The Effect of Environmental Awareness on Car Sales

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Abstract

In this study I investigate the effect of environmental awareness on consumers' car choice and the effect of the latter on car sales in five European car markets. I build the relationship between the attitude and the sales based on a discrete-choice utility model using market-level data. In this framework, the attitude determines the consumers' taste for fuel consumption rather than the behavior itself. I find insignificant effect for the entire sample of cars, but the effect is mixed when the sample is broken down into categories of cars. Mixed evidence is due to endogenous prices and the poor quality of the data on environmental attitude.

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Table of Contents

Introduction

It is widely assumed that environmental awareness leads to an environmentally friendly behavior, e.g. recycling of trash and usage of fuel efficient cars. Moreover, market research is often based on the assumption of a direct link between the attitude of consumers and their behavior. In spite of previous studies showing that there is a very low correlation or no correlation at all between the attitude and the behavior of a person (Hini, Gendall, & Kearns, 1995; Wright & Klÿn, 1998), the attitudes remain an important component of surveys (Worlds Value Survey, International Social Survey Program) and is further used in studies of consumer behavior.

The relationship between the environmental attitude and environmental behavior was studied in Hini, Gendall and Kearns (1995), Wright and Klÿn (1998) and Schultz (2002). These studies looked at the relationship of the self-declared attitude with environmental actions such as protesting, donating money, recycling trash and cutting back on driving. The estimated correlations were all below 0.3, most of the values being close to zero. The authors suggest that either the attitude cannot predict behavior or the self-declared measure of environmental sentiment is not reliable.

Most of the papers addressing the issue of environmental awareness study the relationship between environmental attitude and ecological mobility. One of the reasons why they find very low correlations are the external factors that constrain people to act (Jonassen, 1954). A person may want to protest but might not have an opportunity to do this, or alternatively, she would like to recycle the waste but it is a challenge when recycling is not organized at community level (Hini, Gendall, & Kearns, 1995). In this paper, rather than looking at environmental activism, I observe how the environmental attitude changes their usual behavior, namely - the purchasing choice. The purpose of the study is to determine how

the environmental sentiment affects the demand for a particular car model. There appears to be limited research on this question. Rather, the studies are either focused on the correlation between environmental attitude and behavior or the factors affecting the car sales. In this paper I will combine the idea of the first and the method of the latter.

The study covers five European countries: Belgium, France, Germany, Italy and United Kingdom, which account for more than 85% of the total European car market (Goldberg & Verboven, 2001). The environmental awareness is based on the data from World Values Survey. I build the relationship between environmental awareness and the demand for a car model on the basis of a discrete-choice utility model which was also used by Berry (1994) and Berry et al. (2004) to model the demand for differentiated products. According to this model, the environmental sentiment does not have a direct impact on the demand for cars but rather determines the taste for other attributes such as the fuel consumption.

This approach to answering the question has several advantages. The behavior of consumers is not self-declared but is observed independently from the attitude survey and hence does not allow for distortion of attitudes according to behavior. Furthermore, the substitution patterns between the products will reveal whether the consumers with different environmental attitudes value the car attributes in different ways. This result could have implications for designing the marketing strategies for cars. If consumers favor fuel efficient cars not only for budget reasons but also due to the "green" attitude, we would expect the car companies to focus on the environmental benefits of the cars in their design and marketing campaigns. On the other hand the government should put more effort into increasing the social environmental awareness if they want to increase environmental investments and SCR in the car industry.

The paper is structured in five sections. After Introduction, the Literature Review section gives a short overview of papers studying the link between environmental attitude and behavior and papers that used the discrete-choice model for differentiated product markets. I make a detailed description of the model and the underlying assumptions in the third section. In the Data section I describe the data I use, where it was taken and present the summary statistics. The next section reveals the results and their interpretations. Finally I will sum up the findings and conclude in the last section.

Background

The Link between Environmental Attitude and Behavior

The link between attitude and behavior has been the focus of an extensive literature starting with La Piere (1934)[1]. The typical result of the studies was a very weak or no correlation at all. The correlation varied depending on the type of behavior that was studied. For example, strong relation was found between voting behavior and the voting attitudes[2]. The environmental attitude however most of the times was found to be a bad predictor of environmental behavior (Jonassen, 1954; Hini, Gendall, & Kearns, 1995; Wright & Klÿn, 1998). Although there has not been studies specifically asking whether environmental attitude affects the cars sales, some studies estimated correlations between environmental attitude and ecologic activism, sometimes including consumer behavior and driving habits.

One study by Hini et al. (1995) researched the link between environmental attitude and behavior using a mail survey with scaled behavioral and attitude questions. The behaviors included signing petitions, donating money, protesting, cutting back driving and buying product with fewer packages. The authors of the study performed regressions to determine to what extent the declared attitudes can predict the behaviors. Overall, the relationship was found to be weak, with the maximum R^2 being 0.27 for signing a petition. The R^2 was only 0.17 for cutting back driving for environmental reasons. Moreover, this result may be overestimating the real relation, because both attitudes and behaviors were determined from the same questionnaire. The person could distort either their attitudes or behaviors to present more consistent answers (Hini, Gendall, & Kearns, 1995).

