Transport Policy 36 (2014) 1–9

Contents lists available at ScienceDirect

Transport Policy

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

Main drivers for local tax incentives to promote electric vehicles: The Spanish case

Antonio Sánchez-Braza *, José M. Cansino, Enrique Lerma

University of Seville, Department of Economic Analysis and Political Economy, Avda. Ramón y Cajal, 1, 41018 Seville, Spain

ARTICLE INFO

Available online 12 July 2014

Keywords:
Electric vehicle
Local government in Spain
Road tax
Local policies
Probit model

ABSTRACT

Cities are one of the main agents behind the introduction of electric vehicles. In Spain, cities could establish up to a 75% deduction on vehicle tax based on environmental issues. This paper analyzes those variables affecting the establishment of such a measure using the Probit model on a sample of 395 Spanish municipalities. The results show that the urban population, its dispersion, and the municipalities' environmental commitment positively affect the establishment of such incentives, while the rural nature of the population and unemployment do exactly the opposite.

1. Introduction

The 27 countries making up the European Union (EU27) heavily dependent on imported oil for mobility and transportation (European Commission, 2013). In 2011, the energy dependence was estimated at 53.84% (Eurostat, 2013). A quarter of all CO2 emissions is generates by transportation, which also worsens air quality due to the emission of particulate matter (PM10 and PM2.5), NO_x, HC and CO, as well as other related health problems, more specifically in urban areas (European Commission, 2010).

Transportation provides the physical lubrication that allows industry to grow and trade to flourish, but it also is responsible for local atmospheric pollution, noise and soil and water contamination, as well as being a major and growing contributor to greenhouse gas emissions (Button, 2009). Electric vehicles (EVs) could contribute to mitigating this excessive urban traffic pollution. Thus, this paper is addressed in the literature versing on the political economy of transportation (Button, 1993). The base cause behind the problem is that road users are essentially receiving the wrong signal from prices, regulations, and controls; consequently, they undertake excessive numbers of trips, frequently using environmentally sub-optimal modes and in inappropriately engineered vehicles (Button, 2002). This in turn produces the local pollution cocktail and other forms of environmental damage ultimately leading to ill-health, social disruption, noise, etc. In fact, environmental pollutants from transport have adverse effects on health (including cardiovascular and respiratory diseases). Human exposed to high levels of traffic noise suffer not only serious annoyance and sleep loss but it may also cause communication problems and even learning problems in children (Stead, 2008).

Within the transportation sector, there are increasing calls for better horizontal management between transportation and other sectorial policies such as health and environment (EU Joint Expert Group on Transport and the Environment, 1999; Banister et al., 2000; Stead and Banister, 2001; Geerlings and Stead, 2003; Stead et al., 2004; Stead, 2008). Sustainability requires that urban travel policy-making be viewed from a holistic standpoint so that when planning for transportation and the environment, these are no longer be undertaken as isolated matters, independently one from another (Stead, 2008). Consequently, linking transportation and environmental policies are important factors.

Recently, EVs have gained increased worldwide interest as a component of the search for alternative solutions to sustainable personal mobility (Ma et al., 2012; Zheng et al., 2012). EVs could reduce fossil fuel consumption, greenhouse gas emissions and other pollutants (Perujo and Ciuffo, 2010; Camus et al., 2011; He and Chen, 2013). Nevertheless, some authors have criticized this finding (see Sioshansi and Miller, 2011; Prud'homme and Koning, 2012).

Ewing and Sarigöllü (1998) examined those factors that are likely to influence the demand for lower and zero emission vehicles. Each of the vehicle types considered were characterized by varying vehicle costs and performance measures, range and refueling rates, as well as commuting costs and times. This allowed the authors to research how political tools could influence consumer preference. Some governments have taken measures to promote electric mobility (Hans et al., 2012; Shepherd et al., 2012). For example, the US has proposed to development an

* Corresponding author.
E-mail address: asb@us.es (A. Sánchez-Braza).

http://dx.doi.org/10.1016/j.tranpol.2014.06.010
0967-070X/

affordable plug-in EV for the average American family by 2022 as efficient and/or handy as today's gasoline-powered vehicles (US Department of Energy, 2013). The relationship of consumer financial incentives for the adoption of EVs is analyzed by Sierzchula et al. (2014). Furthermore to this political measure, fiscal instruments like command-and-control are widely used in road transport, because they are relatively cheap and simple to implement (Santos et al., 2010). The effectiveness of tax incentives for EVs has been analyzed by Hong et al. (2012) in South Korea, and Jones et al. (2013) in Vietnam. Hong et al. (2012) showed evidence that tax incentives for EVs are effective even more than a lump-sum incentive. Jones et al. (2013) provided proof that economic incentives, particularly sales tax, have significant effects on the adoption of electric motorcycles.

