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LETTER

Is it environmentally desirable to encourage public transport through taxes? Evidence for Spanish households

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Abstract: There are studies that suggests that the use of environmental taxes to promote the consumption of "clean goods" could have unwanted effects in that it leads to the consumption of "dirty goods". The results will depend on the multiple effects of cross-price elasticities. This paper illustrates the above hypothesis as applied to earth transport consumption in Spanish households. Using microdata for Spanish households, we firstly estimate an AIDS model for 16 groups of goods and services. And secondly simulate two alternative revenue-neutral tax reforms in which the relative price of public transport, in terms of private transport, is reduced between 1 and 2%. The results confirm Sandmo's hypothesis. With both reforms, fuel consumption (as measure of private transport use) increases and public transport consumption decreases. The consequence in each case is a net increase in CO_2 emissions per household. So, fiscal reforms of this kind do not seem to be effective to improve the environmental performance of passengers earth transport sector in Spain.

Keywords: transport, environmental taxes, household, AIDS model

JEL classifications: H23, H31, R41

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PUBLIC INTEREST STATEMENT

The objective of this paper is to analyse if taxes are a good instrument to promote the use of public transport among Spanish household's members instead of passenger cars. To do that two tax reforms are simulated: the first one simulates a tax increase in car fuel and the second one simulates a tax increase in car fuel and a tax decrease in public transport. This two exercises permit to observe how the demand of car fuel and the demand of public transport have changed after each tax reform, in a context where the whole demand (the demand of all goods consumed by households) is analysed. The results show that even if car fuel price increases, and public transport prices decreases, Spanish household's members readjust their budget by consuming less quantity of other goods to maintain their consumption level of fuel car, and public transport consumption does not increase.

1. Introduction

Greenhouse gas emissions from the transport sector have increased heavily in recent years (Tarancón Morán & Del Río González, 2007). Between 1990 and 2005, total CO_2 emissions in the EU-15 were reduced by 7.9%. However, these emissions increased by 26% in the transport sector (European Environment Agency [EEA], 2008). In the case of Spain, transport emissions increased by 76.6% in comparison with an increase of 61.2% in the whole economy (Ministry for the Environment, 2006). These data cast significant doubt on the efficiency of transport environmental policies implemented in the European Union since the 1990s. Along these lines, the EEA has suggested that the source of the problem lies in the fact that the implemented policies have focused primarily on supply factors—such as, for example, the development of engines that pollute less—relegating demand factors to a lower plane, i.e. those linked with the behaviour of transport consumers (EEA, 2008, p. 4).

This approach, applied to environmental policies by European institutions, has created a price system which has favoured excessive growth of transport modes that produce the greatest amount of contaminants (Nash, Sansom, & Still, 2001). However, since the mid-1990s, the European Commission has been aware of this problem (Commision of the European Communities [CEC], 1995). For this reason, it has commissioned research on a variety of measures that would make it possible to develop a price policy that internalises the external effects generated by the transport sector (CEC, 2008a, 2008b; High Level Group on Transport Infrastructure Charging [HLG], 1999a, 1999b). Nevertheless, some authors have warned of a possible inefficiency of this type of measures. In particular, Sandmo (2009) recently suggested that the use of environmental taxes to promote the consumption of "clean goods" could have unwanted effects in that it leads to the consumption of "dirty goods". According to this author, this result would depend on the "initial state of the tax system and the structure of demand, especially as regards the cross price effects between markets for clean and dirty goods". Moreover, "more empirical work needs to be undertaken that contrasts this hypothesis with each particular case" (p. 15).

Following the recommendations made by Sandmo, this article offers empirical evidence for his hypothesis in the case of expenditures on transport in Spanish households. In order to do so, we simulate two contrasting fiscal reforms and study, in a steady state context, their effects on public transport consumption ("clean good") and on private transport fuel consumption ("dirty good"). The first reform consists of a 1% increase by means of taxes in the price of fuels. In the second reform, a study is carried out on the impact of a 1% increase in the price of fuels with a simultaneous 1% reduction in the price of public transport. The article is structured as follows: Section 2 presents the complete demand model used to estimate cross-price elasticities. Section 3 presents the results of the simulation. Conclusions are provided in Section 4.

