Energy Economics 40 (2013) S126–S133

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

# Transport and low-carbon fuel: A study of public preferences in Spain

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ARTICLE INFO

Available online 21 September 2013

*JEL classification:*
Q54
Q58
R48

*Keywords:*
Biofuels
WTP
Contingent valuation

ABSTRACT

Transport is essential for the control of future greenhouse gas (GHG) emissions and thus a target for active policy intervention in the future. Yet, social preferences for policies are likely to play an important role. In this paper we first review the existing literature on preferences regarding low-GHG car fuels, but also covering policy instruments and strategies in this area. We then present the results of a survey of Spanish households aimed at measuring preferences for climate change policies. We find a positive willingness to pay (WTP) (in the form of higher car fuel prices) for a policy to reduce GHG emissions through biofuels. There is, however, significant heterogeneity in public preferences due to personal motivations (accounted for via factor analysis of responses to attitudinal questions) and to socio-demographic variables.



## 1. Introduction

Economic development has been historically associated with an increase in personal mobility. Industrialized countries have satisfied such a growing demand for mobility through larger transport infrastructures, public transport networks and, above all, mass private motorization. Yet, given the traditional high reliance of private transport on oil products, the so-called 'energy problems' of transport are a growing concern (Proost and Van Dender, 2012). Acute energy dependence, for instance, has prompted most oil importers to introduce various regulations (e.g. taxes, speed limits, energy efficiency standards) to deal with energy security concerns and reduce the export of rents to petroleum producing countries. Another pressing issue is local pollution (e.g. volatile organic compounds, nitrogen oxides, noise), which produces significant welfare impacts mainly through health-related morbidity and mortality effects (Krzyzanowski et al., 2005).

Transport is also a major contributor to greenhouse gas (GHG) energy-related emissions, which have been identified as a cause of climate change. Indeed, in most developed countries GHG emissions from transportation are not only quite sizable (approximately 20% of total EU emissions in 2010, as reported by the EEA, 2012), but also are growing rapidly. This is due mainly to the rising demand for personal mobility, as noted above, the difficulty of switching to low-GHG technologies in this sector (when compared, for example, to switching the fuel source in electricity generation) and to the limited effectiveness of regulations. The latter is illustrated by the tendency for recent, mostly standard-related, energy-efficiency gains in cars to be partially or completely offset by the purchase of larger and more powerful automobiles (see e.g. Knittel, 2012) and by the growth in fleet size and vehicle usage.

How to deal with the problem of energy use in transportation, and particularly with its considerable GHG emissions? Public intervention should obviously play an important role, given the externalities involved. However, many options are available: pricing (e.g. fuel taxes), design standards (e.g. minimum miles-per-gallon standards), information (e.g. energy efficiency labels), promotion of public transit, subsidies to vehicles running on renewables or non-fossil fuels, etc. Despite the existence of such policy options, many countries seem to be failing to cope with the problem, given the continuing rise in vehicle usage and transportation fuel consumption (see e.g. IEA, 2012). Apart from possible failures of policy design and negative interactions among policy instruments, there seem to be social constraints on introducing stronger or more restrictive policies in this area because those would be seen as an outright attack on current lifestyles (Sandmo, 2009).

This is the general context for the paper, which focuses on the role of public preferences in explaining regulatory limits in this area. We deal with just one of the 'energy problems' of transport, namely GHG emissions, and with a policy to foster the production of low-GHG fuels by current suppliers. Although we recognize other options to mitigate GHG emissions from private transport (mostly behavioral changes and replacement of high-consuming cars for more efficient conventional units or for new technological alternatives, as briefly discussed in Section 2), our main focus is on the use of biofuels since this is currently

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http://dx.doi.org/10.1016/j.eneco.2013.09.010

the most well developed and immediately available alternative for low-carbon transport.[1] Even though there has been a hot debate on the environmental and economic effects of biofuels, a new generation of biofuels seems to be tackling some of the initial and most pressing problems of this option.[2] However, the paper is not just an empirical exercise on the Spanish WTP for biofuels as the application incorporates a wider discussion on other policy alternatives: indeed the results reported in this paper are part of a wider research program on Spanish climate change policies that focused on the promotion of low-GHG options across different sectors (Hanemann et al., 2011).

There are several factors that triggered our interest in the public preferences for low-GHG car fuels in a country like Spain. First of all, Spain is a developed country that shares most of the characteristics noted above (see European Commission, 2011): a remarkable increase in mobility and GHG transport emissions (+66% between 2010 and 1990, which represent around 25% of total emissions nowadays) caused by both a dramatic increase in road infrastructure (around 16,000 km of motorways in early 2012, only behind US and China in absolute terms), the size of the car fleet (around 0.5 cars per capita in 2009, +50% with respect to 1991), and a limited demand response to fuel price increases (see e.g. Labandeira et al., 2006). Yet there are some significant differences as well: a remarkably low taxation of car fuels (approximately 20% below European averages in 2010, as depicted in Labandeira, 2011), a huge dieselization of the fleet due to lower taxes on diesel, and the corresponding intensification of local pollution problems in Madrid and Barcelona (see e.g. Monzón and Guerrero, 2004). Moreover, Spain has adopted a rather proactive approach to the current European legislation, Directive 2009/28/EC, as it has set a renewable energy target (as percentage of final energy consumption) in the transport sector 3.6 points above the 10% binding European objective for 2020 (Cansino et al., 2012). These initiatives may lead to significant future changes in the transport sector in Spain, providing a useful context for the present study.