For EU27, an electric mobility promotional strategy has been included in the European Green Cars' Initiative, which is part of the European Economic Recovery Plan. Both initiatives note the importance of cooperation between public and private organizations. One essential element is local government, whose cities are in a position to reduce both air and noise pollution.

In the case of Spain, one of the measures that local governments could implement to promote the use of EVs is the establishment of a deduction on vehicle tax EVs, which could be up 75% of the gross tax and work as a tax credit. For Spain, this would be road tax (or IVTM, its acronym in Spanish). It is direct tax paid annually for owning a motor vehicle that travels on public roads. This tax is established by local governments, who are the responsible for handling, verifying and collecting this specific tax. As mentioned, the tax falls upon the ownership of any vehicle that is roadworthy and that is listed on any official record, usually the Traffic Department or other regulated vehicle registration.

The aim of this paper is to analyze the main drivers affecting deductions established by local governments on the road tax for EVs. To date and to the best of our knowledge, there has been no prior research on this issue for the case of Spain.

Specifically, we perform an empirical model to describe the behavior of local governments in Spain with regards to adopting this measure. This model is a binary choice model which is a function of various economic, political and technical factors. A cross-section Probit model is used with a database specifically gathered for this research.

Previous studies have analyzed the main drivers leading national (Matisoff, 2008; Lyon and Yin, 2010) and local (Zahran et al., 2008; Feiock et al., 2009; Lubell et al., 2009a,b; Sharp et al., 2011; Wang, 2012) governments to adopt environmental measures. Matisoff (2008) highlighted the importance of the population's political ideology, the carbon intensity of the economy, renewable energy potential and the unemployment rate when adopting renewable portfolio standards. Lyon and Yin (2010) studied the size of local government, its budget, political ideology, administrative capacity, the general tax burden, environmental stress, actions of stakeholders, the neighboring effect and environmental predisposition.

In Spain, González-Limón et al. (2013) analyzed the establishment of tax credits for Property Tax upon installing of solar energy systems, granted by local governments. The main drivers analyzed were solar radiation, type of housing, local government income and debt, local productive structure and neighboring effect. Moreover, Sánchez-Braza and Pablo-Romero (2014) evaluate the effects of property tax deductions to promote the installation of solar thermal energy systems on rooftops.

The rest of the paper proceeds as follows. Section 2 describes the data and the main motivations analyzed. Section 3 presents our empirical model while Section 4 shows the results. The paper concludes with Section 5 which offers a summary of the mayor finds.

2. Data and variables

2.1. Preliminary

A binary decision model has been used to analyze the main motivations that lead to the establishment of a local government road tax deduction for EVs. The dependent variable is *Deduction* EV. Its value is 1, when an EV tax credit has been established in the municipality, whatever the percentage, and 0 otherwise.

The mean reason for selecting this model is that although the deduction could be up to 75%, the vast majority of local governments that decided to apply this measure finally chose the maximum of 75%, or close to that amount. In the end, the decision of local governments focuses more on whether or not to adopt this tax deduction than in the setting a higher or lower percentage level. In other words, it is a matter of whether or not local governments are in favor of promoting this type of vehicle, with all that EVs imply in terms of environmental policies and sustainable urban transport.

The information to construct this variable has been taken from the road tax ordinance. The data base has been built specifically for this research. Due to the lack of a central registry for environmental road tax deductions, data have been taken from provincial and local government gazettes.

The sample includes the 395 municipalities in Spain with over 20,000 inhabitants. The three municipalities in province of Navarre have not included as this process was delegated to the regional government rather than the local government.

Previous research by authors such as Lubell et al. (2009b), and Lyon and Yin (2010) used a similar size. According to the aforementioned studies, independent variables have been clustered in five groups.

2.2. Local features

The first set includes variables such as *Population*, *Surface* and *Population centers*.

The available literature has considered the population both in absolute values (Wang, 2012), or its logarithm (Lubell et al., 2009a; Feiock et al., 2010) and population density (Lubell et al., 2009b; Sharp et al., 2011), measure the stress climate (Zahran et al., 2008).

The collinearity makes impossible the analysis overall of surface and density, so this paper considers the population as an absolute value. Following Wang (2012), population size indicates a city's overall administrative capacity, because this is highly correlated with the City Hall's budget. A larger budget makes the recruitment of specialist in environmental tasks much easier. Data for the *Population* variable have been taken from 2011 municipal register published by Spain's National Institute of Statistics (INE, 2013) and expressed in thousands.

