	−19%	0,660(3.7)	6%	−0,825(-5,2)	−12%	–	–
Postgraduate	−1,012(-6,53)	–22%	0,384(4,96)	10%	−0,998(-6,0)	−13%	–	–
Household size								
Two people	0,524(6,9)	10%	0,373(4.8)	6%	0,768(8,9)	9,4%	0,289(3,4)	3,3%
Three people	–	–		–	–	–	–	–
four people	2,73(3,5)	4%		–	0,311(3,4)	0,6%	−0,158(-1,8)	−1,2%
Five people	0,860(7,0)	1%	−0,138(-1.8)	−1,8%	−0,401(-3,9)	−2,5%	−1,43(-12,0)	−4,1%
Six or more people	−0,675(-4,6)	−6%	0,821(6.5)	2,6%	1,108(7,8)	1,6%	0,547(3,9)	7,6%
Gender							−0,855(-5,1)	−3,6%
Female	0,060(2,1)	1%	0,086(2,2)	1,3%	0,210(4,6)	1,7%	–	–
Driving Frequency								
3 to 4 occasions week	–	–	–	–	–	–	0,323(4,0)	1,7%
4 to 5 occasions week	–	–	–	–	–	–	–	–
More than 5 occasions a week	0,08(1,8)	1,5%	–	–	–	–	–	–
Job trips					–	–		
Frequent	−0,08(1,9)	−1,6%	0,136(2,3)	2%	–	–	0,122(2,0)	0,5%
Little	–	–	–	–	–	–	–	
Never	–	–	–	–	–	–	0,112(1,7)	0%
Shopping trips								
Frequent	0,194(3,8)	19%	0,285(5,5)	4,4%	–	–	0,213(3,6)	1%
Little	–	–	0,017(3,0)	2%	–	–	0,153(2,1)	0,8%
Never	–	–	–	–	–	–	–	
Recreational trips								
Frequent	0,095(1 97)	9%	−0,185(-3,6)	−3%	–	–	−0,108(-1,8)	−0,6%
Little	–	–	−0,250(-4,1)	−4%	−0,166(-2,4)	–1,3%	−0,148(-2,1)	−0,9%
Never	–	–	–	–	–	–	–	
Long trips								
Frequent	0,125(2,5)	2,2%	0,117(2,3)	0,9%	0,179(3,1)	1,4%	0,157(2,6)	0,9%
Little	0,155(3,2)	2,8%	0,184(2,7)	1,8%	0,213(3,8)	1,7%	0,127(2,2)	0,7%
Renewal years								
After 3 to 4 two years of use	−0,156(-2,0)	−3,2%	–	–	–	–	–	–
After 5 to 6 two years of use	−0,143(-1,8)	−2,9%	–	–	–	–	–	–
After more than 6 years of use	–	–	–	–	–	–	–	–
Income CT								
678,3 $ US – 1204,7 $ US	0,163(1,9)	3%	–	–	0,289(2,4)	2,3%	0,198(1,6)	1,2%
1206,1 $ US – 20052,6 $U	–	–	–	–	–	–	–	–
2054 $ US – 3435,6 $ US	–	–	–	–	–	–	–	–
3437,1 $ US – 5789,4 $US	0,22(2,1)	4,4%	–	–	0,287(2,0)	2%	–	–
More than 5789,4 $ US	–	–	–	–	0,289(2,2)	2%	–	–
Model Fit								
Final log likelihood:	−5725,4834	−5345,0557	−4044,3191	−3803,1845				
Akaike Criteria:	11550,97	10782,07	8180,638	7698,369				

asked the following question:

(a) If the subsidy policy is the return of the purchase price difference between an electric or hybrid vehicle and a conventional vehicle, through the income tax. ¿How willing are you to pay for this type of vehicle?
(b) If the subsidy policy is an exemption from VAT and any other tax on the purchase and trading sale of electric and hybrid vehicles. ¿How willing are you to pay for this type of vehicle?

