A REVENUE-NEUTRAL TAX REFORM TO INCREASE DEMAND FOR PUBLIC TRANSPORT SERVICES

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A Revenue-Neutral Tax Reform to Increase Demand for Public Transport Services

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Abstract

Transportation, energy and environmental tax reforms represent an ongoing debate in contemporary policy. The main aim of this paper is to shed some light on this debate using microsimulation tools to analyse consumer response and welfare effects of environmental policy consisting of an increment of the indirect taxes on fuels to finance the elimination of VAT on the public means of transport. In order to do so, we first estimate an Almost Ideal Demand System for 16 different groups of goods in the Spanish economy, for the purpose of evaluating expenditure and price elasticities. Using this information, we then micro-simulate the abolition of VAT on public transport services and a simultaneous increment on fuel taxes, so that total revenue remains unchanged. The welfare effects of this revenue-neutral tax reform are evaluated. The aim of this simulation is to define a public policy that increases public transportation availability and use in order to bring about decreases in pollution and congestion.

JEL classification numbers: D12, H23, H31.

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1. INTRODUCTION

The empirical issue of this research can be encompassed within the increasing interest in environmental taxes which would target the enforcing of significant reductions in the use of private transportation, thereby reducing pollution and congestion (Laird et al., 1999). In fact, fiscal policies that attempt to promote public transport can be justified in terms of the externalities that they will induce. If externalities are defined as the benefits and costs that result from unplanned side-effects of economic activities that concern individuals other than the parties involved in the activity, then air pollution and the greenhouse effect are illustrative examples of externalities. Both these examples are negative externalities, of which one of the major contributory factors is excessive private transport demand. Obviously, they could be reduced by substituting private by public transport services (Emmerink et al., 1994).

In this sense, if, as expected, fuel and public transport services are substitutive goods, one way to increase demand for public transport could be by raising the tax on fuel for private transport. Moreover, to enforce stronger effects, this rise could finance a cut in public transport services taxation. Furthermore, these simultaneous changes could be calculated in order to constitute a revenue-neutral tax reform. The more radical of such a type of fiscal reform is analysed in this paper, since we propose the abolition of Value Added Tax (VAT) on public transport services in Spain[1], while keeping revenue constant by means of the corresponding increase of fuel taxes. Transport policies involving tax cut proposals are often drawn up without taking into account all their economic effects. That is to say, they generally lack the support provided by empirical evidence. This justifies their approval. However, there are different economic tools which allow us to understand the effects of such proposals. One of these tools is micro-simulation (Alcock and Docwra, 2005; Liu et al., 2006), which enables the assessment of public reforms even before they are passed by Parliament. These techniques are increasingly used in developed countries (Algers et al. 1997; Mertz 1991, O`Donoghue (2001).

The main aim of this paper is to shed some light on this debate using micro-simulation tools to analyse the expected demand shifts and their effects on consumers' welfare. In order to meet this objective, the first stage of this research is to examine

[1] For a general analysis of indirect taxes on welfare see Creedy (1999). The impact of indirect taxation on fuels and carburant in Spain has been studied by Romero and Sanz (2003).

consumers' revealed preferences. Thus, we will assess own-price elasticities, cross-elasticities and expenditure elasticities of 16 different groups of consumer goods, including cultural goods. This will allow us to analyse rarely studied issues in economic literature such as the consumers' response to price or income changes, as well as the complementary or substitute nature of the different cultural goods. This type of empirical analysis is uncommon. Nevertheless, it is crucial to understand, from an economic perspective, demand patterns and the effectiveness of public policies which support these goods and services.

The econometric basis for these simulations was the estimation of an Almost Ideal Demand System (AIDS), proposed by Deaton and Muelbauer (1980a, 1980b), which will permit us to control all cross-effects due to any price or real income changes. The data set to estimate this model is the Spanish Continuous Household Expenditure Survey (ECPF).

The paper is organised as follows: in Section 2, we describe the contextual setting; in Section 3, we present the Almost Ideal System; in Section 4, we estimate the elasticities; in Section 5, we estimate the distributive and welfare results; and finally, in Section 6, we discuss the results and present the conclusions.

2. TAXATION OF TRANSPORT SERVICES IN SPAIN

In Spain, as in other European Union countries, indirect taxation on consumption is concentrated primarily on Value Added Tax (VAT) and the different excise duties imposed on specific consumer goods, such as spirits, beer, hydrocarbons, tobacco, electricity and vehicle registration.

