



The effects of ecolabels on environmentally- and health-friendly cars: an online survey and two experimental studies

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Abstract

Purpose Given the increasing importance of political decision-making to reduce emission targets, the main purpose of the current paper is to identify and test the considerations that would nudge consumers towards an environmentally and health-friendly motor vehicle.

Methods An online survey was conducted to assess public responses and the role of public authorities to a voluntary emission standard for passenger cars. In addition, two online experiments were conducted to test incentives in the design of ecolabels (e.g. price, safety, performance) for optimization. A random sample of 6400 individuals was drawn from eight countries: Germany, Ireland, Italy, the Netherlands, Spain, UK, Czech Republic and Lithuania. An online survey was conducted among 3200 respondents, 400 in each of the 8 countries, and 2 online experiments with 3200 subjects, 400 in each of the 8 countries, allowing for 200 respondents for each experiment in each country.

Results and discussion The survey shows that Europeans are aware of the health and environmental impact of cars. The findings also confirm the gap between self-reported attitudes/intentions and actual behaviours. In influencing car purchase decisions, health and environmental concerns are less important than other attributes such as price, safety and performance. The experiments show that all these attributes have a significant effect on consumers' choices. However, message content was found to have the strongest effect. Respondents are more likely to choose European Union Low Emitting cars (EULES)-friendly cars when the label shows information on lower costs or lower taxes and less likely to be influenced by health-related benefits, convenient parking or access fees. Finally, combinations of one message with other elements—EULES logo, CO₂ logo or both—within the same label have a small but positive effect on respondents' choices.

Conclusions The findings of this study assist governmental decision-making processes by identifying those issues that have the greatest impact on consumers' car purchasing decisions. Furthermore, the results will help to guide environmentally conscious customers towards the purchase of vehicles with clean emission profiles.

Keywords Behavioural economics · Consumers' choice · Ecolabels · Environmental benefits · Experiment

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1 Introduction

The Paris Agreement, ratified globally by practically every country, except the USA and North Korea (UNFCCC 2018), states that economy-wide decisions should be introduced to achieve absolute emission reduction targets. Road transportation in Europe is a significant contributor to CO₂ emissions, as well as air pollutants such as particulate matter and nitrogen oxides (EEA 2015; Davis et al. 2010). The greenhouse gas emissions from road transportation have significant impact on the environment and on human health (Woodcock et al. 2009). Furthermore, exposure to air pollutants has been identified as a significant risk factor in a number of health conditions including respiratory infections, heart disease, stroke and lung cancer (EEA 2015; WHO 2018). Greenhouse gas emissions still remain above agreed levels and would need to fall dramatically in order to meet international agreements (UNFCCC 2018). In order to comply with the directives of the Paris Agreement, European member states will be obliged to take green initiatives (e.g. fiscal incentives, local access restrictions for particular vehicles, local environmental zones differentiating vehicle access according to emission classes or ecolabels) to reduce air pollution in cities and highly trafficked areas (Kushwaha and Sharma 2016). Ecolabels are viewed as voluntary environmental and consumer policy instruments and taken to be a simple and pragmatic option.

Increasing concern about climate change has led to calls for labelling to allow consumers to differentiate between more or less sustainable purchasing options (Teisl et al. 2008). It is assumed that with appropriate labelling information, some consumers will be motivated to purchase cars that are more sustainable (Thøgersen et al. 2010). Ecolabelling is seen an important way of enhancing transparency and consumer trust in environmental claims. It is also viewed as a method for improving the sustainability of consumption patterns without compromising freedom of choice and at the same time reducing consumers' information search costs (Grunert and Wills 2007). The elaboration likelihood model (ELM; Petty and Cacioppo 1986) describes different ways of processing stimuli and how these affect outcomes, such as attitude change and eventually consumption behaviour. The ELM proposes two major routes that are used to process messages: the central and the peripheral routes. The central route involves an active consideration of the arguments presented in the message. By contrast, the peripheral route makes use of a simple heuristics about the merits of the advocated position, such as the credibility or attractiveness of the message. In the context of an ecolabel, the likelihood of elaboration with the central route is determined by an individual's motivation and ability to evaluate the information presented. With the purchase of a costly product such as a car, it is assumed that consumers will adopt the 'high-effort' central path (Thøgersen et al. 2010) in their assessment of ecolabels.

Importantly, Thøgersen et al. highlight the importance of constructs such as 'environmental involvement', the credibility of ecolabels and the extent to which consumers understand the information in choice behaviour (Bamberg 2003; Gadenne et al. 2011; Thøgersen 2000, 2002, 2005; Thøgersen et al. 2012; Thøgersen and Noblet 2012). For example, the credibility of labels can be influenced also by consumers' prior beliefs with regard to sustainable products (Teisl et al. 2003). The perceived effectiveness regarding their own behaviour and faith in the behaviour of others appear to be positively associated with increased effectiveness of labels as sources of information (Berger and Corbin 1992; Bougherara et al. 2005). As regards the labels as such, their effectiveness apparently increases when consumers can adequately rank competing products by key attributes (Teisl and Roe 2005), consumers' prior beliefs (Teisl 2003) or when consumers are educated about the presence and meaning of ecolabels (Song et al. 2019). Comparative labels are also considered a potentially effective way of rendering complex numerical information into simple categorical scales (Peters et al. 2009). However, the use of ecolabels has been criticised because they are based on the assumption that consumers and firms behave irrationally, such as the absence of evidence of an energy-efficiency gap (Gayer and Viscusi 2013) and on the assumption that labels influence consumer to over-value energy consumption in the purchase of goods (Sahoo and Sawe 2015). Making use of ecolabels must therefore be based on robust evidence (Codagnone et al. 2016).

To encourage consumers to purchase less polluting vehicles, the European Commission is considering a voluntary emission standard, called European Union Low Emitting carS (EULES) with three complementary strategies (Ntziachristos et al. 2016): first, to promote clean transportation by providing a benchmark for local or national authorities in their development of financial or in green procurement projects; second, to provide an incentive for manufacturers to produce vehicles that deliver significant emission reductions; and third, by guiding environmentally conscious customers towards the purchase of vehicles with 'clean' emission profiles (low real-world driving emissions) by ecolabelling cars. The main focus of the present study is on this third strategy, the effect of ecolabelling cars.

Broadly defined ecolabelling is a signalling method to encourage future consumers towards forms of sustainable consumption (Thøgersen et al. 2010). In comparison to the more general literature on ecolabels, and especially to that focusing on white goods and food, studies examining the effects of car labelling are scarce, with a small number of scientific articles and a few policy reports (Choo and Mokhtarian 2004; Kurani and Turrentine 2002; Lane and Potter 2007; Loureiro et al. 2012; Noblet et al. 2006; Teisl et al. 2008; Teisl and Roe 2005). Therefore, it is necessary to establish which factors are associated with the effectiveness of labelling cars and to examine causal effects on consumption choices.

To date, there is no single experimental study on the effect of car ecolabels on consumers' decision-making. Teisl et al. (2008) argue that rather than focusing on either the correlation between individual characteristics and environmental friendly behaviour (eco-behaviour) or between labels' characteristics and eco-behaviour, it is important to test a model linking individual characteristics and labels characteristics. They found that both label design and underlying psychological factors need to be taken into account. More specifically, if the label is well-designed, it can affect individuals' perceptions of the eco-friendliness of a product.

Findings concerning consumers' preferences and the car purchase process are reported by Achtnicht (2012), COWI (2002), Lane and Potter (2007), Noblet et al. (2006), Teisl et al. (2008), and Codagnone et al. (2013). These studies show that purchasing decisions are dominated by attributes such as price, performance and safety with eco-friendly attributes playing a secondary role. Secondly, the purchase of a car is found to be a two-stage process. Purchasers first determine the class of car they want to buy. It is only when they move to select the model that eco-friendly and fuel economy features are more seriously considered. Achtnicht (2012) finds that people in Germany say they are willing to pay more for a car that has lower CO² emissions and that willingness to pay decreases for those who reported lower price ranges for a future car purchase and that differences were found by age, gender and educational level. Younger individuals, women and individuals with a higher education entrance qualification have a significantly higher willingness to pay.

