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Consumer Structure in the Emerging Market for Electric Vehicles: Identifying market segments using cluster analysis

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ABSTRACT

This paper presents results from a segmentation analysis of the emerging market for Electric Vehicles (EVs). Data has been sourced through the application of a self-completion household questionnaire distributed over two cities in the United Kingdom (UK). A two stage cluster analysis methodology has been followed to identify market segments in a dataset of UK drivers. Five unique segments have been identified in the analysis and are characterised by their preferences for EVs, socio-economic characteristics, current car details, and socio-psychological profiles. These segments hold a range of different EV preference levels, from those who appear unwilling to adopt an EV to those which are clearly attracted to EVs. Moreover, the features of these segments tend to suggest that segments might be attracted to or repelled from EVs for different reasons. These results demonstrate that a significant degree of consumer stratification is present in the emerging market for EVs, with the possible implications being that policy interventions at the market, as opposed to segment, level may prove ineffective due to their inability to cater for the nuances of important segments.

KEY WORDS

Electric Vehicles, Market Segmentation, Demand, Demographic Profiling, Psychographic Profiling

1. INTRODUCTION

Electric Vehicles (EVs) represent an innovation in automotive technology whereby the powertrain of the vehicle operates partly or solely from electricity stored in an on-board battery pack (van Vliet et al. 2010; IEA, 2011; Dijk et al. 2013). EVs have the potential to improve the energy efficiency, energy security and reduce the carbon intensity of passenger vehicle transport (Contestabile et al. 2012; Odeh et al. 2013). The diffusion of EVs into the mainstream vehicle fleet is regarded as a primary means through which the environmental sustainability of the United Kingdom's (UK) transport system will be improved (DfT, 2009; Schwanen et al. 2011; OLEV, 2013). This diffusion has been further clarified through an appreciation of how the transport system may transition onto a low carbon trajectory (Geels, 2012; Whitmarsh, 2012; Epprecht et al. 2014) and what that trajectory may involve for the passenger vehicle market (Struben and Sterman, 2008; van Bree et al. 2010; Offer et al. 2011; Köhler et al. 2013, Steinhilber et al. 2013).

The Committee on Climate Change (2013) has recommended that all cars sold in the UK after 2035 be ultra low emission vehicles in order for a zero carbon car fleet to be attained by 2050. Realising such an objective will require significant annual increases in the number of new EVs being registered. The UK Government has implemented a series of demand side polices in an effort to accelerate the diffusion of EVs into the national fleet (OLEV, 2011; OLEV, 2013; Morton et al. 2014). Firstly, financial incentives have been provided which aim to reduce the total cost of ownership attributed to an EV. Secondly, information campaigns have been conducted to raise awareness and to assist consumers in making informed decisions in reference to EVs. Thirdly, schemes to install EV charging infrastructure in public places have been initiated in an effort to overcome anxieties concerning the ability to recharge EVs. However, with the sales of EVs in the UK amounting to only 0.12% of total new car registrations in 2013 (DfT, 2014), it is clear that a step-change in demand for EVs is required.

With the market for EVs required to grow rapidly over the next twenty years, an important question to consider relates to where the increase in demand is likely to originate from. In the study reported in this paper, an evaluation of the consumer structure in the emerging market for EVs in the UK is produced to provide guidance on this issue. The research was timed to coincide with the introduction of EVs into the mainstream automotive market and thus represents an analysis of consumer structure at a crucial phase of market development. The structure is framed through a market segmentation analysis which partitions consumers into groups based on similarities in key characteristics. This partitioning presupposes that certain consumer segments are likely to be attracted towards or repelled from EVs for different reasons. This presumption is assessed from both a psychographic

approach, which considers the significance of attitudes, values and receptivity to innovations alongside a demographic approach which evaluates the importance of socio-economic and existing car ownership characteristics. A detailed profiling of the consumer segments which are forming in the early market for EVs will likely allow for an appreciation of how they differ in their ancillary characteristics which may provide insights regarding the development of tailored sub-market strategies intended to respond to the distinct features of the segments. In this sense, market segmentation analysis allows for the understanding of consumer response to EVs to progress beyond the findings from research which focus on the generalisations which hold true for all customers (Jansson et al. 2011; Al-Alawi and Bradley, 2013; Schuitema et al. 2013; Morton et al. 2016a) to a position which appreciates the nuances and distinctions of consumer groups.

Data to conduct the analysis has been collected through a self-completion household questionnaire distributed in the cities of Dundee and Newcastle upon Tyne in the UK. A two stage cluster analysis is employed to identify consumer segments, with a hierarchical analysis utilised to determine the optimum number of clusters followed by a K-means solution to further refine the output. To assist in structuring the study, three specific issues are considered; firstly, covering whether or not distinct consumer segments are forming in the emerging market for EVs; secondly, defining the features of any distinct segments identified; and thirdly, reflecting on what insights the findings of the analysis offer for policy in this area.

In the following section, an overview of the existing literature in the demand for EVs is offered which assists in framing the contributions made in this paper. The paper progresses by outlining the methodology followed before presenting the results of the analysis. To conclude the paper, the findings of the analysis are discussed and a number of policy relevant conclusions are put forward.

2. PAST RESEARCH

Recent interest in EVs represents only a renewal of an extended history of activity surrounding this technological innovation (Høyer, 2008), partially motivated by the presence of hype cycles in this market which inflate expectations concerning market potential (Bakker, 2010). Initial research in EV demand (some 30 years ago) utilised econometric models to identify a number of prominent barriers to adoption associated with EV price premiums, high discount rates of operating costs and anxiety towards reductions in vehicle range (Beggs et al. 1981; Calfee, 1985). Moreover, with mainstream consumers purchasing a new car tending not to consider greenhouse gas emissions to be particularly important in their purchasing decisions (Caulfied et al. 2010), one of the unique benefits of EVs has

often proven to be inhibited. These identified limitations coincided with low expectations regarding the future potential of the EV market (Train, 1980; Lieven et al. 2011) which have generally been validated by observed EV sales rates.

The requirement for EVs to attain price parities with market alternatives is considered a necessity for widespread EV adoption (Larson et al. 2014), with Eggers and Eggers (2011) forecasting EVs as having the potential to achieve 25.8% of all new car sales in the German market in 2018 under conditions of price parity, decreasing to 8.2% if EVs have a 20% purchase premium. A similar result is observed by Krause et al. (2016), whose assessment of vehicle preferences in the USA found that 44% of consumers would select a pure battery EV under the conditions of price and performance parities. The high costs associated with the production of EV battery packs are often cited as the primary source of EV price premiums and thus one of the main inhibitors of adoption (Axsen et al. 2010; Hidrue et al. 2011). Examining the future cost trajectories of EV battery packs, Cluzel and Douglas (2012) find that, by 2030, costs of production have the potential to decrease to $215 per kilowatt hour with similar estimates noted by Offer et al. (2010) who found that, by 2030, EVs have the potential to exhibit significantly lower lifecycle costs compared to conventional internal combustion engine vehicle.

However, Egbue and Long (2012) argue that the attainment of price parities between EVs and conventional internal combustion engine vehicles (ICEVs) represents only part of the solution to unlocking mainstream market demand for EVs. Their analysis of *Technology Enthusiasts*, who are considered to represent an important group in the early diffusion of EVs, indicates that EVs will need to be perceived as technically superior to ICEVs for this group of consumers to consider adoption. The argument of Egbue and Long (ibid.) is supported by the findings of Graham-Rowe et al. (2012), whose qualitative investigations of the response of mainstream car drivers to experiences with EVs suggests that drivers tend to evaluate EVs in comparison to the technical performance levels of ICEVs. Thus, the emergence of widespread demand for EVs will likely be contingent on EVs attaining both price and performance parities with ICEVs.

Following an assumption that such price and performance parities are realised and that demand for EVs grows substantially in the future, attention is shifting towards understanding the likely nuances and dynamics of this demand (Lieven, et al. 2011; Shepherd et al. 2012; Zubaryeva et al. 2012; Plötz et al. 2014). With the importance of accounting for the idiosyncrasies of different groups in the transport market well established (Anable, 2005; Burkhardt and Milard-Ball, 2006; Barr and Prillwitz, 2012; Al-Alawi and Bradley, 2013; Budd et al. 2014; Fürst, 2014), it is assumed that exploring the response of different market segments to EVs will likely prove rewarding. Specifically related to the

focus of this paper, some preliminary research on the consumer structure of the EV market has already taken place. Offering initial guidance on this topic, Kurani et al. (1996) explored the automotive market in California through a reflexive empirical study in an attempt to identify the optimum market segment for EVs. Their analysis uncovered a substantial potential segment of adopters, referred to as *Hybrid Households* due to their ability to integrate an EV into a multi-car fleet. These *Hybrid Households* tend to consider the ability of EVs to be recharged at home to be a primary attraction which more than offsets the reduced range of EVs vis-à-vis conventional ICEVs.

Whilst the effectiveness of fiscal policies to incentivise the adoption of low emission vehicles has been investigated at the market level (Ewing and Sarigöllü, 1998; Diamond, 2009; Ryan et al. 2009; Harrison and Shepherd, 2013; Sierzchula et al. 2014), Borthwick and Carreno (2012) demonstrate that market segments are likely to have different responses to incentives. Their findings indicate that a segment of hesitant adopters, referred to as *Go-With-The-Flow-Greens*, are susceptible to changes in situational factors and could potentially be encouraged towards pure battery EV adoption through fiscal incentives. Examining the stratification of individuals who participated in a trial of pure battery EVs, Skippon and Garwood (2011) identified four clusters of participants based on their levels of personal involvement with cars and their concerns about the environment. The results of their analysis reveal that the cluster which exhibits low levels of car interest yet high concerns for the environment is the most likely to consider adopting an EV. Investigating the spatial distribution of potential EV adopters, Campbell et al. (2012) applied cluster analysis to census data in order to identify possible uptake hotspots in a large metropolitan area in the UK. The findings of their analysis suggest that suburban areas are likely to represent locations of initial EV diffusion whilst there is a low degree of adoption potential in urban areas. The results of Campbell et al.'s (ibid.) study have been supported by the findings of Namdeo et al. (2014) who considered the spatial location of potential plug-in EV adopters in a metropolitan region of the UK through an examination of journey-to-work profiles and socio-economic characteristics. Their analysis suggests that a citizen cohort labelled *Corporate Chieftains*, who are primarily located in suburban areas and are characterised as individuals who are senior managers living in detached houses, represent the consumer group most likely to adopt an EV.