Respondents could answer the question by choosing one of three ordered alternatives: "very willing", "willing" and "indifferent". The explanatory variables considered were: marital status, age range, educational level, household size, gender, income range, as well as variables associated with the use of the vehicle: driving frequency, vehicle-renewal time and frequency of use according to the purpose of the trip. Table 6 presents the estimation results of the four ordered probit models estimated. Each model corresponds to one of the two policies and type of vehicle (electric and hybrid) evaluated. Row one of Table 6, reports the predicted probability of answering the first category (very willing) for each model. The rest of the rows correspond to the parameters of the variables considered in the estimation. Column one in each estimated model reports the coefficients and test statistics (in brackets); column two reports the marginal effects for the first category (very willing); that is, the probabilities.

As expected, the predicted probabilities for the first category, both for electric and hybrid vehicles and the two policies, are consistent with the results of the descriptive statistics reported in Figs. 2–5. This reinforces the idea that buyers prefer incentives that generate immediate rather than future payments. This result is in line with findings reported in Diamond, (2009), who reports that in US states, incentives that provide upfront payments also appear to be the most effective.

On the other hand, regarding the marital status, the marginal effects of policy one indicates that being divorced decreases the probability of responding "very willing" by 11% for electric vehicles and 3% for hybrid vehicles. In the case of policy two the effects are similar. Being divorced decreases the probability of responding "very willing" by 3% for electric vehicles and 2.5% for hybrid vehicles.

Regarding the age, the marginal effects of policy one for electric vehicles were only significant for the 40–49 age range. In this range, the policy increases the probability of responding "very willing" by 12%. The marginal effects of policy one for hybrid vehicles were significant for the 30–39, 40–49 and 50–59 age ranges. Specifically, in relation to the lowest age range (30–39), being between 40 and 49 and between 50 and 59 years old increases the probability of responding "very willing" by 3.3% and 5.1%, respectively.

In relation to the income, the marginal effects of policy one indicates that being in the upper class (More than 5789.4 US dollars) in relation to lower class (0 to 677 US dollars) increases the probability of responding "very willing" by 1.2% for electric vehicles and 6% for hybrid vehicles. In the case of policy two, the increase of the probability ranges between 1.2% and 2.2% for electric and hybrid vehicles, respectively.

These results suggest that policy two, which offers incentives that generate immediate or anticipated payments, is the most attractive policy for future buyers.

5. Discussion of the estimated results

The results of measuring the impact of fiscal incentives in the consumption of low emission vehicles, reported in the descriptive analyses, as well as in the mixed logit models and the estimated ordered probit model, are consistent with each other. As indicated in section 3, the incentive has a positive effect for all the specifications of the estimated models; in particular, the subsidy policies evaluated in section 2 and 4, indicate that the second policy (exemption of the VAT payment and any other type of tax on the purchase and sale of electric and hybrid vehicles) seems to be more attractive than the first policy (return of the value paid in the income tax). A policy of exemption of the VAT payment and any other type of tax on the purchase and sale of electric and hybrid vehicles has a greater impact on the potential consumption of low pollution vehicles, where 72% of the sample declared to be willing to buy an electric vehicle and 76% a hybrid vehicle. In this order of ideas, the ordered probit model estimated in section 4, indicates that there is a 70% probability that an individual in the sample responds to be very willing to pay for an electric vehicle if the subsidy policy is exemption of the VAT payment and any other type of tax on the purchase and sale, and 73% in the case of hybrid vehicles.

In addition, the marginal effects of the estimated ordered probit model indicates that, for individuals in the sample who drive a vehicle between 3 and 4 times per week, the probability of responding to be very willing to pay for a hybrid vehicle increases by 1.7%. In the case of respondents making long trips frequently the probability increases by 0.9%, and if the long trips are infrequent the probability increases by 0.7%, In a similar way, for individuals in the sample who have an income between 678.3 and 1204.7 US dollars and under policy 2, the probability of responding to be very willing to pay for an electric vehicle increases by 2.3%, and increases by 1.2% in the case of hybrid vehicles.

