Will consumers use biodiesel? Assessing the potential for reducing CO2 emissions from private transport in Spain

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Abstract. This paper analyzes the intention to use (pure) biodiesel under different scenarios. A model of the intention to use biodiesel has been developed based on the Theory of Planned Behavior (TPB) and estimated using data from a survey conducted in Spain in 2010. Results show that the intention to use biodiesel depends on the price and availability of the biodiesel in the market. Even when biodiesel would be available in the market at the same price and widely spread through the current fuelling network less than 50% of all motorists would purchase biodiesel. These percentages diminish when consumers are required to pay higher prices or change behavior.

Keywords: Intention to use, ordered probit, biofuels, consumer behaviour, theory of planned behaviour

1. INTRODUCTION

Reducing greenhouse gas (GHG) emissions, particularly carbon dioxide, has become a key policy objective to mitigate climate change. Then, EU Directive on the promotion of the use of energy from renewable sources (EC, 2009) agreed to establish mandatory targets for an overall 20% share of renewable energy and 10% share of renewable (primary biofuels) in transport in the European Union's consumption in 2020. The Commission has increased the reduction in emissions to 40% by 2030, however the Commission does not think it appropriate to establish new targets for renewable energy or the greenhouse gas intensity of fuels used in the transport sector or any other sub-sector after 2020 (EC, 2014). Moreover, the use of biofuels is an immediately available alternative because biofuels do not require swift changes in the car fleet, as they can be used blended (bioethanol) or unblended (biodiesel) (Loureiro *et al*., 2013)).

However, besides the widely accepted benefits of using biofuels instead of conventional fuels, the use of biofuels in transport in Europe seems to have reach a ceiling, and consumption has only slightly increased in the last three years accounting for 14.4 billion tonnes of oil equivalent (toe) in 2012 (EurObserv'ER, 2013). Behind this stagnation of consumption lie two main drivers (EurObserv`ER, 2013), the economic crisis and the uncertainty surrounding forthcoming EU regulation. In the fuels market, the public acceptance of biofuels becomes an important issue to explore the future potential of biofuel consumption in Europe. However, to date, a low number of empirical studies look into the public acceptance of biofuels. Most of them have specifically assess consumers' WTP for biofuels used in transportation (Giraldo et al., 2010; Solomon and Johnson, 2009; Petrolia et al., 2010; Savvanidou et al., 2010; Loureiro et al., 2013; Khachatryan et al., 2013). These papers found a positive although small willingness to pay for biofuels over fossil fuels and detected a very limited consumer knowledge regarding biofuels. Other group of papers address specifically consumers' acceptability of biofuels by assessing perceptions and attitudes towards them (Ulmer et al., 2004; Van de Velde et al., 2009; Zhang et al., 2011; Mariasiu 2013). Findings from these papers indicated that consumers perceived that biofuels are better for the environment, the regional economy and reduce oil dependency. Moreover, results suggested that the main obstacles for the use of biofuels are price and availability, the most important characteristics that consumers take into account when choosing transport fuels. However, so far no study has analysed the use of biofuels and the factors behind their adoption to inform their development and marketing.

In particular, this study focuses on biodiesel, a biofuel for which the EU is the world's largest producer and represents, on volume basis, about 70 percent of the total biofuels market in the transport sector (USDA, 2012). This is partly due to the high level of dieselification of the European car fleet and the fact that it can be used directly unblended in current car engines without modification and can be sold using current fuelling infrastructures. As far as Spain is concerned, the country has experienced a remarkable increase of GHG transport emissions caused by both an increase in road infrastructure and car fleet (Loureiro et al, 2013). Spain is the world´s third biodiesel producing and consuming country (USDA, 2012) with biodiesel consumption accounting for 1,719 ktoe (EurObserv'ER, 2013). However, according to CORES (Spanish Corporation of Strategic Reserves of Oil-based Products) data, nearly all biodiesel is placed in the market in the form of blends. B100 only represents about one percent of total biodiesel consumption. Only about 400 petrol stations sell labelled and pure biodiesel, while in the remaining petrol stations biodiesel is being marketed only as not labelled blends (USDA, 2011). In this sense, Spain has a great challenge in the coming years to expand the use of pure biodiesel (called biodiesel since now) to increase the biodiesel consumption and meet its renewable energy in transport targets. For this to happen a key piece of information missing is the knowledge on public acceptability of biodiesel and, in particular, the intention to use biodiesel and the factors explaining this intention. This is precisely the aim of the paper.