[1] Cited from Wright and Klÿn (1998)

[2] Paul F. Lazarsfeld, The People's Choice (New York: Columbia University Press, 1948), cited from Christen T. Jonassen (1954)

Wright and Klÿn (1998) study the correlation between the self-declared attitude and the actions of a person using the data from the International Social Survey Program, which includes information about the environmental attitude and environmental behavior in 21 countries. The behavior signaling environmental awareness and concern include sorting the glass, buying organic food, cutting back on driving, refusing meat, signing petitions, donating money, protesting, and joining environmental groups. These actions were divided into three types of motivators: concern about environment, consumption and activism. The authors of the study find that the environmental attitude is mostly reflected in the consumption behavior of the people. The highest correlations were 0.21 and 0.15 - for organic products purchase and car driving cut back respectively. Moreover, the questionnaire had specific questions on the attitude reasoning. The correlation between the behavior and the attitude towards driving that was perceived as danger to environment is 0.15. The correlation with the attitude which perceived driving as a danger to family and self is 0.13. The correlations between attitude and behavior were also found to be higher in English-speaking and West-European countries.

Discrete-Choice Utility Model

In this paper I use discrete-choice model to build the relationship between the attitude and consumer car model choice. Discrete-choice utility models are generally used to explain and predict buying decisions at a micro-level with the product attributes and consumer characteristics as explanatory variables. The discrete-choice utility model was initially used by Berry (1994) to model the demand side of a demand-supply system of differentiated products. In this paper Berry (1994) focuses on the price endogeneity problem caused by the unobserved characteristics of the products. To overcome the need to use instrumental variables for prices he applies the *mean utility method*. He determines the mean levels of utility by inverting the function of market shares. A similar model with differentiated products and based on micro-level data was presented in Berry et al (2004). They use a rich

dataset, with second choice information, to make better estimates of substitution patterns between the products.

Goldberg (1995) develops and estimates a model for the US Car Industry using a discrete choice logit model for the demand side and applies it to micro data. She uses an algorithmic approach to the buying decision behavior of the consumers and models the probability of a household to buy a vehicle with certain characteristics. The probability to be purchased depends on vehicle attributes and household features. She splits the sample of cars in subcategories (small, luxury and other cars), and according to the origin (home and foreign) allowing different behavioral patterns for different type of cars. Following her study I will also split the sample to detect different behaviors. Overall, the model underestimates the sales, and the price elasticities range between -1 and -10.13.

Unlike the previous authors, Petrin (2002) models the demand for cars using market-level data instead of microdata. While this method is less preferable, it compensates for lack of more detailed information. Since I did not have access to consumer level data, I follow Petrin (2002) by using macrodata to describe tastes. Petrin (2002) uses a discrete-choice model, but assumes invariant tastes within a market and within one year. He explains the market share of a certain type of car by relating consumer demographic averages to vehicle attributes. Petrin (2002) uses a random effects discrete choice approach, which allows detecting the heterogeneity in tastes by looking at the substitution patterns between products. In order to improve precision, the model is enhanced with the difference between actual and the predicted household behavior to penalize for significant deviations from the real values. The resulting demand model is used to determine the welfare effects from the introduction of the minivan in the US market. Compared to consumer-level data, this model brings larger estimates for welfare numbers, due to its dependence on the idiosyncratic error. He also mentions that micro data is still desirable for demand and welfare measurements.

Finally I would like to mention the two studies of Goldberg and Verboven (2001) and Brenkers and Verboven (2006). In these studies, the authors analyze the European car market using detailed data on car models. To be more specific Goldberg and Verboven (2001) analyze the dispersion of prices across European car markets and find that this is due to a "selective and exclusive" cars distribution system that limits the across-border trade. Brenkers and Verboven (2006) proceed by estimating the welfare effects of liberalization of the 'selective and exclusive' cars distribution system. In this study they use the same data on cars I am using in this paper. Following Berry (1994) they estimate the demand using a discrete-choice utility model. Overall they find that liberalization would bring modest welfare effects and the gains of the manufacturers will be either small or zero.

Model

In order to answer the question of how the environmental awareness affects the sales of cars I use the discrete-choice model used by Berry (1994) and Berry et al. (2004). The discrete-choice model is derived under the assumption of utility-maximizing behavior of a decision making consumer. His decision, to buy or not to buy a car, is determined by the attributes of the product and by his/her tastes for these attributes.

The model consists of two main components: the product attributes and consumers' tastes for these attributes, which are observed by the market participants. Not all of these attribute are observed by the researcher though. If we denote with U_{ijt} the actual utility and by V_{ijt} *the representative utility* – the utility that can be explained in terms of observed variables – the relationship between the two utilities is as follows:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} = \beta_{jt} * X_{it} + \varepsilon_{ijt}$$

where X_{it} represents the observed attributes of the product *i* at time *t*, which may also vary over time, β_{kjt} is the taste of consumer j for the attribute k at time t, and ε_{ijt} incorporates the unobserved characteristics of the product that also affect the utility. Assuming utility maximization, the probability of consumer j to purchase product i is the following:

$$\Pr\left(U_{ijt} > U_{iht}, \forall\, h \neq i\right) = \Pr\left(V_{ijt} + \varepsilon_{ijt} > V_{hjt} + \varepsilon_{hjt}, \forall\, h \neq i\right)$$

$$= \Pr(\varepsilon_{ijt} - \varepsilon_{hjt} > V_{hjt} - V_{ijt}, \forall\, h \neq i)$$