The following section presents an overview of the literature on public preferences regarding low-GHG transport options and policies, with an emphasis on biofuels. Section 3 describes the survey implemented with a representative sample of the Spanish public and summarizes the responses. Section 4 presents an empirical strategy for estimating the willingness to pay (WTP) for biofuels of Spanish households that accounts for latent variables related to underlying motivations; this utilizes a factor analysis of the responses to attitudinal questions in the questionnaire. Section 5 presents the results of the estimation. Some concluding remarks are presented in Section 6.

## 2. Literature: preferences for cleaner private transportation

Private transport, particularly by car, is so widespread in modern societies that policies with an impact in this area could have profound public implications. A growing strand of the academic literature on energy and transport economics has dealt with public preferences for cleaner transportation. Without presenting an exhaustive review, in this section we describe a selection of papers that have dealt with policy instruments and strategies (including mode shifts), and the specific promotion of biofuels.

With respect to social attitudes towards policy interventions, Anderson and Stradling (2004) examined the effects of doubling car fuel prices in 10 years, congestion pricing in city centers, improvements in public transport reliability and price reductions for public transit in Scotland. They find a significant heterogeneity (dependent on income, location, age, etc.) in the effects of such 'carrot and stick' policies on individual car use. Also in the UK and with a similar set of policies, Thorpe et al. (2000) analyzed the public acceptability of generic measures to manage transport, alternative transport options, and the use of public funds obtained through taxes and charges. They show that a combination of better public transit and pricing of car use in city centers is the preferred option. Dietz et al. (2007) analyzed public preferences for several GHG mitigation measures related to transport in the US indicating that a climate-related gasoline tax has little support when compared to standards on emissions per km or taxes on high-polluting automobiles. Hersch and Viscusi (2006) used a survey of European citizens to study the support for environment-related gasoline price increases, finding a limited willingness to pay for increased gasoline prices especially among older people. In a similar setting, Hsu et al. (2008) analyzed the factors that influence the unpopularity of gasoline taxes in Vancouver (Canada); limited reliance on cars, residence in a 'green' constituency, income, and environmental earmarking of revenues are all factors leading to the support for increased gasoline taxes.

There are many papers on public preferences towards biofuel promotion and use. Delshad et al. (2010) used surveys and focus groups to analyze attitudes towards different policies to promote biofuels in the US state of Indiana. Although most people are in favor of a public promotion of biofuels, there is a varying support for some specific policies (minimum quantity standards, subsidies to non-food crops, etc.) that seems largely related to justice concerns. Li et al. (2013) studied the preferences of US consumers regarding the purchase of flexible-fuel and hybrid cars, finding again a significant heterogeneity: respondents concerned about climate change and energy security are more likely to favor these types of cars. In addition, rural residents generally favor flexible-fuel automobiles, unlike those who believe that agricultural lands should just be used for food crops and thus prefer hybrid cars. Brownstone et al. (2000) used stated and revealed preference data to study the public preferences for four types of car fuels in California (gasoline, natural gas, electricity and bio-methanol), finding that natural gas and bio-methanol are generally preferred to gasoline, although people with university education favor electric cars.

A number of articles have specifically addressed consumers' WTP for biofuels used in transportation. Giraldo et al. (2010) used a survey of diesel-car drivers conducted in the city of Zaragoza to elicit perceptions and WTP for biodiesel. They showed that, although drivers have a limited knowledge of this product, there is a positive perception of biodiesel due to its lower GHG emissions and other environmental impacts, with consumers willing to pay a premium for biodiesel of up to 5% over the price of standard diesel. Savvanidou et al. (2010) conducted a survey of car users and report a similar lack of knowledge on biofuels in Greece, even though around 45% of drivers would be willing to pay a premium for biofuels (an average WTP of 0.078 Euro/l over the standard fuel). Solomon and Johnson (2009) used contingent valuation to obtain the WTP for (non-food) biomass ethanol in three US states finding that the main factors are income levels, political orientation, gender and concern about climate change. Also in the US, Petrolia et al. (2010) used contingent valuation to analyze the preferences of consumers regarding fuels with different percentages of ethanol (E-10 and E-85). In general they observe a positive perception and WTP towards these fuels, although consumers generally favor other alternatives for transport. Finally, Zhang et al. (2011) analyzed the attitudes of Chinese drivers in the area of Nanjing regarding the introduction of biofuels. As in other papers, Nanjing consumers have a limited knowledge of these fuels but generally exhibit a positive perception of their use due to the reduction in GHG emissions and energy dependence.

## 3. Survey and data

As noted above, this study is part of a wider program on public preferences regarding climate change policies in Spain that began in mid 2010 through a contingent valuation survey of a representative sample of the

[1] Biofuels (biodiesel and bioethanol) do not require swift changes in the car fleet, as they can be used mixed (even unmixed in the case of biodiesel) with diesel and gasoline in current fueling infrastructures. Actually, in many countries (e.g. in EU members) there are binding objectives for minimum shares of biofuels in available car fuels.

[2] The first generation of biofuels relied largely on food crops. The second generation is based on the use of agricultural wastes (i.e. with no effects on food production and prices), algae and other non-food crops with high capture of atmospheric GHG concentrations and significant growth rates (see e.g. Carriquiry et al., 2011).