Recently, research examining consumer stratification in the early market for EVs has progressed by offering more detailed perspectives concerning the characteristics and distinctive features of segments which exist across a spectrum of EV preference levels. An in-depth assessment of the potential market for EVs in the UK is offered by Anable et al. (2016), whose analysis identifies the presence of eight segments from a large-scale survey of car buyers. These segments are distinguished by a number of prominent characteristics including the degree to which EVs are viewed as being

consistent with personal identity, the level of anxiety felt concerning the operation of EVs, perceived difficulty in recharging an EV, the amount they are willing to pay in order to reduce the environmental damage of car use and the symbolic motivations they assign to EV ownership inclusive of status and social acceptability. Interestingly, socio-economic characteristics prove to be insufficient in separating the identified segments, with the analysis stressing the importance of less tangible issues such as attitudes concerning EV performance, personal image and enthusiasm for technology.

A similar approach to evaluating the stratification in the early market for EVs is offered by Axsen et al. (2015) who provide two perspectives of consumer segmentation in the Canadian market based on preference and lifestyle heterogeneity. In terms of preference heterogeneity, their analysis indicates that the segment most enthusiastic about EV adoption tends to display strong environmental awareness and to be enthusiastic about technology. Moreover, their lifestyle heterogeneity approach demonstrates that consumers who have high levels of willingness to pay for and interest in EVs can have distinct lifestyle profiles. The degree of stratification identified in Axsen et al.'s (.ibid) analysis implies that looking beyond generalised issues relating to EV adoption (i.e. range anxiety, willingness to pay and environmental attitudes) is a necessary step in order to appreciate the barriers to and motivations of adoption at the segment level. This perspective is similar to the findings of Nayum et al. (2016) who presented a latent class cluster analysis comparing recent EV adopters to five other mainstream car buyer segments in Norway. Comparisons between the segments indicates that EV adopters are particularly distinct from the mainstream market and tend to represent individuals who are highly educated with very high household incomes, who do not consider the functional attributes of cars to be of particular importance whilst tending to have a more environmentally friendly disposition.

3. METHODS

The methodology section is composed of three parts. Firstly, a description of the nature and importance of market segmentation analysis is offered followed by an overview of the segmentation approach taken in this study. Secondly, the statistical approach utilised to apply the segmentation analysis is described. Thirdly, the data collection technique employed to attain the dataset evaluated in the analysis is detailed.

3.1 Market Segmentation

3.1.1 Background

Offering initial guidance on how the heterogeneity of demand can be accounted for in economic models of imperfect competition, Smith (1956, p. 5) describes market segmentation as ‘‘*based upon developments on the demand side of the market and represents a rational and more precise adjustment of product and marketing efforts to consumer and user requirements*”. Since Smith’s (ibid.) initial description of the concept, market segmentation quickly became a widespread strategy in academic and applied marketing, allowing firms to pursue price discrimination strategies in heterogeneous markets (Wind, 1978). In essence, market segmentation assumes that the demand for certain goods and services is likely to exhibit some degree of consumer stratification, with distinct groups of consumers sharing similarities in their characteristics and preferences. Initially, these similarities in the characteristics of consumers were primarily evaluated by demographic features such as age profiles, formal education levels and household compositions. Whilst these features are easily observable and can be quickly deployed in sales environments, they can be rather coarse in their categorisation of consumers and may not be effective when applied in niche market environments.

In an effort to attain more detailed descriptions of market segments and their orientations to particular goods and services, marketers began to augment demographic features with psychographic profiles (Wells, 1974), which cover measurements of psychological constructs such as attitudes, values and personality traits. Lin (2002) argues that the combined application of demographic and psychographic characteristics in market segmentation allows for the development of sub-market strategies which can cater for the particular nuances of consumer groups. Exploring consumer evaluations for environmentally friendly products, Straughan and Roberts (1999) compare the usefulness of demographic and psychographic characteristics, with their results suggesting that psychographic features are more effective in explaining ecologically conscious consumer behavior. From this observation, Straughan and Roberts (ibid.) recommend that psychographic characteristics should be used in the profiling of consumer segments in the markets for environmentally friendly products.

3.1.2 Overview of Segmentation Approach

In Wind’s (ibid.) review of the early segmentation literature, he notes that researchers have tended to base their studies around either an *a priori* separation of individuals (often based on a single defining feature) or an empirical design based on cluster analysis. Early applications of market

segmentation through cluster analysis seemed to grow rapidly ahead of the empirical understanding of the technique and without a firm theoretical basis. Punj and Stewart (1983) provided clarification on this issue in an effort to alleviate the confusion by producing a series of guidelines on the appropriate application of cluster analysis. However, Dibb and Stern (1995) express persisting concerns related to the reliability of segmentation solutions based on cluster analysis, arguing that researchers need to ensure that their approach is based on theoretical principles to avoid spurious results.

Responding to these concerns, the segmentation analysis presented in this paper is built out of a previously applied conceptual framework which identified psychographic antecedents to attitudes towards EVs (Morton et al. 2016a) and preferences towards EVs (Morton et al. 2016b). The segmentation analysis offers fresh insights by illustrating that antecedents which have a universal effect over the demand for EVs are likely to be few in number (such as attitudes towards environmental concern) and that exploring the characteristics of market segments offers a more nuanced perspective on how consumers are forming opinions of and preferences towards EVs**.** The psychographic constructs contained in this framework originate from theories concerning consumer responsiveness to innovations, theories of environmental behavior and antecedents to EV preferences identified in past empirical research. These constructs are summarised in Table 1 (with the specific configuration of the constructs detailed in Table 7 in the appendix) and are briefly defined in the following paragraphs with citations to theoretical and supporting literature. These constructs are combined with an inventory of socio-economic and current car details to allow the segmentation to generate profiles which are rich in psychographic and demographic detail.

Powertrain Preferences: representing the focal issue of the research, the inclusion of stated powertrain preferences allows the analysis to characterise the identified segments in accordance with their likelihood to consider an EV. In order to make this a realistic assessment, a range of different propulsion systems are included in the assessment, including petrol and diesel engines through four EV options which differ in their degrees of electrification in the powertrain. With expressed preferences towards EVs being a common framing for research which considers consumer reaction to these vehicles (Al-Alawi and Bradley, 2013) their inclusion in the segmentation analysis allows the results to be considered in reference to past evaluations of EV demand.

Table 1: Summary of the conceptual framework constructs included in the segment description

Category	Category Description
Powertrain Preferences	Measurements of stated preferences towards a series of powertrains inclusive of two conventional propulsion systems and four propulsions systems with varying degrees of electrification (Mild Hybrid EV, Full Hybrid EV, Plug-in Hybrid EV* and Pure Battery EV*). Preferences are framed in terms of the likelihood to select the powertrain in the next vehicle purchasing cycle
Electric Vehicle Attitudes	Incorporates constructs which measure negative and positive evaluations of the instrumental performance of EVs Constructs – *EV Attitudes: Negative** (EVA: N) (α: .701, TVE: 28.5%) *EV Attitudes: Positive** (EVA: P) (α: .508, TVE: 19.5%)
Car Attitudes	Measurements of a number of different attitudes concerning cars including the perceived importance of car ownership, the degree of concern about the environmental consequences of car use and the level of knowledge relating to cars in general and EVs in particular Constructs – *Car Attitudes: Importance* (CA: I) (α: .805, TVE: 21.7%)*; Car Attitudes: Environment** (CA: E) (α: .785, TVE: 16.8%)*; Car Attitudes: Knowledge* (CA: K) (α: .772, TVE: 13.6%)
Car Meanings	Contains two constructs measuring the meanings which an individual assigns to car ownership and use inclusive of symbolic, emotive and instrumental meanings Constructs – *Car Meanings: Symbolism and Emotion** (CM: S&E) (α: .907, TVE: 41.8%)*; Car Meanings: Instrumental** (CM: I) (α*: .696, TVE: 15.5%)*
Consumer Innovativeness	Measurements of the innovativeness of an consumer associated with their [1] innate tendency to behave in an innovative manner based on psychological and sociological determinants and [2] their acquisitive adoption of household and consumer technology Constructs – *Sociological Determinants* (SD) (α: .865, TVE: 45.2%)*; Psychological Determinants* (PD) (α: .736, TVE: 29%) Total Technology Owned (M: 4.26 SD: 2.59); Total Technology Desired* (M: 2.15; SD: 2.16)
Life Principles	Includes three constructs which determine the principles that govern an individual's life Constructs – *Principles: Biospheric* (LP: B) (α: .858, TVE: 28.5%)*; Principles: Egoistic* (LP: E) (α: .734, TVE: 18.9%)*; Principles: Societal* (LP: S) (α: .668, TVE: 9.9%)

*: used as a segmentation variable in the cluster analysis

Electric Vehicle Attitudes: the attitudes an individual holds towards the functional characteristics of EVs have been measured to consider how consumers are evaluating these issues. With past research in the demand for EVs having identified interpretations of functional EV performance, such as vehicle range and reliability, as being prominent issues in consumer evaluations (Franke and Krems, 2013; Graham-Rowe et al. 2012), the inclusion of these issues in the market segmentation allows for an appreciation of how functional evaluations of EVs varies across consumer groups.

Car Attitudes: the attitudes an individual holds towards cars in general have been measured across a number of aspects. These aspects cover expressed concerns regarding the environmental consequences of car use, interest in automotive technology and the perceived importance placed on car ownership which past research has indicated represent salient issues in consumer evaluations of clean fueled vehicles (Sangkapichai and Saphores, 2009; Ozaki and Sevastyanova, 2011; Krupa et al. 2014; Plötz et al. 2014). The inclusion of these issues allows the analysis to simultaneously consider the views which consumer groups hold towards EVs specifically and cars in general.

Car Meanings: car ownership and use is often connected with a series of meanings which transcend simple assessments of their functional characteristics to include such issues as symbolic associations and emotional attachments (Dittmar, 1992). These meanings have been found in past research to be central issues in how car use is interpreted by drivers (Steg, 2005) and also useful in understanding consumer assessments of plug-in EVs (Schuitema et al. 2013) and hybrid vehicles (Heffner et al. 2007). Thus, it is likely that these issues will vary across consumer groups which are more or less likely to consider the purchase of an EV.

Consumer Innovativeness: with EVs representing an assemblage of advanced automotive technology, there is the possibility that they might be attractive to technology enthusiasts. To evaluate this proposition, measurements of consumer innovativeness across two different levels of abstraction have been taken. Firstly, innate innovativeness (which considers the degree to which an individual has a predisposition to being attracted to technology) has been measured across key psychological and sociological determinants (Midgley and Dowling, 1978; Rogers, 2003; Roehrich, 2004). Secondly, acquisitive innovativeness (which monitors technology ownership) has been measured to determine the quantity of technology currently owned and the quantity desired to be owned across common household and consumer technologies.

