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Analyzing consumer attitudes towards electric vehicle purchasing intentions in Spain: Technological limitations and vehicle confidence

Beatriz Junquera [a], Blanca Moreno [b,*], Roberto Álvarez [c]

[a] Department of Business Administration, Faculty of Economics and Business, University of Oviedo, Avd. Cristo s/n, 33006 Oviedo, Spain
[b] Regional Economics Laboratory-RegioLab, Department of Applied Economics, Faculty of Economics and Business, University of Oviedo, Avd. Cristo s/n, 33006 Oviedo, Spain
[c] Department of Electrical Engineering, University of Nebrija, Calle Pirineos 55, 28040 Madrid, Spain

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ABSTRACT

The history of the automotive industry was initially linked to electricity. However, the combustion engines would become the dominant paradigm later. Nowadays, because of several factors, the automotive industry has been researched on electric vehicles (EVs) for several decades, although this industry will have to overcome important obstacles to commercialise this kind of vehicles efficiently.

In this context, the main aim of this paper is to discover to what extent some issues are key to explain consumers' willingness to buy an electric vehicle. We focus on consumers' perceptions about technical specifications of electric cars, such as charging times, consumers' perception of the price of the electric vehicle, driving range and drivers' ages, among others.

We design a survey in order to obtain some factors linked to consumers' profile which are later crossed with their expectations to buy an electric vehicle. A logistic regression analysis was conducted to explain the willingness to buy an electric car by using the information of 1245 Spanish respondents.

Our results indicate that the higher a consumer's perception of the price of electric vehicles and the longer charging times are, the less a consumer's willingness to buy a new electric car is.

The results are useful to define key elements linked to the most appropriate industrial policy which helps companies promote the electric vehicle.

1. Introduction

Electric vehicles have become a new alternative in the automotive industry because of some factors, such as emissions control,[1] noise pollution, the ease with which to drive or fuel prices (Beaume and Midler, 2009). However, despite these positive effects, commercializing electric vehicles has been attempted without major important level of success. In fact, the failure of electric vehicles has never been benefited from economies of scale since the beginning of the 20th century when the first prototypes were developed (Beaume and Midler, 2009). Actually, the first automobiles were electric vehicles. However, there were different paradigms in the market until the combustion engine became the leader and, as a result, the other paradigms failed at that moment. One basic fact was the achievement of scale economies linked to the combustion engine. Nevertheless, this kind of economies became an important problem for automobile manufacturers. As a result, they were not be able to take advantage of economies of scale linked to manufacturing.

A second problem appears after manufacturing. A small number of electric vehicles lead both to a disadvantage because of economies of scale and a poor recharge network. In fact, both problems are linked to each other. As a result, it has become a vicious circle for electric vehicles. That is, as hundreds of thousands of electric vehicles are not manufactured, economies of scale cannot be achieved, so that companies have not accepted to invest in a recharge network (Beaume and Midler, 2009).

Furthermore, in a globalised market, where the level of competition is extremely high, it is very difficult for a start-up to penetrate the market. An investment in an entirely new car manufacturer requires a huge capital cost. However, some companies are successful. Tesla Motors,[2]

* Corresponding author.
E-mail address: morenob@uniovi.es (B. Moreno).

[1] This issue has been discussed for several decades. Several years ago research carried out addressed that electric vehicles could be more harmful because of emissions, supporting their arguments on the lack of efficiency of the electric vehicle power storage device (Adcock and McCusker, 1995). Nevertheless, new research (Álvarez et al., 2015) has studied the greenhouse gas (GHG) emissions derived from the use of battery electric vehicles and it shows that plug-in electric energy for transportation is one option to reduce oil use and GHG emissions, although these results reveal the necessity to particularise emissions according to electricity generation mix, driver's behaviour profile and traffic density conditions.

[2] Tesla Motors is a luxury all-electric Silicon Valley-based automaker which currently designs, manufactures and markets two vehicle models. Tesla was founded in California, where it invests heavily. It employs nearly 6500 workers at its headquarters in Palo Alto, primary car and battery factory in Fremont, design studio in Hawthorne and a specialized production plant in Lathrop.

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which has developed strategies to overcome some of these entry barriers to this market as high capital cost or to joint manufacturers efforts to increase investment profitability (Stringham et al., 2015). One key factor for Tesla's success is the expansion and invest in an own financed supercharger infrastructure. The superchargers are charger stations with the aim that Tesla cars' owners charge their vehicles along highways in North America and Europe in a 200 miles range-30 min free charging. Tesla Motors hardly invests in expansion of the "free forever" Tesla supercharger network, open now with 536 superchargers worldwide and 3053 charge posts.

In any case, the advantages of environmentally-friendly vehicles are widely recognized. However, a question remains: Why is their commercialisation so difficult? An answer is that their constraints remain: product eco-innovations[3] must be perceived more advantageous than conventional products (Pickett-Baker and Ozaki, 2008). A customer must perceive a value increasing to choose a product eco-innovation when there are conventional products in the market. That is to say, they must focus on the most traditional attributes (if we are talking about cars, safety and reliability), as well as on environmental characteristics, combination which could become a powerful competitive advantage in the long term (Jansson, 2011).