To calculate surface, the considerations by Lubell et al. (2009a, b), who found a positive relationship between the surface and environmental policies and the environmental land-use, have been used; and Lyon and Yin (2010) analyzed agricultural land use. Moreover, Zahran et al. (2008) assert that higher population density leads a greater efficiency of public transport. Consequently, for the same population, larger municipalities with the lower densities will be more interested in promoting individual transport solutions, such as EVs instead of public transport or non-mechanized, such as walking and cycling. The *Surface* variable data were obtained from INE (2013), expressed in square kilometers.

The variable for *Population centers* is the number of population centers existing in the municipality. Broadly, a population center is considered a set of at least ten buildings that are made up of streets, squares and other urban roads. An exception would be less than 10 buildings, if and when the population living in that area exceeds 50 inhabitants. This article assumes that the increase in population centers makes it difficult to provide this population with public transportation. Hence, municipalities with more population centers have greater interest in promoting sustainable individual transport solutions, such as EVs. This data have been obtained from INE (2013).

A similar variable was used by Sharp et al. (2011). These authors defined the fragmentation of the metropolitan area as the number of general purpose local governments and counties existing within a metropolitan area.

2.3. Environmental commitment

The second set contains variables such as *Spanish Network of Cities for the Climate*, *Covenant of Mayors*, *Regional strategy*, *Solar deduction* and *Electric vehicles* variables. These variables reflected the municipality's environmental awareness.

The binary variables for *Spanish Network of Cities for the Climate* and *Covenant of Mayors* indicate that the municipality is a member of these associations as of October 31st 2012 and December 31st 2012, respectively. González-Limón et al. (2013) analyzed the membership for the Covenant of Mayors. The members of this European association have to reduce CO_2 emissions; therefore, they must establish a sustainable energy action plan (Covenant of Mayors, 2013). Local governments seeking to join Spanish Network of Cities for the Climate must accept the commitments adopted by Aalborg + 10 and establish a plan of action that includes a section for mobility (Spanish Federation of Municipalities and Provinces, 2013).

Regarding the *Regional strategy*, if the municipality falls within a region whose regional government established a EVs strategy before 2011, its value is 1; otherwise it is 0. The official web from the Movele project (IDAE, 2013) indicates that only Castile and Leon, Catalonia and the Basque Country had established a regional EVs strategy.

These strategies could help to enjoy the environmental benefits of EVs, both before the public and Town Halls. Likewise, these could support the municipalities in the establishment of measures.

Local governments could establish other environmental measures. One such measures is the creation of a deduction for tax property. In Spain, City and Town Halls have the ability to establish a deduction or tax credit to install solar energy systems; this could reach up to 50% of the gross tax. The *Solar deduction* variable is 1 when this deduction existed in 2012, otherwise it was 0. These data have been obtained from the General Directorate for Cadastre (2013). However the data for the Basque Country, Ceuta and Melilla were obtained directly from fiscal ordinances.

Finally, another measure of the environmental commitment is the EVs fleet. The *Electric vehicles* variable has been included. The purpose of incorporating this variable is an attempt to measure the degree of concern and engagement with the environment of the municipality's inhabitants. To do this, the number of EVs registered in the municipality and therefore belonging to inhabitants was quantified. The EVs fleet could be either public or private. In the case of public ownership, this indicates the commitment of local government with electric mobility, while in the case of private owners it indicates the awareness of citizens and enterprises. The *Electric vehicles* variable is an estimation of the number of EVs in the municipalities at January 2013. The data for this estimation were obtained from Spain's National Traffic Department (DGT, 2013). It is expressed in units per 10,000 inhabitants.

2.4. Environmental stress

The third set indicates the municipality's level of contamination. Polluted municipalities may consider the need to promote greener transport. This group includes the variables for *Agricultural companies* and *Vehicles per capita*.

According to the literature, the effect of the production structure could move in two opposite directions. Some authors argue that a large number of construction and industrial companies may oppose the establishment of environmental measures (Lubell et al., 2009b; Sharp et al., 2011). Other authors consider the productive structure as an indicator of the environmental stress (Zahran et al., 2008). This paper follows the second argument because the measure under study is a deduction. González-Limón et al. (2013) found a negative relationship between the percentage of agricultural enterprises and the establishment of tax deductions for property tax upon installing solar energy systems. Following these authors, the variable for *Agricultural companies* is the percentage of agricultural enterprises in the municipality. These data has been obtained from Caja España (2012), a savings and loan bank.