The value of the above probability depends on the distribution of ε_{ijt}. It also describes the distribution of the utility determined by unobserved characteristics around the observed utility. Similarly to Berry et al. (2004) I assume a logit distribution of the error term. The implications of this assumption will be discussed further in this section. I obtain the following probability of a car model *i* to be purchased:

$$\Pr_{ijt}\left(V_{ijt} + \varepsilon_{ijt} > V_{hjt} + \varepsilon_{hjt}, \forall\, h \neq i\right) = \frac{e^{V_{ijt}}}{\sum_h e^{V_{hjt}}} = \frac{e^{V_{ijt}}}{\sum_h e^{V_{hjt}}}$$

where V_{ijt} is the estimated utility function. In the context of a large population of consumers facing the same decision, the probability that a consumer buys a product *i* is the same as the share of the population that buys product *i* so I substitute the probability with the market share of a particular car model in a given year. I denote this share by s_{imt}. Assuming invariant preferences of consumers within one market, I can also substitute V_{ijt} with V_{imt}, where *m* stands for market. The resulting relationship between market share and observed utility is the following:

$$s_{imt} = \frac{e^{V_{imt}}}{\sum_h e^{V_{hmt}}}$$

If we take logs of the above expression, we obtain a logarithmic linear version of a probability model:

$$\log(s_{imt}) = V_{imt} - \log\left(\sum_h e^{V_{hmt}}\right)$$

or

$$\log(s_{imt}) = \beta_{mt} * X_{it} - \log\left(\sum_h e^{\beta_{mt} * X_{ht}}\right)$$

In this specification, the term $\log\left(\sum_h e^{\beta_{mt} * X_{ht}}\right)$ varies solely along the market and time dimension, and thus can be denoted by α_{mt}.

Using this final result I will estimate a linear model with the log of market shares of a car model as a dependent variable, and product attributes and consumer tastes as explanatory variables.

$$\log(s_{imt}) = \sum_k \beta_{mtk} * x_{ik} + \alpha_{mt} + \xi_i + \varepsilon_{mit} \qquad (1)$$

The variables vary along three dimensions: time denoted by *t*, market (country) denoted by *m*, and car model denoted by *i*. Each car model i has *k* observed characteristics, denoted by x_{ik}, and some unobserved characteristics specific to each model - ξ_i. The observed characteristics include such variables as price, fuel consumption, maximum speed, acceleration, length, and width. The unobserved characteristics either cannot be quantified or are not available and are specific to a car model with no variation across markets and time, for example design and reputation. The LHS variable s_{ict} represents the probability of a random consumer from market *m* to purchase car model *i* at time *t*. ε_{mit} is the error term and represents the idiosyncratic individual error or the distribution of the unobserved part of market share around the observed part of market shares.

β_{mtk} is the taste of consumers for a certain product attribute. This parameter varies across countries, time, and attribute. Normally, each individual consumer should have a different β. Due to lack of micro data I assume that all the consumers within a market and during one year are homogenous and possess average characteristics. In this situation, market average and aggregate demographics compensate for the lack individual level data (Petrin, 2002).

$$\beta_{mtk} = \delta_k + \sum_r \gamma_{kr} * z_{mtr} + e_{mtk} \quad (2)$$

Here z_{ct} represents the observed average consumers' characteristics that affect the preferences, such as income, and the variable of interest – environmental awareness. e_{ctk} captures the unobserved characteristics, and δ_k is the average effect of all unenclosed factors. The first part of the right hand equation side represents the average or expected consumers taste for an attribute based on observed information, and it depends on the market-level variables. The heterogeneity among consumers within a market, i.e. their distribution around

the mean, as well as their unobserved characteristics is captured by the last term, which is the residual in this equation.

The discrete choice model is found by putting together equations (1) and (2):

$$\log(s_{imt}) = \sum_{k} \delta_k * x_{ik} + \sum_{k} \sum_{r} \gamma_{kr} * z_{mtr} * x_{ik} + \alpha_{mt} + \xi_i + \varepsilon_{mit} \quad (3)$$

The main feature of this model is the presence of the interaction terms between product attributes and market characteristics, which allows for the consumers' tastes for different product attributes to differ. Furthermore, there are two car model specific terms, one of them being a linear function of its attributes and another one is the model specific constant that captures the unobserved characteristics. α_{mt} in this model captures the market/time effects. These are the country fluctuations that affect the demand for cars, such as recessions/, tax reforms etc.

As it was already mentioned, I assume there is no heterogeneity in preferences across the consumers within one market. A consequence of this assumption is that a change in the distribution of preferences may not be properly reflected in the mean change and hence result in unreasonable substitution patterns (Berry, Levinsohn, & Pakes, 2004).

The endogeneity of prices, also known as simultaneity bias, can also be a problem. The error term incorporates factors that influence both the demand for cars and their price, such as unobserved characteristics or shocks that affect the price and sales. The unobserved characteristics can be controlled by the fixed effects estimation and the demand shocks by the time effects. Nevertheless, the effect of the unobserved characteristics that vary over time cannot be captured by FE. For example a sudden increase in the demand for a Toyota model due to a popular design. This may result in an upward sloping demand curve.

Turning back to the assumption about the distribution of the residual, the logit density function has some advantages but also imposes some restrictions on the model. The logit model assumes that the errors are i.i.d. and more importantly are uncorrelated across

alternatives. This assumption does not entirely correspond to reality, because in the presence of unobserved characteristics, the reasons why a car model is more demanded may be the same reason why some other model is more demanded. The same applies for errors over time. The reason why a car is popular one year is most likely the same why it is popular in consequent years. The independent errors assumption can be justified only in the presence of prefect data that accounts for all possible attributes. Given the rich dataset used here with a broad range of variables covering most of the attributes of concern to the buyer, this effect may be insignificant.

By applying this model to the data, one would expect to find a substitution pattern between different types of car model, based on their characteristics and consumers' tastes.

Data Description

Dataset of Cars

To estimate the consumer environmental attitude's effect on the car sales I will use a cars database from the website of Frank Verboven, which was constructed using information from various public sources[3]. The same data was used in the study of the liberalization of the European car market – Brenkers and Verboven (2006). The dataset contains 11549 observations with information on sales, prices and characteristics of all the car models sold in five European markets during 1970-1999.