To achieve this goal, a model of the intention to use biodiesel has been developed based on the Theory of Planned Behavior (TPB) proposed by Ajzen (1991). This model is used to study the intention to use biodiesel under three different scenarios: no change in price or behavior, change in price and change in behavior. These scenarios have been selected taking into account that previous empirical papers stated that fuel price and availability are the most important fuel characteristics for users. Under current oil price levels, production costs of biofuels are higher than fossil fuels one and biodiesel should be marketed at higher prices than the conventional diesel be competitive for industry. Moreover, biodiesel is still sold in a small number of fuelling stations which may cause consumers loss of convenience as they should move to other fuelling station different from the one they usually go. Thus, the first scenario considers consumers find biodiesel at the same price than the conventional and in all fuelling stations. In the second scenario, biodiesel is sold at a higher price than the conventional diesel but it is available in all fuelling stations. This scenario will allow analysing the impact of an extra price in the use of biodiesel. Finally, in the third scenario, biodiesel is sold at the same price than the conventional diesel but it is only available in few fuelling stations which allow studying the influence of the consumers' convenience in the acceptability of biodiesel. Based on this model, , an ordered probit model is specified and estimated using data from a survey conducted in SpainFrom the analysis we are capable of identifying factors related to the intention to use biodiesel, a topic not yet dealt with in the literature, and also to expand the analysis to three different biodiesel scenarios. This will allow providing policy recommendations as how to facilitate reaching the 10% renewable energy in transport target.

2. THEORETICAL FRAMEWORK

The study of intentions to use a product needs a different approach than the one used to analyse actual consumption. Intention and actual consumption are two different phenomenon and the factors explaining them are also different. While economic theory is well suited to explain final consumption of one product, social psychology is normally used to explain intentions. This is because actual consumption is likely to be explained by economic (price, income, etc.) and

contextual factors (availability, regulation) while intentions are likely to be related to personal attitudes, norms and other subjective variables. Then, as we are interested in the potential use of the product, we develop a theoretical framework using insights from social psychology models. Among the social psychology models, the theory of planned behaviour (TPB) by Ajzen (1991) is a widely used theoretical model for explaining intentions. According to the TPB, the intention to perform a behavior is the best predictor of the behavior. Behavioral intentions are an indication of the extent to which people are willing to try to perform a particular behavior. In turn, intentions are assumed to be determined by attitudes, subjective norms, and perceived behavioral control. This model has been widely used in several empirical studies on energy-related behaviors, such as renewable energy uses (Abrahamse and Steg, 2011; Shah and Rashid, 2012; Halder et al., 2013; Park and Ohm, 2014), automobile use (Bamberg and Schmidt, 2003) and energy conservation (Harland et al., 1999), among others. The TPB assumes that people make planned, rational decisions, typically motivated by self-interest (Abrahamse and Steg, 2011).

Several extensions of the TPB model have been proposed to improve its capacity to explain intentions, these extensions have been mostly product-specific. First, some authors extended the TPB model by introducing consumer self-identity to account for predispositions that are expected to have an important influence on intention (Conner and Armitage, 1998). The introduction of self-identity in the prediction of intention has been successfully tested for recycling (Mannetti et al., 2004), organic food (Cook et al., 2002) and animal welfare meat products (Gracia, 2013), among others. As we believe that predisposition to environmental conservation can have a role in explaining intentions for biodiesel, the model proposed includes consumers' ecological consciousness. Second, when trying to explain intentions related to novel products , research shows that the knowledge about the product is an important aspect explaining intention because knowledge represents the only instrument that consumers have to differentiate the attributes of new products (Gracia and de Magistris, 2007; Halder et al., 2013). Again, despite biodiesel having been in the market for quite some time, we believe that consumers are not fully aware of its differentiating characteristics and thus include knowledge regarding biodiesel into the final mode. Last, socio-demographic variables were also included in the explanation of the intention to use biodiesel. Figure 1summarises the basic structure of the model proposed.