With regard to public transportation services, VAT is the only indirect tax that affects them (i.e. there are no excise duties to be paid). The tax rate levied on these services does not differ across different categories of public transport and is currently fixed at 7 percent. So, as other members of the EU, Spain applies a reduced rate of VAT to the transport of passengers (European Union, 2005b). However, the Spanish rate is not among the most favourable treatments since other countries, such as The United Kingdom, apply a zero rate on passenger transportation, i.e. an exemption with a refund of the tax paid at the preceding stage. Some member States, like Greece, have fixed exemptions without refund on these services, while others, such as Denmark, apply a combination of both, zero rates and exemptions. Finally, a 3-percent super-reduced rate

is applied in Luxembourg. Hence, there is some margin to implement cuts in the indirect taxation on public transport services in Spain and align its VAT rate more closely with those applied in other member States with more favourable tax regimes in relation to public transport services.

With regard to the indirect taxation on petrol and fuels, Spain, as its EU partners, applies an excise duty on these products, in addition to VAT. The Spanish VAT rate on petrol (leaded and unleaded), diesel, and LPG is the national standard rate of 16 percent, which is the second lowest in the European Union after Cyprus (European Union, 2005b).

In relation to the excise duty, the European Union has fixed a minimum that EU member States are permitted to exceed. In fact, some countries such as Germany, Denmark and France have established their own excise duties well above this minimum. For example, Germany's excise duty for leaded petrol is currently fixed at 721€ per 1000 litres, for unleaded petrol at 669.80€ and for LPG at 485€. However, these are not the highest figures, since the UK has set its excise duties for these products at 813.37€, 726.39€ and 532.79€ respectively. Once again, the Spanish tax regime is relatively favourable with respect to the excise duties levied on fuels and petrol. The figures for Spain are presented in Table 1 and show that for LPG, the Spanish excise duty constitutes an exception to the European system, since it is fixed below the minimum adopted by the Council in 2003.

The relative position of Spain within the European Union regarding this issue is illustrated by Figures 1 and 2. It can be observed that compared with its EU-15 partners (member States prior to May 2004), only Greece has lower excise duties on unleaded petrol and gas oil than Spain.

To summarise, although this paper's analysis of a fiscal reform that would abolish VAT on public transport services and keep revenue constant by means of a corresponding increase in fuel taxes can be generalized to other countries, it is true that Spain is in a particularly favourable position to implement the proposed reform since, compared to other European countries, its indirect tax system can be characterised by

relatively high VAT rates on public transport services and relatively low taxes regarding fuels.

Thus, we have calculated that an increment on the Spanish VAT rate on fuels from the current 16 percent to 22.78 percent and the simultaneous application of an exemption on public transport services would maintain the revenue constant. This is the particular tax reform that we have evaluated and propose, in view of the efficiency and welfare changes that would be forthcoming.

3. A COMPLETE DEMAND SYSTEM: DATA AND ESTIMATION PROCESS

The database used in this paper is The Spanish Continuous Household Expenditure Survey (ECPF). The ECPF is a panel created and distributed by the Spanish National Institute of Statistics (INE). The survey provides quarterly and annual information on household incomes and consumption, including self-consumption, self-supply and payment in kind. It is targeted at 3,200 families chosen by sampling techniques and one eighth of the sample is renewed each quarter. In addition, it includes exhaustive information on household characteristics such as employment status, demographics, etc. (Browning and Collado, 2001).

The empirical study adopted in this paper is made up of two phases: an estimation phase and a simulation phase. The first phase obtains the price elasticity and expenditure elasticity matrix by using ECPF data corresponding to the period 1985 (third quarter) to 1995 (fourth quarter). Based on these results, the second phase then simulates the effects of a tax reform, taking the 1998 ECPF data as a reference.

The model used in the estimation phase is the Almost Ideal Demand System (AIDS) proposed by Deaton and Muellbauer (1980a and 1980b). The main attraction of AIDS is that it allows a first-order approximation to an unknown demand system (Nicol, 1989). The model is estimated using the assumption that individuals will alter their spending decisions as a result of the price changes generated by the simulated reform.