The dataset is structured along three dimensions: car model, market and time. The observations are evenly distributed across all three dimensions, making the sample representative. There are 356 car models in the dataset. Each model is reported together with physical dimensions (length, weight, height and width), performance characteristics (fuel consumption, acceleration, maximum speed) and engine power (cylindrical volume and horsepower). There is also a home dummy, which takes the value 1 if the car has a domestic brand, and *zero* otherwise.

There are five markets that are segmented along the national lines of 5 European countries: Belgium, France, Germany, Italy and United Kingdom. By using this structure, I assume that consumers from one country do not have access to other markets' products. This assumption is reasonable because the cars distribution system in Europe is "selective and exclusive", and the cross-border trade is limited (Goldberg & Verboven, 2001; Brenkers & Verboven, 2006). The dataset is also enhanced with macroeconomic data on nominal and real GDP per capita, and consumer price indices. The variables varying along all 3 dimensions are

[3] Detailed description of how it was constructed in Brenkers and Verboven (2006)

Table 1 Summary Statistics by Market

Car Model Characteristics	All Markets		Belgium	France	Germany	Italy	UK
	Mean	SD			Means		
Price	10994.5	6527.52	9881.69	10728.8	10584.4	11108.6	13041
Sales	19813.2	37719.9	3925.42	23305.8	31002.6	24292.1	19784.3
Fuel Consumption	8.17993	1.71534	8.21884	8.12091	8.24054	8.07737	8.22304
Displacement	1477.58	464.78	1483.67	1459.31	1504.73	1428.05	1518.28
Horsepower	58.61	24.22	58.09	57.39	58.71	57.91	61.76
Maximum Speed	162.97	23.69	161.83	161.36	163.54	161.43	167.94
Acceleration	15.14	5.16	15.27	15.39	15.09	15.48	14.25
Weight	997.67	225.28	997.66	990.08	1001.72	988.97	1013.17
Length	417.51	45.41	418.10	416.50	418.13	414.66	420.65
Width	165.53	9.40	165.37	165.27	165.60	164.95	166.76
Observations	11549		2673	2265	22283	2027	2301

prices and sales. The prices are listed in both domestic currency and in the common currency ECU, which can also be interpreted as Euro. The summary statistics are presented in Table 1.

The car models are additionally divided according to five classes: subcompact, compact, intermediate, executive and luxury. The class is generally correlated with the car quality, its performance characteristics and dimensions. If we break down the sample according to these classes, one can see the differences (Table 2). The number of models and

Table 2 Summary Statistics by Class

Car Model Characteristics	Subcompact	Compact	Intermediate	Executive	Luxury
			Means		
Price	6353.86	8915.97	11430.8	14706.2	22205
Quantity	25900.5	24441.8	17932.4	9991.99	13014.1
Fuel Consumption	6.72315	7.88063	8.51348	9.59653	9.95767
Displacement	998.70	1316.85	1534.71	1965.93	2160.31
Horsepower	34.39	50.65	61.30	81.05	97.36
Maximum Speed	139.47	157.42	169.11	181.29	193.79
Acceleration	19.66	15.00	13.74	12.31	11.26
Weight	747.71	926.22	1043.46	1231.13	1328.12
Length	358.81	408.19	438.48	463.77	470.24
Width	154.21	165.00	168.84	173.83	175.57
Observations	3254	2681	2534	2154	926

especially the quantity sold goes down as we move from subcompact to luxury. The characteristics of the cars also change significantly: the price and the fuel consumption increase, performance features improve, the dimensions of the car increase.

The observations are distributed evenly over time. The quantity of cars sold increases over the years for all the countries, except Belgium, where the quantity is stable.

Index of Environmental Sentiment

The variable of interest for the question of this paper is the environmental awareness of consumers. Given its subjective nature, it is quite a challenge to find a good measure that is comparable across markets. Moreover, the surveys on attitudes are once in several years, therefore continuous data on attitudes is not available. I retrieved data on consumers' attitude variable from the World Values Survey database. The retrieved data is presented in Table A2 from the Appendix. The information is based on the answer to the following statement: 'I am willing to give up a part of my income for the environment protection' with the possible answers being Strongly Agree, Agree, Disagree and Strongly Disagree.

Using the share of people responding in each of this ways, I compute a simple indicator that shows the degree of environmental awareness within a country according to the following formula:

$$Index\ of\ Environmental\ Sentiment = \%"Strongly\ Agree" + 0.5 * \%"Agree" - 0.5 * \%"Disagree" - \%"Strongly\ Disagree"$$

The resulting index – the Index of Environmental Sentiment or simply IES – is presented in Table 3 below. A value of the index that is close to -1 implies that the society is strongly against giving up income for environment protection. The society is willing to give up income for this purpose if IES is close to 1. Finally it is neutral or the opinions are rather

Table 3 The Index of Environmental Sentiment (IES)

	Belgium	France	Germany	Italy	UK
1981		0.128			
1990	0.065	0.136	0.0595	0.22	0.216
1999	0.069	-0.109	-0.348	0.166	-0.0335
2005			-0.246	0.118	

Note: Computed according to the following formula
$\boldsymbol{Index\ of\ Environment\ Sentiment} = \%\text{Strongly Agree} + \mathbf{0.5} * \%\text{"}\boldsymbol{Agree}\text{"} - \mathbf{0.5} * \%\text{"}\boldsymbol{Disagree}\text{"} - \%\text{"}\boldsymbol{Strongly\ Disagree}\text{"}$

equally distributed among the supporters and opponents of the statement if IES is around *zero*. This index will be used based on the assumption that if people care about the environment they would give up a part of their income for its protection.