Related with the debate in environmental behavioural economics is the legitimate question whether 'nudges' based on information supply differ from various forms of informational instruments (Kosters and Van der Heijden 2015). According to Ölander and Thøgersen (2014), ecolabels play the role of information provision at the point of sale but change the choice architecture of consumers when (if) consumers become familiar with and consider them as credible. Following the work of Peters et al. on label that performs well in summarizing complex numerical information (Peters et al. 2009), Johnson et al. (2012) consider 'good labels' (as opposed to bad ones) as an instrument of attribute parsimony to reduce attribute overload and as such they qualify them as a nudge for they alter the choice architecture. A further element for considering 'ecolabels' as a nudge is the evidence that their design affects consumers' perceptions (Heinzle and Wüstenhagen 2012).

In this study¹, the main purpose is to identify and test the elements that would nudge consumers towards a preference for an environmentally and health-friendly EULES car. The

¹ This study is part of a larger study conducted for the European Commission (No. ENV.C.3/FRA/2013/0013, Service No. 8, EC DG ENV). The principal objective of the project was to provide the background on the potential of a voluntary low-emission standard for passenger cars in order to deliver real-world emission levels below the most stringent current emission limits, as well as to develop the technical and legal background for its implementation

study focusses on two separate objectives: first, mapping the contours of public responses and the role of public authorities to a voluntary emission standard for passenger cars that would deliver real-world emission levels below the current limits; second, experimentally testing the impact of different incentives designed to support the EULES policy. The outcomes of the research will:

1. Extend the knowledge base about car ecolabels.
2. Support governmental decision-making process on the successful introduction of the EULES labels.
3. Assess the differential impact on consumers' preferences between the CO₂ label and the EULES label.
4. Help guide environmental conscious customers towards the purchase of vehicles with clean emission profiles.
5. Provide a benchmark for local or national authorities when developing financial or access and demand policies to promote clean transportation and to integrate footprint approaches into effective ecolabels.

2 Methods

To assess public responses to a voluntary emission standard for passenger cars, an online survey was conducted. In addition, two online experiments tested incentives for optimal message impact (see also Fig. 1). A random sample of 6400 individuals was drawn from 8 countries Germany, Ireland, Italy, the Netherlands, Spain, UK, Czech Republic and Lithuania. The sample was divided and allocated to (i) an online survey with 3200 respondents, 400 per each of the 8 countries, and (ii) two online experiments with 3200 respondents, 400 per each of the 8 countries, giving 200 respondents for each experiment and country. The randomization was ensured at the country level, such that each country was equally represented in the survey ($n = 400$) and

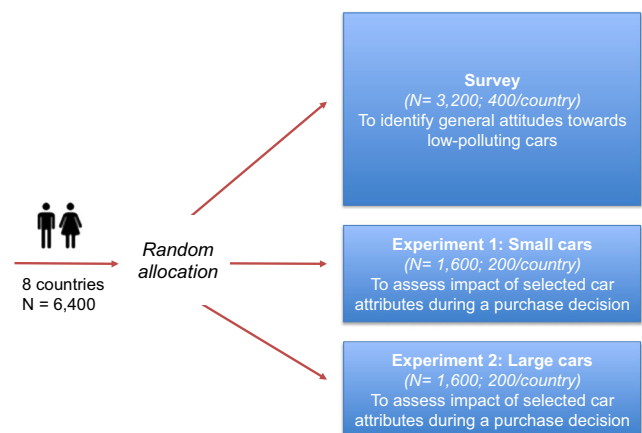


Fig. 1 Overview of the research design

Fig. 2 Choice set no. 2 for small car

We would like you to consider the two cars presented below and their characteristics. Which car would you choose?



in the experiments ($n = 200$). Gathering the data across countries made it possible to ensure the validity and possibility to generalize findings on awareness, understanding and attitudes regarding the EULES standard as well as the comparison between EULES and CO₂ emissions.

2.1 Survey

The online survey was designed to explore the level of understanding of, and the attitudes towards, EULES-related issues (Annex 1—[Electronic Supplementary Material](#)). The survey questionnaire was structured as follows:

Block A: Self-reported purchase process: Questions assessed self-reported steps and factors that the respondent would take into account in the car purchasing process (class and model, dynamics of purchase process, main attributes considered, information sources).

Block B: Contextual factors: Questions assessing environmental attitudes through consolidated scales, respondents' faith in the eco-behaviours of others and in the effectiveness of their behaviours as consumers, and perceived trade-offs between, for example choosing eco-friendly and performance.

Block C: Questions assessing the awareness of the environmental and health impacts of car usage.

Block D: Questions assessing awareness, trust and the effect of labels.

Block E: Questions assessing socio-demographic profile (e.g. sex, age, possession and usage car).

2.2 Experiments

The online experiments were designed to examine the effect of ecolabels on car purchasing. The experiments used the discrete choice methodology to simulate a car purchasing decision and to

Fig. 3 Choice set no. 1 for large car

We would like you to consider the two cars presented below and their characteristics. Which car would you choose?

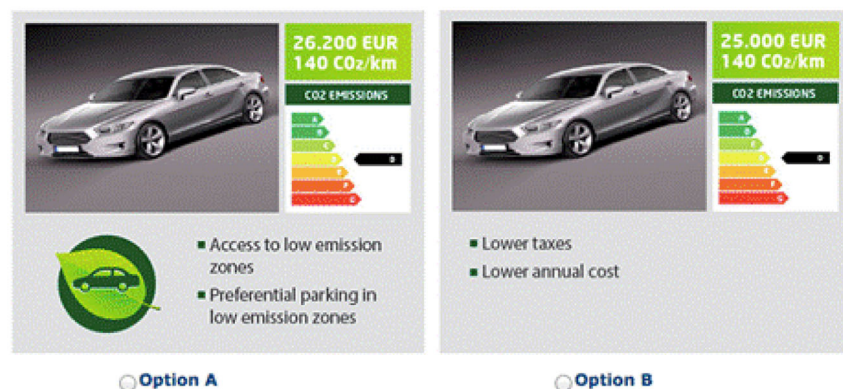
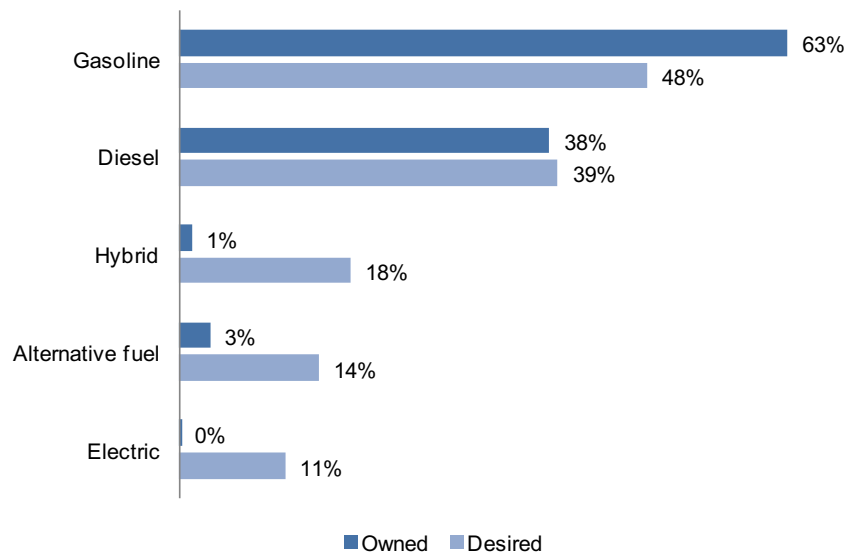


Fig. 4 Type of car, by engine



assess the relative impact of different attributes of the cars on respondents’ choices. Briefly, it is assumed that when choosing between several cars, consumers consider a range of attributes—number of seats, engine size, price, etc.—prior to making a purchase. The literature reports that price is the most influential attribute; it dominates other attributes. To assess the relative importance of non-price attributes, in our case an EULES or CO₂ label, we offer respondents a series of binary choice between versions of the same model that differ with respect to the presence or absence of environmental information. This is the technique of discrete choice modelling. From a series of choices between cars with different ‘environmental profiles’, it is possible to estimate whether the presence or absence of a particular attribute increases the probability of choosing a car that features that attribute.