Previous research based on the Lancaster model for consumer preferences, has identified factors limiting the expansion of biofuel consumption concluding that price and convenience or availability in the market are the most important (Khachatryan et al. 2013). To take into account these two products characteristics into our theoretical framework, three models of intention to use biodiesel are defined. The first one studies the intention to use biodiesel if sold at the same price than the conventional diesel and it is available in all fuelling stations. The second model analyses the intention to use biodiesel if sold at a higher price but available in all fuelling stations. Last model studies the intention to use biodiesel if only available in some fuelling stations but sold at the same price than the conventional diesel.

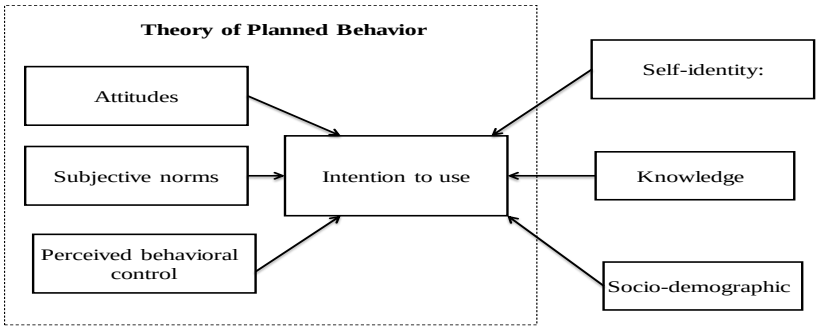

Figure 1. Model of intention to use biodiesel

2. METHODOLOGY

3.1 Data collection: population and sample

Data was collected from a survey conducted in Zaragoza, during September 2010 and the interviews were carried out face-to-face throughout the town and its suburbs.

Target respondents were adults who own or use a motor engine vehicle in a medium-sized town located in northwest Spain (Zaragoza). This town was selected to be representative of Spain because their socio-demographics are similar to the Spanish Census of Population. A stratified random sample of consumers was made on the basis of district and age. Sample size was set at 400, resulting in a sampling error of ±5%, and a confidence level of 95.5% when estimating proportions (p=q=0.5; k=2).

3.2 Questionnaire design and variable definition

The questionnaire used was developed based on a previous pilot study (Giraldo et al., 2010) and contained several questions related to fuel purchase habits (where and why), knowledge about biodiesel, attitudes towards biodiesel, biodiesel consumption (actual use of biodiesel, place of purchase, etc.) and intention to use biodiesel. The questionnaire also contained questions on socio-demographic characteristics.

The intention to use biodiesel was measured asking respondents three questions. First, whether they intended to use it if sold at the same prices than the conventional and available in the same fuelling stations in a scale from 1 (definitely not) and 5 (definitely yes) (Table 1). The second question was whether they intended to use if sold at a higher price than the conventional but it is available in the same fuelling stations, using the same scale. Finally, the third question asked participants whether they intend to use biodiesel if sold at the same prices than the conventional but available in fewer fuelling stations using the same scale. Table 1 shows that most of respondents (76.5%) stated that they would probably and definitely use biodiesel if sold at the same price than the conventional l and available in the same fuelling stations. However, only 39.5% of respondents would use biodiesel if they had to pay a higher price than for the conventional diesel. This result indicates that price could be a limiting factor in the expansion of biodiesel. Finally, 61.2% of respondents stated that they would definitely or probably use

biodiesel if they had to go to another fuelling station because it would not be available in their usual one.

In order to measure knowledge on biodiesel an "objective knowledge" question as an alternative to self-reported knowledge measures which can suffer from bias was used. Respondents were asked to indicate if three statements related to biodiesel were true or false[1]. Respondents providing correct responses to the three questions were considered to have an objective knowledge about biodiesel. Then, individuals who gave correct answers to all three questions were given a KNOWLEDGE value of one and the rest of participants were given a value of zero. Using this definition, less than 20% of respondents are classified as having knowledge about biodiesel (Table 2).