In Spain, more than 50% of the urban population is exposed of noise caused by road traffic (NOISE, 2013) with levels that surpass 60 dB, which also produces emissions of PM, NO_x, HC and CO. Thus, internal combustion vehicles are one of the main factors behind urban contamination. In this regard, Zahran et al. (2008) analyzed the number of workers who commute with private vehicles, while Wang (2012) uses the number of injuries due to road accidents. To work out the *Vehicles per capita* variable, total vehicles in the municipality as of January 2013, as obtained from DGT (2013) is divided by the total population.

2.5. Economic situation

The fourth set of variables includes *Income per capita*, *Debt per capita* and *Unemployment*. The first two variables indicate the financial position of the Town Hall, while the last reflects the municipality's economic situation.

Some authors argue that environmental policies are more easily established by governments with greater resources (Lubell et al., 2009b; Wang, 2012). In keeping with this line of thought, Sharp et al. (2011) found a positive relationship between the tax burden and the probability of being a member of an International Council on Local Environmental Initiatives. Moreover, Lubell et al. (2009a) found that the tax burden is positively related to the adoption of environmental policies. These data have been obtained from SGCAyL (2013). Municipal incomes were obtained from the 2012 budget and debts refer to December 31, 2012; this data in thousands of euros were divided by total number of inhabitants.

Referring to municipality's economic situation, the EU considers that to innovate in electric propulsion systems could ensure its general industry competitiveness (European Parliament, 2011). Some authors suggest that a green economy offers the possibility of new jobs. Subsequently, a high unemployment rate could be a motivating factor to establish environmental measures (Engel and Orbach, 2008). However, Lyon and Yin (2010) found a negative relationship between unemployment and the adoption of Renewable Portfolio Standards. Data for the local unemployment rate were obtained from SEPE (2013), which is Spain's National Employment Office. These data refer to December 31.

2.6. Other drivers

The last set of drivers includes *Neighboring effect* and *Citizen ideology*.

The *Neighboring effect* variable reflects the impact that the introduction of the deduction has on decisions made by City/Twon Halls for the surrounding municipalities. Wang (2012) found a negative relationship between the percentage of cities that had signed the U.S. Conference of Mayors Climate Protection Agreement in one county and the probability of joining. Neighboring effect could be explained by demonstrating the effect and informal advice from municipalities that had established the measure, or external factors such as organizations interested in promoting EVs. In this sense, Zahran et al. (2008) includes the number of nonprofit environmental organizations as a civic capacity variable, approaching the environmental human capital.

According with Matisoff (2008), the neighboring effect is the share of municipalities that had established the measure up to 2013 in a given region, excluding the municipality for which is calculated. Eq. (1) shows this variable:

$$\text{Neighboring effect}_{ij} = \frac{\sum_{k=1}^{N_j} \text{Deduction EV}_{kj} - \text{Deduction EV}_{ij}}{N_j - 1} \quad (1)$$

In this equation, i is the municipality for which the neighboring effect is estimated, j is the region i belongs to and N_j is the total number of municipalities in region j. Ceuta and Melilla have been included in Andalusia.

Regarding *Citizen ideology*, previous literature suggests that liberal ideologies facilitates the establishment of environmental policies. National (Matisoff, 2008; Whitford, 2009; Lyon and Yin, 2010) and local (Wang, 2012) studies found that a liberal ideology makes the establishment of environmental policies easier. In the case of Spain, González-Limón et al. (2013) found a negative relationship between the existence of a conservative majority in the municipality and the establishment of deductions on property tax for the installation of solar energy systems. In this paper, the *Citizen ideology* variable is 1 when there is a majority of conservative aldermen/women; otherwise, it is 0.

Table 1 shows a statistical summary for dependent and explanatory variables.

3. Methodology

The aim of this paper is to identify the drivers that influences the establishment of a road tax deduction for EVs by a local government. In this case, the *Deduction EV* variable takes 1 or 0. For this purpose, we have to consider the case of binary outcome models used to estimate the relationships between a dependent variable with only two possible outcomes, and consider all explanatory variables.

Binary outcome models have been used in a number of previous studies to analyze the behavior of local governments with regards to the adoption of specific environmental decisions (Matisoff, 2008; Lyon and Yin, 2010; Sharp et al., 2011). Specifically, we use the specification of a Probit model. The Probit model specifies the probability of observing a single specific outcome (0 or 1) for the explained variable as a function normally distributed for regressors.

This model has been explained following the specifications by Cameron and Trivedi (2005). The response model would be:

$$y_i^* = \alpha + X_i'\beta + \varepsilon_i \quad (2)$$

where y_i^* shows the probability that i has introduced the measure. This is a latent variable that is incompletely observed; X_i is the k-dimensional vector of the explanatory variables (so X_i' is the transposed), β is the vector of coefficients that multiplying the regressors we want to estimate, while α is the fixed effect and ε_i is the error.