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

where i notes the i-th houshold, j the j-th group of goods and t is the time. Hence, w_{iht} is the expenditure share of good i-th for the household h-th at perid t; p represent prices and y is the real expenditure, which is obtained from the expenditure on all goods deflated by the Stone Index.

Parameter a is modelled using a series of dummies which allow households to be categorized by home tenure, alcohol and tobacco consumption, education, size of town of residence, employment status (active or inactive) and employment category. The model is estimated under the assumption that individuals will alter their expenditure decisions as a result of the price changes generated by the simulated reform. Hence, the share that each good has in the total expenditure, w_i, must be predicted and adjusted by the prediction error, ε, where $w_i = Y_i\hat{\beta} + \hat{\varepsilon}_i$. Moreover, to fulfil the theoretical properties of the theory of consumption, the parameters of this equation system have been estimated imposing the homogeneity (equation [2], [3]) a symmetry constraints [4]:

$$\sum_{i=1}^{16} a_{ih} = 1 \qquad [2]$$

$$\sum_{i=1}^{16} \beta_i = \sum_{i=1}^{16} \gamma_{ij} = 0 \qquad [3]$$

$$\gamma_{ij} = \gamma_{ji} \quad \forall i, j \qquad [4]$$

Moreover, the add up of all the expenditure shares, w_i, should verify:

$$\sum_{i=1}^{16} w_{iht} = 1 \qquad [5]$$

Given that the AIDS is made up of a system of dependent linear equations, n-1 equations of the system have been estimated, excluding the equation which corresponds to consumer durables. The parameter values of the equation that is omitted in the estimation have been obtained by taking the constraints included in equations [2] to [5] into account.

Infrequent purchase and seasonal variation are among the main econometric problems with this type of data. To avoid the first of these problems, the model has been estimated following the procedure proposed by Baker, Mckay and Simons (1990), which consists of using instrumental variables in a three-stage least squares estimation process. Seasonal variation, on the other hand, is corrected by including a variable which takes account of the trend of the series, and by introducing a dummy variable for each quarter of the series (the variable which corresponds to the fourth quarter is omitted in the estimation).

4. DEMAND SYSTEM ESTIMATION

The expenditure and price elasticities of this demand system are obtained from the following expressions:

$$e_i = \frac{\beta_i}{w_i} + 1 \qquad [6]$$

$$\varepsilon_{ij} = \frac{1}{\left(1 + \beta_i \ln P_i\right)}\left[\frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i}\left[w_j + P_j \sum_{k \neq i}^{n} \ln P_k \frac{\partial w_k}{\partial P_j}\right]\right] - \delta_{ij} \qquad [7]$$

where $\delta_{ij} = 1$, if $i = j$ and 0 in all other cases

The estimated expenditure elasticity and the Marshallian own-price elasticity are presented in Tables 2 and 3. As may be seen, all goods are observed to have positive expenditure elasticity; that is to say, none of the categories is an inferior good. This is the expected outcome, since the expenditure items considered in the equations involve a certain degree of aggregation and, although it may be the case that a specific good is inferior, it is unlikely that an entire category of goods would meet that definition. However, several expenditure groups are defined as necessities since their expenditure elasticity is less than one (including food, as might be expected). Conversely, fuel and public transport services conform to the profile of luxuries since their expenditure elasticity is greater than one. This means that the consumption of fuel and public transport services are highly sensitive to an income increase and, by extension, to the economic cycle.

The own-price elasticities have the expected sign for fuels and public transport services. Results show that demand for these goods is very sensitive to price changes, particularly in the case of group 16. In both cases, a 1% price increase will raise consumption of such goods more than proportionately.

The furniture and household services is the only group that exhibits a positive price elasticity mean. In any case, as can be seen in Table 3, this elasticity presents negative values at least for the last ten percentiles. So, since the zero value is included in any two-tail confidence interval for the standard confidence levels, we can consider that the elasticity of such goods is not significantly different from zero. Finally, all the goods analysed exhibit inelastic demands with the exception of private and public transport services and durable goods. Consequently, we can expect more than proportional changes in the demand for public transport as a reaction to VAT rate reductions.