2. Theoretical background: the AIDS

In order to calculate consumers' reactions to changes in their real income and in the prices of purchased goods and services, we use the AIDS model proposed by Deaton and Muelbauer (1980). The main advantage of the AIDS model is that it permits to aggregate consumer's individual decisions satisfying the rules of Consumer's Theory. On the contrary to other models, AIDS does not impose restrictions on the utility function.[1]

In the estimation of the model, we use the micro-data from the Family Budget Survey [*Encuesta de Presupuestos Familiares*, (EPF)] conducted in the period 1998–2005. EPF provides household socioeconomic information, such as expenditure on the consumption of goods and services, place of residence and status of the principal breadwinner. For the periods used in this paper, a rotating panel is available (e.g. households collaborate for eight consecutive quarters), which includes interviews with approximately 3,200 households in each quarter. The AIDS model used in this paper assumes that consumers carry out their budget allocation in two phases. First, they divide their total income into savings and expenditure on durable and non-durable consumer goods. Afterwards, expenditure

is allocated among non-durable goods based on consumer preferences. The functional form utilized in this study is the following:

$$w_{iht} = a_{ih} + \sum_{j=1}^{16} \gamma_{ij} \log p_{jt} + \beta_i \log y_{ht} + \varepsilon_{iht} \quad (1)$$

where the sub-indexes *i*, *h*, *t* indicate, respectively, the type of good purchased, the sample household and the year the good was purchased. The variable w_{iht} defines, therefore, the participation in the total expenditure that good *i* represents in household *h* during year *t*. Finally, the variables *p* and *y* are, respectively, the real price and real expenditure. The parameters *a*, γ and β have been estimated imposing zero degree homogeneity restrictions on prices and income $\sum_{i=1}^{16} a_{ih} = 1; \sum_{i=1}^{16} \beta_i = 0$ $\sum_{i=1}^{16} \gamma_{ij} = 0$ $ye_{ij} = e_{ji} (i,j = 1, \ldots, n)$.

Likewise, the sum of the different prices relative to purchases w_i should verify $\sum_{i=1}^{16} w_{iht} = 1$. Parameter *a* is constructed based on a series of dummies that make it possible to characterise the households: the primary breadwinner's profession, size of the county of residence, level of education, type of home (with or without children), employment status (employed or unemployed) and so on. Real expenditure is constructed based on the total expenditure on all of the goods deflated by the Stone index, which takes a specific value for each household:

$$\log p_{ht} = \sum_{j=1} w_{jht} p_{jt} \quad (2)$$

The model assumes that the households alter their purchase decisions due to changes in prices generated by indirect taxes. For this reason, the participation of each one of the goods in the total expenditure, w_i, needed to be predicted and adjusted by prediction error ε, where $w_i = Y_i \hat{\beta} + \hat{\varepsilon}_i$. The model has been estimated with the *Iterative Seemingly Unrelated Regressions* procedure available in Stata 10. Once the model has been estimated, the price and expenditure elasticities are obtained based on the following equations:

$$e_{ij} = \frac{\gamma_{ij}}{w_i} - \delta_{ij} \quad (\text{where } \delta_{ij} = 1, \quad \text{if } i = j \text{ and 0 in the rest}) \quad (3)$$

$$e_i = \frac{\beta_i}{w_i} + 1 \quad (4)$$

Table A1 of Appendix 1 presents the cross-price elasticity matrix of the 16 groups of expenditure that comprise the weekly budget of Spanish households.[2] The results show, although weakly, that public transport and fuels are complementary goods. In particular, the cross elasticities obtained for both goods are −.019 and −.025.

3. Simulation

Table 1 presents the impact of the two reforms under study on the patterns of consumption in Spanish households. As mentioned at the outset, Scenario A simulates a 1% increase in the price of fuels by means of an increase in VAT to which these goods are subject. Scenario B simulates the same measure together with a 1% decrease in the price of public transport via a reduction in VAT. The results in Table 1 show that expenditure on fuels increases by .119% in Scenario A, whereas expenditure on public transport decreases by .039%. These results show that the loss of real purchasing power, resulting from the rise in the price of fuels, causes a reallocation in the weekly budget of Spanish households. This process of weekly budget reallocation is the result of the interaction of multiple cross effects existing between the various goods that comprise the above-mentioned household budget. In fact, in this scenario, expenditure increases on some goods, such as tobacco or gas, whereas other expenditures decrease, for example, foods and beverages. In the case of transport, the increase in the price of fuels does not manage to produce an increase in the

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Table 1. Impact of the reforms on the weekly budget in households

Expenditure groups		Weights	Variation in weights	Variation in weights
		Initial stage	Scenario A (%)	Scenario B (%)
1	Food and beverages	.2043	−.053	−.107
2	Alcoholic beverages	.0070	−.064	−.090
3	Tobacco	.0176	.152	.716
4	Clothing and footwear	.0730	.058	.070
5	Rent	.2378	−.052	−.295
6	Household goods	.0871	.075	−.198
7	Heating fuels	.0163	.132	.151
8	Medical expenses	.0235	−.231	1.586
9	Car fuels	.0361	.119	.140
10	Vehicle repair and maintenance	.0282	.067	−.943
11	Public transport	.0077	−.039	−.978
12	Telephone and communication costs	.0241	−.297	−.085
13	Leisure	.1398	−.107	−.184
14	Education	.0130	.654	4.899
15	Consumption of durable goods	.0613	.088	−.272
16	Other goods	.0231	.792	3.589

Source: Own calculations.