However, this model cannot be estimated as y_i^* is not observed. Instead, we observe:

$$y_i = \begin{cases} = 1 & \text{if } y_i^* > 0, \quad \text{deduction applied to EVs in 2013} \\ = 0 & \text{if } y_i^* \leq 0, \quad \text{deduction not applicable to EVs in 2013} \end{cases} \quad (3)$$

p is defined as the probability that y is equal to 1. Thus, $(1-p)$ is the probability that y is equal to 0. Moreover, p is a function of explanatory variables included in vectors X and β. For binary outcome models, conditional probability is given by:

$$p[y_i = 1|X] = p[\alpha + X_i'\beta + \varepsilon_i > 0]$$
$$= p[-\varepsilon_i < \alpha + X_i'\beta] = F[\alpha + X_i'\beta] \quad (4)$$

Table 1
Variables and descriptive statistics.

Variable	Description	Obs.	Mean	Std. dev.	Min.	Max.
Dependent variable						
Deduction EV	1 = Deduction applied to EVs in 2013 0 = Not applicable deduction EVs in 2013	395	0.572	0.495	0	1
1. Local features						
Population	Thousands of inhabitants	395	80.793	200.201	20.087	3265.038
Surface	Area in square kilometers	395	161.940	247.516	1.963	1750.327
Population centers	Number of municipal cores	395	17.061	31.949	1	292
2. Environmental commitment						
Spanish Network of Cities for the Climate	1 = The municipality belongs to Spanish Network of Cities for the Climate; 0 = otherwise	395	0.451	0.498	0	1
Covenant of Mayors	1 = The municipality belongs to the Covenant of Mayors; 0 = otherwise	395	0.458	0.499	0	1
Regional strategy	1 = Prior to 2011, the Regional Government had established a EV strategy; 0 = otherwise	395	0.248	0.432	0	1
Solar deduction	1 = Applies deduction for installing solar panels in 2012; 0 = otherwise	395	0.304	0.460	0	1
Electric vehicles	Estimated EVs per ten thousand inhabitants	395	0.916	1.150	0	13.102
3. Environmental stress						
Agricultural companies	Percentage of primary sector enterprises	395	4.911	7.681	0.000	54.033
Vehicles per capita	Vehicles per inhabitant	395	0.623	0.095	0.430	1.514
4. Economic situation						
Income per capita	Budgeted revenue, thousands of € per inhabitant	395	1.099	0.379	0.000	3.191
Debt per capita	Debt on 31/12/2012, thousands of € per inhabitant	395	0.678	0.478	0.000	3.272
Unemployment rate	Local unemployed rate	395	16.124	4.104	6.402	33.348
5. Other drivers						
Neighboring effect	Percentage of municipalities implementing the measure in an given region of Spain, excluding the municipality for which it is calculated	395	56.717	22.309	0	100
Citizen ideology	1 = Existence of a simple conservative majority; 0 = otherwise	395	0.527	0.500	0	1

Table 2
Correlation matrix.

	Population	Surface	Population centers	Spanish Network of CC	Covenant of Mayors	Regional strategy	Solar deduction	Electric vehicles	Agricultural companies	Vehicles per capita	Income per capita	Debt per capita	Unemployment rate	Neighboring effect	Citizen ideology
Population	1.00														
Surface	0.14	1.00													
Population centers	0.06	0.17	1.00												
Spanish Network of CC	0.20	0.08	−0.04	1.00											
Covenant of Mayors	0.15	0.10	−0.11	0.18	1.00										
Regional strategy	0.01	−0.26	−0.21	−0.12	0.14	1.00									
Solar deduction	0.09	−0.04	−0.11	0.04	0.04	0.10	1.00								
Electric vehicles	0.19	0.02	0.01	0.13	0.05	0.05	0.12	1.00							
Agricultural companies	−0.12	0.32	−0.03	−0.01	0.18	−0.28	−0.06	−0.14	1.00						
Vehicles per capita	−0.08	0.00	0.09	−0.07	−0.16	−0.16	0.03	0.25	−0.04	1.00					
Income per capita	0.11	−0.08	−0.15	0.00	0.06	0.24	0.00	0.19	−0.12	0.06	1.00				
Debt per capita	0.18	0.12	−0.16	0.13	0.08	0.01	0.01	0.09	0.07	−0.03	0.27	1.00			
Unemployment rate	−0.07	0.15	−0.01	0.05	0.11	−0.32	−0.02	−0.20	0.08	−0.17	−0.25	0.07	1.00		
Neighboring effect	0.06	−0.22	0.01	−0.06	−0.01	0.68	0.10	0.13	−0.29	−0.02	0.15	0.01	−0.47	1.00	
Citizen ideology	0.08	0.18	0.07	0.09	−0.12	−0.48	−0.04	0.09	0.02	0.13	−0.19	0.06	0.03	−0.28	1.00

Table 3
Variance inflation factors.