This index may suffer from several serious flaws. First of all the estimates may not reflect the reality due to the social desirability drive of those answering the survey questions. When people believe that being environmental is good or that the surveyors expect them to be 'green', they may overestimate their love towards environment. Secondly, given that the index is computed on the basis of a question, it may be that people care about the environment, but are not ready to give up a part of the income for environment protection, and hence do not agree with the statement. The indices are available for all the countries at the same time for only two dates: 1990 and 1999 surveys. There is available data also for 1981 for France. The indices for these years are presented in Table A2 in the Appendix.

As one can see, towards 1999, the index of environmental attitude has decreased compared to 1990. Belgium is an exception; the index here did not change significantly. In France it has been decreasing since 1981, and the same it did in Germany, Italy and UK from 1990 onwards. In 1990 in Germany the sentiment was 0.0595, which means that the attitude towards environment is evenly distributed among opponents and supporters of the cause. We can compare it to the 1999 level, where the environmental sentiment is -0.348, significantly skewed towards the opponents of the statement. In Italy, in contrast, the sentiment is higher

than in Germany, and its decrease rate over time is lower. This pattern is not very consistent with what we observe in reality.

For the period in between the surveys I will generate values by assuming a constant change in the sentiment overtime. In this way the index will either be increasing, decreasing or constant if there is no change.

Even though this may not totally reflect the reality, it is a good approximation because the countries' attitude toward environment does not change significantly over time, but builds up slowly being highly correlated with the cultural and educational values of the society (Schultz, 2002), which is usually unidirectional and not erratic in movement. The data from the World Value Survey and the indexes are presented in the tables. Since most of the attitude- behavior correlations are found to be very low, and often close to zero (Wright & Klÿn, 1998), the fact that index is available for just a few years may further complicate the determination of a robust correlation between the attitude and the behavior of the consumer.

Results

Estimation Results

The main features of the discrete-choice model are the attributes of the product, and the interaction between these attributes with the consumers' characteristics. I will start with the three most important attributes: price, fuel consumption and the home dummy. The home dummy was found to be very important in Goldberg (1995) so I decided to include it. I am then adding the first two attributes interacted with nominal GDP per capita in common currency and environmental sentiment respectively. The price, income and fuel consumption are used in their logarithmic form. The resulting basic specification looks as follows:

$$\log(s_{imt}) = \delta_1 * \log(price_{imt}) + \delta_2 * \log(fuel\ consumption_i) + \gamma_{11} * \log(GDP/cap_{mt})$$
$$* \log(price_{imt}) + \gamma_{22} * IES_{mt} * \log(fuel\ consumtion_1) + \theta$$
$$* home\ dummy + \alpha_{mt} + \xi_i + \varepsilon_{mit}$$

The data is structured into a two dimensional unbalanced panel. The first dimension is the model car. Fixed effects along this dimension will control for the unobserved attributes of the car that do not vary over time, such as design or style. The second dimension is market combined with time. Market/Time Fixed effects will capture macroeconomic shocks that affect the decision to purchase a car, such as a recession or inflation. Both fixed effects are applied using dummy variables. ε_{mit} captures the remaining unobserved factors affecting the demand that vary across markets, models and time. I use White Cross-Section robust standard errors. The results of this basic specification are displayed in the first column of Table A3 from the Appendix.

All the coefficients in the basic specification are significant. The price elasticity and the coefficient of the log of fuel consumption are negative, as expected. The coefficient of the interaction term is negative implying that an increase in income increases the price elasticity.

If the price increases with 1%, the share is expected to drop by 1.3+log(GDP/capita)*0.03 percent. It predicts that the market share of a car model will be lower in markets with higher GDP per capita. Since we are not talking about some particular model or car type at this stage, this result implies that generally in countries with higher GDP per capita there are more car models on the market. Each model thus has a smaller share compared to models sold in countries with lower average income.

Furthermore, the interaction term between the environmental sentiment index and the log of fuel consumption is negative and significant at 10% significance level. A higher environmental awareness increases the sensitivity of consumers to the fuel consumption characteristic of the car. Holding all the factors constant, in a neutral market with an IES equal to 0, the share of a car model will decrease with 1.11% if the fuel consumption increases with 1%. If the sentiment is for example 0.5, the market share will decrease by 1.44%.

It would be interesting to see how receptive people are to changes in car fuel efficiency and how much they are willing to pay for a reduction in fuel consumption. Assuming that the consumers are keeping their utility constant, we get the following expression for:

$$\log(s_{imt}) = \alpha + (\delta_1 + \gamma_{11} * \log(GDP/cap_{mt})) * \log(price_i) + (\delta_2 + \gamma_{22} * IES_{mt}) * \log(fuel\ consumption_i) = constant$$

$$\frac{\log(price_i)}{-\log(fuel\ consumption_i)} = \frac{\delta_2 + \gamma_{22} * IES_{mt}}{\delta_1 + \gamma_{11} * \log(GDP/cap_{mt})}$$

The willingness to pay is thus described as the a percent of price a consumer is willing to pay for 1% percent decrease in fuel consumption to keep his/her utility unchanged. This measure is a function of both income and environmental sentiment:

$$Willingness\ to\ Pay = \frac{\delta_2}{\delta_1 + \gamma_{11} * \log(GDP/cap_{mt})} + \frac{\gamma_{22}}{\delta_1 + \gamma_{11} * \log(GDP/cap_{mt})} * IES_{mt}$$

Table 4 Willingness to Pay by Market

Market	IES	Willingness to pay
Belgium	0.0629	0.7524
France	0.2640	0.8538
Germany	0.2654	0.8625
Italy	0.2456	0.8060
UK	0.3406	0.9082

Belgium, for example, has an average environmental attitude of 0.063 and an average GDP per capita of 10788.5 Euros. In this market, an average consumer will be willing to pay 0.75% above the initial price if the fuel consumption is reduced by 1%, holding other attributes constant. The same estimates are computed for each market separately and presented in Table 4. From this table we can see that the estimates are very close in values. Furthermore, the willingness-to-pay estimates are consistent with the average environmental sentiment levels in each country. The UK consumers, for example, are the ones valuing fuel consumption the most, and their environmental sentiment is on average the highest.