Table 4 lists the cross-elasticities between the 16 groups of goods and the two groups concerned by the tax reform. For substitutes, cross-elasticity has to be positive. On the other hand, complementary goods have a negative cross-elasticity. With regard to fuels, the most important complementarity and substitutability relations arise with clothing and footwear and gas, respectively. On the other hand, alcoholic beverages is the consumption group with the higher positive cross-elasticity with respect to public transport, i. e., both groups are substitutes and this relationship is stronger than that between another group and public transport. The strongest observed complementary relationship between public transport and other consumption goods is with furniture. A conclusion that arises from Table 4 is that, as expected, fuel and public transport are substitutive goods, but this relation is weaker than other relationships observed between these two groups and other categories included in the AIDS model estimations.

After the estimation phase had been completed, the proposed tax reform, consisting of an increment of the VAT rate on fuels from the current 16 percent to 22.78 percent and the application of an exemption on public transport services was simulated. When P_j varies, it can be proved that shares variations are approximately equal to:

$$\Delta w_i = w_i \left(e_{ij} + \delta_{ij} \right) \frac{\Delta P_j}{P_j} \qquad [8]$$

where $\frac{\Delta P_j}{P_j}$ is approximately the VAT rate change and $\delta_{ij} = 1$, if $i = j$ and 0 otherwise. It can be observed that, according to equation (10), an inelastic good will increase its share –although its demand will decrease - if its price rises, as should be the case of fuel with the proposed reform. On the other hand, if own-price elasticity is higher than one, in absolute values, the share and demand quantity will increase where there is a price reduction, as expected for public transport services. Furthermore, complementary goods will increase their share of total expenditure when prices decrease because of tax cuts, but substitutes will reduce their share. Changes in the shopping basket induced by the simulated reform, using the consumption behaviour implicit in the AIDS model, are shown in Table 5. Such changes in the shares of each group of goods within total expenditure are a direct consequence of the own- and cross-effects on spending derived from the reform.

Moreover, although the proposed reform is revenue-neutral, it will induce changes in the real expenditure of households and hence, an expenditure effect is also incorporated in these changes.

Since public transport has an elastic demand and is substitute for fuel, the proposed reform must lead unambiguously to an increment in its share, as shown in Table 5. Although its demand is elastic, it is almost unitary and the estimated percentage increment in its share is smaller than the expected increments for other groups of goods such as furniture and communications. However, share variations for these groups are equal to their demand quantity changes, but not for public transport since its price would change. In fact, the increment in its share is much smaller than the demand quantity variation that, by applying simple algebra, can be assessed at approximately 9-percent rise.

Moreover, we may also expect a rise in the fuel share, since its demand is inelastic and its price is increasing. However, this effect would be partially counterbalanced by the drop in the public transport prices. The total effect of the proposed reform would be an increase in the share, but a drop in the demanded quantity of fuel, as we shall demonstrate below.

5. DISTRIBUTIVE AND WELFARE RESULTS

In this section, the distributive and welfare outcomes are analysed using population values. Even when dealing with revenue-neutral tax reforms, a thorough assessment of such reform requires prior knowledge on at least two critical issues. Firstly, it is necessary to calculate the effects of the tax reform on the expenditure distribution. Secondly, the effect on individual well-being and social welfare must be evaluated. The set of results obtained will enable us to establish a clearer view of the likely effect induced by the implementation of the analysed tax reform. These effects will be calculated from the elasticities presented in the previous section and derivated from the AIDS model.

First, we analyse the revenue effects by groups evaluated at population values that are displayed in Table 6. Obviously, these changes are related to changes in Table 5 (although these referred to the sample used to estimate the AIDS model) and the changes in the final prices of fuel and public transport services.

It can be observed that the revenue changes for the goods groups that would not suffer a price modification have the same sign as the changes in their expenditure shares displayed in Table 5, since the tax weight in their price would remain constant. Hence, for these groups revenue or share changes are related to changes in their demand due to relative price, and in less extend real expenditure, changes. However, for fuel, we have pointed out that the proposed reform would imply an increment in its expenditure share, as the expected percentage increment in prices would be higher than the percentage decrease of the demand. This is clear from Table 6, since the (unaltered) excise duties would be lower by more than 4 percentage points. This decrease represents the reduction in the expected demanded quantity. On the other hand, VAT revenue would rise by 36 percent, although the VAT rate would rise to more than 40 percent. The total expected effect is a 4- percentage point increase in the total revenue for this group. Finally, the revenue associated to public transport services would disappear.

These changes in the revenue prove that the changes in indirect tax revenue are not equally distributed. Hence, as regards expenditure distribution, we can establish that the reform considered here leads to slightly increased inequality, as shown in the Gini indices in Table 7.

