THE UNIVERSITY OF MELBOURNE

Department of Economics

Working Paper Series

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Desiderio Romero-Jordán,
José Félix Sanz-Sanz
&
Mercedes Burguillo-Cuesta

July 2009

Research Paper Number 1076

ISSN: 0819-2642
ISBN: 978 0 7340 4040 4

Department of Economics
The University of Melbourne
Parkville VIC 3010
www.economics.unimelb.edu.au

Is it environmentally desirable to encourage public transport through taxes? Evidence of Sandmo's hypothesis in Spanish households

Desiderio Romero-Jordán
Universidad Rey Juan Carlos

José Félix Sanz-Sanz†
Universidad Complutense de Madrid

Mercedes Burguillo-Cuesta
Universidad de Alcala de Henares

Abstract:

Sandmo (2009) 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". This would therefore cast doubt on both the efficiency of environmental policy measures that act through price setting and the concept of double dividends which could be extracted from the environmental taxes. In this context, this paper illustrates the above hypothesis as applied to transport consumption in Spanish households. To this end, we simulate two alternative fiscal reforms and analyze their impact based on the complete demand model proposed by Deaton and Muellbauer (1980). The first reform establishes a 1% increase in the price of fuels, modifying the rate of VAT. Using this same approach, the second reform simulates the former measure together with a 1% decrease in the price of public transport. The results obtained confirm Sandmo's hypothesis. Expenditure on fuel increases by 0.119% in the first reform and 0.140% in the second. On the contrary, public transport expenditures are reduced respectively by 0.039% and 0.978%.

Keywords: Transport, environmental taxes, household, AIDS model.

JEL codes: H23, H31, R41

* This paper was finished during a research leave enjoyed by Jose Felix Sanz-Sanz at the Department of Economics with Professor John Creedy in Melbourne University. The provision of facilities by the Department of Economics at Melbourne University during this research period is greatly acknowledged. Jose Felix Sanz-Sanz appreciates the funding from the Spanish Ministry of Science and Innovation through its program for promoting mobility among senior researchers and to grant SEJ2006-04444. Funding from Universidad Complutense through Research Group grant 940392 is also acknowledged.

† Corresponding author: Jose Felix Sanz-Sanz

e-mail: jsanz@unimelb.edu.au

1. Introduction

Greenhouse gas emissions (GGE) from the transport sector have increased heavily in recent years (Tarancón Morán and 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, 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 90s. Along these lines, the European Environment Agency (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 behavior of transport consumers (European Environment Agency, 2008, p.4).

This approach, applied to environmental policies by European institutions, has created a price system which has favored excessive growth of transport modes that produce the greatest amount of contaminants (Nash *et al.*, 2001). However, since the mid-90s the European Commission has been aware of this problem (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 internalizes the external effects generated by the transport sector (HLG, 1999a) (HGL, 1999b) (CEC, 2008 a) (CEC, 2008 b). 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 *inital 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 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 on the price of fuels. In the second reform, a study is carried out on the impact of a 1% increase on 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). In the estimation of the model we use the micro-data from the Family Budget Survey (*Encuesta de Presupuestos Familiares*) conducted in the period 1998-2005. 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 (see Blundell, 1988). The functional form utilized in this study is the following:

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

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 $\sum_{i=1}^{16} a_{ih} = 1;\ \sum_{i=1}^{16} \beta_i = 0\ \ \sum_{i=1}^{16} \gamma_{ij} = 0$ y $e_{ij} = e_{ji}\ (i, j = 1......n)$.

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 characterize 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:

$$\log p_{ht} = \sum_{j=1} w_{jht} \, p_{jt} \qquad [2]$$

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 (see Baltagi, 2005). Once the model has been estimated, the price and expenditure elasticities are obtained based on the following equations:

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

$$e_i = \frac{\beta_i}{w_i} + 1. \qquad [4]$$

Table A1 of Annex 1 presents the cross-price elasticity matrix of the 16 groups of expenditure that comprise the weekly budget of Spanish households[1]. The results show, although weakly, that public transport and fuels are complementary goods. In particular, the cross elasticities obtained for both goods are -0.019 and -0.025.

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 of VAT. The results in Table 1 show that expenditure on

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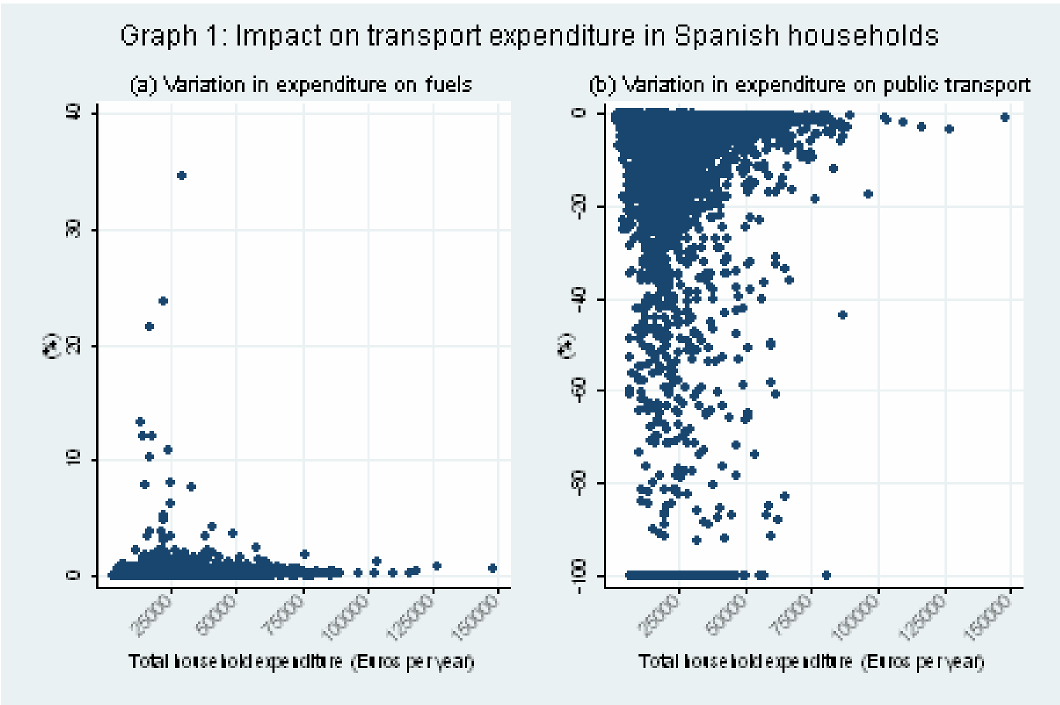
[1] Estimation results of the model are available from the authors upon request.

