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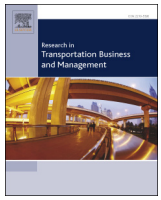

Exploring consumer preferences towards electric vehicles: The influence of consumer innovativeness

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ABSTRACT

The diffusion of electric vehicles (EVs) is regarded as an important aspect of government policy which aims to generate a transition to a low-carbon mobility system in the United Kingdom and the wider European context. This paper investigates consumer demand for EVs by examining the influence of consumer innovativeness alongside attitudes concerning the functional capabilities of EVs over EV preferences. A conceptual framework is developed and applied which includes measurements of innovativeness at both an adoptive level, through an assessment of technology ownership, and at an innate level, by measuring a cohort of psychological and sociological factors. Additionally, the framework incorporates measurements of attitudes towards the functional performance of EVs to determine their effect on preferences. Data has been collected through the application of a self-completion household survey distributed over the cities of Dundee and Newcastle upon Tyne in the United Kingdom. Results of the analysis indicate that adoptive innovativeness and attitudes concerning the functional performance of EVs significantly affect preferences for plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs).

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1. Introduction

The challenge of transitioning the transport sector onto a low carbon trajectory is one that will likely define research in this field over the next decade (Schwanen, Banister, & Anable, 2011). The magnitude of this challenge is significant, with the transport sector accounting for 40% of final energy consumption in the United Kingdom (UK) in 2011, with consumption having increased by 52% since 1980 (DECC, 2012). This energy is sourced almost entirely from fuels derived from crude oil (DECC, 2013a) resulting in a situation where the transport sector represents the second largest emitter of greenhouse gases (GHG), accounting for 21% of UK territorial emissions in 2011 (DECC, 2013b).

The UK Government has expressed a commitment to encouraging the uptake of electric vehicles (EVs; comprising both pure battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs)) (OLEV, 2013), which are viewed as representing a means by which significant reductions in GHG emissions from the transport sector can be realised (CCC, 2013). Moreover, the UK Government considers EVs to represent a way in which the UK's strength in propulsion system technology can be maintained (BIS, 2013) and a mechanism to generate consumer demand for low carbon products (BIS, 2010). This strategic vision is replicated at the EU level, with the European Commission establishing a Green Cars Initiative to ensure the EU is a world leader in EV technology (EC, 2013).

The technical specification of EVs represents a substantial divergence from vehicles operating internal combustion engine (ICE) propulsion systems (Dijk, Orsato, & Kemp, 2013; van Vliet, Kruithof, Turkenburg, & Faaij, 2010). Specifically, functional issues concerning vehicle range, price premiums, operating costs, refuelling behaviours and stated environmental benefits combine to distinguish EVs from conventionally powered vehicles. This has led commentators to define EVs as representing a form of disruptive innovation (Christensen, 1997). As a result of the unique features of EVs and the current low sales volumes of these vehicles (DfT, 2013), it proves challenging to determine likely consumer response based on the existing market. Nonetheless, a detailed understanding of consumer response to EVs is likely to be necessary if the diffusion of these vehicles is to be widespread.

This paper contributes to improving the understanding of consumer response to EVs by evaluating if consumer innovativeness is related to the expressed preference towards EVs using a UK case study. The concept of consumer innovativeness can be considered to represent the inherent and revealed propensity of a consumer to adopt new products with different or advanced features and functions. This concept has been widely researched in the marketing sciences (Bartels & Reinders, 2011; Midgley & Dowling, 1978; Roehrich, 2004;) though has received only modest attention in transport studies (Lin & Filieri, 2015). With the transport sector likely to witness a range of new innovations being introduced over the next decade, this paper provides a first step in

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evaluating if the concept of consumer innovativeness can be useful in distinguishing the early adopters of innovations in private vehicle transport.

2. Consumer demand for electric vehicles

Whilst EVs remain a niche market application, research examining consumer demand for EVs has been an active area of enquiry for the past thirty years. Research was initiated in the early 1980s due to the occurrence of the 1970s oil shocks and the growing awareness of air quality issues in some of the major conurbations of California which combined to generate interest in the possibility of shifting away from ICE vehicles (Sperling & Eggert, 2014). Initial research tended to approach the assessment of consumer demand using econometric methods, such as discrete choice modelling based on random utility theory (Train, 2009), which allowed researchers to quantify the effect of the novel functional features of EVs over consumer preferences (Mannering & Train, 1985). Research conducted using these methods assisted in identifying prominent adoption barriers such as aversion to the limited range of EVs, the price premiums associated with EVs and high discount rates for operating costs (Beggs, Cardell, & Hausman, 1981; Calfee, 1985). These issues corresponded with generally low expectations of the potential market for EVs (Train, 1980) which have been validated by low sales figures. As anxieties relating to the stability of oil supplies began to subside and the technical deficiencies associated with the functional performance of EVs became clearer, interest in understanding the market potential of EVs declined.