Life Principles: the principles which individuals use to govern their lives can be considered to represent core dimensions of character. Whilst the concept of life principles can be quite broad, past research has identified a stable structure of three principles (which cover egoistic, biospheric and altruistic dimensions of principles) to be useful when considering environmental behavior (de Groot and Steg, 2008). Jannson et al. (2011) illustrates that these principles can be of use in distinguishing between EV adopters and non-adopters. These life principles have been included in the segmentation analysis to consider the core character of the identified segments.

3.2 Cluster Analysis

In the study reported in this paper, a two stage cluster analysis, based on the approach outlined by Mooi and Sarstedt (2011), was selected to identify segments of car owners. In the first stage, a hierarchical cluster procedure was employed using Ward's distance measurement (Everitt et al. 2009) in order to attain an understanding of how the dataset was partitioning. A visual inspection of the Dendogram and an application of the Variance Ratio Criterion (Caliński and Harabasz, 1974; Kryszczuk and Hurley, 2010) were utilised to determine the appropriate number of segments to base the final solution on to achieve intra-cluster homogeneity and inter-cluster heterogeneity. The Variance Ratio Criterion utilises the between group sum of squares (BGSS), within group sum of squares (WGSS), number of clusters (N) and number of observations (K) with its formulaic expression reported in equation 1. In the second stage, the initial cluster centroids calculated in the hierarchical solution were used as seed points for a K-means analysis (Hartigan and Wong, 1979) which is used to identify the final clusters utilised in the market segment description.

$$VRC = \frac{(BGSS/(k-1)}{WGSS/(n-k)} \tag{1}$$

In order for a cluster analysis to be specified, a group of segmentation variables requires to be identified to allow the analysis to evaluate the relative degree of separation between respondents. In the analysis reported in this paper, eight segmentation variables are utilised. The selection of these variables was driven primarily by the expressed preferences towards EVs, including preference levels of Plug-in Hybrid EVs and Pure Battery EVs alongside variables which share significant correlations to these expressed preference levels (these variables are highlighted in Table 1). In this sense, the segmentation presented in this paper is principally a preference based segmentation, similar to that of Axsen et al. (2015), who utilised responses from a stated preference EV choice experiment to partition respondents, and that of Nayum et al. (2016), who employed revealed preferences for car type as segmentation variables.

Tests of difference were employed to determine if the segments exhibit statistically significant differences from each other. The tests of difference used varied dependent on the nature of the specific variable under examination, with a combination of Pearson's chi-square and Kruskal-Wallis tests utilised. From a total of 30 descriptive variables included in the dataset, 24 were found to demonstrate statistically significant differences between segments. This finding suggests that distinct market segments have been identified by the analysis. The degree to which each segment loads onto a particular variable has been calculated in two primary ways. In terms of categorical variables (such

as age and education level), segments are defined by the proportion of their assigned respondents which are associated with specific categories. For continuous (such as construct loadings) and ordinal (such as preference levels) variables, the average value for the respondents assigned to a specific segment has been calculated.

3.4 Data Collection

In order to attain the dataset necessary to conduct the statistical analysis, a self-completion household questionnaire was distributed over the cities of Dundee and Newcastle upon Tyne in the UK. This survey contained 17 separate sections, which were ordered in such a way as to elicit behaviors and attitudes towards cars in general to begin with, followed by more focused assessments of preferences and opinions regarding EVs in particular. To attract a range of respondents, the covering letter to the survey did not allude to EVs but rather described the survey as primarily interested in opinions about cars. In order to ensure respondents were not expressing views on a technology which they have no knowledge of, an information pack was provided that contained details concerning the technical performance of EVs and how they differ compared to conventional (i.e. petrol and diesel engine) vehicles.

A stratified random sampling approach was followed to attain the dataset with the Index of Multiple Deprivation (IMD), which is a composite indicator including measurements of household income, employment, health, education, crime and quality of the living environment available at lower super output level of spatial resolution, utilised as a partition metric (DCLG 2010; ONS 2009). Three locations representing low, medium and high scoring areas on the IMD were identified in each of the two cities with questionnaires being randomly distributed over these locations. Distribution areas were selected based on the IMDʾs spatial variation within the cities with an equal count approach used to separate low, medium and high areas whilst the random distribution involved selecting every other street from arterial roads and then every other household on the selected streets. To incentivise response, respondents were entered into a draw with the chance to win two £50 gift vouchers.

Table 2: Comparison between population and sample characteristics

Characteristic	Category	Sample	Population
Gender	Male	60.3%	52.3%
	Female	39.7%	47.7%
Age (years)	17-39	14.7%	29.5%
	40-59	39.1%	38.8%
	60 or above	46.2%	31.7%
Highest Level of Academic Achievement	No formal qualification	6.9%	12.0%
	Professional qualification	12.1%	5.4%
	Non-university qualification	34.6%	54.0%
	University Degree	45.8%	28.6%
Cars in Household	1	60.0%	64.7%
	2	31.9%	30.4%
	3 or more	8.1%	4.9%
Household Tenancy	Owned	90.0%	77.0%
	Rented	7.9%	22.0%
	Living rent free	1.6%	1%
Number of Adults	1	24.1%	21.7%
	2	67.1%	59.2%
	3 or more	8.3%	19.0%
Number of Children	0	75.5%	70.3%
	1	9.5%	13.0%
	2	12.6%	11.8%
	3 or more	2.5%	4.9%

In total, 4,000 paper questionnaires were evenly distributed across the two cities during the winter of 2011-2012 from a single drop-and-return approach with a total of 506 completed surveys returned, representing a response rate of 13.4% for the Newcastle distribution and 12.0% for the Dundee distribution. At the time of the data collection, no respondent to the survey in either city owned an EV. A comparison of a number of primary characteristics of the sample attained from the survey distribution to car owners taken from the UK's National Travel Survey (DfT, 2013) is shown in Table 2. This comparison indicates that, for certain characteristics (e.g. household cars and household composition), the sample appears to provide a close fit to UK car owners, though for other characteristics (e.g. gender and age profiles) there is a clear separation. This separation has the potential to bias the analysis presented in the paper. For instance, the low degree of sampling of young drivers (younger than 39 years old) might lead to this demographic cohort being underrepresented in the analysis. In an effort to correct for this potential bias, a univariate post-stratification weighting has been calculated from the observed differences between the sample attained and UK car owners reported in Table 2. This weighting has then been applied to the analysis reported in this paper in order for it to more accurately reflect the population of interest.

4. RESULTS

4.1 Cluster Analysis Solution

The Dendrogram calculated from the hierarchical stage of the cluster analysis is illustrated in Figure 1 and depicts the agglomeration of the sample (reading from left to right) into clusters of respondents. The Dendrogram is useful in visualising the manner in which the sample can be partitioned and the relative distance between each potential cluster solution. For instance, a significant degree of segment merging occurs between the distance 0 to 5 (horizontal axis), with the analysis displaying an increased degree of stability (characterised by extended distances between cluster merging) beyond this point.

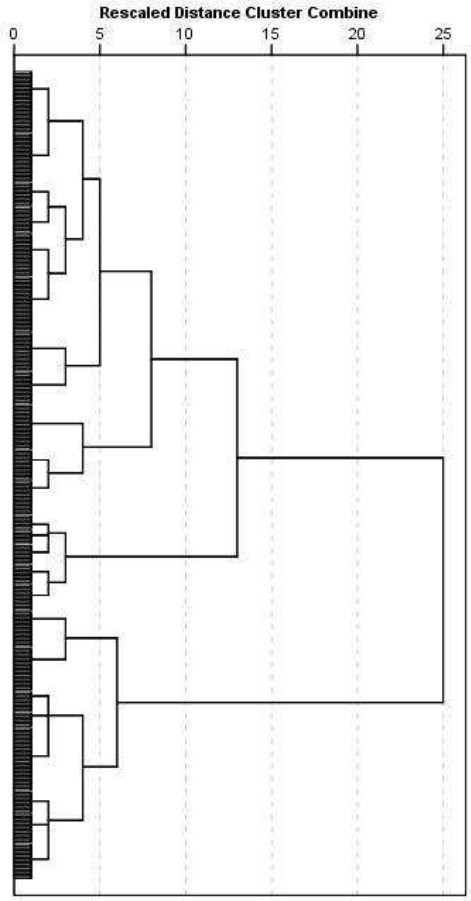

Figure 1: Dendrogram from the first stage of the cluster analysis illustrating the agglomeration of respondents into clusters

Focusing on the distance 5 to 10, this phase of the analysis includes solutions covering four, five and six clusters with the Dendrogram demonstrating how the clusters across these alternative solutions nest. Considering a final cluster solution which exists within this distance range seems appropriate, as

the analysis exhibits increasing distance between alternative cluster solutions whilst the numbers of clusters will allow the description of the analysis to be manageable. The results of the Variance Ratio Criterion are presented in Table 3 and indicate that a five cluster solution proves optimal at producing inter-cluster heterogeneity and intra-cluster homogeneity. The centroids from the five cluster solution of the hierarchical analysis are further refined in a K-means analysis which required eleven iterations to reach stabilisation.

Table 3: Calculation of the Variance Ration Criterion for all segmentation variables utilised in the cluster analysis across different potential solutions

Variable	4 Cluster	5 Cluster	6 Cluster	7 Cluster
Plug-in Hybrid EV preferences	140.23	83.13	54.61	77.23
Pure Battery EV preferences	63.96	51.23	67.60	108.05
Total Technology Owned	326.38	588.71	520.59	382.78
Car Meanings: Symbolism and Emotion	5.45	2.46	2.64	8.57
Car Meanings: Instrumental	4.32	2.65	4.14	3.20
EV Attitudes: Negative	11.93	5.17	8.21	5.29
EV Attitudes: Positive	8.29	3.83	4.74	6.64
Car Attitudes: Environment	12.68	7.79	10.10	5.91
Sum of VRC	573.23	744.98	672.63	597.66

4.2 Market Segment Description

In this section, the market segments identified in the cluster analysis are described. To assist with the interpretation of the results, each of the five identified segments has been assigned a name which is shown in Table 4 alongside the relative size of each of the segments. To begin the description, the powertrain preference structures of the identified segments are displayed followed by their socio-economic characteristics and current car details. To conclude this section, an illustration of the psychographic profiles of the segments is offered which highlights differences in their attitudes and values.

Table 4: The names and sizes of the market segments identified in the cluster analysis

Segment Number	Segment Name	Segment Size
1	Environmental Cynics	23.6%
2	Weekend Drivers	19.9%
3	Keen Greens	19.6%
4	Early Adopters	18%
5	Car Enthusiasts	18.8%

The powertrain preference structures for each of the segments identified in the analysis are presented in Figure 2. A significant degree of variation in preference levels can be clearly observed, with the Environmental Cynics and Weekend Drivers having distinctly low preferences for the four EV options whilst Keen Greens and Early Adopters display the highest EV preference levels. Falling between these two groups, Car Enthusiasts exhibit relatively moderate EV preferences with a greater propensity to select the Diesel option.