Finally, for individuals in the sample who have incomes greater than US $ 3437.1 – US $ 5789.4 US dollars, the probability of responding to be very willing to buy an electric vehicle decreases by 0.3%, compared to the individuals in the sample belonging to the income segment between 678.3 and 1204.7 US dollars, meaning that the marginal utility for the discount/incentive diminishes as income increases as shown in the mixed logit models estimated in section 3.

Unlike the results Like Rotaris et al., (2021), Jensen et al. (2014) and Mabit and Fosgerau, (2011), our estimator of the income effect was statistically significant, but with the opposite sign. We will insist on testing this effect in our next research, considering a much larger and more diverse sample in terms of income.

6. Conclusion and policy implications

This work aimed to shed light on (1) the effect of incentives for EV and HV versus/discount for conventional cars regarding the preference of the type of engine and (2) the attractiveness of two possible subsidy policies in the context of Chile. The results reveal that in the case of electric vehicles, individuals are more sensitive to the autonomy and the incentive in comparison to conventional and hybrid vehicles. The demand for conventional vehicles is less sensitive to the value of discount offered by automotive in comparison to the value of incentives presented for electric and hybrid vehicles. This result is interesting because, although there has been a discount campaign by the automotive to capture clients of high range vehicles to counter the breakthrough of hybrid and electric vehicles, a subsidy to the price of purchase will make the buyers more sensitive to this type of incentive.

In the case of the incentive, subsidy for EV and HV and discount for CV (Conventional Vehicles), the values are of the following order: 0.334, 0.238 and 0.205, respectively. In essence, individuals present high sensitivity to a possible subsidy policy on the purchase.

Specifically, in the case of electric vehicles, vehicle buyers are willing to pay $21.45 US for one more kilometer of autonomy per load. In the case of hybrid vehicles, individuals are willing to pay $16.87 US for one more kilometer of autonomy per complete load. In the case of conventional vehicles $13.22 US per complete load, taking the results of the second estimated model.

Even more, it shows that the barriers that causes the most concern in the context of Chile are the absence of electrolytes (67%), battery cost (78%) being the highest, and the value of the car with (66%). The type of charging and the autonomy of the vehicles obtained a percentage inferior to 50%.

38% of respondents reported a renewal time after 3 to 4 years of use, 36% after 5 and 6 years of use, which means that 74% of the surveyed are willing to renovate their vehicles after 3 to 6 years of use; this information is of great importance. It provides us with the terms in which the impact of the renewal of the automotive fleet, with low-emission vehicles, would be seen when an eventual subsidy policy was implemented in the country.

We demonstrate individual's high sensitivity to the incentive (Subsidy to the purchase price for EV and HV), we also evidence individuals have concerns about some barriers that hinder the technological transition (availability of charging stations, the cost of batteries and recharging times). These findings contribute to our understanding of the impact between the development of fiscal incentive policies and the transition to electric and hybrid vehicle market in the Chilean context.

International evidence, as well as experience of successful European countries in a transition toward mobility such as Norway, Sweden, and England, indicates that the transition can only be achieved if electric vehicles become competitive in prices and the necessary infrastructure is available for their operation.

In the Chilean case, based on our results, we consider that the policies should focus in the first instance on subsidizing the purchase price, later on developing and strengthening the necessary infrastructure that guarantees the operation and circulation of electric vehicles and regulations of energy cost.

The current Chilean Government has designed an energy policy called "Energy Route 2018–2022", which establishes a long-term goal that consists of 100% of the public transport fleet and 40% of private vehicles being electric by 2050, accompanied by a National Electromobility strategy focused on 5 axes (Market regulation, public transport, research promotion, promoting formation for human capital and knowledge transfer and information delivery). The problem with these initiatives is that in no case it is intended to subsidize the purchase price of the private use fleet.