Over the past decade, interest in EVs has resurfaced (Rezvani, Jansson, & Bodin, 2015), mostly due to the importance placed on this technology in transitioning the transport sector onto a low carbon trajectory (Dijk et al., 2013; Geels, 2012; Greene, Park, & Liu, 2014; Steinhilber, Wells, & Thankappan, 2013; van Bree, Verbong, & Kramer, 2010). A significant quantity of forecasting studies have been conducted to assess potential adoption pathways for EV demand (Anable, Brand, Tran, & Eyre, 2012; Eggers & Eggers, 2011; Karplus, Paltsev, & Reilly, 2010; Musti & Kockelman, 2011; Shepherd, Bonsall, & Harrison, 2012). These forecasting studies have tended to investigate the potential effect of different market developments, such as improvements to battery technology and reductions in price premiums, alongside the influence of government incentives. Whilst market forecasting at the system level allows for the effect of different technical development scenarios and policy mixes to be considered, it provides little insight regarding how EVs are being evaluated by individual consumers. In an effort to shed light on this issue, research activity in consumer demand for EVs has progressed through the application of psychometric models which draw on concepts originating in psychology and sociology (Lane & Potter, 2007). This is an extension of the increasing application of socio-psychological methods in order to evaluate the challenge of transitioning towards a sustainable transport system (Gehlert, Dziekan, & Gärling, 2013), with the importance of attitudes (Gärling, Gillholm, & Gärling, 1998) alongside affective and symbolic motives (Steg, 2005; Steg, Vlek, & Slotegraaf, 2001) in explaining travel behaviour now being well established (van Acker, Van, & Witlox, 2010).

In relation to EVs, studies which apply psychological theory comprise a rapidly growing and already substantial body of literature examining a variety of emotional or non-conscious regulatory processes, but with only loose consensus as to the factors emerging as most directly or even indirectly influential on an individual's adoption intention or behaviour (Anable et al., 2014). The examined factors include relatively rational and linear relationships between consumer attitudes and their EV adoption intentions (Moons & Pelsmacker, 2012), more normative models of behaviour investigating personal norms such as strong moral obligation towards environmental issues or values (Moons & Pelsmacker, 2015), as well as those focusing on indirect and social processes (Axsen, Orlebar, & Skippon, 2013) that impinge on behaviour including symbolic meanings attached to cars (Heffner, Kurani, & Turrentine, 2007; Morton, Anable, & Nelson, 2015; Noppers, Keizer, Bockarjova, & Steg, 2015), self-identity (Barbarossa, Beckmann, De Pelsmacker, Moons, & Gwozdz, 2015; Peters, Gutscher, & Scholz, 2011a) and personality (Skippon & Garwood, 2011). Whilst methodologically and theoretically diverse, these studies consistently demonstrate the importance of the degree to which EVs are perceived to be compatible with lifestyle and personal image alongside the relative advantage of operation. For example, several studies have found that hedonic and symbolic motives are valid predictors of preferences towards EV variants (Ozaki & Sevastyanova, 2011; Schuitema, Anable, Skippon, & Kinnear, 2013) and others have concentrated specifically on how pro-environmental values, beliefs and social norms assist in explaining the adoption of an alternatively fuelled vehicle (Jansson, Marell, & Nordlund, 2011; Ozaki & Sevastyanova, 2011; Peters, Popp, Mareike, & Raphael, 2011b). Whilst the majority of studies attempting to include psychological factors in their models of EV adoption behaviour have found these elements to explain more or at least as much of the variance as functional factors, this is not always the case. For instance, when comparing adopters of EVs to owners of conventional cars in Norway, Nayum, Klöckner, and Mehmetoglu (2016) found that attitudes towards functional issues such as car performance and convenience are most useful in distinguishing EV owners vis a vis norms and values.

Whilst existing research has explored some of the psychological antecedents to preferences towards EVs and has attempted to identify the prominent characteristics of consumers more inclined to consider the purchase of an EV, little attention has been paid to the fundamental predisposition of consumers to be attracted to the innovative and unique features of EVs. To this end, this paper specifically concentrates on the concept of consumer innovativeness in order to consider if this characteristic is useful in distinguishing consumers who are more likely to adopt an EV. In this sense, the research presented here responds to a call for a broadening of the factors included in demand models for EVs in order to more fully account for the diverse range of aspects which potentially hold influence in this emerging market (Daziano & Chiew, 2012).

3. Consumer innovativeness

When new innovations are introduced into a market, they undergo a diffusion process. The process is illustrated in the Diffusion of Innovation (DOI) theory which postulates that the adoption of innovations tends to follow a normal temporal distribution, with a small quantity of innovators and early adopters acquiring the innovation relatively early, followed by the majority of mainstream consumers with the diffusion process concluded when the laggard consumers decide to adopt (Rogers, 2003; Rogers & Shoemaker, 1971). Central to this theory is the concept of consumer innovativeness, which can be considered at a general level to represent a characteristic which relates to an individual's basic tendency to adopt new innovations.

Midgley and Dowling (1978) note that the initial research investigating the concept of consumer innovativeness tended to be vague in the description of the concept and usually assigned degrees of innovativeness to individuals based on a simple measurement of the relative time taken to adopt an innovation. They proceed to argue that such an approach is prone to error due to factors which may inhibit individuals from being innovative across all contexts. To account for the described limitations, Midgley and Dowling (ibid.) propose that consumer innovativeness should be considered as a multidimensional concept which has different levels of operation.

At the abstract level, individuals have an innate tendency to be attracted to the unique qualities of innovations. This is generally referred to as innate innovativeness and concerns an individual's inherent propensity to desire to adopt innovations. Innate innovativeness can be considered to represent a personality trait which is possessed to a greater or lesser extent by all members of society (Goldsmith & Hofacker, 1991) and includes psychological aspects such as curiosity, ambition

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