Variable	VIF	Tolerance indicator: 1/VIF
Population	1.21	0.8265
Surface	1.28	0.7820
Population centers	1.21	0.8289
Spanish Network of Cities for the Climate	1.13	0.8829
Covenant of Mayors	1.22	0.8207
Regional strategy	2.68	0.3725
Solar deduction	1.05	0.9495
Electric vehicles	1.23	0.8104
Agricultural companies	1.43	0.6981
Vehicles per capita	1.21	0.8239
Income per capita	1.31	0.7631
Debt per capita	1.22	0.8172
Unemployment rate	1.58	0.6333
Neighboring effect	2.39	0.4185
Citizen ideology	1.45	0.6920

where F is the cumulative distribution function which depends on the cumulative distribution of ε.

In the case of Probit model, cumulative distribution of ε is normally distributed. In this model, the probability is determinate as follow:

$$p[y_i = 1|X] = \int_{-\infty}^{\alpha + X'_i\beta} \left(\frac{1}{\sqrt{2\pi}}\right)^{(-z^2/2)} dz, \quad \text{for} \quad -\infty < Z < \infty \tag{5}$$

β can be estimated by using maximum likelihood estimation, maximizing the likelihood function (Wooldridge, 2002):

$$£(\beta) = \sum_{i=1}^{N} y_i \ln\left[F(\alpha + X_i'\beta)\right] + (1 - y_i) \ln\left[1 - F(\alpha + X_i'\beta)\right] \tag{6}$$

As in all other discrete choice models, only the sign of the coefficient has a direct interpretation in the Probit model. Then, for more analytical information, we can use the marginal effects that provide ample information about the relationships between explanatory variables and the dependent. According with

Table 4
Probit regression models summary: estimating probability of application of tax deductions EVs.

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Constant	−0.1466	−1.1016***	−1.1938**	−0.3167	−0.5580	−0.4960	−0.1713
	(0.1152)	(0.1717)	(0.5062)	(0.5069)	(0.5548)	(0.5716)	(0.3855)
1. Local features							
Population	0.0059***	0.0036**	0.0026*	0.0026*	0.0028**	0.0031**	0.0026**
	(0.0017)	(0.0017)	(0.0015)	(0.0015)	(0.0014)	(0.0015)	(0.0013)
Surface	−0.0003	0.0002	0.0005	0.0006*	0.0007**	0.0007**	0.0007**
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Population centers	0.0012	0.0083***	0.0079***	0.0076***	0.0062**	0.0039	0.0075***
	(0.0022)	(0.0027)	(0.0027)	(0.0027)	(0.0028)	(0.0026)	(0.0027)
2. Environmental commitment							
Spanish Network of Cities for the Climate		0.5756***	0.5956***	0.5928***	0.5826***	0.5099***	0.5902***
		(0.1482)	(0.1502)	(0.1504)	(0.1509)	(0.1495)	(0.1506)
Covenant of Mayors		0.1387	0.2869*	0.3528**	0.3614**	0.4165***	0.3572**
		(0.1458)	(0.1537)	(0.1558)	(0.1574)	(0.1531)	(0.1557)
Regional strategy		1.3371***	1.2222***	1.0474***	0.6927***		1.0606***
		(0.1890)	(0.1965)	(0.2015)	(0.2656)		(0.2010)
Solar deduction		0.2546	0.2654*	0.2840*	0.2643*	0.2763*	0.2780*
		(0.1580)	(0.1593)	(0.1620)	(0.1590)	(0.1598)	(0.1613)
Electric vehicles		0.2863***	0.2093**	0.1722**	0.1796**	0.1607**	0.1796**
		(0.0826)	(0.0841)	(0.0765)	(0.0765)	(0.0730)	(0.0772)
3. Environmental stress							
Agricultural companies			−0.0359***	−0.0387***	−0.0350***	−0.0427***	−0.0389***
			(0.0123)	(0.0117)	(0.0118)	(0.0112)	(0.0116)
Vehicles per capita			0.4644				
			(0.7525)				
4. Economic situation							
Income per capita				0.1498			
				(0.2974)			
Debt per capita				−0.0295			
				(0.1717)			
Unemployment rate				−0.0409**	−0.0350*	−0.0413**	−0.0425**
				(0.0207)	(0.0210)	(0.0205)	(0.0203)
5. Other drivers							
Neighboring effect						0.0081*	0.0142***
						(0.0048)	(0.0042)
Citizen ideology						−0.1931	−0.3547***
						(0.1616)	(0.1509)
Obs.	395	395	395	395	395	395	395
Log. likelihood	−252.72	−213.70	−208.91	−206.31	−204.35	−207.58	−206.44
Pseudo-R^2	0.0628	0.2075	0.2253	0.2350	0.2422	0.2302	0.2345
Wald chi^2	12.89	88.26	101.49	105.03	107.88	103.06	103.00
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: Standard errors robust to heteroskedasticity in brackets. One, two, or three asterisks indicate coefficient significance at the 10, 5, and 1% levels, respectively.