Graham-Rowe et al. (2012), Daziano and Bolduc (2011) and Turcksin et al. (2013) identified some latent attitudes to explain why people buy electric cars, such as vehicle confidence or environmental attitudes, among others. However, they are related to subjective beliefs and tastes, which cannot be directly observed or objectively derived from the measurable technical specifications of electric cars. These latent attitudes are related to subjective beliefs and tastes, which cannot be directly observed or cannot directly lead to behaviours (Oreg and Katz-Gerro, 2006). One of the limitations of the use of attitudes in electricity-cars-purchase-intention studies is that they are not enough to explain why people buy an item.

Moreover, some disadvantages have been pointed out as a limitation in the electric vehicle market penetration: its limited range, although it should not been considered an insuperable problem from other authors' point of view (Beaume and Midler, 2009) and the necessary time to recharge the battery, among others (Glerum et al., 2013).

In order to throw light about this issue, Aggeri et al. (2009) have found out that the path to electrification in the automotive industry should explore new marketing, technological and business model concepts. Several topics should still be studied before achieving some definitive conclusions. It is particularly necessary an increased understanding of how electric vehicle companies and consumers are affected by some variables related to those concepts. In that sense, as Al-Alawi and Bradley (2013) or Daziano and Chiew (2012) have pointed out, there is a need for more micro-data to properly inform models of potential electric vehicle market penetration and to improve their usefulness as decision-making tools. In their recent review, Al-Alawi and Bradley (2013) strongly recommended a need for narrower connection between consumer surveys and electric-drive vehicle adoption modeling.

Thus, with this paper, our main aim is to discover to what extent some issues are key to explain Spanish consumers' willingness to buy an electric vehicle by using a survey and the information obtained by 1245 Spanish respondents.

According to the Association of European Manufacturers (2015) data, in 2014, the whole market of the European Union reached 75,331 electric vehicles sold. In Spain a total of 1405 electric vehicles were sold. However, it is not enough, especially if we consider that the Spanish economy is more than the 8% of the European Union's economy. Nevertheless, only about 1.8% of the electric vehicles commercialized in the European Union are sold in Spain. That is to say, this market in Spain is small according to its economic importance in the European Union. Consequently, it is necessary to carry out new studies in this country to understand what is happening in a better way and to find out new ideas to foster the market of electric vehicles in Spain.

With this aim, the likelihood of consumers' stated willingness to consider the future purchase of an electric vehicle is explored using logistic regression. We focus on consumers' perception about technical specifications of electric cars, such as charging times, their perception of the price of electric vehicles, driving range, and drivers' ages, among others.

The present study contributes to the literature on this topic in three ways: (i) it provides an empirical study about consumers' decision-making to buy an electric vehicle; (ii) it is the first study about this topic in the Spanish market; and (iii) it provides useful information to policy makers to discuss the key elements related to the most appropriate industrial policy which help to promote the electric vehicle.

The paper is structured as follows: firstly, we expose our theoretical framework. Later, an empirical study is carried out. Finally, some concluding remarks and recommendations are presented.

2. Theoretical framework

Some instrumental attributes are key to explain the intention to adopt electric vehicles because they influence people's emotional responses to electric vehicles (hedonic function) and are used to form and express an identity (symbolic function) (Schuitema et al., 2013). Previous studies have focused on the role of these instrumental attributes linked to the willingness to buy an electric vehicle. Research has include purchase price, driving range and recharging time, assuming that they would be the most important determinants of adoption (Beggs et al., 1981; Bunch et al., 1993; Chéron and Zins, 1997; Lieven et al., 2011; Zhang et al., 2011; Egbue and Long, 2012; Moons and De Pelsmacker, 2012; Carley et al., 2013; Jensen et al., 2013; Krupa et al., 2014). We have included those three classical variables. However, we have added the so-called variable 'age'.

2.1. Perception of price

Electric vehicles are usually more expensive to be bought. However, energy-saving technologies could be net-cost savers in the long run. Despite these savings, consumers may decline to purchase them. It is the so-called 'energy-efficiency paradox' or 'energy-efficiency gap' (Gillingham et al., 2009; Allcott and Greenstone, 2012; Gillingham and Palmer, 2013). In any case, according to the usual relationships, the level of price of electric vehicles may influence consumers' willingness to adoption. As a result, we can deduce our first hypothesis:

Hypothesis 1. The higher the perception of the price of an electric vehicle by consumers is, the more their willingness to adopt it is.

2.2. Age

Sustainable products, such as electric vehicles, have pro-environmental characteristics which correspond to activated environmental values. Hence, when environmental values are activated, consumers should be motivated to pay more for electric vehicles. That is, value activation is expected to result in higher internal price thresholds and lower sensitivity towards electric vehicles prices. Moreover, when product information is provided, activation of environmental values is expected to influence consumers' information processing regarding sustainable products resulting in more positive evaluations of provided electric vehicle attributes (Hahnel et al., 2014). Several reasons may

[3] There are different classifications of innovations according to different criteria. One of them distinguishes between product innovations and process innovations. When we are talking about an electric vehicle, we are thinking of a product innovation.