Given the rich dataset, I will try to use more attributes to control for the model specific characteristics. A larger number of attributes will be able to capture more variation and thus reveal some new information. If I do not use the model fixed effects, the explanatory power is 0.46. Since the attributes also vary across time and markets, I can apply the model fixed effects to control for the unobserved characteristics. The Model FE was also found significant by the redundant FE test. The results are presented in the fifth column of Table A3.

None of the coefficients, except for the log of fuel consumption has changed significantly. The effect of fuel consumption has decreased from -1.11 to -0.8. The change in the value of the coefficient is a result of multicollinearity of the attributes included in the regression. The attributes, even though contributing to the explanation of the dependent variable, provide overlapping information. Multicollinearity is especially severe within

groups of attributes (dimensions, engine power and performance) with the correlation coefficient ranging from 0.7 to 0.93. Fuel consumption is correlated with cylindrical volume and horsepower (0.74 and 0.7), maximum speed with acceleration (-0.78), and all the physical dimensions are correlated with each other (0.89 on average). The interaction term of fuel consumption and IES has a positive value but is insignificant in this specification.

The change in the values of attributes of the same model over time and across markets is usually a result of some minor technical or design improvements, therefore the variation is low. This makes the coefficients less reliable, so I prefer to use fixed effects without the explicit inclusion of attributes.

To further observe what affects people's choice of a model, I turn back to the basic specification. It may be that people with environmental consciousness are concerned not with fuel consumption but cylindrical volume, which can be thought as more related to the level of pollution. Since the environmental taxes on cars are based on cylindrical volume rather than fuel consumption, this is a reasonable assumption. I replace fuel consumption with cylindrical volume, and then with horsepower. The results are presented in columns 2 and 4 of Table A3. The explanatory power did not improve, and the coefficients of all the variables are stayed unchanged.

Another approximation for the car attributes is the class. There are five classes of cars in the available dataset: subcompact, compact, intermediate, executive and luxury. While this classification may be subjective it is generally correlated with all the car characteristics. For example, the correlation between car class and fuel consumption is 0.5, and between car class and width is 0.78. I will first augment the basic specification with class dummies. In this case I will not use model fixed effects, because the class does not vary within model group.

The explanatory power of this specification is very low compared to the previous models, because the class captures very little information. Fuel consumption has a large

effect on the market share, because in a specification with no model fixed effects, it captures the effects of all the excluded car attributes. The interaction terms are insignificant, and so the model does not capture any differences in behavior for different levels of income and environmental sentiment.

The class dummies gets only the class fixed effects. However, we may reasonably assume that each class of cars targets different types of consumers. Apart from different levels of income, the targeted consumers may have different preferences towards cars. I will separate the sample based on the classes of cars to allow different behavior within these subcategories.

Table A4 from the Appendix provides the estimates for five classes of cars. The obtained coefficients are conditional on consumer's decision to buy a certain type of car. In this way, if the consumer decides to buy a compact car, his behavior will be described by the estimates in the first column of table A4.

This specification has both model specific and time/market fixed effects. The coefficients for the log of price and the log of fuel consumption are negative and significant at 1% significance level. The exception is the coefficient for log of fuel consumption for intermediate cars, which is positive but not significant. Furthermore, the interaction term between log of income and log of price is negative for subcompact and compact cars, but positive for the rest of the classes. The buyers of subcompact and compact cars hence become more sensitive to price as their income increases, while the buyers of intermediate, executive and luxury cars become less sensitive to price changes. This results contradict the conclusion of Brenkers and Verboven (2006) that consumers perceive cars in the cheaper categories (subcompact and compact) as more homogeneous, and hence are more sensitive to prices.

The evidence on the effect of environmental sentiment on the coefficient for log of fuel consumption is mixed. The environmental sentiment increases the sensitivity to fuel

consumption level for subcompact and intermediate cars with 2.5 p.p.. On the other hand, the sensitivity decreases as the sentiment goes up for compact and executive cars. These contradictory findings may be a result of poor data on environmental sentiment. As I explained earlier in the Data Description Section, this variable suffers from several caveats, and mainly that it is self-declared and may not reflect the reality.