There were two experiments, one featuring small cars and the other large cars. Respondents were shown a picture of two visually identical cars—option A and option B. The two options differed with respect to four attributes or features—the

price (baseline or baseline plus a few hundred Euros), the EULES label (present or absent), the EULES message (present or absent) and the CO₂ label (present or absent).

The small and large cars differed in terms of prices and the level of CO₂ emissions. For the small car, the price was either 10,000 or 10,700 Euros; for the larger car, it was 25,000 or 26,200 Euros. The rationale behind the price differential was the estimated additional cost of introducing the EULES standard that might be passed on to consumers. The small car was associated with a lower level of CO₂ emissions (i.e. in the categories B and C) and the large car was associated with a higher level of CO₂ emissions (i.e. in the category D). In the experimental design, the label either was present or absent, depending on the choice set.

Figures 2 and 3 below illustrate the choice sets for each car type. In Fig. 2, the respondents had to choose between the small car that had the EULES label and the CO₂ label and the same car that had no labels. In Fig. 3, the respondents chose between a large car with the EULES label and without

Fig. 5 Attributes considered in the car purchasing process

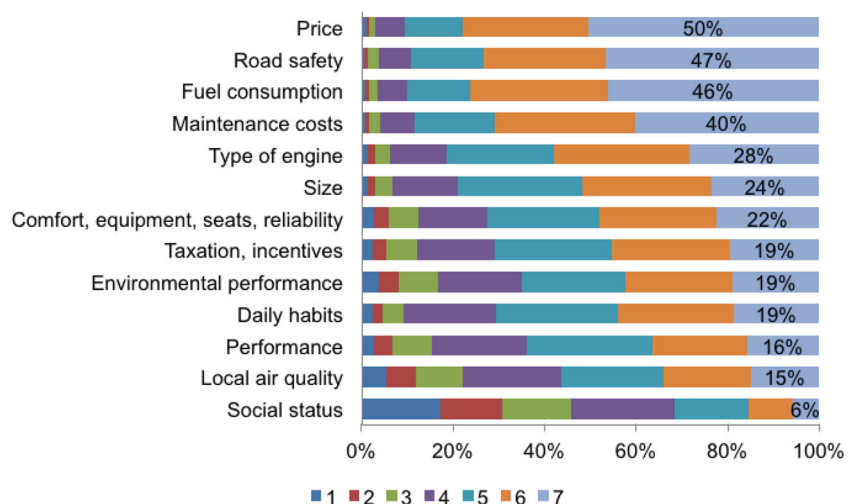
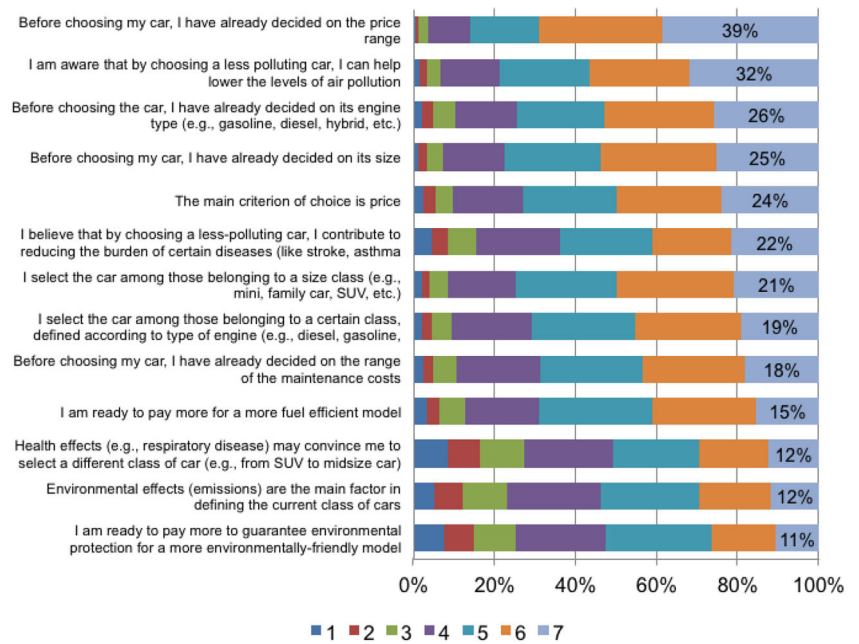


Fig. 6 Assessment of statements related to the car purchase process (%)



it; in both cases, the CO₂ label was present. In addition, the EULES messages and the prices differed in all the choice sets.

To avoid any experimental biases and priming issues the respondents were not given an explanation about the meaning of the EULES label. Respondents were presented with three implications of EULES-friendly cars, including health effects (cleaner air in cities), city accessibility (access to low-emission zones, preferential parking in low-emission zones) and financial impacts (lower taxes, lower annual costs). These were captured in three simple messages to the respondents and appeared beside the EULES label, the CO₂ label or as stand-alone in those conditions without any environmental information. Respondents were asked to make choices between 10 pairs of cars with differing attributes. The study sampling errors (overall and by quotas) are calculated for a probability no greater than 95.5% and for the least desired context, i.e. a maximum indeterminate probability ($p = q = 50%$) for the reference population.

The fieldwork was conducted between February and March 2015. A pilot study was conducted in the UK, followed by the full launch went ahead in the UK. Finally, after the

translation of the questionnaire in the other languages, a joint launch took place in the remaining countries.

3 Results from the survey

3.1 Decision-making: describing the purchase process

In order to gain an indication of the decision-making process behind car purchases, survey respondents were initially asked to report the size of their current car. The most popular car class appears by far to be the small-family car (such as Ford Focus, Volkswagen Golf, Citroën C4) owned by 39% of respondents. About 19% of subjects own at least one large-family car (such as Renault Laguna, Volkswagen Passat or Ford Mondeo). Supermini cars—Peugeot 208, Volkswagen Polo and Renault Clio—come a close third having been selected by 11% of respondents. In terms of current and future car purchase decisions (Fig. 4), it is worth noting that while

Table 1 Profiles of car purchasers

Factor	Cluster		
	1. Non-sensitive 57% (n = 1815)	2. Sensitive 43% (n = 1385)	ANOVA
Emphasis on environmental and health issues	-0.22	0.29	201.52*
Emphasis on cost	0.41	-0.54	699.54*
Emphasis on the present	0.51	-0.67	1106.73*
Emphasis on the future	-0.14	0.19	86.28*

* $p < 0.05$

Fig. 7 Present-future attitudes



few respondents reported owning environmentally friendly cars, many more said they would buy one in the future. About 18% of the subjects reported planning to buy a hybrid car. Cars that run on alternative fuels, such as CNG and LPG, were mentioned by 14% of the respondents (as opposed to 3% of current owners). About 11% plan to buy an electric car, currently owned by less than 1% of current owners.

In terms of car usage, one in two respondents (47%) reported driver to work on a daily basis. Almost all subjects drive for shopping, although only 10% do so daily. About 18% drive their children to and from school every day. Finally, most respondents use their car for weekend getaways (more than 90%) and holidays (more than 80%) at least once a year.

Individuals were then asked to identify what were the main attributes considered during the purchase decision. Respondents were asked to rate each attribute on a 1–7 importance scale, with 7 being ‘very important’. As Fig. 5 shows, a car’s environmental performance is considered as ‘very important’ by less than one in five respondents (19%). Likewise,

local air quality is a very important attribute for only 15% of respondents. On the other hand, about half of the subjects consider price (50%), road safety (47%) and fuel consumption (46%) followed by maintenance cost (40%) and type of engine (28%) as very important attributes. After price and road safety, attributes pertaining to the broadly defined ‘Fuel Economy’ score fairly high in importance.