Although the initial efforts of the Chilean government's electromobility project prioritizes education, outreach, electrification of public transport, and the construction of the network of electric charging stations, international evidence and the findings of this research indicates the mechanism with highest impact towards the transition of electromobility is to subsidize the purchase price and then incentive policies should be oriented towards non-monetary incentives such as strengthening public cargo networks and access to parking areas and special roads.

Finally, it is important to keep in mind that the design of fiscal policies favors different people groups and automobile segments, to which not all people can access, so in the Chilean case, more research on socioeconomic aspects is needed to evaluate how the policies of subsidy to the purchase price, can be transferred to a broader economic group than the socio-economic segment considered in our study. We therefore strongly advise policy makers to be cautious when considering these results. We do not recommend extrapolating from the results for policy design. We do recommend using them to undertake future research to validate the efficiency of the policies considered here.

We consider a limitation of the study the size of the sample used, although it reflects the characteristics of the population, we believe that a bigger sample would allow to capture the heterogeneity of individuals and validate the interactions that were non-significant. Another limitation in the research is the absence of real data of electric and hybrid vehicle sales that would allow the prediction of the market share with the obtained parameters. The official sales data for low-emission vehicles that exist in Chile do not report the figures by type of low-emission vehicle. This lack of discrimination in data makes it impossible to estimate the market share with our estimated model. These limitations have generated two lines of future work:

The first line of work is aimed at forecasting the market share, under the assumption that the diffusion of low emission vehicles in Chile follows a diffusion process similar to another country that is comparable in some relevant socioeconomic aspects. We intend to use their sales data, to estimate the market share of this type of vehicle in Santiago, Chile.

The aforementioned is motivated by two key elements: a) in Chile the demand for electric and hybrid vehicles is practically zero in the present, thus there is no reference to estimate any prognostic. b) the prevailing need to test the sensibility of the demand in the face of the proposed incentives.

The second line of work is to increase the sample size to identify segments of the population more sensitive to different types of incentives given the heterogeneity of individuals. This would allow proposals for targeted incentives to segments of the population.

CRediT authorship contribution statement

Jorge Urrutia-Mosquera: Conceptualization, Funding acquisition, Investigation, Data curation, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Jorge Fábrega:** Funding acquisition, Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors are grateful for the financial support provided by the Vice-Rectory of Research of the Universidad del Desarrollo-Chile, in the framework of the project: D2325-1002.

The corresponding author thanks Professor Luis Ignacio Rizzi at the transport department of the Pontifical Catholic University of Chile, for the advice received during the first phases of the research, and Professor of Transport Elisabetta Cherchi at School of Civil Engineering of Newcastle University, for being extremely accessible and supportive throughout the research and my visit Newcastle University, was a rewarding stay and it helped me to improve specific parts of the research. Thank you for all your help and inspiration. I would also like to thank Postdoctoral Research Associate at School of Civil Engineering of Newcastle University Ángel Simón Marrero, who kindly devoted time to discuss my research with me and it helped me to improve Models.