Cameron and Trivedi (2009), the coefficient sign gives the marginal effect, which measures the increase of the probability p when the explanatory variable considered has increased a unit. A change in the j^{th} regressor, assumed to be continuous, this is:

$$\frac{dp[y_i = 1|X]}{dx_{ij}} = F\,(\alpha + X_i'\beta)\,\beta_j \tag{7}$$

4. Results and discussion

Previously, we examined the correlation matrix to test the possible interaction among the diverse explanatory variables to be included in the models (see Cohen et al., 2013). Table 2 shows this information.

As seen, in all cases, the coefficients are low, showing the absence of significant correlation among the explanatory variables considered. Also, values of VIF's (variance inflation factors) have been included in Table 3 to clearly rule out any possible multicollinearity problems. These VIF's quantify the severity of multicollinearity among explanatory variables in a regression analysis. In general, it is recommended that for each explanatory variable the value of VIF should not exceed the value of 10 since, in such case, there were problems with the efficiency of the estimators obtained. This is equivalent to a value of 0.1 for the tolerance indicator (1/VIF). Nevertheless, all values of VIF's are very low, thus ruling out possible problems of multicollinearity.

Finally, after having properly performed all previous steps, Table 4 summarizes the results obtained for the Probit model within the context of explanatory variables from Table 1. Explanatory variables have been added by groups for a better understanding, resulting in 7 models. So, regressions are carried out in stages by groups of variables in order to take into account the development of the significance of the explanatory variables and the explanatory levels of the whole models.

The first model includes only local feature variables. It shows that *Population* is significant and its coefficient is positive. This coincides with the findings of Sánchez-Braza and Pablo-Romero (2014), being consistent with the hypotheses of the administrative capacity (Wang, 2012).

The second model adds environmental commitment variables. The coefficient for *Population centers* is positive and significant. Thus, it is correlated with individual transportation needs. A green way to satisfy this is the EV. Regarding environmental commitment variables, column 2 shows that *Spanish Network of Cities for the Climate*, *Regional strategy* and *Electric vehicles* are significant and positive.

Regional strategy is the most influential variable of the four binary variables. The coefficient for *Electric vehicles* suggests that the deduction for EVs was established before 2013 and that it increased the VEB fleet. Also, the measure may fall within a set of measures for promoting EVs.

Solar deduction and *Covenant of Mayors* variables are not significant in this model, although they will be in the next model.

The third column adds environmental stress variables. *Vehicles per capita* is not significant because the registered vehicles from a given municipality circulate in another; this is especially true in metropolitan areas. Thus, it is not a reliable indicator for pollution in the municipality. If *Electric vehicles* are removed, the variable becomes significant, although we retain it because the model with *Electric Vehicles* have higher pseudo R^2 and the variables included are more significant.

Regarding *Agricultural companies*, it is significant and its coefficient is negative, which is consistent with González-Limón et al. (2013) and Sánchez-Braza and Pablo-Romero (2014). Moreover, Lyon and Yin (2010) also found a negative relationship between the agricultural character and the adoption of Renewable Portfolio Standards, but this variable was not significant. This inverse relationship may indicate that municipalities with a highest percentage of agricultural enterprises have fewer pollution problems; therefore, their town councils are less interested in establishing this type of measures.

Table 5
Marginal effects.

Variable	Sign	Variation (%)	Std. dev.
Population	Δ	0.098	(0.0004)**
Surface	Δ	0.022	(0.0001)**
Population centers	Δ	0.284	(0.0010)***
Spanish Network of Cities for the Climate	Δ	21.824	(0.0547)***
Covenant of Mayors	Δ	13.378	(0.0575)**
Regional strategy	Δ	34.420	(0.0519)***
Solar deduction	Δ	10.284	(0.0581)*
Electric vehicles	Δ	6.793	(0.0292)**
Agricultural companies	∇	1.472	(0.0045)***
Unemployment rate	∇	1.607	(0.0077)**

Note: Standard errors robust to heteroskedasticity in brackets. One, two, or three asterisks indicate coefficient significance at the 10, 5, and 1% levels, respectively.