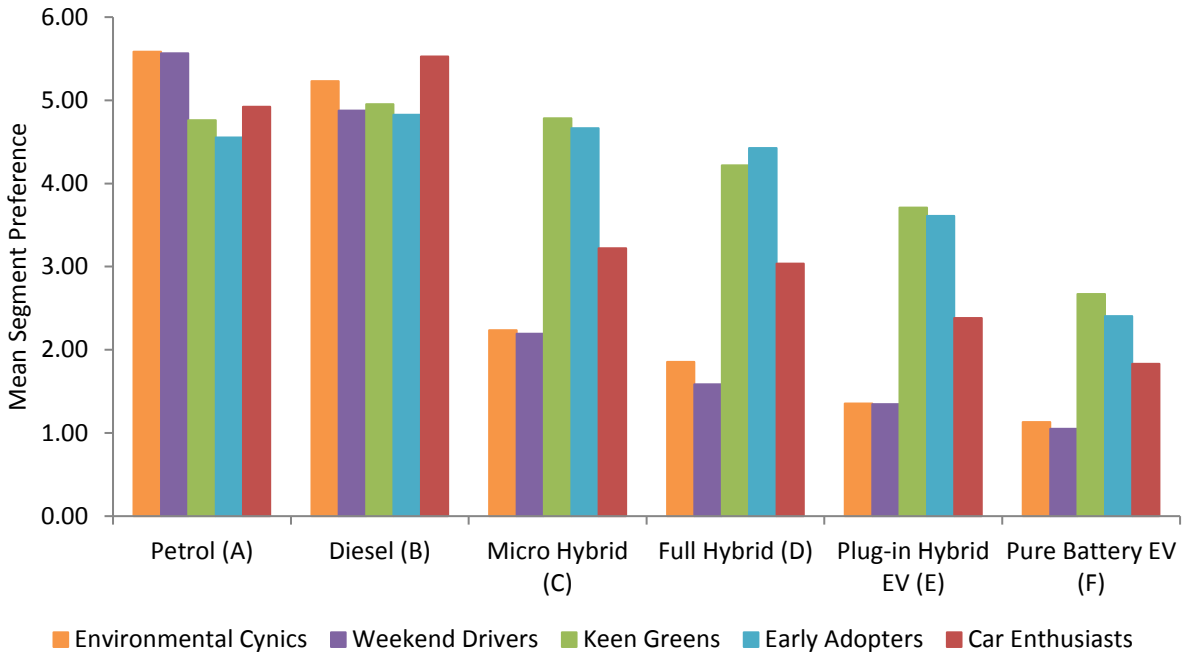

Figure 2: Powertrain preference structures of the identified market segments
(A): H = 26.86, p = .000 (B): H = 8.56, p = .073 (C): H = 126.69, p = .000 (D) H = 173.21, p = .000 (E): H = 174.13, p = .000 (F): H = 99.89, p = .000

The socio-economic characteristics of the identified segments are presented in Table 5. These attributes often form the basis of most traditional market segmentation analyses due to their ability to link with population census data and their ease of transfer into sales and marketing environments. Examining the socio-economic profiles of the segments, it is apparent that Early Adopters and Car Enthusiasts tend to hold the highest levels of academic qualification with the individuals placed into

these two segments being the most likely to hold a university degree. Conversely, Weekend Drivers have the lowest likelihood to have a university level qualification. A similar pattern is observed with gross household incomes, with Car Enthusiasts having the highest proportion of individuals with household incomes in excess of £50,000 per annum whilst 86.2% of the individuals placed in the Weekend Drivers segment have gross household incomes below this threshold. In terms of age profiles of the segments, the Weekend Drivers represent the oldest respondents of the sample whilst Car Enthusiasts tend to be younger respondents.

Table 5: Socio-economic characteristics of the identified market segments

Variable	Category	Cluster				
		EC	**WD**	**KG**	**EA**	**CE**
Gender (χ^2 = 4.01, p = .404)	Male	64.8%	63.0%	54.2%	55.2%	66.7%
	Female	35.2%	37.0%	45.8%	44.8%	33.3%
Highest level of academic achievement (χ^2 = 22.95, p = .028)	No formal qualifications	6.7%	15.1%	8.3%	3.0%	4.2%
	None university qualification	41.1%	43.8%	30.6%	26.9%	33.3%
	University degree	44.4%	31.5%	44.4%	55.2%	54.2%
	Professional qualification	7.8%	9.6%	16.7%	14.9%	8.3%
Employment status (χ^2 = 43.34, p = .009)	Employed part time	4.4%	9.5%	11.1%	7.5%	12.9%
	Employed full time	53.8%	39.2%	44.4%	59.7%	61.4%
	Unemployed	0.0%	0.0%	0.0%	3.0%	0.0%
	Retired	36.3%	51.4%	41.7%	26.9%	18.6%
	Full time education	2.2%	0.0%	0.0%	0.0%	4.3%
	Disabled	2.2%	0.0%	2.8%	1.5%	1.4%
	Looking after children/home/family	1.1%	0.0%	0.0%	1.5%	1.4%
Gross household income per annum (GBP) (χ^2 = 39.66, p = .006)	Less than 10,000	0.0%	9.2%	2.9%	1.5%	2.8%
	10-30,000	40.2%	50.8%	38.6%	28.8%	21.1%
	30-50,000	29.3%	26.2%	30.0%	39.4%	33.8%
	50-70,000	19.5%	7.7%	11.4%	18.2%	18.3%
	70-90,000	7.3%	1.5%	10.0%	4.5%	9.9%
	More than 90,000	3.7%	4.6%	7.1%	7.6%	14.1%
Age (years) (χ^2 = 43.178, p = .000)	17-39	23.3%	2.8%	8.2%	19.4%	33.8%
	40-59	28.9%	39.4%	46.6%	50.7%	42.3%
	60 and over	47.8%	57.7%	45.2%	29.9%	23.9%
Number of adults in household (χ^2 = 23.00, p = .003)	1	19.8%	40.0%	26.0%	13.4%	16.7%
	2	65.9%	57.1%	61.6%	76.1%	76.4%
	3 or more	14.3%	2.9%	12.3%	10.4%	6.9%
Number of children in household (χ^2 = 22.25, p = .063)	0	78.9%	81.4%	79.5%	67.2%	58.9%
	1	11.1%	2.9%	9.6%	14.9%	16.4%
	2	8.9%	11.4%	9.6%	16.4%	19.2%
	3 or more	1.1%	4.3%	1.4%	1.5%	5.5%

EC – Environmental Cynics **WD** – Weekend Drivers **KG** – Keen Greens **EA** – Early Adopters **CE** – Car Enthusiasts

The employment status of the segments tends to correspond with their age profiles, with Weekend Drivers being the most likely to be retired whilst Car Enthusiasts and Early Adopters tend to be in employment. For household composition, Weekend Drivers have a higher likelihood of being sole occupant households whereas Early Adopters have the greatest tendency to have more than one resident adult.

Shifting the focus to the details of the cars the segments drive, Table 6 displays the segment loadings on the characteristics of the household's main car. Here, a lower degree of difference is observed between the segments, suggesting that characteristics of the current car may not be a good indicator of preferences towards EVs. Environmental Cynics appear to be the most likely to be multicar households, with the highest propensity to own 3 or more cars, whereas Weekend Drivers tend to be single car households. Early Adopters seem to drive their cars the most whilst Weekend Drivers have the lowest levels of annual mileage. Concerning how much each segment tends to pay when purchasing a car, Weekend Drivers have a propensity to spend the least, perhaps due to their relatively low car mileage, whilst Car Enthusiasts are more inclined to spend a comparatively large sum when purchasing a car, likely linked to their relatively high levels of household income.

Table 6: Current car details and usage levels (for main car) of the identified market segments

Variable	Category	Cluster				
		EC	**WD**	**KG**	**EA**	**CE**
Cars in household	1	47.1%	75.0%	64.8%	55.4%	53.5%
(χ^2 = 44.161, p = .001)	2	39.1%	19.4%	32.4%	38.5%	35.2%
	3 or more	13.8%	5.6%	2.8%	6.2%	11.3%
Fuel type	Petrol	60.5%	70.0%	67.1%	71.2%	50.0%
(χ^2 = 4.011, p = .404)	Diesel	39.5%	30.0%	32.9%	28.8%	50.0%
Engine size (litres)	0.0 – 1.5	34.6%	34.9%	29.7%	38.7%	18.8%
(χ^2 = 18.273, p = .108)	1.6 – 2.0	55.6%	54.0%	68.8%	56.5%	59.4%
	2.1 – 3.0	8.6%	9.5%	1.6%	3.2%	18.8%
	3.1 or more	1.2%	1.6%	0.0%	1.6%	3.1%
Annual mileage (miles)	Mean	8870	6673	8754	9058	8459
(H = 12.01, p = .017)	Standard Deviation	3987	3180	5437	6041	4655
Usual car purchase expenditure (GBP)	Mean	9265	8888	10206	9607	12026
(H = 8.426, p = .077)	Standard Deviation	4973	5555	4964	5597	7618

EC – Environmental Cynics **WD** – Weekend Drivers **KG** – Keen Greens **EA** – Early Adopters **CE** – Car Enthusiasts

One of the novel attributes of the research reported in this paper is offered by the further description of the identified segments through an examination of their psychographic profiles (outlined in section

3.1.2). Segments are defined according to the meanings they assign to car ownership, their attitudes towards cars in general, their attitudes towards EVs, their level of consumer innovativeness and the principles which govern their lives. The differences observed between the segments in terms of their average loading on these constructs is summarized in Figure 3.