References

Assum, T., Kolbenstvedt, M., & Figenbaum, E. (2014). The future of electromobility in Norway–some stakeholder perspectives. TØI report, 1385/2014.
Beresteanu, A., Li, S., 2011. Gasoline prices, government support, and the demand for hybrid vehicles in the United States. International Economic Review 52 (1), 161–182.
Bjerkan, K.Y., Nørbech, T.E., Nordtømme, M.E., 2016. Incentives for promoting battery electric vehicle (BEV) adoption in Norway. Transportation Research Part D: Transport and Environment 43, 169–180.
Brand, C., Anable, J., Tran, M., 2013. Accelerating the transformation to a low carbon passenger transport system: The role of car purchase taxes, feebates, road taxes and scrappage incentives in the UK. Transportation Research Part A: Policy and Practice 49, 132–148.
Bunch, D.S., Bradley, M., Golob, T.F., Kitamura, R., Occhiuzzo, G.P., 1993. Demand for clean-fuel vehicles in California: a discrete-choice stated preference pilot project. Transportation Research Part A: Policy and Practice 27 (3), 237–253.
Caulfield, B., Farrell, S., McMahon, B., 2010. Examining individuals preferences for hybrid electric and alternatively fuelled vehicles. Transp. Policy 17 (6), 381–387.
Chandra, A., Gulati, S., Kandlikar, M., 2010. Green drivers or free riders? An analysis of tax rebates for hybrid vehicles. Journal of Environmental Economics and management 60 (2), 78–93.
Cherchi, E., Ortúzar, J. de Dios, 2006. Income, time effects and direct preferences in a multimodal choice context: Application of mixed RP/SP models with non-linear utilities. Networks and Spatial Economics 7–23 (In press).
Diamond, D., 2009. The impact of government incentives for hybrid-electric vehicles: Evidence from US states. Energy Policy 37 (3), 972–983.
Ewing, G.O., Sarigöllü, E., 1998. Car fuel-type choice under travel demand management and economic incentives. Transportation Research Part D: Transport and Environment 3 (6), 429–444.
Ewing, G., Sarigöllü, E., 2000. Assessing consumer preferences for clean-fuel vehicles: A discrete choice experiment. Journal of public policy & marketing 19 (1), 106–118.