Table 1. Extended Theory of Planned Behavior model: Endogenous variables definition

Variables	Name	Value
Intention to use biodiesel if sold at the same price than conventional and available in the same fuelling station.		
Definitely not		3.0%
Probably not		5.3%
Indifferent	IU1	15.2%
Probably yes		30.3%
Definitely yes		46.2%
Intention to use biodiesel if sold at a higher price than the conventional but available in the same fuelling station.		
Definitely not		19.7%
Probably not		18.3%
Indifferent	IU2	22.5%
Probably yes		19.5%
Definitely yes		20.0%
Intention to use biodiesel if sold at the same price than conventional but not available in the same fuelling station.		
Definitely not		8.8%
Probably not		11.5%
Indifferent	IU3	18.5%
Probably yes		31.0%
Definitely yes		30.2%

The self-identity construct used in the paper is the respondents' ecological consciousness measured by membership of environmental association. Interviewees were asked whether they were members of an environmental association. If so, it is assumed that they would predispose to use a more environmental friendly diesel. Table 2 shows that only 10% of respondents were members of an environmental association.

[1] The statements were: biodiesel is produced from vegetable or animal oils; biodiesel is a renewable energy; and biodiesel can be used in any diesel engine without specific modifications. All three statements are true.

As knowledge on biodiesel was limited, in order for interviewees to provide meaningful answers to the questions on attitudes, subjective norms and intentions, prior to these questions a brief text with neutral information on biodiesel was read to them. The definition of the scales related to these aspects was done based on previous empirical papers. Respondents were asked to indicate their agreement or disagreement with the statements provided using a five point Likert scale where one indicates strong disagreement and five, strong agreement. The scale items for the different aspects are shown in table 2.

Table 2. Extended Theory of Planned Behavior model: Exogenous variables definition

Variable definition	Name	Value
Knowledge		
Dummy 1=correct answer to the three statements; 0=otherwise	KNOWLEDGE	19.2%
Self-identity: Membership of an environmental association *Dummy 1=yes; 0=otherwise*	*SELF-IDENTITY*	10.0%
Attitudes towards biodiesel		
Biodiesel can be produced from raw material from my region	REGIONAL	4.1 (0.67)
Biodiesel may increase the price of food products	FOOD	3.4 (1.03)
Biodiesel may diminish import oil dependence	DEPENDENCE	4.0 (0.77)
Biodiesel is a renewable fuel	RENEWABLE	3.6 (0.99)
The use of biodiesel may diminish the climate change	CLIMATE	3.9 (0.82)
Biodiesel may help the increase of farmer' incomes	FARMERS	4.0 (0.84)
The use of biodiesel decreases the greenhouse gas emissions	GHGEMISSIONS	4.0 (0.81)
Attitudes towards using biodiesel		
I believe that using biodiesel is good	GOOD	3.8 (0.70)
Subjective norm		
People close to me think that I should use biodiesel	SNORM	3.0 (0.87)
Perceived behavioral control		
Whether I will eventually use biodiesel is entirely up to me	CONTROL	3.4 (1.08)
If biodiesel was available all fuelling stations, I do not think I would ever be able to use	ABILITY	3.0 (1.00)

Finally, some questions on socio-demographic characteristics were included. Summary statistics for the characteristics of the sample are presented in table 3. About half of respondents were male (51%) with an average age of 44 years and living in households with three members. Around 30% of respondents stated that their household monthly net income was between € 1,500 and € 2,500 and between € 2,500 and €3,500. More than half of participants had university studies.

Before the final questionnaire was administrated, a pilot survey was undertaken to a small sample of respondents (N=20) to check for understanding and interview length.

Table 3. Sample characteristics (%, unless stated) and exogenous variables definition.