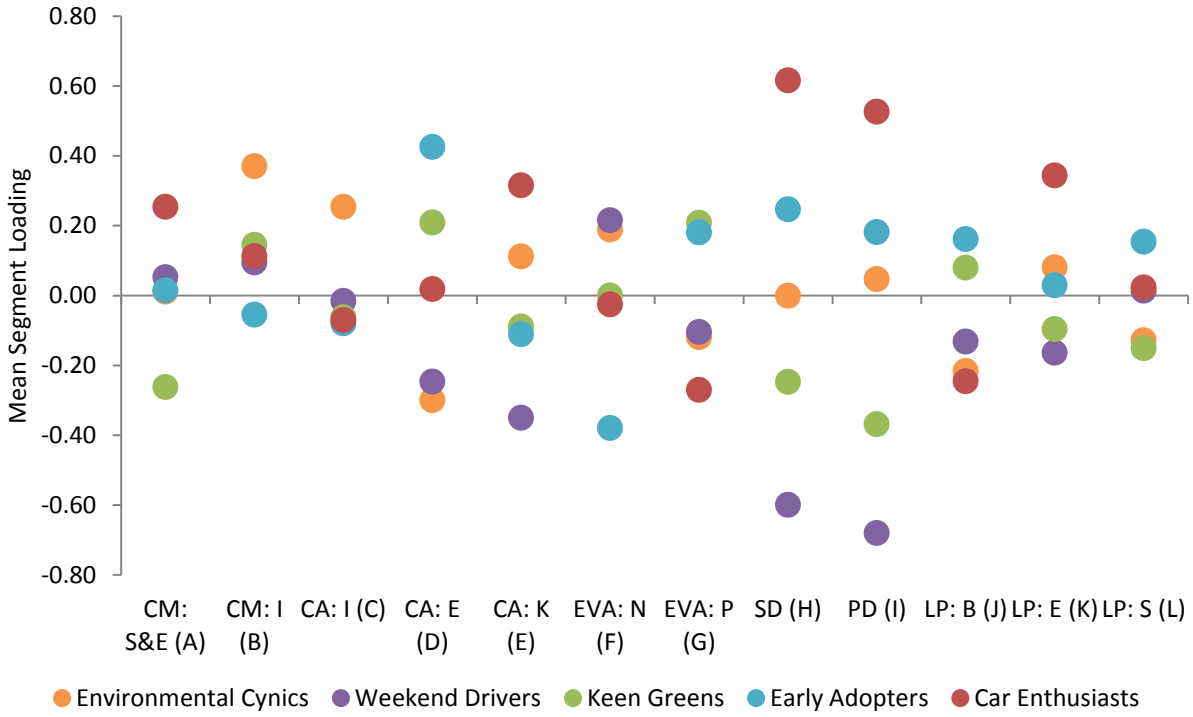

Figure 3: Mean segment loadings on the psychographic constructs defined in Table 1
(A): H = 13.05. p = .011 (B): H = 13.36, p = 0.01 (C): H = 6.27, p = 0.18 (D): H = 34.14, p = .000 (E): H = 18. 87, p = .001 (F): H = 14.62, p = .006 (G): H = 16.87, p = .002 (H): H = 74.04, p = .000 (I): H = 67.24, p = .000 (J): H = 10.08, p = .039 (K): H = 14.10, p = .007 (L) H = 7.38, p = .117

Generally, the attitudes that the segments hold regarding the instrumental capabilities of EVs (constructs EVA: N and EVA: P) tend to correspond with their preferences towards these vehicles. The Environmental Cynics and Weekend Drivers have an inclination to display negative attitudes towards EVs (such as considering EVs to lack reliability and holding concerns over EV safety) whilst the Early Adopter segment is strongly adverse to this assignment. Moreover, the Keen Greens and Early Adopter segments appear to load positively on the construct *EV Attitudes: Positive*, indicating that these segments consider EVs to offer sufficient range, adequate performance and that they value the ability to recharge EVs at home.

Examining the segment loadings on the constructs measuring general car attitudes (constructs CA: I, CA: E and CA: K) and the meanings individuals associate with car use (CM: S&E and CM: I), a significant degree of variation is observed on four out of the five constructs. In terms of the car meanings

constructs, the results suggest that Car Enthusiasts tend to consider cars to represent symbolic expressions of their identity and a source of positive emotion. This result partially overlaps with to the findings of Nayum et al. (2016) who found that buyers of powerful cars tend to place importance on car performance. With the exception of Early Adopters, all segments are inclined to consider cars in general to have instrumental value, with the Environmental Cynics holding a distinctly large loading. In reference to the car attitudes constructs, both the Keen Greens and Early Adopters positively load on the construct *Car Attitudes: Environment*, suggesting that these two segments are concerned about the environmental consequences of car use and consider it their responsibility to address this issue whereas the Environmental Cynics and Weekend Drivers display negative loadings on this construct.

These results provide support to the understanding that environmental concerns are valid motivators to EV adoption (Sangkapichai and Saphores, 2009; Ozaki and Sevastyanova, 2011) whilst also indicating that the environmental symbols currently attached to EVs (Heffner et al. 2007; Schuitema et al. 2013) might not match the attitudes of certain segments of the car market such as the Environmental Cynics. In terms of awareness of the functional aspects of car operation, Car Enthusiasts have a propensity to be knowledgeable about cars in general and EVs in particular whereas the Weekend Drivers are more likely to have little knowledge of these issues. When considering the negative loadings of Keen Greens and Early Adopter segments on the *Car Attitudes: Knowledge* construct in combination with their loadings on the *Car Attitudes: Environment* construct, the results presented here seem to support the findings of Skippon and Garwood (2011) in their assertion that EV adopters are likely to be characterised by individuals with low involvement with cars in general but high concerns about the environment.

The consumer innovativeness of the identified segments is evaluated across two different levels of abstraction. Firstly, acquisitive innovativeness has been measured by noting the total quantity of household and consumer technology owned and desired to be owned in the near future with the cluster loadings on these variables displayed in Figure 4. There appears to be a distinct overlap between these two variables, with the Car Enthusiasts both owning the most and desiring the most household and consumer technology whilst the Weekend Drivers own and desire the least. At a higher level of abstraction, consumer innovativeness has also been approached in this paper by measuring the psychological and sociological determinants of innovativeness, which is generally referred to as innate innovativeness (Roehrich, 2004), with the segment loadings on the constructs measuring this concept displayed in Figure 3 (SD and PD). A similar pattern between the segment loadings on the innate innovativeness constructs and their ownership and desire for household and consumer

technology can be discerned. The Car Enthusiasts and Early Adopter segments display positive loadings on both of the innate innovativeness constructs whilst the Weekend Drivers and Keen Greens have the propensity to load negatively.

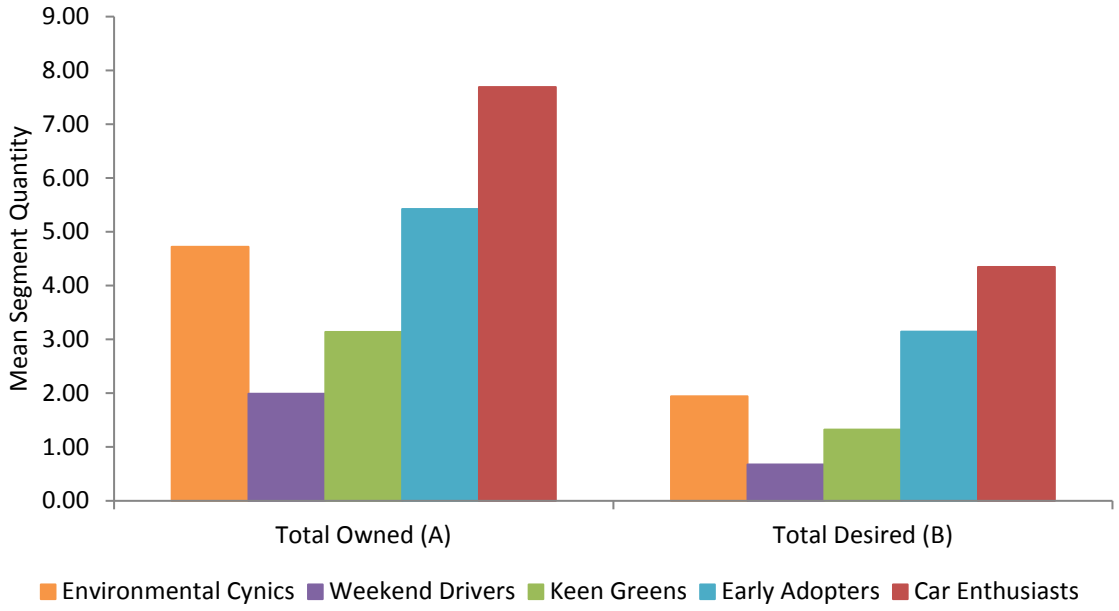

Figure 4: Segment loadings on the measurements of acquisitive innovativeness
(A): H = 203.95, p = .000 (B): H = 148.02, p = .000

To conclude the psychographic profiling, the value structures of the segments have been measured. Three life principles are considered including biospheric (LP: B), egoistic (LP: E) and societal (LP: S) value structures. In terms of biospheric principles, which measure the tendency to consider preventing pollution and protecting the environment to be important, the Keen Greens and Early Adopters are likely to load positively whilst all of the other identified segments display negative loadings. In terms of egotistic principles, which incorporate issues such as a desire for personal wealth and power over others, it is apparent that Car Enthusiasts display a distinctly high loading on this construct with Environmental Cynics and Early Adopters also loading positively whereas the remaining segments tend to exhibit negative loadings.

5. DISCUSION

The five market segments identified in the cluster analysis have the potential to offer a series of insights regarding the structure of demand in the emerging market for EVs. Firstly, the analysis indicates the presence of preference heterogeneity across a typology of consumer groups (Axsen et al. 2015), implying that demand for EVs will likely originate from a sequence of different segments as the market matures. One implication of this preference heterogeneity is that models which forecast demand for EVs into the future (Eggers and Eggers, 2011; Musti and Kockelman, 2011; Shepherd et al. 2012) could be augmented through an appreciation of which market segment is likely to become active at which time horizon. Indeed, this combination of market segmentation and forecasting analysis could provide rich descriptions of potential EV adoption trajectories by noting the temporal dynamics of demand and the consumer structures underpinning these dynamics.

Secondly, the analysis supports the view that an archetypical early EV adopter may not be present (Anable et al. 2016), and that the initial demand for EVs could originate from a set of niche consumer groups which are similar in certain characteristics yet distinct in others. This finding shares similarities to those made by Axsen et al. (2015), who note that disaggregating potential early adopters of EVs into sub-groups illustrates a varied pattern of lifestyle profiles, potentially indicating that the factors motivating the purchase of an EV might have different orders of importance across different groupings of early adopters. To elaborate this point, consider the structure of the Early Adopter and Keen Green segments which both display EVs preference levels which are similar to their preference levels for conventional powertrains, indicating these segments may represent innovators in this market. These segments are quite comparable in their socio-economic and current car characteristics, though Keen Greens represents somewhat older drivers whilst Early Adopters are more likely to hold a university level education and have annual household incomes in excess of £50,000. Moreover, both segments are concerned about the environmental implications of car use, are motivated by biospheric life principles and hold positive opinions regarding the instrumental capabilities of EVs.