Table 5 provides the estimates for the willingness to pay of buyers from each category for 1% reduction in fuel consumption. The estimates are computed on the basis of sentiment and GDP per capita averages over time and market for each class. Hence, the estimates describe the behavior of an average buyer of a particular class of cars. The buyers of subcompact cars are willing to give up 0.87% of the initial price in return for a 1% fuel consumption reduction. The same estimate for compact, subcompact and executive cars are 0.74%, 0.12% and 0.25%. The lowest estimate is for luxury cars buyers, who are willing to pay only 0.09% for the same reduction in fuel consumption. According to these estimates, the subcompact and compact cars consumers are more concerned with fuel consumption relative to others. The question how much it is due to budget constraints and how much it is due to environmental sentiment. Column (a) of the table displays the first part of the Willingness to Pay computed in the first part of this section $\frac{\delta_2}{\delta_1+\gamma_{11}*\log(GDP/cap_{mt})}$, and it describes how much are consumers willing to pay when there attitude towards environment is *zero*; column (b) shows the coefficient of IES $\frac{\gamma_{22}}{\delta_1+\gamma_{11}*\log(GDP/cap_{mt})}$, which describes the effect of the

Table 5 Willingness to Pay by Class

Class	(a)	(b)	IES	Willingness to Pay
Subcompact	0.5929	1.1402	0.2404	0.8670
Compact	1.0785	-1.4197	0.2356	0.7441
Intermediate	-0.0558	0.8698	0.2109	0.1277
Executive	0.4482	-0.7775	0.2494	0.2543
Luxury	0.3879	-1.6566	0.1812	0.0877

environmental attitude. For example for subcompact cars, in case of a neutral sentiment towards environment, consumers are willing to pay 0.59% of the price in return for a 1% reduction of fuel consumption. The environmental sentiment brings the amount they are willing to pay to 0.87%. According to these estimates, the environmental sentiment increases the price buyers are willing to pay for fuel consumption reduction only in case of subcompact and compact cars. For other classes buyers are willing to pay less for fuel consumption reduction when the environmental sentiment increases.

Discussion

The focus of this study is to determine the effect of environmental attitude on car sales. The proposed model is based on a discrete-choice utility, with product attributes and consumer tastes as explanatory variables. I started with a basic specification and went on to estimating the coefficients separately for each class. Before discussing the coefficient of environmental attitude, it is useful to look at the whole model, and how well it describes a person's buying behavior.

The estimated price elasticities are negative and significant. They are comparable to the elasticities found by Goldberg (1995) between -1 and -10.13, but are much lower than the estimates from Brenkers and Verboven (2006) that use the same data. The estimates in the study of Brenkers and Verboven (2006) vary from -10.9 to -4.5, from subcompact to luxury. The different results are due to different estimation methods and especially because of endogeneity of prices that bias the coefficients downwards. Brenkers and Verboven (2006) use competitor's characteristics as instrumental variables for prices. Berry (1995) applies the mean utility method for the same reason. In this paper I attempted to use the average price index of exporter country as an instrumental variable for prices. The PPI of the exporter country affects the prices but does not affect the demand for cars directly. The correlation between PPI and price was only 0.05, not allowing for a robust estimation.

The bad estimates of price elasticities may not have affected the coefficients of other variables, but it definitely affected the estimates of Willingness to Pay. A downward bias in price elasticity will overestimate the price a person is willing to pay for lower level of fuel consumption. The resulting estimates are not reliable. Instead we should look directly at the coefficients of fuel consumption and the interaction between fuel consumption and environmental sentiment. The coefficients for fuel consumption are negative and significant. For the whole sample, the coefficient was estimated at -0.8 and -1.11, depending on specification. The environmental sentiment was found to have very weak effect on the demand in the basic specification, and insignificant effect in the others. This result is in line with the weak correlations between environmental attitude and behavior of previous studies. On the other hand, when breaking down the sample, the effect of environment on sensitivity to fuel consumption is negative for compact and intermediate cars and positive for subcompact and executive cars. For luxury cars the coefficient on the interaction term is insignificant. The mixed results with regard to the environmental attitude are a result of the poor data on environmental attitude. First, the attitude is self-declared, and may be affected by the social desirability. Second, surveys are conducted once in several years, so it is hard to find continuous data on environmental attitudes. By generating the variables for the periods between the surveys, I assumed constant change, which may not correspond to reality. The period between surveys is approximately 9-10 years. Even though the trends in attitudes change slowly and not often, they *do* more than once in 9-10 years. In particular, the trend shifts occur after certain events such as oils spill incidents or celebration of the 20th Earth Day (Dunlap & Scarce, 1991).

Finally, the data is structured into an unbalanced panel, so that the car models with zero shares are excluded. It may be that the absence of this car models is not only due to cross-border trade obstacles, but also due to some endogenous reasons. In this case, the *zeros*

would provide additional information on consumers' car model choice. The logarithmic form of the model used in this paper did not allow including the *zeros,* but it is important to note that if a car models is excluded from markets due to consumers' choice, all the effect of the explanatory variables is overestimated.

Conclusion

In this paper I investigate whether the environmental attitude affects the consumers buying decision in the European car market. The paper sets a different approach to studying the link between attitudes and behavior through the discrete-choice utility model. In this framework, the attitudes are viewed as determinants of tastes, rather than determinants of behavior itself. I looked at five European countries between the years 1970 and 1999.

The evidence on the link between the environmental attitude and consumer behavior is mixed. I do not find reliable estimates for how much people a willing to pay above the price for a reduction in fuel consumption due to endogeneity bias in prices prices. On the other hand, I found the effect of environmental awareness to be insignificantly different from zero for the complete sample.

Because the results are not clear, I restrain form making any recommendations. Using better estimates of the environmental attitude, and preferably consumer level data, are improvements to this model that could yield more reliable results in future research on the topic. Additionally, considering largest events in the sphere of environmental protection would account for break points in attitude trends.