Variable definition	*Name (type)*	*Value*
Gender		
Male	FEMALE (dummy: 1=female)	51.2
Female		48.8
Age (Average from total sample)	AGE (continuous)	44.0
Education of respondent		
Primary School	UNIVERSITY (dummy:	12.2
Secondary School	1=university)	30.0
University or higher		57.8
Average monthly household income		
Less than 1,500 €		13.8
Between 1,501 and 2,500 €	HIGH_INCOME (dummy:	31.2
Between 2,501 and 3,500 €	1=higher than 3,500 €)	29.5
Between 3,501 and 4,500 €		14.0
More than 4,500 €		11.5
Household Size (Average from total sample)	HSIZE (continuous)	3.2

3.3 Statistical analysis

The three endogenous variables of the intention to use biodiesel model (Figure 1) are discrete variables with five ordered levels. To explain these variables the following ordered probit model was specified:

$$IU_i^* = \beta X_i + u_i \qquad (1)$$

where, X_i is a vector of all exogenous variables (attitudes beliefs towards the product, use attitudes, subjective norms, perceived behavioral control, knowledge, self-identity and consumers' socio-demographic characteristics), and u_i is the error term normally distributed N(0, σ_u^2). IP_i^* is unobserved. However, the intention to use stated by the individual is observed and measured by five levels (see definition in table 1), as follows:

$$\begin{aligned} IU_i &= 1 \quad if \quad IC_i^* \le \tau_1 \\ IU_i &= 2 \quad if \quad \tau_1 \le IC_i^* \le \tau_2 \\ IU_i &= 3 \quad if \quad \tau_2 \le IC_i^* \le \tau_3 \\ IU_i &= 4 \quad if \quad \tau_3 \le IC_i^* \le \tau_4 \\ IU_i &= 5 \quad if \quad \tau_4 \le IC_i^* \end{aligned} \qquad (2)$$

where τ_i are the unknown threshold parameters to be estimated. The first threshold parameter is normalized to zero ($\tau_1 = 0$). The estimated parameters for the model defined by (1) for the three different types of biodiesel were estimated using STATA 10.0.

4. RESULTS

First, we estimated the model with all explanatory variables defined in tables 1, 2 and 3. Those variables individually and/or jointly insignificant (at 5% significance level) were dropped one by one in the subsequent estimations until we got the final model presented in table 4. All the threshold parameters in the three models are positive and significant at the 5% level, indicating that the endogenous variables do indeed suggest an ordered sequence.

Only two socio-demographic variables in the intention to use biodiesel if it sold at the same price than conventional diesel and it is available in all fuelling stations are significant, gender (FEMALE) and level of education (UNIVERSITY). The positive coefficients associated with these variables indicated that female and more educated individuals were more likely to use in the future biodiesel with the same price and convenience than the conventional one. As expected, consumer knowledge and self-identity had a statistically positive significant effect on the intention to use this biodiesel. This result indicates that consumers with higher knowledge and predispositions to environmental conservation, measured as their membership in an environmental association, were more likely to definitely use this biodiesel in the future. In other words, as stated by several studies on the intention to purchase/use different products, consumer self-identity is a predictor of behavior (Shaw et al., 2000 and Shaw and Shiu, 2003). This means that consumer predispositions have an important influence on the intention to use. Moreover, knowledge regarding the product is also a predictor of the intention to use the product as stated by Halder et al. (2013) and Shah and Rashid (2012) for renewable energy.

Moreover, the intention to use biodiesel under the first scenario, as stated by the TPB, was related to attitudes towards the product and towards its purchase, subjective norms and perceived behavioral control. The positive and statistically significant estimates for the attitudes towards the products and its purchase indicated that positive attitudes increased consumers´ intention to use. In particular, the positive value for the DEPENDENCE variable indicates that the more consumers believed that biodiesel may diminish import oil dependence, the more likely they were to use them. In the same way, the more consumers believed that the use of biodiesel may help the increase of farm incomes (FARMERS) and decrease the greenhouse gas emissions (GHG), the more likely they were to use it. In addition, there was a significant relation between the intention to use biodiesel at the same price and convenience as conventional diesel and the attitudes towards its use (GOOD). This finding suggests that consumers who believed that using biofuels is good were more likely to use it. The subjective norm variable (SNORM) was positive and statistically significant indicating that social pressure felt by the consumer, as expected, had a positive influence on the intention to use biodiesel. Similar findings for renewable energy use are reported in Shah and Rashid (2012). Last, there was a negative and significant relation between the intention to use this biodiesel under this scenario and the perceived behavior control (ABILITY). Results indicated that the more consumers believed that they were less able to use the biodiesel, the less likely they are to use it.