Table 2. Price elasticities

Expenditure groups	Car fuel	Public transport
Car fuel	−.895	−.019
Public transport	−.025	−.551

Source: Own calculations.

consumption of public transport ("clean good"), but instead brings about the entirely opposite effect.

In Scenario B, expenditure on fuels increases by .140%, whereas expenditure on public transport decreases by .978%. Here again, the increase in the price of fuels creates a process of reallocation whose result is increased expenditure on fuels and decreased expenditure on public transport. Note that the decrease in the price of public transport reinforces the result of the increase in the price of fuels. In fact, this measure creates greater expenditure on fuels and less on public transport. These results show that, for the case of Spanish households, when making decisions related to expenditure on public transport, the income effect is greater than the substitution effect. In other words, the relation between public and private transport expenditure is complementary and not substitutable—as indicated by the cross elasticities of Table A1 in Appendix 1. Furthermore, when Spanish households experience an increase in their purchasing power, they consider public transport to be an inferior good. In fact, as has been seen, lowering the price of public transport has served to accentuate even further the decrease in consumption. In this sense, as shown in Tables 1 and 2, and in Figure 1, the change in purchasing power resulting from the variation in price of public transport is even greater than in the purchasing power resulting from the variation in the price of fuels.

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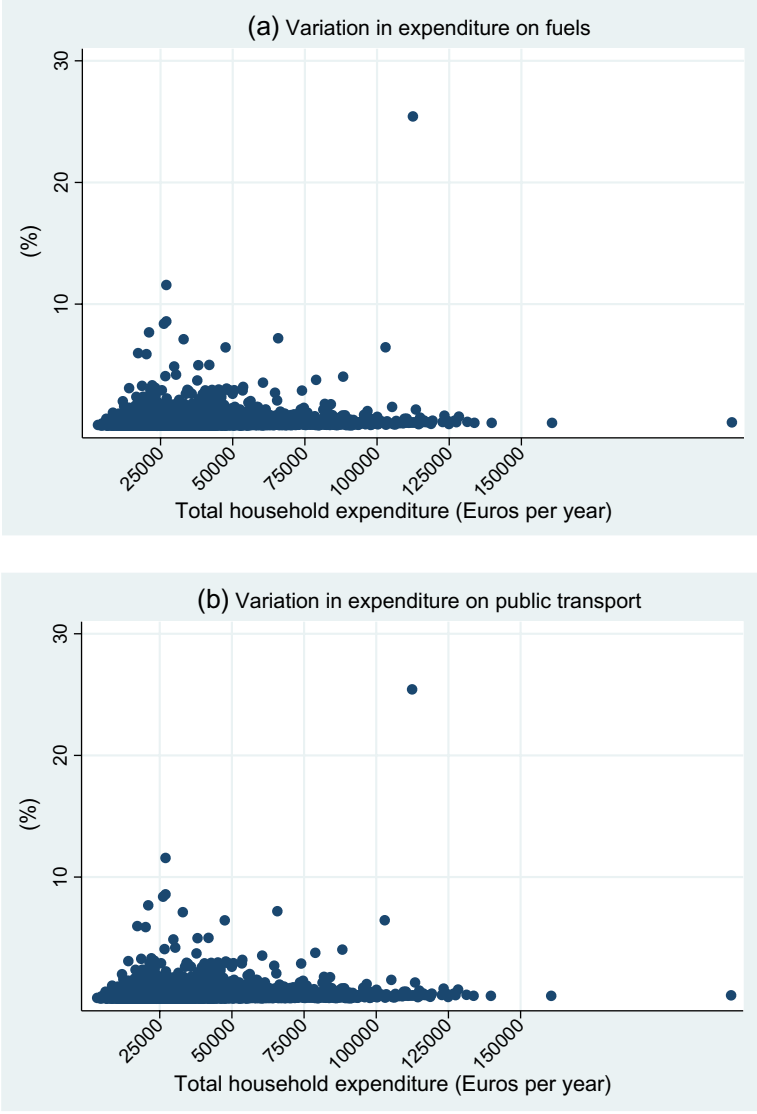

Figure 1. Impact on transport expenditure in Spanish households.

4. Concluding remarks

For the case of Spanish homes, this paper shows that pricing policies used to promote spending on public transport with a view to protecting the environment can be clearly inefficient.