In addition to car’s attributes, individuals were asked to report about the process followed in choosing a car (Fig. 6). From the responses, it can be seen that individuals favour price and its range (24% and 39%, respectively), along with size and engine (25% and 26%, respectively). Environment and health effects are less important. While one third of respondents (32%) are aware that less polluting cars, *ceteris paribus*, lower the level of pollution, statements on environmentally friendly attitudes in car purchasing yield very low percentages of full agreement. Health consequences would convince only 12% of respondents to select a different class of car (e.g. from sport utility vehicle to midsize car). The environmental effects are also not particularly important when

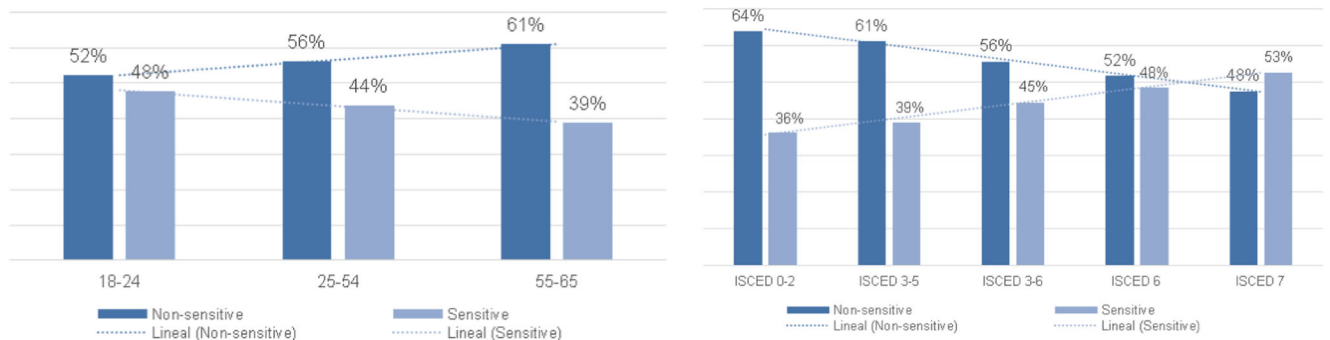
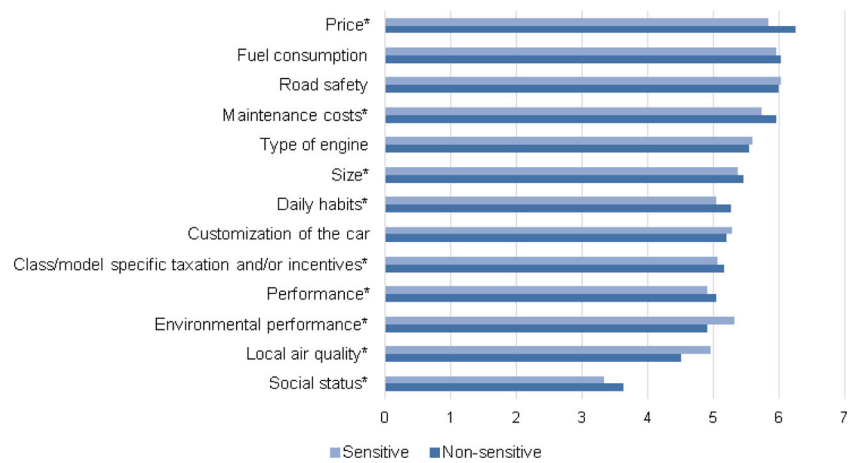


Fig. 8 Profiles of car purchasers, by age group (left) and education (right)

Fig. 9 Profiles of car purchasers by cars' attributed importance (%)



Note: *p<0.05

choosing the car's class (12%). Finally, a mere 11% of the sample is ready to pay for a more environmentally friendly model.

The responses to the purchase process show that features such as price, type of engine and class of car drive decisions and are likely to have been determined before selecting a particular model. As such, it is likely that environmental and health-related attributes are something of an afterthought. To investigate this further, we can look at answers to questions about respondents' attitudes towards taking current or future consequences into the decision-making process (see Fig. 6).

To examine and summarize these attitudes, a principal component analysis was performed on the questions concerning taking account of the current or future consequences of choices. Two factors emerged: (i) emphasis on the immediate issues (34.43% of variance explained) and (ii) a focus on how future impacts on health and the environment affect current behaviour (25.58% of variance explained). To develop a typology of consumers' understanding and attitudes towards health and environmental issues in the car purchase process, a cluster analysis of K-means was carried out (Table 1). Cluster 1 consists of respondents who place a

greater emphasis on a car's price and maintenance costs, whose behaviour is likely to be influenced by the immediate outcomes of their actions, and who are less likely to sacrifice their current well-being for future gains. This group is referred to 'eco-insensitive consumers' (57% of respondents). The label is used descriptively in order to capture the sense that, for these respondents, environmental and health issues are not important. By contrast, cluster 2 is characterised by a notably different syndrome of attitudes. Here, respondents place a notable emphasis on environmental and health issues. They are more likely to say that they will pay more for an environment-friendly car. They place more emphasis on the future and are more likely to engage in behaviours with long-term outcomes. Members of cluster two are labelled 'eco -sensitive consumers' (43% of respondents).

Comparing those who score highly on clusters 1 and 2, we find no statistically significant gender differences. However, the eco-sensitives are more likely to be younger, highly educated and with a slightly higher self-attributed socioeconomic status than the 'eco-insensitives', see also Fig. 7.

We investigated how these two clusters view the importance given to attributes of cars (see Figs. 8 and 9). As might

Fig. 10 Profiles of car purchasers by next car's engine (%)

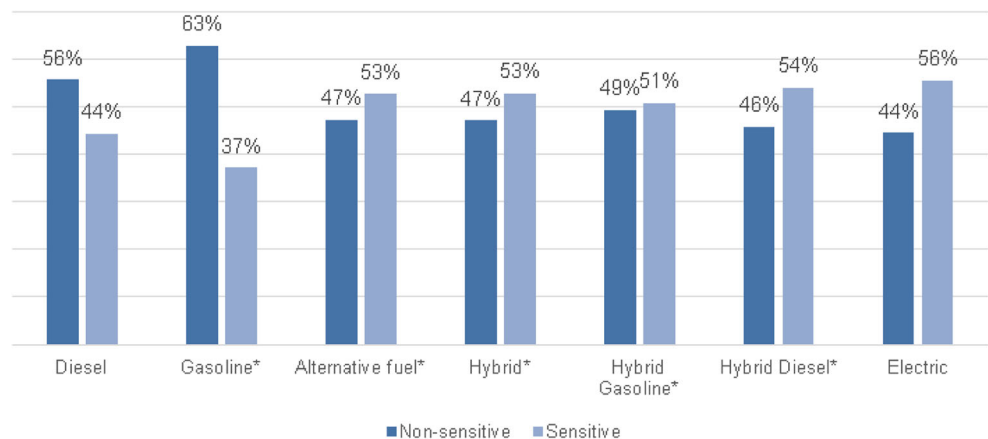
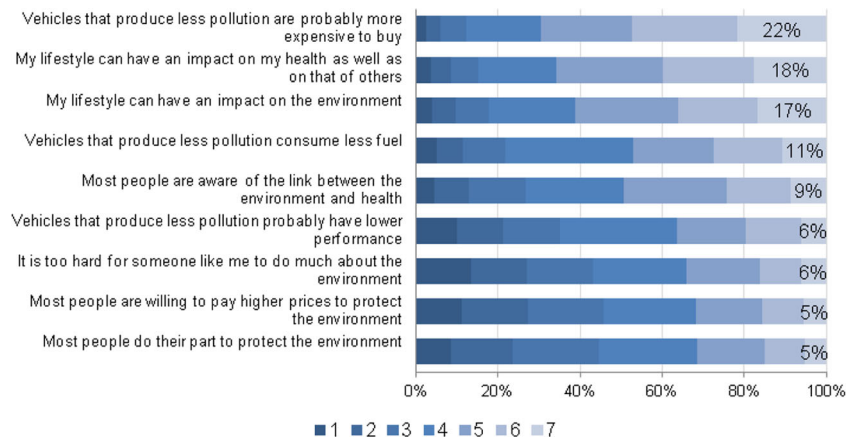


Fig. 11 Contextual factors (%)



be expected, the ‘eco-sensitives’ are slightly more oriented towards environmental performance and local air quality than the ‘eco-insensitives’. Price, maintenance costs and size are considered slightly less important by the ‘eco-sensitives’ than the ‘eco-insensitives’. This characterization suggests that the post-materials might be in favour of paying a slightly higher price/cost for less polluting cars as they value positively the environmental and health consequences of the car selected.