Similar results were found for the intention to use biodiesel under scenario 2. The main difference is that the perceived behavioral control (ABILITY) is not statistically significant in this case. Moreover, related to the attitudes toward the product, while the belief that the biodiesel diminish the greenhouse gas emissions (GHG) was statistically significant for the previous estimations, it is not significant for this scenario. Moreover, the belief that biodiesel may increase the price of food products was statistically significant and negative for this biodiesel. This means

that the more consumers believed that the biodiesel may the increase the price of food, the less likely they were to use it.

Finally, results from the third scenario differs more from the two previous estimations. The first remarkable difference is that consumer knowledge is no longer statistically significant in explaining the intention to use biodiesel. Second, consumers´ belief that biodiesel might be produced from raw material from the region that was not statistically significant in the previous estimations, is statistically positive now. This means that the more consumers believe that biodiesel might be produced from raw material from the region, the more likely they were to use it changing their fuelling habits. Third, consumers' belief that biodiesel may help to increase farm incomes that were statistically significant in the previous cases, and not anymore.

Marginal effects were calculated to assess the magnitude of the exogenous variables effect on the intention to use biodiesel, which allow comparing the effect of these variables among the different types of biodiesel (Table A1 and Table A2 in the Appendix). In the case of dummy variables, the marginal effects were calculated taking the difference between the predicted probabilities in the respective variables of interest, changing from zero to one and holding the rest constant. The results show that the impact of dummy variables on biodiesel use is statistically different from zero although rather small except for the impact in the probability of having definitely intentions to use biodiesel for the three models and the effect of all the dummy variables in the intention to use biodiesel with the same price and convenience than conventional. The most important conclusion is that the impact of all these dummy variables follows a similar pattern for the three biodiesel scenarios, although the magnitude of the impact differs among types of biodiesel and exogenous variables.

In this case, and for the continuous exogenous variables, effects were calculated by means of the partial derivatives of the probabilities with respect to a given exogenous variable. The impact of the continuous exogenous variables on biodiesel use is statistically different from zero although rather small except for the attitudes toward the use (GOOD) which is the most important factor explaining the intention to use biodiesel for the three models. Then, an increase in the consumers' attitudes toward the use increases the probability of reporting higher use in the three types of biodiesel. However, the impact of these attitudes is almost double for the biodiesel with the same price and convenience than for the other two types of biodiesel.

Table 4. Estimates of the Ordered Probit Model: Intention to Use Biodiesel in Spain

Variables	IU1		IU2		IU3	
Coefficients	Estimates	t-ratio	Estimates	t-ratio	Estimates	t-ratio
Socio-demographic characteristics						
FEMALE	0.2592	2.18	0.2805	2.50	0.2319	2.09
HIGHINCOME	0.2892	2.01	0.3826	2.73	0.2441	1.89
Knowledge about biodiesel						
KNOWLEDGE	0.4709	3.08	0.4181	2.93	---	---
Self-identity: respondents' ecological consciousness						
SELF-IDENTITY	0.6803	2.96	0.7422	3.47	0.5508	2.48
Attitudes towards the biodiesel and the use						
REGIONAL	---	---	---	---	0.2886	3.18
FOOD	---	---	-0.1583	-2.65	-0.1339	-2.20
DEPENDENCE	0.2250	2.74	0.2636	3.27	0.2809	3.44
FARMERS	0.1480	1.85	0.1897	2.63	---	---
GHGEMISSIONS	0.1725	2.11	---	---	0.2310	2.74
GOOD	0.6605	5.51	0.6793	5.84	0.5677	5.46
Subjective norms						
SNORMS	0.1720	1.87	0.2314	2.79	0.2131	2.94
Perceived behavioral control						
ABILITY	-0.1512	-2.38	---	---	---	---
Threshold parameters						
μ_1	2.5610	4.39	3.7753	6.80	3.9450	6.78
μ_2	3.2117	5.61	4.5088	7.88	4.6624	8.00
μ_3	4.1270	6.81	5.3171	9.03	5.4163	9.15
μ_4	5.2500	8.26	6.1628	10.2	6.5326	10.65
N	400		400		400	
Log Likelihood	-407.14		-521.79		-488.69	