fuels increases 0.119% in scenario A, whereas expenditure on public transport decreases 0.039%. 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 abovementioned 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 consumption of public transport ("clean good"), but instead brings about the entirely opposite effect.

In scenario B, expenditure on fuels increases 0.140%, whereas expenditure on public transport decreases 0.978%. 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 Annex 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 Graphs 1 and 2, 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.

Table 1. Impact of the reforms on the weekly budget in households				
	Expenditure groups	Weights Initial stage	Variation in weights Scenario A (%)	Variation in weights Scenario B (%)
1	Food and beverages	0.2043	-0.053	-0.107
2	Alcoholic beverages	0.0070	-0.064	-0.090
3	Tobacco	0.0176	0.152	0.716
4	Clothing and footwear	0.0730	0.058	0.070
5	Rent	0.2378	-0.052	-0.295
6	Household goods	0.0871	0.075	-0.198
7	Heating fuels	0.0163	0.132	0.151
8	Medical expenses	0.0235	-0.231	1,586
9	Car fuels	0.0361	0.119	0.140
10	Vehicle repair and maintenance	0.0282	0.067	-0.943
11	Public transport	0.0077	-0.039	-0.978
12	Telephone and communication costs	0.0241	-0.297	-0.085
13	Leisure	0.1398	-0.107	-0.184
14	Education	0.0130	0.654	4.899
15	Consumption of durable goods	0.0613	0.088	-0.272
16	Other goods	0.0231	0.792	3.589



4. Concluding remarks

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

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ANNEX 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	-0.659	0.046	-0.041	-0.104	-0.066	-0.285	0.033	0.184	-0.083	-0.088	0.051	0.218	-0.040	-0.152	-0.051	-0.338
2	0.446	-0.995	-0.183	0.004	2.325	0.167	0.112	0.238	-0.045	0.554	0.014	0.009	-1.238	-1.009	-0.220	-1.181
3	-0.137	-0.112	-1.171	0.048	0.824	-0.683	-0.031	0.136	0.097	0.093	-0.263	0.117	0.677	-0.017	0.067	-0.576
4	-0.217	0.000	0.020	-1.234	-0.243	-0.204	0.089	-0.105	0.076	0.098	-0.012	-0.048	0.391	-0.292	0.686	-0.073
5	0.148	0.260	0.164	-0.022	-0.422	0.264	-0.005	-0.333	-0.060	-0.150	0.273	-0.035	-0.870	0.422	-0.458	0.669
6	-0.561	0.053	-0.306	-0.163	0.616	-1.766	-0.092	1.620	0.113	0.108	0.296	-0.047	-1.227	0.951	0.243	-0.546
7	0.451	0.128	-0.035	0.341	-0.095	-0.314	-0.572	-0.301	0.139	-0.145	-0.003	0.734	2.167	-0.736	-1.363	-0.783
8	0.997	0.146	0.130	-0.214	-2.188	3.524	-0.196	-4.360	-0.231	1.062	-1.171	-0.535	0.666	0.423	1.069	-0.240
9	-0.284	-0.025	0.058	0.094	-0.475	0.134	0.042	-0.169	-0.895	0.042	-0.019	-0.206	-0.410	0.211	0.169	0.457
10	-0.352	0.289	0.072	0.160	-0.954	0.169	-0.089	0.897	0.055	-1.619	0.886	-0.264	-1.294	0.400	0.134	0.338
11	0.429	0.012	-0.369	-0.030	2.103	0.879	-0.015	-1.620	-0.025	1.459	-0.551	-0.200	0.427	-2.051	0.956	-2.405
12	1.876	0.024	0.198	-0.089	-0.332	-0.121	0.665	-0.772	-0.387	-0.432	-0.198	-1.041	0.881	0.513	-1.709	0.683
13	-0.047	-0.210	0.166	0.189	-1.603	-0.753	0.325	0.168	-0.155	-0.408	0.073	0.131	0.080	0.016	-0.514	1.205
14	-0.773	-0.656	-0.024	-0.611	2.429	2.137	-0.475	0.439	0.317	0.493	-1.538	0.336	0.091	-1.699	-0.824	-0.758
15	-0.213	-0.075	-0.010	0.476	-1.441	0.115	-0.354	0.388	0.058	0.030	0.246	-0.487	-0.854	-0.341	0.640	-0.216
16	-2.125	-0.935	-0.733	-0.166	4.998	-1.532	-0.610	-0.294	0.850	0.527	-2.208	0.572	5.922	-0.921	-0.597	-3.487

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 (16) Other goods.