Appendix

Table A1 Description of Variables

Code	Variable	Unit of measurement
ye	year	1st dimension
ma	market	2nd dimension
co	model code	3rd dimension
org	origin code (demand side)	country with which consumers associate model
cla	class	
home	domestic car dummy	appropriate interaction of org and ma
qu	sales	number of new car registrations
cy	cylinder volume or displacement	in cc
hp	horsepower	in kw
we	weight	in kg
le	length	in cm
wi	width	in cm
he	height	in cm
li	fuel consumption	avg used in papers
sp	maximum speed	km/hour
ac	acceleration time	in seconds from 0 to 100 km/h, some from 0 to 96 km/h
pr	price final (incl. VAT)	in domestic currency
eurpr	price in common currency	in SDR times 1.2956 to interpret in Euros
tax	percentage VAT	
pop	population	
ngdp	nominal gross domestic product of destination country	destination currency
rgdp	real gross domestic product	
engdp	ngdp/avdexr: nominal gdp in common currency (SDR)	
sent	sentiment towards environmnet	

Source: Cars Data Set: Frank Verboven Personal Page (URL:http://www.econ.kuleuven.be/public/ndbad83/frank/cars.htm)
Note: The table is not complete and includes only variables used in the estimations

Table A2 The World Values Survey Data on Environmental Protection Awareness

		Belgium	France	Germany	Italy	UK
1981	Strongly agree		0.171			
	Agree		0.442			
	Disagree		0.244			
	Strongly disagree		0.142			
1990	Strongly agree	0.153	0.173	0.114	0.162	0.148
	Agree	0.412	0.445	0.446	0.513	0.527
	Disagree	0.282	0.241	0.325	0.253	0.257
	Strongly disagree	0.153	0.139	0.115	0.072	0.067
1999	Strongly agree	0.165	0.135	0.046	0.108	0.079
	Agree	0.415	0.327	0.274	0.54	0.409
	Disagree	0.233	0.261	0.298	0.28	0.388
	Strongly disagree	0.187	0.277	0.382	0.072	0.123
2005	Strongly agree			0.058	0.095	
	Agree			0.314	0.519	
	Disagree			0.332	0.299	
	Strongly disagree			0.295	0.087	

Source: WorldValuesSurvey.org
Note: The numbers represent the percentage of persons from the total of surveyed individuals that responded to the statement: 'I am willing to give up a part of my income for the environment protection' with the possible answers being Strongly Agree, Agree, Disagree and Strongly Disagree

Table A3 Estimation Results

Dependent Variable: Log(share of sales)										
	(1)		**(2)**		**(3)**		**(4)**		**(5)**	
Variable	Coefficient	Prob.	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.
Log(price)	-1.3499	*0.0000*	-1.1627	*0.0000*	-1.2937	*0.0000*	-1.4138	*0.0000*	-0.5916	*0.0028*
Log(fuel consumption)	-1.1117	*0.0000*					-0.8091	*0.0000*	-2.1219	*0.0000*
Log(cylindrical volume)			-0.9305	*0.0000*			-0.9030	*0.0000*		
Log(horsepower)					-0.3486	*0.0068*	-0.8440	*0.0000*		
Log(maximum speed)							5.6204	*0.0000*		
Log(acceleration)							1.4007	*0.0000*		
Log(weight)							8.4854	*0.0000*		
Log(length)							-0.4395	*0.6490*		
Log(width)							1.1275	*0.0001*		
Log(height)							3.5588	*0.0032*		
Home dummy	1.8240	*0.0000*	1.8140	*0.0000*	1.8191	*0.0000*	1.8043	*0.0000*	1.9401	*0.0000*
Log(GDP/capita)*log(price)	-0.0321	*0.0029*	-0.0359	*0.0007*	-0.0318	*0.0040*	-0.0289	*0.0060*	-0.3807	*0.3804*
IES*log(fuel consumption)	-0.6659	*0.0597*	-0.3561	*0.1550*	-0.2554	*0.1514*	-0.5816	*0.1711*	-0.0130	*0.2826*
Compact class dummy									0.7035	*0.0000*
Intermediate class dummy									0.6717	*0.0000*
Executive class dummy									0.5057	*0.0000*
Luxury class dummy									0.8622	*0.0000*
C	12.7532	*0.0000*	16.1214	*0.0000*	11.2405	*0.0000*	-75.9852	*0.0000*	5.1752	*0.0000*
R-squared	0.7329		0.7317		0.7301		0.7581		0.3475	
N	9442		9442		9442		7922		9442	

Note: Car Model and Time/Market FE, White Cross-Section Standard Errors

Table A4 Basic Specification by Class

Dependent Variable: LOG(share of sales)										
	Subcompact		Compact		Intermediate		Executive		Luxury	
Variable	Coef.	Prob.	Coef.	Prob.	Coef.	Prob.	Coef.	Prob.	Coef.	Prob.
Log(price)	-2.0905	*0.0035*	-1.6868	*0.0156*	-4.3200	*0.0000*	-3.7269	*0.0000*	-2.7269	*0.0007*
Log(fuel consumption)	-1.3419	*0.0001*	-2.0402	*0.0000*	0.1594	*0.5941*	-1.3831	*0.0000*	-0.6850	*0.2598*
Home dummy	1.6831	*0.0000*	1.7453	*0.0000*	1.9338	*0.0000*	1.8576	*0.0000*	1.8055	*0.0000*
Log(GDP/capita)*log(price)	-0.0265	*0.6094*	-0.0317	*0.5829*	0.2243	*0.0000*	0.0997	*0.0279*	0.1459	*0.0122*
IES*log(fuel consumption)	-2.5806	*0.0056*	2.6856	*0.0022*	-2.4866	*0.0047*	2.3993	*0.0249*	2.9254	*0.1114*
C	18.9348	*0.0000*	16.5286	*0.0000*	9.8039	*0.0003*	19.7954	*0.0000*	3.6908	*0.2556*
R-squared	0.7148		0.7141		0.7461		0.7608		0.8641	
	2558		2195		2151		1728		810	

Note: Time/Market FE, White Cross-Section Standard Errors

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