3.2 Perceptions and understanding of the health and environmental issues

Respondents were asked about contextual factors and about their health attitudes and awareness. Only 5% of respondents agreed that ‘most people are willing to pay higher prices to protect the environment’ and ‘most people do their parts to protect the environment’. This indicates that assumptions about the eco-friendly motivation and commitment of others are low. This may reduce the perceived effectiveness of one’s behaviour as a consumer and induce a sense of rationalised apathy—if others are doing nothing, why should I bother?

However, the data shows (see Fig. 10) that lack of faith in others does not prevent 61% of respondents from agreeing with the statement ‘my lifestyle can have an impact on the

environment’ and 43% from disagreeing with the statement ‘it’s hard for someone like me to do much about the environment’. So, despite the lack of faith in others, respondents do not feel that this exempts them from their individual responsibility.

Another constraint to opting for environmentally more sustainable cars is the widespread perception that less polluting and/or lower fuel consumption vehicles are more costly and give poorer performance. We find evidence that many consumers perceive buying eco-friendly car as entailing losses and a sacrifice. Such perceptions suggest that there is not a complete understanding of the connection between CO₂ emissions, fuel efficiency, performance and prices.

In this regard, the characterization of the two profiles previously identified reveals that ‘non-sensitive consumers’ put more responsibility on others (‘most people...’) than themselves (‘my lifestyle...’) in comparison with ‘sensitive consumers’ (see also Fig. 11).

Around 7 out of 10 respondents (68%) understand that high pollution emissions could make them ill and 1 in 2 (50)% are concerned about how choices today may lead to future health problems. Nevertheless, whereas general awareness about the environmental impact of car usage is fairly high, 43% of the respondents say they are not worried about getting ill due to

Fig. 12 Profiles of car purchasers by contextual factors (%)

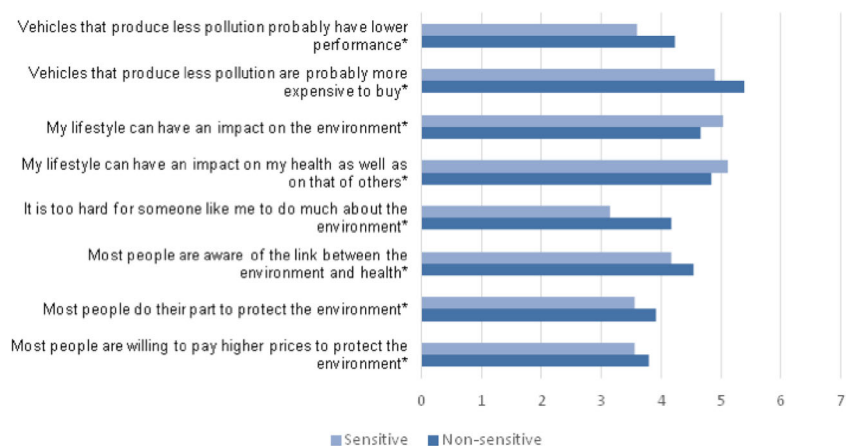
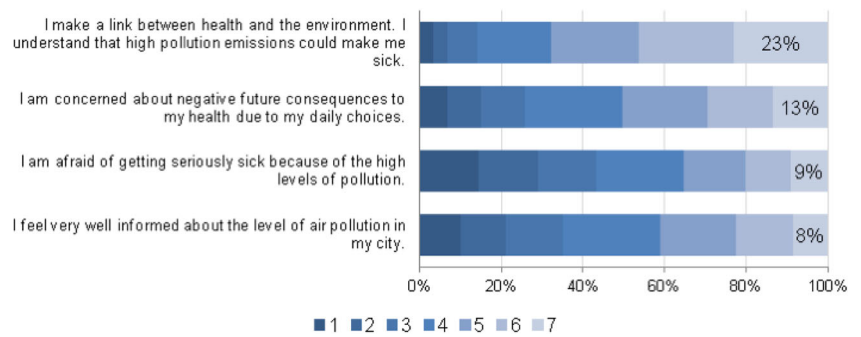


Fig. 13 Health awareness (%)



high levels of pollution. Moreover, when asked about information on levels of pollution in their cities, just 8% said they feel ‘well informed’ (see also Fig. 12).

Again, the analysis of the profiles reveals slightly different patterns (see Fig. 13). ‘Sensitive consumers’ are generally more aware than ‘non-sensitive consumers’ about the health consequences of car usage, even though they stated that they are less well informed about the level of air pollution (Fig. 14).

3.3 Incentives to influence the purchase process

Respondents were asked for their opinion on a number of policy-related issues, including incentives for the environmentally friendly choices. Around 30% of subjects believe that higher financial incentives (such as tax breaks and subsidies) for low-emitting products would be a very effective strategy to tackle air pollution. This policy option ranks second, after ‘applying stricter pollution controls on industrial and energy production activities’. The option of requiring the application of best available technology was selected by 38% of respondents. Overall, while there is support for a range of policies to promote low-emitting vehicles, there is no clear preference for between financial or non-financial incentives. As Fig. 15 shows, around 3 in 10 respondents consider a number of policies as diverse as exemptions for registration and road taxes, schemes for scrapping old vehicles and charging points for electric cars as ‘very important’. On the other hand, cheaper parking options and road taxes for low-emitting car owners

gain less support (‘very important’ only by 16% and 15%, respectively).

Responses to the eight measures were later grouped into the two broader categories of ‘financial incentives’, which includes tax breaks and subsidies, and ‘non-financial incentives’, such as access and parking options. Overall respondents tend to consider financial incentives as ‘more important’ (mean = 5.24, using a 1–7 importance scale) than non-financial incentives (mean = 4.71).

The impression that priority access and parking options are not as attractive as tax breaks and subsidies finds further support when respondents were asked to react to different non-financial incentives. When posed a scenario of a ban on high-emitting cars from being used during high pollution days, for example, more people stated that they would switch to public transport, bike or foot (23% of respondents ‘totally agree’), rather than buy a low-emitting car (18%). Likewise, if low-emitting cars got ‘substantially cheaper parking places in the city centre’, more respondents would rather commute (18% of full agreement) than buy (14%). The only scenario where respondents said they would buy a low-emitting car, although by a small margin (20% ‘buy’, 19% ‘switch to another mode’), is the introduction of a low-emission zone in the city centre (see Fig. 16).