However, these segments are also different in a number of important aspects, with Early Adopters displaying relatively high levels of innate and acquisitive innovativeness whereas Keen Greens exhibit distinctly low levels of innovativeness across both levels of abstraction. Thus, the motivation for Keen Greens to consider purchasing an EV for the next car is unlikely to originate from their degree of innovativeness. Moreover, with Keen Greens exhibiting a large negative loading on the construct *Car Meanings: Symbolism and Emotion*, it is possible that the high EV preferences displayed by this

segment might be motivated by their dissatisfaction with conventional cars. Conversely, given the comparatively high scores for innate and acquisitive innovativeness displayed by the Early Adopters, it can be proposed that their relatively high preferences for EVs may also stem partially from an attraction to the advanced technologies which these vehicles incorporate. The inclusion of both 'push and pull' measures of this kind is surprisingly rare in studies on EV adoption which do not necessarily calibrate the attractiveness of EVs against the incumbent ICEV technology. This is particularly important given the fact that ICEVs are improving in terms of fuel efficiency and performance in parallel with innovations in the EV market.

Thirdly, the analysis implies that the augmentation of psychographic profiling with traditional socio-economic characteristics provides a detailed description of the distinct features of the identified segments (Straughan and Roberts, 1999; Anable et al. 2016). This detailed description offers insight concerning the motivations behind the expressed EV preference levels of the different segments. The Car Enthusiast segment represents a case in point, being a highly distinctive segment, spending considerably more than other segments when purchasing cars, are the most likely to own a diesel car and cars with a large engine displacement, indicating a taste for car performance. Moreover, Car Enthusiasts tend to assign a significant degree of symbolic and emotive meaning to car ownership, thinking of their cars as an extension of their identity and a way to improve their mood. This segment scores highly on both measurements of consumer innovativeness, owning and desiring the most household technology whilst exhibiting the largest loadings on the constructs measuring the psychological and sociological determinants of innate innovativeness. However, this innovativeness does not appear to be transferring to the EV market, perhaps as a result of this segment's lack of concern for biospheric values and scepticism relating to the instrumental attributes of EVs. Thus, whilst Car Enthusiasts are generally innovative individuals who desire to own new technologies, they are unlikely to adopt an EV, at least in the near-term, as they may consider these vehicles not to match their personas. This segment has some similarity with the Conventional Sceptics segment found in the recent UK-based Anable et al. (2016) study, but provides a more detailed understanding of how generalised innovativeness tendencies might currently lead to active avoidance of EVs when combined with these other functional and symbolic motives.

Fourthly, the identified consumer structure for EVs on their introduction to the mainstream market reported here could prove useful when investigating the introduction of future advanced propulsion system vehicles. For instance, the introduction of commercially viable Hydrogen Fuel Cell Electric Vehicles (HFCEVs) could occur in the next decade. One question which future research could pursue

relates to whether the segments which were most likely to consider an EV on their introduction are similar to those most likely to consider a HFCEV. Research of this nature could be important in understanding how different low emission propulsion system vehicles may interact when multiple alternatives are available in the market.

Whilst these interpretations of the analysis could prove of value, they should also be considered in the light of the certain limitations. Firstly, with the analysis representing a cross-sectional evaluation of the emerging market at its inception, there is the possibility that the identified segments may only be indicative of the early stages of market development. The temporal stability of the market structure detailed in this assessment could be volatile, meaning the segment descriptions may diverge as the market advances. The validity of the analysis may also be susceptible to significant changes in market conditions, such as the current volatility in world energy prices and the effect of the recent report by the Environmental Protection Agency (EPA, 2015) which notifies the public of the situation whereby certain vehicles are in violation of the Clean Air Act's regulations of the emissions of nitrogen oxides. Considered differently, this could also represent an opportunity for future research which evaluates the consumer structure of the EV market at other phases of market development, such as the transition point between innovators and early adopters (generally considered to occur at when a technology attains a 2.5% market share) or when EVs attain market share parity with incumbent petrol and diesel engine vehicles. A comparison between such future studies and the analysis reported in this paper could offer insights concerning how the consumer structure of a market for advanced propulsion system vehicles alters as the technology matures and consumers become more accustomed to their presence.

Secondly, the degree to which the findings of the analysis can be transferred to other national markets is questionable. Transferability of findings relating to EV attitudes and preferences across countries and cultures has been studied empirically to a very limited extent. For instance, Barbarossa et al. (2015) contrasted intentions to adopt EVs in three countries and found that the role of green self identity was diluted where uncertainty avoidance was high (e.g. Belgium) but played a strong role in combination with low uncertainty avoidance (e.g. Denmark). Helveston et al. (2015) found responses to incentives for EVs to differ between the US and China, with the supply of BEVs being relatively restricted so far in China and therefore commanding higher status and a willingness to pay a premium.

Thirdly, many studies of EV adoption, including this one, fail to examine the antecedents to different variants of plug-in vehicle technology separately (e.g. plug-in hybrids versus full battery electric

vehicles). However, several studies have separated out these powertrains and found that different consumer characteristics correlate with different powertrains. For instance, Vergis and Chen (2015) found environmentalism and vehicle miles travelled to be less influential on PHEV compared to BEV preferences. Axsen et al. (2015) identified segments with very different preferences for HEVs, PHEVs and BEVs and similarly, Anable et al. (2016) found a discrete segment with a positive attitude and high intention to adopt PHEVs, but a lower than average evaluation of BEVs. Again, an expansion of this study with its particular emphasis on psychographic characteristics would benefit from a separate examination of the role of these constructs for different powertrains. Fourthly, with this analysis relying on the application of a significant number of hypothesis tests in order to identify the differences which exist between the identified segments, the opportunity exists for the occurrence of Type 1 error leading to false positives. Thus, future applications of segmentation analysis in the EV market may want to test some of the findings of the research outlined in this paper to determine if the results can be replicated.

6. CONCLUSIONS

Overall, the results presented in this paper demonstrate that a significant degree of stratification is present in reference to the early market for EVs. Segments have formed with distinct features which may indicate that their preferences for EVs are motivated by different factors. With this in mind, this research supports the view that developing transport policy at a market level is limited to only a few options which are likely to hold an effect over all segments. With current UK Government policy toward promoting the demand for EVs focusing primarily on fiscal incentives, information provision and the installation of charging infrastructure (OLEV, 2013), more novel approaches which appreciate the importance of segment profiles have the potential to offer a means through which the transition towards EVs can be accelerated. A potentially more effective approach would be to develop government strategy at the sub-market level, allowing market interventions to be tailored to the specific nuances of targeted segments (Skerlos and Winebrake, 2010; Green et al. 2014). Such an approach is akin to the sub-market strategies which are applied in marketing environments (Lin, 2002) to promote demand. This has already occurred to a degree, with the Department for Transport in the UK beginning to experiment with market segmentation approaches in order to attain an improved understanding of the mobility needs of citizens (DfT, 2011).

Considering the distinctive characteristics of the segments identified in this analysis offers one approach to constructing segment level policy. With the segments Environmental Cynics and Weekend Drivers expressing significant aversions to EVs, it is unlikely that these segments will adopt

an EV in the near future. Indeed, the aversion appears to be significantly entrenched, with these segments neither considering the environmental consequences of car use to be their responsibility nor the instrumental capabilities of EVs to be particularly valuable. Indeed, the significant degree of importance placed on the instrumental meanings of cars by the Environmental Cynics likely means this segment would only consider an EV once they are perceived as being functionally equivalent to conventional cars. Moreover, the low annual mileage driven by Weekend Drivers and their relatively small outlays on the purchase of vehicles means this segment might be more price sensitive to upfront costs and less concerned with operating costs. These findings suggest that the Environmental Cynics and Weekend Driver market segments are unlikely to become active in the EV market in the short-term and should be considered for focused policy attention only when the market and the vehicle technology has matured.

At the other end of the EV preference scale, the segments Early Adopters and Keen Greens display markedly high preferences for EVs. Indeed, these two clusters have EV preferences comparable to those for conventional vehicles, indicating their distinct likelihood to consider an EV in their next car purchase. Knowing the features of these segments allows decision makers to better target policy and market interventions to the individuals who will be most receptive to it. Moreover, the principal features of these market segments provide insights regarding what type of interventions may be more effective. Keen Greens, for example, are likely to be receptive to short-term policy which focuses on the environmental benefits of EVs whilst stressing the negative externalities associated with the operation of conventional cars. In terms of the Early Adopter segment, with this group exhibiting a desire to own new technology alongside a self-perception of being innovative, they are likely to be open to policy that positions EVs as prominent technological innovations. Targeting these two segments with policy initiatives and market interventions during the short term has the potential to enhance the probability of EV adoption.

Car Enthusiasts display a number of encouraging characteristics, such as high levels of consumer innovativeness and an interest in and connection to cars in general, but hold relatively muted preferences for EVs. This market segment could perhaps benefit from medium-term policy initiatives intended to shift the symbolic meanings associated with EVs away from environmental considerations and more towards their embodiment of advanced technologies. If EVs continue to be regarded as instrumentally inferior to conventional cars on issues related to performance, it is unlikely that individuals who fit the Car Enthusiast profile will be attracted to them. Indeed, with this segment being motivated by egoistic principles, it is likely that they would desire a car which matches their self-image of power and authority.

However, the development and application of sub-market strategies may also present a number of challenges which could affect the viability and acceptability of the approach. Firstly, the formation of sub-market policy necessitates an accurate and broad understanding of the different segments active in the area of interest. The research presented in this paper provides a template of how to conduct such an analysis (through an integrated psychographic and demographic approach), though repeated sampling will be required in order to understand the dynamics of the segments and how they respond to interventions. Such an extended project would likely require the allocation of considerable resources to conduct effectively. Thus, the benefits of applying a sub-market policy approach should be considered alongside the possible costs. Secondly, the development of sub-market policy could introduce inequalities into the market, whereby the interests of certain segments are given precedence over others. This could occur unintentionally, as civil servants may naturally concentrate on the nuances of particular segments without considering the implications on other consumer groups. Thus, a balanced approach seems preferable, which encourages policy makers to repeatedly alter the resolution of their perspectives (from segment to market) to consider the needs of the segments and the wider market together rather than in isolation. With this in mind, a cautious approach to considering the implementation of sub-market policy, potentially based on a staged introduction of initiatives which gradually build in scope, would likely prove favourable.