The fourth model adds economic situation variables. *Income per capita* and *Debt per capita* are not significant. This may be due to the small fleet of VEB, 0.04%, and hybrids, 0.10%, (DGT, 2013). Thus, this type of deduction fails to significantly reduce the local council's income.

According to Lyon and Yin (2010), *Unemployment* is a significant variable and its coefficient is negative. Thus, it can be assumed that local councils do not consider EVs as a way to create employees in their municipalities.

The *Surface* variable has become significant and its coefficient is positive. This is is consistent with the findings by Lubell et al. (2009a,b), and Lyon and Yin (2010).

Column 5 shows that the variables for *Neighboring effect* and *Citizen ideology* are not significant. This is due to their relationship with *Regional strategy*. Those regions with an EV strategy have a higher rate of municipalities that have adopted the measure. Furthermore, the conservative majority rate in City/Town Halls is 11.22% against 66.33% in the rest of Spain.

To analyze this interaction in the sixth model, the *Regional Strategy* has been removed. It indicates that the *Neighboring effect* and *Citizen ideology* have become significant. The positive sign for the *Neighboring effect* differs from Matisoff (2008) and Wang (2012). However, in the first case, the variable was not significant, and in the second case, a survival analysis is applied, although it is consistent with González-Limón et al. (2013).

According to previous research, the coefficient for *Citizen ideology* is negative. Some authors have associated a positive coefficient to liberal ideology (Matisoff, 2008; Lyon and Yin; 2010; Wang, 2012). On the other hand, others have associated a negative coefficient to conservative ideology (González-Limón et al., 2013).

Regional strategy is retained because it better explains the behavior of the dependent variable. So, finally, the last model (column 7) includes only significant variables. By using this latter model, Table 5 shows marginal effects.

Table 5 indicates that all marginal effects are significant. The results obtained show that *Regional strategy* has an effect on the probability of establishing a deduction on road tax for EVs is greater than the overall effects of being a member of environmental agreements. This probability increases in 34.420% when the municipality is supported by a regional strategy against a 13.378% or 21.824% when it has signed Covenant of Mayors or Spanish Network of Cities for the Climate, respectively. Also, the establishment of a deduction on tax property for installing solar energy system increases this probability lesser than other binary variables.

5. Conclusions

Local government in Spain can establish a deduction on road tax for EVs to promote such vehicles as an alternative solution for sustainable personal mobility. This paper, using a cross-section Probit model, has studied the main drivers that leads local governments to adopt this measure. The results obtained show that the population, its dispersion, and the environmental commitment of municipalities have a positive effect on the establishment of such incentives, while a more rural character and unemployment do just the opposite.

In general, the results show that the local councils that adopt this measure are: municipalities with high population, large surface, numerous population centers, and fewer agricultural companies, consequently there is high environmental stress, and lower unemployment rates. Also, these municipalities may be support by a regional strategy and have adopted another environmental commitment measures such as promoting the installation of solar panels or signing the Covenant of Mayors or Spanish Network of Cities for the Climate.

Furthermore, the main findings of this article allow us to conclude that the capacity of the local council´s tax administration is one of the main drivers behind the adoption of tax deductions to promote EVs. Tax administration capacity requires higher qualification than other municipality utilities, with it being easier for larger local councils to hire such staff. In the future, the fulfillment of tax liabilities through government will help smaller municipalities adopt this type of measures.

On the other hand, the environmental administration requires specialized personnel; thus, if we want to promote environmental measures, such as the measures analyzed, municipalities must be helped. In this sense, regional governments could provide the municipalities with such support, especially the smaller ones. Nevertheless, this support could also come from other stakeholders, including automotive industry.

Similarly, having a environmental commitment is decisive in the establishment of environmental measures. Even in this case, budget constraints are not significant. Environmental education will be very useful in the long term to establish environmental measures, especially in rural areas. However, in municipalities with high unemployment rates, these actions are not expected to be effective.

In the literature, there is no general agreement about the effect of these various drivers. However, the available literature and this paper conclude that surface is a driver to the establishment of these measures.

Regardless of their relationship with the fact that the municipality is integrated into a regional strategy for the promotion of EVs, the results conclude that the neighboring effect and non-conservative ideology of citizens are drivers to establish this measure, however the literature remains inconclusive.

Acknowledgements

The authors acknowledge financial support received from the Cátedra de Economía de la Energía y del Medio Ambiente – Fundación Roger Torné at the University of Seville. The first and second authors also acknowledge financial support from SEJ 132 project of the Andalusian Regional Government. The standard disclaimer applies.

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