These results point to the conclusion that non-financial incentives (low-emission zones, driving restrictions, cheap parking fees) might not be effective in moving consumers towards low-emitting cars. However, it may be the case that

Fig. 14 Profiles of car purchasers by health awareness (%)

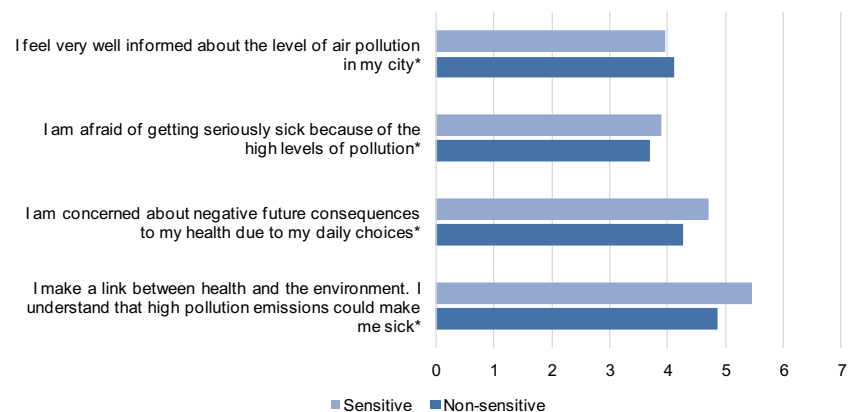
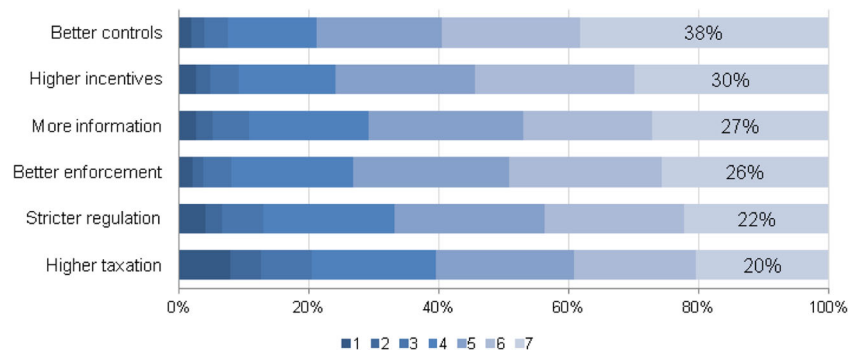


Fig. 15 Strategies to tackle air-related problems (%)

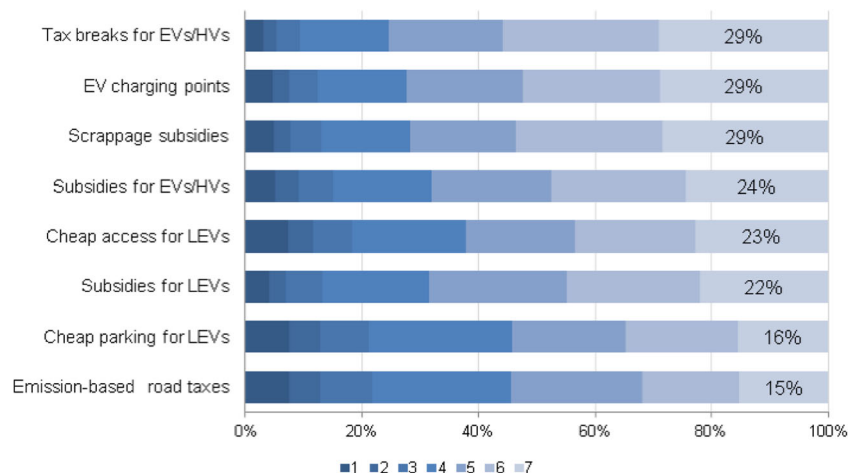


the attractiveness of non-financial incentives varies across consumer groups. For example, cheaper parking fees are likely to be less attractive for those with a residential garage. Similarly, low-emission zones are likely to affect commuters more than city centre residents. In order to investigate such differences, we split the sample into those who drive to work daily (commuters) and the rest (others). Almost half the sample (47%) fall into the commuter category. Do commuters have different views compared to the others about non-financial incentives? The comparison is shown in Fig. 17 which shows that non-commuters are more likely to switch mode of transport in all three scenarios, while commuters would buy a low-emitting car when faced with low-emission zones (23%) or cheaper parking fees (18%). For commuters, buying is also almost as popular as switching to public transport (both at 21%) in case of driving restrictions.

3.4 Attitudes and perception towards labels

In the last section of the survey, respondents were presented with several questions on car labels. Existing car labels do not score particularly well if judged by the level of agreement/disagreement with the statements depicted in Fig. 18. As many as 43% of the sample agree with the statement that they are unfamiliar with car labels and almost the same percentage of respondents agree (38%) and disagree (39%) on their

Fig. 16 Respondents who consider 'very important' the following policies



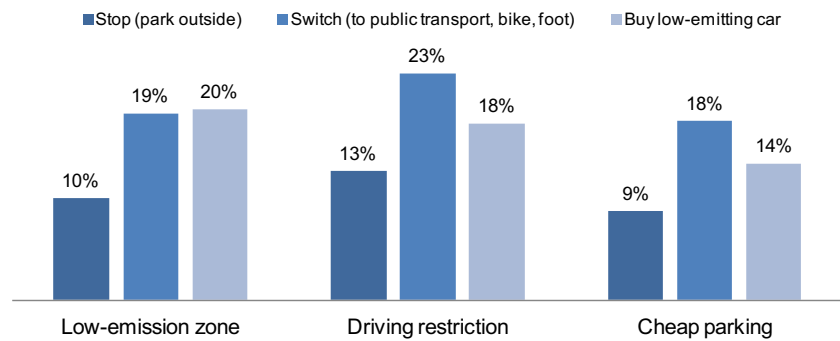
familiarity with car labels. These percentages agreeing (39%) and disagreeing (37%) are similar when respondents were asked about the recognition of car labels.

It is notable that percentage of respondents who do not trust the information in car labels (39%) is higher than for those who trust this information (33%). However, 38% of the sample agree with the statement that *car labels are a symbol of a product's trustworthiness* (27% disagree) and as many as 37% believe (agree) that *information contained in car labels is truthful* and 34% that the *information is sufficient* (32% disagree to both statements). When asked to react to the statement concerning how they use labels when they buy a car, 35% of the respondents state (agree) that they base their decision upon a (or several) car label (29% disagree) (Fig. 19).

4 Results from the experiment

In the online experiments, respondents were asked to choose between one of two car options. Each option consisted in the picture of the car and additional information. The first experiment featured two versions of the same small car, and the second featured two versions of a large car. Additional information featured a designed combination of one of the two conditions for the four car attributes.

Fig. 17 Respondents' reaction to different incentives



1. The car's base price or with a surcharge to fund ecolabelling (either 10,000 EUR or 10,700 EUR for small cars and either 25,000 EUR or 26,200 EUR for large cars)
2. A label on the car's CO₂ emissions (present or absent)
3. A hypothetical EULES label (present or absent)
4. A message on the car's positive features in terms of (i) 'Taxes', i.e. lower costs, (ii) 'Access', i.e. urban accessibility or (iii) 'Health', i.e. health benefits

The experimental data was analysed using a conditional logistic regression to estimate the increase in the probability of selecting a car when each of the attributes described above was added to the car label.

For each of the four attributes, the tables show coefficients, odds ratios, standard errors, 95% confidence intervals, and the outcome of the effect likelihood ratio tests expressed by the L-R chi-square (the value of the likelihood ratio chi-square statistic for a test of the corresponding effect; DF, the degrees of freedom for the chi-square test $\text{Prob} > \text{ChiSq}$, the p value for the chi-square test). We also report the models likelihood, AICc and BIC². In discrete choice models, each coefficient is a 'part-worth' estimate or the utility associated with that attribute. In the analysis, the 'Taxes' message was used as a reference point for the categorical variable 'EULES Message' and therefore does not appear in the output tables. 'Taxes' is used as a reference. 'Access' yields a negative part-worth compared to 'Taxes', while 'Health' has a positive part-worth. By default, estimates are based on the Firth bias-corrected maximum likelihood estimators (MLEs) and therefore are considered to be more accurate than MLEs without bias correction.