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APPENDIX

Table 7: Opinion statement configurations of the psychological constructs utilised in the market segmentation analysis

Statement	L	M	SD
EV Attitudes: Negative (α: .701) (TVE: 28.8%)			
Electric cars are less reliable than conventional cars	.794	3.923	1.224
I would feel relatively less safe in an electric car	.789	3.784	1.490
I think electric cars would be complicated to use	.762	3.493	1.467
Electric cars don't offer enough performance	.517	4.670	1.364
EV Attitudes: Positive (α: .508) (TVE: 19.4%)			
I think I can fulfil all my transport needs with an electric car that has a range of 100 miles before recharging	.719	3.137	1.822
Electric cars are relatively more expensive to purchase but can pay for themselves in lower fuel costs	.657	4.432	1.391
I would value the ability to refuel my car from home	.572	5.004	1.541
I think it would be easy for me to find places to plug in an electric car	.511	2.816	1.568
Car Attitudes: Importance (α: .805) (TVE: 24.8%)			
I consider my car to be part of the family	.839	2.204	1.547
The car I drive is irreplaceable	.814	2.051	1.377
If my car was stolen, I'd feel as if I had lost a part of myself	.803	3.551	1.949
My car is the most important thing I own	.670	2.352	1.592
I often treat my car as if it were a person	.669	1.934	1.522
Car Attitudes: Environment (α: .785) (TVE: 20.4%)			
I am concerned about the environmental impact of driving my car	.877	4.759	1.428
I am willing to spend more on a car that has lower pollution levels	.831	4.247	1.414
I think it is my responsibility to reduce the environmental impact of driving my car	.803	5.222	1.404
I am willing to spend more on a car that has better fuel economy	.551	5.165	1.160
Car Attitudes: Knowledge (α: .772) (TVE: 16.7%)			
I know how my car works on a mechanical level	.902	3.879	2.047
I'm capable of fixing any rudimentary problems with my car	.825	2.585	1.945
I know a lot about the new types of cars (such as hybrid and electric cars) being released into the car market	.731	3.546	1.812
Car Meanings: Symbolism and Emotion (α: .907) (TVE: 41.6%)*			
Improve my appearance or the way I look	.879	2.245	1.442
Make others think well of me	.875	2.537	1.516
Provide me with social status	.858	2.972	1.756
Improve my mood	.765	3.021	1.808
Provide emotional security	.748	2.616	1.678
Be beautiful or attractive in appearance	.719	3.729	1.756
Allow me to express myself	.679	3.200	1.690
Car Meanings: Instrumental (α: .696) (TVE: 15.5%)*			
Allow me to be efficient in my daily life and work	.713	5.886	1.403
Be a sensible financial decision	.677	4.181	1.695

Have a lot of practical usefulness	.660	6.044	1.102
Provide enjoyment	.629	5.064	1.552
Be a hassle	-.555	3.487	1.755
Psychological Determinants (α: .736) (TVE: 29.3%)			
I'm never satisfied with my current position in life	.634	3.284	1.658
I'm usually one of the first people to acquire the latest consumer technology	.600	2.498	1.487
I quickly incorporate new ideas into how I live my life	.596	4.160	1.406
Compulsive behavior usually governs my purchasing decisions	.596	2.705	1.554
My friends and family would consider me to be an innovative person	.585	3.951	1.453
I'm always looking for ways to alter my life to make it better	.562	4.780	1.393
I'm a very ambitions person setting high standards and expectations for myself	.469	4.449	1.681
Sociological Determinants (α: .865) TVE: 45.3%)			
Friends and colleagues regularly come to me about advice concerning new consumer technology	.892	2.731	1.637
I often know about the next 'must have' piece of consumer technology before it is released into the market	.889	2.523	1.586
I regularly seek information about the latest consumer technology	.887	2.702	1.659
I keep up-to-date with consumer technology by reading newspapers/magazines, websites or watching relevant TV shows	.755	4.091	1.871
I have frequent contact with people working with new consumer technology	.524	3.688	1.801
Life Principles: Biospheric (α: .858) (TVE: 29.0%)			
Protecting the environment (preserving nature)	.840	5.744	1.116
Unity with nature (fitting into nature)	.818	4.967	1.374
Respecting the earth (harmony with other species)	.816	5.667	1.104
Preventing pollution (protecting natural resources)	.801	5.636	1.129
Life Principles: Egoistic (α: .734) (TVE: 18.8%)			
Authority (the right to lead and command)	.842	3.589	1.600
Social power (control over others, being dominant)	.744	2.746	1.518
Influential (having an impact on people and events)	.693	4.352	1.442
Ambitious (hard working and aspiring)	.581	5.100	1.448
Wealth (acquiring material possessions and money)	.575	4.168	1.484
Life Principles: Socetial (α: .668) (TVE: 10.1%)			
Social justice (correcting injustice)	.749	5.992	1.039
Helpful (working for the welfare of others)	.728	5.808	1.082
Equality (equal opportunity for all)	.669	5.981	1.162
A world at peace (free of war and conflict)	.520	6.000	1.205

*Scale anchor phrase: "Most of the time, I think a car can…"
α - Cronbach's alpha
TVE - Total variance explained
L: Factor loading
M: Mean
SD: Standard deviation

REFERENCES

Al-Alawi B.M. Bradley T.H. 2013. Review of hybrid, plug-in hybrid, and electric vehicle market modeling Studies. Renewable and Sustainable Energy Reviews. 21:190–203.

Anable J. 2005. ‘‘Complacent Car Addicts’’ or ‘‘Aspiring Environmentalists’’? Identifying travel behaviour segments using attitude theory. Transport Policy. 12:65–78.

Anable J. Kinnear N. Hutchins R. Delmonte E. Skippon S. 2016. Consumer segmentation and demographic patterns. Transport Research Laboratory report. Available at: http://www.trl.co.uk/reports-publications/report/?reportid=7035 (Accessed 17th August 2016).

Axsen J. Kurani K.S. Burke A. 2010. Are batteries ready for plug-in hybrid buyers? Transport Policy. 17:173–182.

Axsen J. Bailey J. Castro, M.A. 2015. Preference and lifestyle heterogeneity among potential plug-in electric vehicle buyers. Energy Economics. 50: 190–201.

Bakker S. 2010. The car industry and the blow-out of the hydrogen hype. Energy Policy. 38:6540–6544.

Barbarossa C. Beckmann S. C. De Pelsmacker P. Moons I. Gwozdz W. 2015. A self-identity based model of electric car adoption intention: A cross-cultural comparative study. Journal of Environmental Psychology, 42, 149–160.

Barr S. Prillwitz J. 2012. Green travellers? Exploring the spatial context of sustainable mobility styles. Applied Geography. 32:798–809.

Beggs S. Cardell S. Hausman J. 1981. Assessing the potential demand for electric cars. Journal of Econometrics. 17:1–19.

Borthwick S. Carreno M. 2012. Persuading Scottish drivers to buy low emission cars: The potential role of green taxation measures. Proceedings of the Scottish Transport Applications and Research Conference.

Budd T. Ryley T. Ison S. 2014. Airport ground access and private car use: a segmentation analysis. Journal of Transport Geography. 36:106–115.

Burkhardt J. Millard-Ball A. 2006. Who Is Attracted to Carsharing? Transportation Research Record: Journal of the Transportation Research Board. 1986:98–105

Calfee J.E. 1985. Estimating the demand for electric automobiles using fully disaggregated probabilistic choice analysis. Transportation Research Part B: Methodological . 19:287–301.

Caliński T. Harabasz J. 1974. A dendrite method for cluster analysis. Communications in Statistics. 3:1–27.

Campbell A.R. Ryley T. Thring R. 2012. Identifying the early adopters of alternative fuel vehicles: A case study of Birmingham, United Kingdom. Transportation Research Part A: Policy and Practice. 46:1318–1327.

Caulfield B. Farrell S. McMahon B. 2010. Examining individuals preferences for hybrid electric and alternatively fuelled vehicles. Transport Policy. 17:381–387.

Committee on Climate Change 2013. Meeting Carbon Budgets: 2013 Progress Report to Parliament. http://www.theccc.org.uk/wp-content/uploads/2013/06/CCC-Prog-Rep-Book_singles_web_1.pdf (Accessed 20th February 2014).

Cluzel C. Douglas C. 2012. Cost and Performance of EV Batteries. Report by Element Energy to the Committee on Climate Change. Available at: http://www.element-energy.co.uk/wordpress/wp-content/uploads/2012/06/CCC-battery-cost_-Element-Energy-report_March2012_Finalbis.pdf (Accessed 24th May 2014).

Contestabile M. Offer G. North R. 2012. Electric Vehicles: A Synthesis of the Current Literature with a Focus on Economic and Environmental Viability. Available at: http://www.lcaworks.com/EV%20Lit%20Rev%20FINAL.pdf (Accessed 20th February 2014).

DCLG 2010. English Indices of Deprivation 2010.https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6222/1871538.pdf (Accessed 20th February 2014).

DfT 2009. Low Carbon Transport: A greener future. Available at: http://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/pgr/sustainable/carbonreduction/low-carbon.pdf (Accessed 24th May 2014).

DfT 2011. Transport choices segmentation: Final report. Available at: https://www.gov.uk/government/publications/climate-change-and-transport-choices-segmentation-study-final-report (Accessed 16th August 2016.

DfT 2013. National Travel Survey 2013. Available at: https://www.gov.uk/government/statistics/national-travel-survey-2013 (Accessed 18th April 2016).

DfT 2014. Vehicle Licensing Statistics: VEH0253 – Cars registered for the first time by propulsion/fuel type. Available at: https://www.gov.uk/government/collections/vehicles-statistics (Accessed 24th May 2014).

Diamond D. 2009. The impact of government incentives for hybrid-electric vehicles: Evidence from US states. Energy Policy. 37:972–983.

Dibb S. Stern P. 1995. Questioning the reliability of market segmentation techniques. Omega. 23:625–636.

Dijk M. Orsato R.J. Kemp R. 2013. The emergence of an electric mobility trajectory. Energy Policy. 52:135–145.

Dittmar H. 1992. The Social Psychology of Material Possessions: To have is to be. Prentice-Hall.

Egbue O. Long S. 2012. Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. *Energy Policy*,*48*, 717–729.

Eggers, Felix, Eggers, Fabian, 2011. Where have all the flowers gone? Forecasting green trends in the automobile industry with a choice-based conjoint adoption model. Technological Forecasting and Social Change. 78: 51–62.

EPA 2015. Notice of violation. Available at: https://www.epa.gov/sites/production/files/2015-10/documents/vw-nov-caa-09-18-15.pdf (Accessed 16th August 2016).

Epprecht N. et al. 2014. Anticipating transitions beyond the current mobility regimes: How acceptability matters. Futures. 60:30–40.

Everitt B.S. Landau D.S. Leese D.M. 2009. Cluster Analysis. John Wiley & Sons.

Ewing G.O. Sarigöllü E. 1998. Car fuel-type choice under travel demand management and economic incentives. Transportation Research Part D: Transport and Environment. 3:429–444.

Franke T. Krems J.F. 2013. What drives range preferences in electric vehicle users? Transport Policy. 30: 56–62.

Fürst E. 2014. Making the way to the university environmentally sustainable: A segmentation approach. Transportation Research Part D: Transport and Environment. 31:1-12.