In addition, the reforms considered here impair the redistributive capacity of indirect taxation, as evidenced by the Reynolds-Smolensky index in Table 7. This is due mainly to the loss of progressiveness of indirect taxation, computed via the Kakwani index.

The effects of such reforms on the individual well-being may be studied using two approaches: firstly, through the assessment of the reform just after its introduction (static monetary variation). That is, it is assumed that in the short term, households do not modify their behaviour in response to fiscal parameter changes; and secondly, the individual well-being is assessed through Hicks' Equivalent Variation and Compensating Variation (1939) and King's Equivalent Expenditure (1983) which assume that households reallocate expenditure where relative prices change.

The equivalent expenditure, given a vector of reference of prices, P_R , is defined as the expenditure level that allows the household to attain a reference level of utility, v_R. That is, if the indirect utility function is known, the equivalent expenditure can be obtained by solving the following equation:

$$v(P_R, G_e) = v_R \qquad [9]$$

That can be expressed in terms of the expenditure function as:

$$G_e = e(P_R, v_R) \qquad [10]$$

In order to evaluate a fiscal reform, the equivalent expenditure measure can be computed at the initial level of utility achieved by the household, v^0, and will be identified as the initial equivalent expenditure, G_e^0, or at the post-reform level of utility, v^1, and be called final equivalent expenditure, G_e^1.

$$G_e^0 = e(p^1, v^0) \qquad [11]$$

$$G_e^1 = e(p^0, v^1) \qquad [12]$$

A fiscal reform that generates welfare gains will imply that: $G_e^0 < G < G_e^1$ where G represents the actual level of expenditure. If the reform means losses, then this order is reversed having: $G_e^0 > G > G_e^1$.

In Table 8, these measures are presented by deciles. In all the cases, the final equivalent expenditure is smaller than the real expenditure and this, in turn, is smaller than the initial equivalent expenditure. Hence, according to this measure, the proposed reform will imply losses along all the expenditure distribution.

This order can be informative, but the particular value of the welfare gain or loss for each taxpayer can be assessed as the difference between his initial and final equivalent expenditures:

$$GEB_i = G_{e_i}^1 - G_{e_i}^0 \qquad [13]$$

The Compensating Variation (CV) and the Equivalent Variation (EV) are also metrics that represent monetary equivalents of changes in welfare. CV is defined as the monetary amount by which the impaired households should be compensated, or which should be demanded from the gainers due to the price change induced by the reform. This compensation allows us to maintain households on the initial indifference curve. EV is identified with the amount of money that the households which lost (gained) in the reform would be willing to pay to prevent (ensure) the actual occurrence of the change in the price vector. The Equivalent Variation and the Compensating Variation, as King (1983) proved, can be expressed in terms of the equivalent expenditure as:

$$VC = e\left(p^1, v^0\right) - e\left(p^0, v^0\right) = G_e^0 - G \qquad [14]$$

$$VE = e\left(p^1, v^1\right) - e\left(p^0, v^1\right) = G - G_e^1 \qquad [15]$$

CV and EV thus defined (Deaton and Muelbauer, 1980b; Creedy, 1999) will both take on negative values when there is a gain in welfare, and positive values if there is a loss.

These measures depend on the particular form of the indirect utility function. In the particular case of an AIDS model, the aforementioned function, expressed in logarithms terms, is (Baker, Blundell and Micklewright, 1989):

$$\ln v = \frac{\ln y - \ln a(p)}{b(p)} \qquad [16]$$

where *b(p)* and $\ln a(p)$ are defined as:

$$b(p) = \beta_0 \cdot \prod_{i=1}^{16} p_i^{\beta_i} \qquad [17]$$

and

$$\ln a(p) = a_0 + \alpha_i \sum_{i=1}^{16} \ln p_i + \frac{1}{2} \sum_{i=1}^{16} \sum_{j=1}^{16} \gamma_{ij} \ln p_i \ln p_j \qquad [18]$$

Thus, taking into account the equivalent expenditure definition, we have:

$$\frac{\ln G - \ln a(p)}{b(p)} = \frac{\ln G_e - \ln a(P_R)}{b(P_R)} \qquad [19]$$