² This technique seeks to estimate the parameters of a model, which we denote generically by (β) , by maximizing the likelihood function. The likelihood function, denoted $L(\beta)$, is the product of the probability density functions (or probability mass functions for discrete distributions) evaluated at the observed data values. Given the observed data, maximum likelihood estimation seeks to find values for the parameters, β , that maximize $L(\beta)$. Rather than maximize the likelihood function $L(\beta)$, it is more convenient to work with the negative of the natural logarithm of the likelihood function, $-\text{Log } L(\beta)$. The problem of maximizing $L(\beta)$ is reformulated as a minimisation problem where you seek to minimize the negative log-likelihood ($-\text{LogLikelihood} = -\text{Log } L(\beta)$). Therefore, smaller values of the negative log-likelihood or twice the negative log-likelihood (-2LogLikelihood) indicate better model fits.

The result of the statistical analysis for the two experiments shows that all four attributes considered have a significant impact ($P < 0.05$) on the participants' choices (see Tables 2 and 3). The presence of logos, either EULES or on CO₂ emissions, has a small negative effect, 12% less likely for both logos for small cars and 7% (EULES) and 6% (CO₂) for large cars. For small and large cars, the additional price had a marginal positive effect in terms of increasing probabilities of selection by respondents (17% for small cars and 38% for large cars). The effect of the added messages is slightly positive in the case of 'health', increasing odds of selection of 13% for small cars and 11% for large cars while negative for 'access', decreasing odds of selection by 50% for small cars and 40% for large cars.

Of significance is the finding that the single most important predictor affecting choices is the message conveying the benefits of a low-emission car that accompany the logo. Tables 4 and 5 show how the different benefits captured in the messages (taxes, urban access and health) impact on choices.

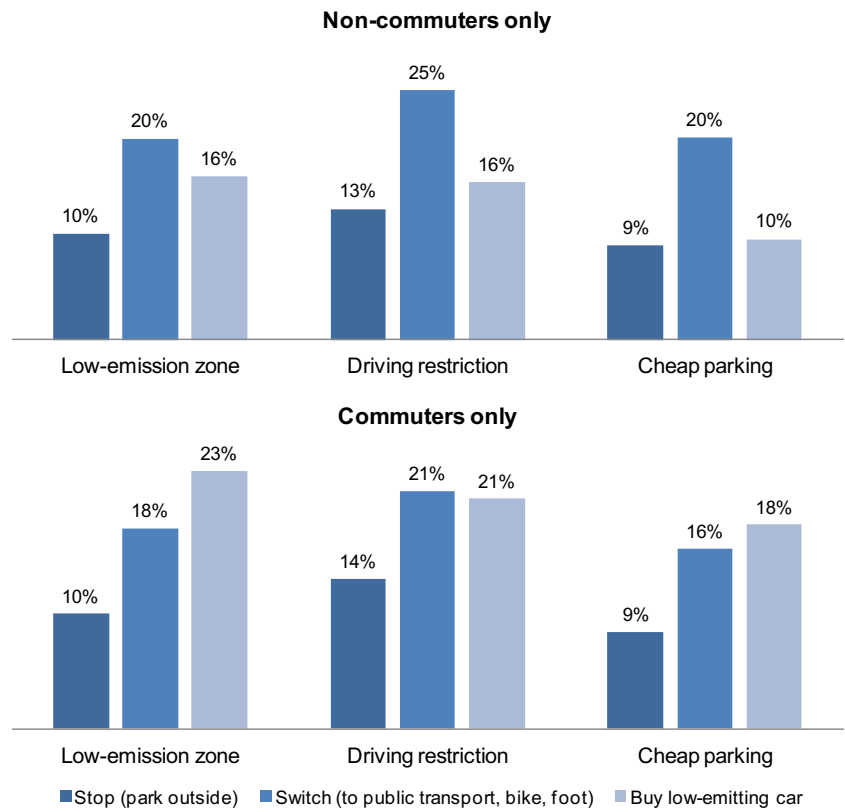
Table 5, focusing on larger cars, is based on the same analysis as Table 1. The odds ratio was 2.48 versus urban access and 1.34 versus health benefits. This means that information about the tax advantages of low-emission cars makes the choice of selection 1.48 times more likely than the urban access benefit and 0.30 more likely than a health benefit.

Overall, this shows that information attached to a low-emission logo is the most important attribute in increasing the likelihood of choice. But, crucially a message about tax advantages has considerably more impact than messages about the benefits of urban access and health. This effect is particularly strong for those choosing small cars and to a lesser extent for those choosing large cars.

5 Discussion

In order to comply to the Paris Agreement (UNFCCC 2018), greenhouse gas emissions have to reduce significantly. Current levels of air pollution are above international agreements and an important factor that contributes to air pollution is road transportation (Davis et al. 2010; EEA 2015). It is

Fig. 18 Respondents' reaction to different incentives



therefore of great importance to examine effectiveness of behavioural techniques that might improve consumers' choices when buying cars. The main objectives of the current study were (1) to assess and explore public responses and the role of public authorities to a EULES in order to deliver real-world emission levels below the most stringent current emission limits and to (2) experimentally test the incentives for this optimization.

First, as the results from the survey show, Europeans are aware of the health and environmental impact of cars. The survey points to a general understanding of the adverse health effects of pollution. Results showed that the respondents recognize that there is a link between the environmental protection and human health. Second, people think that the pollution

in their cities or neighbourhoods is rather high. Third, the result also shows respondents are aware of the environmental impact of polluting vehicles. More than half of respondents (54%) believe that 'cars contribute significantly to the air pollution' in their city or neighbourhood. Despite the high environmental awareness, the main factor that subjects take into account when buying a car is price (50% of respondents), followed by road safety (48%) and fuel consumption (46%). Most importantly, only 1 in 10 (11%) is ready to pay more for a more environment-friendly car. Finally, results also confirm the gap between self-reported attitudes/intentions and actual behaviours: health and environmental concerns come only after many other attributes (price, safety, performance, etc.) in terms of importance in influencing car purchase decisions.

Fig. 19 Existing awareness and perception on car labels

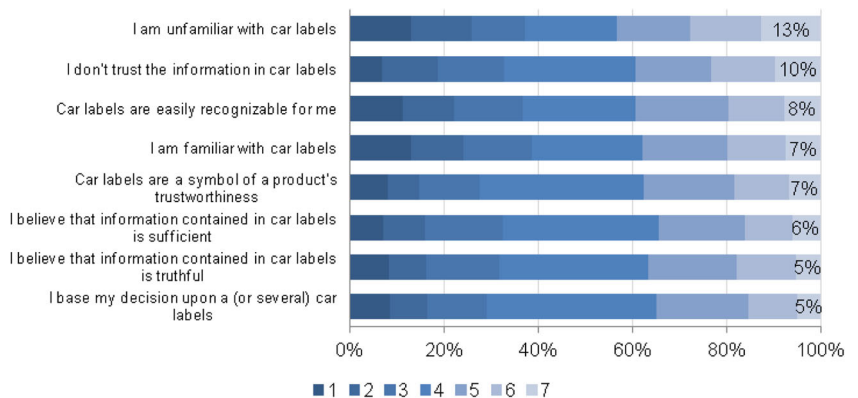


Table 2 Parameter estimates SMALL CARS

Term	Estimate	Odds ratios	Std error	Lower 95%	Upper 95%	L-R chi-square	DF	Prob>ChiSq
Price	0.17	1.1752	0.00	0.00	0.00	251.796	1	< 0.0001*
EULES Message Access	-0.65	0.5219	0.01	-0.68	-0.62	2169.130	2	< 0.0001*
EULES Message Health	0.12	1.1287	0.01	0.09	0.15			< 0.0001*
Absence of EULES Logo	-0.13	0.8779	0.01	-0.15	-0.11	167.296	1	< 0.0001*
CO ₂ Logo [NO_CO ₂ _L]	-0.13	0.8764	0.01	-0.15	-0.11	203.018	1	< 0.0001*