Geels F.W. 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. Journal of Transport Geography. 24:471–482.

Graham-Rowe, E. Gardner B. Abraham C. Skippon S. Dittmar H. Hutchins R. Stannard J. 2012. Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: A qualitative analysis of responses and evaluations. Transportation Research Part A: Policy and Practice. 46(1): 140–153.

Green E. H. Skerlos S. J. Winebrake J. J. 2014. Increasing electric vehicle policy efficiency and effectiveness by reducing mainstream market bias. Energy Policy. 65:562–566.

de Groot J.I.M. Steg L. 2008. Value Orientations to Explain Beliefs Related to Environmental Significant Behavior How to Measure Egoistic, Altruistic, and Biospheric Value Orientations. Environment and Behavior. 40(3): 330–354.

Harrison G., Shepherd S. 2013. An interdisciplinary study to explore impacts from policies for the introduction of low carbon vehicles. Transportation Planning and Technology. 0:1–21.

Hartigan J.A. Wong M.A. 1979. Algorithm AS 136: A K-Means Clustering Algorithm. Applied Statistic. 28:100.

Heffner R.R. Kurani K.S. Turrentine T.S. 2007. Symbolism in California's early market for hybrid electric vehicles. Transportation Research Part D: Transport and Environment. 12: 396–413.

Helveston J. P. Liu Y. Feit E. M. Fuchs E. Klampfl E. Michalek J. J. 2015. Will subsidies drive electric vehicle adoption? Measuring consumer preferences in the U.S. and China. Transportation Research Part A: Policy and Practice, 73, 96–112.

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.

Høyer K.G. 2008. The history of alternative fuels in transportation: The case of electric and hybrid cars. Utilities Policy 16:63–71.

IEA 2011. Technology Roadmap: Electric vehicles and plug-in hybrid electric vehicles. Available at: http://www.iea.org/publications/freepublications/publication/name,3851,en.html (Accessed: 24th May 2014).

Jansson J. Marell A. Nordlund A. 2011. Exploring consumer adoption of a high involvement eco-innovation using value-belief-norm theory. Journal of Consumer Behaviour. 10(1): 51–60.

Krause R. Lane B. Carley S. Graham J. D. 2016. Assessing demand by urban consumers for plug-in electric vehicles under future cost and technological scenarios. International Journal of Sustainable Transportation

Köhler J. Schade W. Leduc G. Wiesenthal T. Schade B. Espinoza L.T. 2013. Leaving fossil fuels behind? An innovation system analysis of low carbon cars. Journal of Cleaner Production. 48:176–186.

Krupa J. S. Rizzo D.M. Eppstein M.J. Brad Lanute D. Gaalema D.E. Lakkaraju K. Warrender C.E. 2014. Analysis of a consumer survey on plug-in hybrid electric vehicles. Transportation Research Part A: Policy and Practice. 64: 14–31.

Kryszczuk K. Hurley P. 2010. Estimation of the number of clusters using multiple clustering validity indices, in: Proceedings of the 9th International Conference on Multiple Classifier Systems, MCS'10. Springer-Verlag, Berlin, Heidelberg, pp. 114–123.

Kurani K.S. Turrentine T. Sperling D. 1996. Testing electric vehicle demand in `hybrid households' using a reflexive survey. Transportation Research Part D: Transport and Environment 1, 131–150.

Larson P.D. Viáfara J. Parsons R.V. Elias A. 2014. Consumer attitudes about electric cars: Pricing analysis and policy implications. Transportation Research Part A: Policy and Practice. 69: 299–314.

Lieven T. Mühlmeier S. Henkel S. Waller J.F. 2011. Who will buy electric cars? An empirical study in Germany. Transportation Research Part D: Transport and Environment. 16:236–243.

Lin C. 2002. Segmenting customer brand preference: demographic or psychographic. Journal of Product & Brand Management. 11(4): 249–268.

Midgley D. F. Dowling G.R. 1978. Innovativeness: The Concept and Its Measurement. Journal of Consumer Research. 4(4): 229–242.

Mooi E. Sarsted M. 2011. A Concise Guide to Market Research: The Process, Data, and Methods Using IBM SPSS Statistics. Springer.

Morton C. Anable J. Brand C. 2014. Policy making under uncertainty in electric vehicle demand. Proceedings of the ICE – Energy. 167:125–138.

Morton C. Anable J. Nelson J.D. 2016a. Assessing the importance of car meanings and attitudes in consumer evaluations of electric vehicles. Energy Efficiency. 9(2): 495–509.

Morton C. Anable J. Nelson J. D. 2016b. Exploring consumer preferences towards electric vehicles: The influence of consumer innovativeness. Research in Transportation Business & Management, *18*, 18–28.

Musti S. Kockelman K.M. 2011. Evolution of the household vehicle fleet: Anticipating fleet composition, PHEV adoption and GHG emissions in Austin, Texas. Transportation Research Part A: Policy and Practice. 45(8): 707–720.

Namdeo A. Tiwary A. Dziurla R. 2014. Spatial planning of public charging points using multi-dimensional analysis of early adopters of electric vehicles for a city region. Technological Forecasting and Social Change. 89:188–200.

Nayum A. Klöckner C.A. Mehmetoglu M. 2016. Comparison of socio-psychological characteristics of conventional and battery electric car buyers. Travel Behaviour and Society. 3: 8–20.

Odeh N. Hill N. Forster D. 2013. Current and future lifecycle emissions of key low carbon technologies and alternatives. Available at: http://www.theccc.org.uk/wp-content/uploads/2013/04/Ricardo-AEA-lifecycle-emissions-low-carbon-technologies-April-2013.pdf (Accessed 24th May 2014).

Offer G.J. Howey D. Contestabile M. Clague R. Brandon N.P. 2010. Comparative analysis of battery electric, hydrogen fuel cell and hybrid vehicles in a future sustainable road transport system. Energy Policy. 38:24–29.

Offer G. J. Contestabile M., Howey D. A. Clague R. Brandon N. P. 2011. Techno-Economic and Behavioural Analysis of Battery Electric, Hydrogen Fuel Cell and Hybrid Vehicles in a Future Sustainable Road Transport System in the UK. Energy Policy. 39:1939–50.

OLEV 2011. Making the connection: The plug-in vehicle infrastructure strategy. Available at: https://www.gov.uk/government/publications/making-the-connection-the-plug-in-vehicle-infrastructure-strategy (Accessed 24th May 2014).

OLEV 2013. Driving the Future Today - A Strategy for ULEVs in the UK. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/239317/ultra-low-emission-vehicle-strategy.pdf (Accessed 20th February 2014).

ONS 2009. Scottish Index of Multiple Deprivation: 2009 General Report. http://www.scotland.gov.uk/Resource/Doc/933/0115249.pdf (Accessed 20th February 2014).

Ozaki R. Sevastyanova K. 2011. Going hybrid: An analysis of consumer purchase motivations. Energy Policy. 39:2217–2227.

Plötz P. Schneider U. Globisch J. Dütschke E. 2014. Who will buy electric vehicles? Identifying early adopters in Germany. Transportation Research Part A: Policy and Practice. 67:96–109.

Punj G. Stewart D.W. 1983. Cluster Analysis in Marketing Research: Review and Suggestions for Application. Journal of Marketing Research. 20:134–148.

Roehrich G. 2004. Consumer innovativeness: Concepts and measurements. Journal of Business Research. 57:671–677.

Rogers E.M., 2003. Diffusion of Innovations, Fourth Edition, 5th ed. Free Press.

Ryan L. Ferreira S. Convery F. 2009. The impact of fiscal and other measures on new passenger car sales and CO2 emissions intensity: Evidence from Europe. Energy Economics. 31:365–374.

Sangkapichai M. Saphores J.D. 2009. Why are Californians interested in hybrid cars? Journal of Environmental Planning and Management. 52:79–96.

Schuitema G. et al. 2013. The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. Transportation Research Part A: Policy and Practice. 48:39–49

Schwanen T. Banister D. Anable J. 2011. Scientific research about climate change mitigation in transport: A critical review. Transportation Research Part A: Policy and Practice. 45: 993–1006.

Shepherd S. Bonsall, P. Harrison G. 2012. Factors affecting future demand for electric vehicles: A model based study. Transport Policy. 20:62–74.

Sierzchula W. Bakker S. Keers M. Bert V.W. 2014. The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy. 68:183–194

Skerlos S. J. Winebrake J. J. 2010. Targeting plug-in hybrid electric vehicle policies to increase social benefits. Energy Policy. 382:705–708.

Skippon S. Garwood M. 2011. Responses to battery electric vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. Transportation Research Part D: Transport and Environment. 16:525–531.

Smith W.R. 1956. Product Differentiation and Market Segmentation as Alternative Marketing Strategies. The Journal of Marketing. 21:3–8.

Steg L. 2005. Car use: lust and must. Instrumental, symbolic and affective motives for car use. Transportation Research Part A: Policy and Practice. 39: 147–162.

Steinhilber S. Wells P. Thankappan S. 2013. Socio-technical inertia: Understanding the barriers to electric vehicles. Energy Policy. 60:531–539.

Straughan R.D. Roberts J.A. 1999. Environmental segmentation alternatives: a look at green consumer behavior in the new millennium. Journal of Consumer Marketing. 16(6): 558–575.

Struben J. Sterman J.D. 2008. Transition challenges for alternative fuel vehicle and transportation systems. Environment and Planning B: Planning and Design. 35:1070–1097.

Train K. 1980. The potential market for non-gasoline-powered automobiles. Transportation Research Part A: General. 14:405–414.

van Bree B. Verbong G.P.J. Kramer G.J. 2010. A multi-level perspective on the introduction of hydrogen and battery-electric vehicles. Technological Forecasting and Social Change. 77:529–540.

van Vliet O.P.R. Kruithof T. Turkenburg W.C. Faaij A.P.C. 2010. Techno-economic comparison of series hybrid, plug-in hybrid, fuel cell and regular cars. Journal of Power Sources. 195:6570–6585.

Vergis S. Chen B. 2015. Comparison of plug-in electric vehicle adoption in the United States: A state by state approach. Research in Transportation Economics, 52, 56–64.

Wells W.D. 1975. Psychographics: A Critical Review. Journal of Marketing Research, 12(2): 196–213.

Whitmarsh L. 2012. How useful is the Multi-Level Perspective for transport and sustainability research? Journal of Transport Geography. 24:483–487.

Wind Y. 1978. Issues and Advances in Segmentation Research. Journal of Marketing Research. 15:317–337.

Zubaryeva A. Thiel C. Barbone E. Mercier A. 2012. Assessing factors for the identification of potential lead markets for electrified vehicles in Europe: expert opinion elicitation. Technological Forecasting and Social Change. 79:1622–1637.