IU1: biodiesel at same price and location; IU2: biodiesel at higher price and same location; IU3: biodiesel at same price and different location.

5. CONCLUSIONS AND DISCUSSION

Results show that the intention to use biodiesel depends on price and availability in the market. If biodiesel is sold at the same price and fuelling stations than the conventional diesel, almost half of car users would definitely use biodiesel (46.2%). However, if the biodiesel is sold at a higher price but in the same fuelling stations than the conventional diesel only 20% of car users will definitely use biodiesel. Finally, the percentage of car users willing to definitely use biodiesel sold at the same price but only in few fuelling stations lies between those figures (30%). This finding indicate that the main limiting factor for using biodiesel is the price although the availability in the fuelling stations place a role in the biodiesel use.

Other important finding is that knowledge on biodiesel is still very low among car users, as less than 20% knew what biodiesel is. Moreover, this knowledge is one of the factors affecting biodiesel use and, in particular, car users who knew what biodiesel is were more likely to definitely use biodiesel. Other factors explaining the intention to use biodiesel are gender, level of

income and self-identity, measured as they enrolment in an environmental association. In particular, females with high-incomes who belong to an environmental association were more likely to definitely use biodiesel. Finally, the analysis also suggested that, as the TPB states, other factors associated with the intention to use biodiesel were attitudes beliefs, attitudes towards the purchase, subjective norms and perceived behavioral control. Consumers with positive attitudes towards biodiesel and towards their use would be more likely to definitely use it. In particular, consumers who believe that using biodiesel is good would be more likely to use it. Subjective norms positively influenced the intention to use biodiesel indicating that as the degree of social pressure felt by the consumer increases, the consumer would be more likely to use it.

Our results show that increasing biodiesel shares in total energy consumption for transport remains a big challenge. Even when biodiesel would be made available in the market at the same price and widely spread through the current retail network less than 50% of all motorists would purchase biodiesel. In such a scenario increasing knowledge and awareness would be the most suited policy option. Consumers should be reassured that biodiesel actually reduces GHG emissions and that energy dependence is reduced. Highlighting the additional business opportunities given to farmers would also increase intention to use. The same policies would also increase acceptability of biodiesel sold at higher prices. However in this scenario special attention should be given to the potential negative impacts of biofuels on food security. Last, if consumers were to modify their behavior to purchase biodiesel, special attention should be given to the origin of the biodiesel.

Last, this work poses some limitations that must be taken into account and constitute further research avenues on the topic. The main limitation of the analysis is that although intentions are good predictors of final behavior, the analysis should be also extended to analyze not only the intention to use these products but also, their final use. If intentions are only analysed, a deeper study of the effect of different dimension of social norms on intentions should be done. Finally, other limitation is that the analysis had been only conducted in Spain and results must take into account this geographical coverage. Further research extending the analysis in other European countries should be done.