* $p < 0.05$

In fact, many consumers perceive buying an eco-friendly car as entailing a loss/sacrifice in terms of performance. There is a quite widespread perception that less polluting or lower consumption vehicles are associated with higher prices and that, to some extent, also compromise performance, which is in line with previous research (Gould and Golob 1998; Zhang et al. 2015). In this regard, citizens do not clearly understand the difference between air pollution and greenhouse gas emissions. Nearly half of the respondents (47%) agree with the statement ‘Vehicles that produce less pollution consume less fuel’. Financial incentives are the most likely to change consumers’ behaviour towards low-emission cars. According to 30% of survey respondents, providing higher financial incentives for low-emission products would be an effective strategy to tackle air pollution. Financial measures (tax breaks, subsidies) are more likely to nudge consumers towards low-emission cars than are non-financial incentives. Among the latter, low-emission zones seem more appealing, especially for those consumers who drive to work on a daily basis. Citizens are likely to prefer tax exemptions and subsidies rather than environmental taxes or road pricing. We draw this conclusion from the survey, in which respondents believe they are paying already too much of environmental taxes for their car and are not in favour of applying ‘road pricing’ (e.g. road tax, registration tax) for major metropolitan areas (e.g. cities with over 100,000 inhabitants and their suburbs). At the same time, they welcome proposals in which the government would provide either tax exemptions or subsidies for those purchasing a low-emitting car. European consumers are not too acquainted with car labels. More than 43%

of respondents admit to be ‘unfamiliar with’ existing car labels. Around 37% disagree with the statement that labels are ‘easily recognizable’. As many as 39% do not trust the information displayed, and reportedly, the most common use of labels is ‘to check if what said in the advertisement is true’. Many even misunderstand their purpose: nearly 38% believes that labels symbolize a product’s reliability. In any case, the element of car labels that most attracts the attention of candidate buyers is the message.

To find that out, we ran a series of experiments in which individuals were asked to choose a car between two options. Each option consisted in a label depicting a car and a series of additional elements—logos, price tags and a series of messages. As the results show, all attributes are significant, and they all contribute to the choice. However, the strongest utility is given by the messages. Respondents were more likely to choose EULES-friendly cars when they the label shows information on lower costs or lower taxes. When it comes down to one car purchase decision, consumers are less interested in knowing about health-related benefits, convenient parking or access fees. A minor increase in price has a negligible effect. Finally, combinations of one message with other elements—EULES logo, CO₂ logo or both—within the same label have a small but positive effect on participants’ choices.

Ecolabelling is considered an effective strategy to encourage future consumers towards forms of sustainable consumption (Thøgersen et al. 2010). Compared to the more general literature on ecolabels and especially to that focusing on white goods and food, the study of car labelling is considerably less

Table 3 Parameter estimates—large cars

Term	Estimate	Odds ratios	Std error	Lower 95%	Upper 95%	L-R chi-square	DF	Prob>ChiSq
Price	0.32	1.3858	0.00	0.00	0.00	1286.676	1	< 0.0001*
EULES_Message[Access]	-0.51	0.6019	0.01	-0.53	-0.48	1555.362	2	< 0.0001*
EULES_Message[Health]	0.11	1.1114	0.01	0.08	0.14			< 0.0001*
EULES_Logo[NO_EULES_L]	-0.08	0.9231	0.01	-0.10	-0.06	73.718	1	< 0.0001*
CO ₂ _Logo[NO_CO ₂ _L]	-0.06	0.9436	0.01	-0.08	-0.04	39.794	1	<.0001*

AICc 18,949.468, BIC 18987.866, $-2 \times \text{Loglikelihood} = 18,939.464$, $-2 \times \text{Firth LogLikelihood} = 18,894.23$ * $P < 0.05$

Table 4 Small cars: messages and odds ratio comparison

Compared 1	Compared 2	Probability 1	Probability 2	Odds ratio 1	Odds ratio 2
EULES_Message=Access	EULES_Message=Health	0.312	0.68	0.46	2.16
EULES_Message=Access	EULES_Message=Taxes	0.24	0.76	0.31	3.25
EULES_Message=Health	EULES_Message=Access	0.68	0.32	2.16	0.46
EULES_Message=Health	EULES_Message=Taxes	0.40	0.60	0.67	1.50
EULES_Message=Taxes	EULES_Message=Access	0.76	0.24	3.25	0.31
EULES_Message=Taxes	EULES_Message=Health	0.60	0.40	1.50	0.67

developed with only a limited amount of studies conducted to examine its effects (Choo and Mokhtarian 2004; Kurani and Turrentine 2002; Lane and Potter 2007; Loureiro et al. 2012; Noblet et al. 2006; Teisl et al. 2008; Teisl and Roe 2005). The first strength of the current study is that it established which factors are associated with the effectiveness of labelling cars. Ecolabels are considered as voluntary environmental and consumer policy instruments and therefore considered as a pragmatic option for policy developers. It is a form of choice architecture that does not affect the perceived autonomy of consumers, being an ideal example of a ‘nudge’. The second strength of the study is that we are the first that experimentally examined causal effects on consumption choices. Until now, there has been no experimental study conducted on the effects of car labels on consumers’ decision-making, although it is of great importance to reduce the negative health consequences of road transport (EEA 2015). Teisl et al. (2008) showed that it is important to test a model linking individual characteristics and label characteristics in order to create effective ecolabels that affect individuals’ perceptions of the eco-friendliness of products. Existing studies on ecolabels have been focusing on the relationship between individual characteristics and eco-behaviour or between label characteristics and eco-behaviour but not on the interaction between these two factors. It is therefore important to extend this knowledge by examining both individual characteristics and the manipulation of ecolabels simultaneously and test the effectiveness of the ecolabels. As Teisl et al. (2008) already have shown, it is highly relevant to examine underlying psychological factors and individuals’ priors of the product and of the

environmental problem, because it plays a strong role for the long-run provision of eco-information, in particular in context where individual consumers hold incorrect perceptions.

One limitation of the current study is that participants conducted the survey and experiment online, whereby we did not control the situation in which they participated. This is a potential harm of internal validity. However, it could also be argued that such settings could reflect the real purchasing decisions to a larger extent. One could imagine that a typical consumer usually chooses its vehicle on the basis of a number of attributes by browsing the Internet, and subsequently, the person visits a car dealer to obtain further details. Additionally, future research could investigate the effects of ecolabels on consumption behaviour in real-life car shops. Secondly, only a limited amount of car types were used in the experiments so it is difficult to generalize the results to other type of cars. Nonetheless, the same mechanism that we have found in the current study seems to be applicable to other cars as well, in particular because we assessed public responses to possible incentives in general that might affect the perception of the ecolabels.

6 Conclusions

The current study is of great importance because it will provide the standard that could be presented to consumers either in a form of a label, a message or both. In this study, our research goal was to identify and test the elements which would nudge consumers towards an environmentally and health-friendly EULES car. Our findings will support

Table 5 Large cars: messages and odds ratio comparison

Compared 1	Compared 2	Probability 1	Probability 2	Odds ratio 1	Odds ratio 2
EULES_Message=Access	EULES_Message=Health	0.35	0.65	0.541	1.85
EULES_Message=Access	EULES_Message=Taxes	0.29	0.71	0.40	2.48
EULES_Message=Health	EULES_Message=Access	0.65	0.35	1.85	0.54
EULES_Message=Health	EULES_Message=Taxes	0.43	0.57	0.74	1.34
EULES_Message=Taxes	EULES_Message=Access	0.71	0.29	2.48	0.40
EULES_Message=Taxes	EULES_Message=Health	0.57	0.43	1.34	0.74

governmental decision-making process with respect to the EULES format that should have the greatest impact on consumer purchasing decisions. In addition, we also assessed the likely consumers' preference between the CO₂ label and the EULES label. The results will help to guide environmental conscious customers towards the purchase of vehicles with clean emission profiles. Furthermore, it will provide a benchmark for local or national authorities when developing financial or access and demand policies to promote clean transportation. Finally, it will provide an incentive for manufacturers to produce vehicles that deliver significant emission reductions on the road.

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