Figenbaum, E., Kolbenstvedt, M., 2013. Electromobility in Norway-experiences and opportunities with Electric Vehicles No. 1281/2013.
Fridstrøm, L., Alfsen, K., 2014. Norway's path to sustainable transport. TØI rapport 1321, 2014.
Gallagher, K.S., Muehlegger, E., 2011. Giving green to get green? Incentives and consumer adoption of hybrid vehicle technology. Journal of Environmental Economics and management 61 (1), 1–15.
Gass, V., Schmidt, J., Schmid, E., 2014. Analysis of alternative policy instruments to promote electric vehicles in Austria. Renewable Energy 61, 96–101.
Hackbarth, A., Madlener, R., 2013. Consumer preferences for alternative fuel vehicles: A discrete choice analysis. Transportation Research Part D: Transport and Environment 25, 5–17.
Hardman, S., 2019. Understanding the impact of reoccurring and non-financial incentives on plug-in electric vehicle adoption–A review. Transportation Research Part A: Policy and Practice 119, 1–14.
Hidrue, M.K., Parsons, G.R., Kempton, W., Gardner, M.P., 2011. Willingness to pay for electric vehicles and their attributes. Resource and Energy Economics 33 (3), 686–705.
Horne, M., Jaccard, M., Tiedemann, K., 2005. Improving behavioral realism in hybrid energy-economy models using discrete choice studies of personal transportation decisions. Energy Econ. 27 (1), 59–77.
Instituto Nacional de Estadística (INE). Supplementary Income Survey 2017.
Instituto Nacional de Estadística (INE). Yearbook, vehicular park in Circulation 2017.
Irawan, M.Z., Belgiawan, P.F., Widyaparaga, A., Deendarlianto, Budiman, A., Muthohar, I., Sopha, B.M., 2018. A market share analysis for hybrid cars in Indonesia. Case studies on transport policy 6 (3), 336–341.
Jara-Díaz, S.R., Videla, J., 1989. Detection of income effect in mode choice: theory and application. Transportation Research Part B: Methodological 23 (6), 393–400.
Jenn, A., Azevedo, I.L., Ferreira, P., 2013. The impact of federal incentives on the adoption of hybrid electric vehicles in the United States. Energy Econ. 40, 936–942.
Jensen, A.F., Cherchi, E., de Dios Ortúzar, J., 2014. A long panel survey to elicit variation in preferences and attitudes in the choice of electric vehicles. Transportation 41 (5), 973–993.
Jin, L., Searle, S., Lutsey, N., 2014. Evaluation of state-level US electric vehicle incentives. The International Council on Clean. Transportation.
Kwon, Y., Son, S., Jang, K., 2018. Evaluation of incentive policies for electric vehicles: An experimental study on Jeju Island. Transportation Research Part A: Policy and Practice 116, 404–412.
Langbroek, J.H.M., Franklin, J.P., Susilo, Y.O., 2016. The effect of policy incentives on electric vehicle adoption. Energy Policy 94, 94–103.
Mabit, S.L., Fosgerau, M., 2011. Demand for alternative-fuel vehicles when registration taxes are high. Transportation Research Part D: Transport and Environment 16 (3), 225–231.
McFadden, D., 1981. Econometric models of probabilistic choice. In: Manski, C.F., McFadden, D. (Eds.), Structural Analysis of Discrete Data with Econometric Applications. The MIT Press, Cambridge, Massachusetts.
Nanaki, E.A., Koroneos, C.J., 2016. Climate change mitigation and deployment of electric vehicles in urban areas. Renewable Energy 99, 1153–1160.
O'Neill, E.l., Moore, D., Kelleher, L., Brereton, F., 2019. Barriers to electric vehicle uptake in Ireland: Perspectives of car-dealers and policy-makers. Case Studies on Transport Policy 7 (1), 118–127.
Potoglou, Dimitris, Kanaroglou, Pavlos S., 2007. Household demand and willingness to pay for clean vehicles. Transportation Research Part D: Transport and Environment 12 (4), 264–274.
Rotaris, L., Giansoldati, M., Scorrano, M., 2021. The slow uptake of electric cars in Italy and Slovenia. Evidence from a stated-preference survey and the role of knowledge and environmental awareness. Transportation Research Part A: Policy and Practice 144, 1–18.
Saarenpää, Jukka, Kolehmainen, Mikko, Niska, Harri, 2013. Geodemographic analysis and estimation of early plug-in hybrid electric vehicle adoption. Appl. Energy 107, 456–464.
Sangkapichai, Mana, Saphores, Jean-Daniel, 2009. Why are Californians interested in hybrid cars? J. Environ. Plann. Manage. 52 (1), 79–96.
Tal, Gil, Nicholas, Michael, 2016. Exploring the impact of the federal tax credit on the plug-in vehicle market. Transp. Res. Rec. 2572 (1), 95–102.
Train, K.E., 2009. Discrete Choice Methods with Simulation. Cambridge University Press.
van Eck, Gijs, de Jong, Gerard, Wesseling, Bart, van Meerkerk, Jordy, 2019. Simulating the impact of tax incentives using a type choice model for lease cars. Case Studies on Transport Policy 7 (4), 814–822.
Wang, Ning, Tang, Linhao, Pan, Huizhong, 2017a. Effectiveness of policy incentives on electric vehicle acceptance in China: A discrete choice analysis. Transportation Research Part A: Policy and Practice 105, 210–218.
Wang, Shanyong, Li, Jun, Zhao, Dingtao, 2017b. The impact of policy measures on consumer intention to adopt electric vehicles: Evidence from China. Transportation Research Part A: Policy and Practice 105, 14–26.
Wang, S., Wang, J., Li, J., Wang, J., Liang, L., 2018. Policy implications for promoting the adoption of electric vehicles: Do consumer's knowledge, perceived risk and financial incentive policy matter? Transportation Research Part A: Policy and Practice 117, 58–69.
Wee, Sherilyn, Coffman, Makena, La Croix, Sumner, 2018. Do electric vehicle incentives matter? Evidence from the 50 US states. Res. Policy 47 (9), 1601–1610.
Zhang, Yong, Jiang, Yunjian, Rui, Weina, Thompson, Russell G., 2019. Analyzing truck fleets' acceptance of alternative fuel freight vehicles in China. Renewable Energy 134, 1148–1155.