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Appendix

Table A1. Marginal Effects of dummy variables on the Ordered Probit Equation

Variable	*Prob. IU=1*	*Prob. IU=2*	*Prob. IU=3*	*Prob. IU=4*	*Prob. IU=5*
FEMALE					
Biodiesel same price and convenience	-0.0036*	-0.0121**	-0.0451**	-0.0418**	0.1027**
Biodiesel higher price and same convenience	-0.0539**	-0.0457**	-0.0059	0.0496**	0.0560**
Biodiesel same price and lower convenience	-0.0159**	-0.0312**	-0.0378**	0.0131	0.0719**
HIGHINCOME					
Biodiesel same price and convenience	- 0.0034*	-0.0120**	-0.0478**	-0.0517*	0.1150**
Biodiesel higher price and same convenience	-0.0658**	-0.0636**	-0.0179	0.0628**	0.0846**
Biodiesel same price and lower convenience	-0.0150**	-0.0313*	-0.0408*	0.0085	0.0787*
KNOWLEDGE					
Biodiesel same price and convenience	-0.0047**	-0.0172**	-0.0729**	-0.0911**	0.1859**
Biodiesel higher price and same convenience	-0.0588**	-0.0697**	-0.0236	0.0662**	0.0959**
Biodiesel same price and lower convenience	---	---	---	---	---
SELF-IDENTITY					
Biodiesel same price and convenience	-0.0051**	-0.0199**	-0.0929**	-0.1443**	0.2622**
Biodiesel higher price and same convenience	- 0.0981**	-0.1197**	0.0715**	0.0896**	0.1996**
Biodiesel same price and lower convenience	-0.0254**	-0.0603**	-0.0935**	-0.0139	0.1931**

*** (**) (*) denotes statistical significance at the 1 (5) (10) per cent significance levels

Table A2. Marginal Effects of continuous variables on the Ordered Probit Equation

Variable	*Prob. IU=1*	*Prob. IU=2*	*Prob. IU=3*	*Prob IU=4*	*Prob. IU=5*
REGIONAL					
Biodiesel same price and convenience	---	---	---	---	---
Biodiesel higher price and same convenience	---	---	---	---	---
Biodiesel same price and lower convenience	-0.0198**	-0.0390**	-0.4724**	0.0166**	0.0894**
FOOD					
Biodiesel same price and convenience	---	---	---	---	---
Biodiesel higher price and same convenience	0.0305**	0.0259**	0.0032	-0.0282**	- 0.0314**
Biodiesel same price and lower convenience	0.0092**	0.0181**	0.0219**	-0.0077*	-0.0415**
DEPENDENCE					
Biodiesel same price and convenience	-0.0031*	-0.0105**	-0.0394**	-0.0364**	0.0894**
Biodiesel higher price and same convenience	-0.0508**	-0.0432**	-0.0054	0.0471**	0.0524**
Biodiesel same price and lower convenience	-0.0193**	-0.0380**	-0.0460**	0.0162**	0.0870**
FARMERS					
Biodiesel same price and convenience	-0.0020	-0.0069*	-0.0259*	-0.0239*	0.0587*
Biodiesel higher price and same convenience	-0.0365**	-0.0311**	-0.0038	0.0339**	0.0377**
Biodiesel same price and lower convenience	---	---	---	---	---
GHG					
Biodiesel same price and convenience	---	---	---	---	---
Biodiesel higher price and same convenience	---	---	---	---	---
Biodiesel same price and lower convenience	-0.0158**	-0.0312**	-0.0378**	0.0133*	0.0711**
GOOD					
Biodiesel same price and convenience	-0.0091**	-0.0308**	-0.1155**	-0.1068**	0.2622**
Biodiesel higher price and same convenience	-0.1309**	-0.1114**	-0.0139	0.1212**	0.1349**
Biodiesel same price and lower convenience	-0.0389**	-0.0767**	-0.0929**	0.0327**	0.1756**
SNORMS					
Biodiesel same price and convenience	-0.0024*	-0.0080*	-0.0300**	-0.0278**	0.0683**
Biodiesel higher price and same convenience	-0.0446**	-0.0379**	-0.0047	0.0413**	0.0459**
Biodiesel same price and lower convenience	-0.0146**	-0.0288**	-0.0349**	0.0123*	0.0660**
ABILITY					
Biodiesel same price and convenience	0.0021*	0.0070**	0.0264**	0.0244**	-0.0600**
Biodiesel higher price and same convenience	---	---	---	---	---
Biodiesel same price and lower convenience	---	---	---	---	---

*** (**) (*) denotes statistical significance at the 1 (5) (10) per cent significance levels