

THE RELEVANCE OF LIFE-CYCLE CO₂ EMISSIONS FOR VEHICLE PURCHASE DECISIONS: A STATED CHOICE EXPERIMENT

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Overview

The European Commission adopted a low-emission mobility strategy in July 2016 to support the transition of Europe towards a low-carbon economy. Among others one of the main elements of the strategy is to speed up the deployment of low-emission alternative energy for transport and remove obstacles to the electrification of transport (e.g. European Commission 2016). Since a large share of car ownership is comprised of private vehicles, it is clear that one of such obstacles is private consumers' acceptance of alternative fuel vehicles – specifically, electric vehicles. Although a substantial amount of research has been done on factors that may influence consumers to adopt electric vehicles, policies that promote the diffusion of electric vehicles, and the positive environmental consequences of such vehicles, the number of electric vehicles in use is still low. The purpose of this paper is thus to further examine possible barriers causing the modest adoption of low-emission vehicles by private consumers.

The main situational barriers for the mass adoption of electric vehicles are the driving range, the charging problem (i.e., charging availability and time), and the high purchase prices (e.g. Li *et al.* 2017). However, studies have also found that providing the consumer with total-costs-of-ownership or fuel-cost information has a positive effect on the stated preference for alternative fuel vehicles, because the consumer realizes that high upfront investments can lead to substantial savings from low operating costs in the long run, increasing the willingness to pay for higher levels of fuel efficiency, when choosing between cars (e.g. Dumortier *et al.* 2015, Brazil *et al.* 2019). Furthermore, research shows that consumers have a strong preference for emission reductions in passenger car transport and a high willingness to pay for low-emission vehicles (e.g. Hulshof and Mulder 2020). Yet, these studies only consider vehicle emissions caused during the use of a car. A vehicle attribute which has been neglected so far, is the influence of vehicles' production emissions on the stated vehicle preference of consumers. Similar to the purchase price of battery electric vehicles, the emissions caused by their production is often higher than those of conventional vehicles. However, the total amount of life-cycle emissions by electric vehicles can be considerably lower than those of conventional cars, especially if the battery electric vehicle is charged with renewable electricity (e.g. European Environment Agency 2017). Nevertheless, if consumers are not informed about life-cycle vehicle emissions, just like in the case of vehicles' total-cost-of-ownership, they may perceive high production emissions as another barrier for purchasing battery electric vehicles. Hence, our study examines whether high production emissions are another hurdle for the mass adoption of electric vehicles by private consumers.

Next to the situational factors, however, research shows that considering demographic and psychological factors when analyzing consumers stated preference for low-emission vehicles is just as important. Many studies (e.g. Ziegler 2012, Hackbarth and Madlener 2013, 2016, Tanaka *et al.* 2014) have examined consumer preferences and their willingness-to-pay when it comes to adopting alternative fuel vehicles. Among them, a recurring result is that emission performance does have a substantial effect on the stated preference for such vehicles. However, they all find that the effect varies across the population. The group most likely to adopt alternative fuel vehicles, are mostly young, well-educated, environmentally aware consumers. Hackbarth and Madlener (2016) call this promising group of consumers *Alternative Fuel Vehicle aficionados*, since they are the most impressionable group when it comes to expanding the diffusion of such cars. They are among the households who are willing to pay for vehicle improvements to increase the demand of alternative fuel vehicles. In line with this research, our study thus additionally examines whether consumers who are more environmentally aware are more (or less) sensitive towards (CO₂) emissions caused during vehicle productions.

Methods

The econometric analysis is based on data from a stated choice experiment regarding vehicle choice. The choice experiment is embedded in a currently ongoing large-scale computer-based survey that is conducted in cooperation with a professional market research company. Similar to most studies focusing on consumer preferences for alternative fuel vehicles (e.g. Brazil *et al.* 2019, Hulshof and Mulder 2020), our stated preferences approach is useful as the alternative vehicle market is still under development and such methods enable researchers to examine the demand for potential transport solutions which are not yet available in the consumer market or are struggling to expand, for example, electric or automated vehicles. In addition, stated preference methods allow us to vary attribute

levels that may be correlated in a real-world setting, such as purchase price and propulsion technology in a passenger vehicle context. From a resource perspective, stated preference methods permit researchers to collect larger and more statistically important samples, than what would be possible when using the revealed preference approach. The data of about 550 respondents, who are representative for German household decision makers, are analyzed with flexible mixed logit models (e.g. Train 2003).

Preliminary Results

Similar to consumers' sensitivity towards high purchase prices of electric vehicles and their preference for CO₂ emission reductions during use, we expect that consumers will also be sensitive towards high production CO₂ emissions. Furthermore, we expect that higher levels of consumers' environmental awareness leads to higher sensitivity towards vehicle production emissions. In contrast, our theoretical considerations give us no clear indication whether the positive effect of environmental awareness is stronger for emission reductions during use or for vehicle production emissions.

Preliminary Conclusions

This paper draws implications for policy measures, in particular in accordance to the European Commission's strategy to speed up the deployment of low-emission private transport (e.g. European Commission 2016). The results will give insights into the importance of sharing vehicle life-cycle emissions with consumers. Findings should also offer an indication of consumers ability to consider the vehicles' total emissions when making a purchase choice.

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