In fact, we have seen that policy of pricing fuel leads to a reassignment of the household budget by which households decrease their consumption of other items, in order to maintain or even increase their consumption of fuel. Then, this policy measure did not encourage the substitution of the use of cars for the use of public transport as means of transport. In fact, the literature on pricing fuel as policy issue to promote a sustainable mobility is abundant. Empirical evidence, (see e.g. Espey, 1998; Goodwin, 1992; Goodwin, Dargay, & Hanly, 2004; Graham & Glaister, 2002; Labandeira & López, 2002; Oum, Waters II, & Yong, 1992; Sterner, Dahl, & Franze, 1992 for the case of Spain) shows a low price elasticity of fuel demand, especially in the short term, accompanied with high-income elasticities. These results highlighted the limits of the effectiveness of such a policy: the price signal is insufficient by itself to induce changes in passenger transport demand. Our results are in accordance with literature, showing the lack of effectiveness in the short term of a policy that increases fuel taxes. Moreover, our results show, thanks to the analysis made in a complete demand context (most works are based on uni-equational models), that Spaniards are able to reduce their

consumption of other goods in order to maintain their consumption of fuel when their total budget decrease as a consequence of the increase in fuel price. This result evidences the big preference that Spaniards accord to the use of car in their consumption basket. And so our analysis is more complete than ones based in uni-equational models.

In addition, we have seen that, more than a substitutability relation, private cars and public transport have a complementary relation; this is because public transport is an inferior good for Spaniards. This fact also limits the effectiveness of a policy based on reducing public transport price in order to encourage its use. There are many examples in empirical literature where public transport results an inferior good. For example, Asensio, Matas, and Raymond (2003), for the case of Spanish small and medium cities (his results reinforce ours), Bresson, Dargay, Madre, and Pirotte (2003), for the case of France and England, Crôtte, Noland, and Graham (2009) for the case of Mexico city.

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Notes
1. Other functions oblige to separability and homotheticity like the CES model. The Lineal Expenditure Systems needs a function aditivamente is in addition separable.
2. Estimation results of the model are available from the authors upon request.

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Appendix 1

Table A1. Cross-price elasticities matrix

Expenditure groups	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	−.659	.046	−.041	−.104	−.066	−.285	.033	.184	−.083	−.088	.051	.218	−.040	−.152	−.051	−.338
2	.446	−.995	−.183	.004	2.325	.167	.112	.238	−.045	.554	.014	.009	−1.238	−1.009	−.220	−1.181
3	−.137	−.112	−1.171	.048	.824	−.683	−.031	.136	.097	.093	−.263	.117	.677	−.017	.067	−.576
4	−.217	.000	.020	−1.234	−.243	−.204	.089	−.105	.076	.098	−.012	−.048	.391	−.292	.686	−.073
5	.148	.260	.164	−.022	−.422	.264	−.005	−.333	−.060	−.150	.273	−.035	−.870	.422	−.458	.669
6	−.561	.053	−.306	−.163	.616	−1.766	−.092	1.620	.113	.108	.296	−.047	−1.227	.951	.243	−.546
7	.451	.128	−.035	.341	−.095	−.314	−.572	−.301	.139	−.145	−.003	.734	2.167	−.736	−1.363	−.783
8	.997	.146	.130	−.214	−2.188	3.524	−.196	−4.360	−.231	1.062	−1.171	−.535	.666	.423	1.069	−.240
9	−.284	−.025	.058	.094	−.475	.134	.042	−.169	−.895	.042	***−.019***	−.206	−.410	.211	.169	.457
10	−.352	.289	.072	.160	−.954	.169	−.089	.897	.055	−1.619	.886	−.264	−1.294	.400	.134	.338
11	.429	.012	−.369	−.030	2.103	.879	−.015	−1.620	***−.025***	1.459	−.551	−.200	.427	−2.051	.956	−2.405
12	1.876	.024	.198	−.089	−.332	−.121	.665	−.772	−.387	−.432	−.198	−1.041	.881	.513	−1.709	.683
13	−.047	−.210	.166	.189	−1.603	−.753	.325	.168	−.155	−.408	.073	.131	.080	.016	−.514	1.205
14	−.773	−.656	−.024	−.611	2.429	2.137	−.475	.439	.317	.493	−1.538	.336	.091	−1.699	−.824	−.758
15	−.213	−.075	−.010	.476	−1.441	.115	−.354	.388	.058	.030	.246	−.487	−.854	−.341	.640	−.216
16	−2.125	−.935	−.733	−.166	4.998	−1.532	−.610	−.294	.850	.527	−2.208	.572	5.922	−.921	−.597	−3.487

Notes: Expenditure groups: (1) Food and beverages, (2) Alcoholic beverages, (3) Tobacco, (4) Clothing and footwear, (5) Rent, (6) Household goods, (7) Heating fuels, (8) Medical expenses, (9) *Car fuels*, (10) Vehicle repair and maintenance, (11) *Public transport*, (12) Telephone and communication costs, (13) Leisure, (14) Education, (15) Expenditure on durable goods and (16) Other goods.

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