Hence, the explicit function of the equivalent expenditure used in this empirical research is:

$$\ln G_e = \frac{b(P_R)}{b(p)} [\ln G - \ln a(p)] + \ln a(P_R) \qquad [20]$$

Therefore, the initial and final equivalent expenditures that we have computed for the micro-simulation of the proposed tax reform are defined, respectively, as:

$$\ln G_e^o = \frac{b(p_1)}{b(p_0)} [\ln y - \ln a(p_0)] + \ln a(p_1) \qquad [21]$$

$$\ln G_e^1 = \frac{b(p_0)}{b(p_1)} [\ln y - \ln a(p_1)] + \ln a(p_0) \qquad [22]$$

The static monetary variation evaluates changes in the total monetary expenditure in the short run, that is, just before the consumers have had enough time to modify their behaviour under the new prices. It is defined as:

$$SMV = \sum_{i=1}^{16} w_{ih}^0 x_{ih}^0 \left(p_i^0 - p_i^1\right) / \, p_i^0 \qquad [23]$$

being x_{ih}^0 the pre-reform demanded quantity for the i-th good and the j-th household and w_{ih}^0 the expenditure share for the same good and household. This index will take positive values if the tax reform increases welfare and will have a negative sign otherwise.

Differences in the consumption patterns along the expenditure distribution compel us to study how losses originated by the proposed reform are distributed. As a starting point, Table 9 contains the distribution of such losses by expenditure deciles. As stated previously in Table 8, the results in Table 9 show that the proposed reform would induce, on average, welfare losses in the short and long terms, regardless of the index used to evaluate these changes.

Three effects must be stressed. Firstly, welfare losses are substantially greater if we take into account household behaviour (SME takes the smallest values). Secondly, in absolute terms, these average welfare losses are not very important, since they represent a small percentage in the average household's spending. Finally, results clearly indicate that welfare losses grow with expenditure. Even more, welfare losses of the households from the last decile are more than 15 times greater than those from the first decile.

As a supplement to the analysis of individual well-being, the effects on social welfare of the proposed tax reform have been analysed. Specifically, Table 10 shows the results for the Atkinson indices and King's lambda for different values of the inequality aversion parameter, ε. These results show a small loss in social welfare.

In order to determine the efficiency changes, the usual strategy is to estimate the deadweight loss of the proposed reform, that is, the difference between one of the Hicksian measures associated to the change, *CV* or *EV*, and the revenue variation for the j population households. Hence, there are two possible ways to calculate the efficiency changes using this approach:

$$CDL = \sum_j CV_j + \sum_j \left(R_j^1 - R_j^0\right) \qquad [24]$$

$$EDL = \sum_j EV_j + \sum_j \left(R_j^1 - R_j^0\right) \qquad [25]$$

Finally, using these measures, Table 11 shows that the tax reforms simulated here produce both losses and gains in efficiency. Since the proposed reform is revenue-neutral, the average deadweight loss is equal to the average *EV* or *CV*, respectively. However, the distribution of these efficiency effects along the income distribution is dissimilar. In fact, for the first seven deciles, the deadweight loss is lower than the respective Hicksian measure. This signifies that for these households, there are average increments in their tax bills.

This result is confirmed by the distribution of winners and losers, in respect of their tax bills, along the income distribution displayed in Table 12. So, although both fuels and public transport are luxury goods, the higher the income decile, the lower the average losses associated with the proposed reform. This result explains the small increment in inequality mentioned above and may be related to the distribution of the demand of certain public transport services such as air travel or high speed trains.

6. CONCLUSIONS

In this paper, we have simulated a transportation policy based on the simulation of tax changes for Spain. We adopted a two-step procedure, the first of which was to estimate the elasticities of demand by group of goods, using an Almost Ideal Demand System of equations (Deaton and Muelbauer, 1980a, 1980b). Next, we have simulated the change on fuel tax needed to finance the elimination of VAT in public transportation in order to leave total revenue unchanged. The results displayed enable us to derive the conclusion that this policy can be enforced in Spain. The results show a small loss in social welfare. Moreover, although both fuels and public transport are luxury goods, differences in the consumption pattern along the expenditure distribution signify that the higher the income decile, the lower the average losses associated with the proposed reform. Therefore, the general conclusion is that there is room to implement such a policy in the Spanish economy. This policy would enable private transportation usage to

be substituted by public transportation, leading to urgently needed decreases in pollution and congestion. More investigation is needed to clarify the present results.

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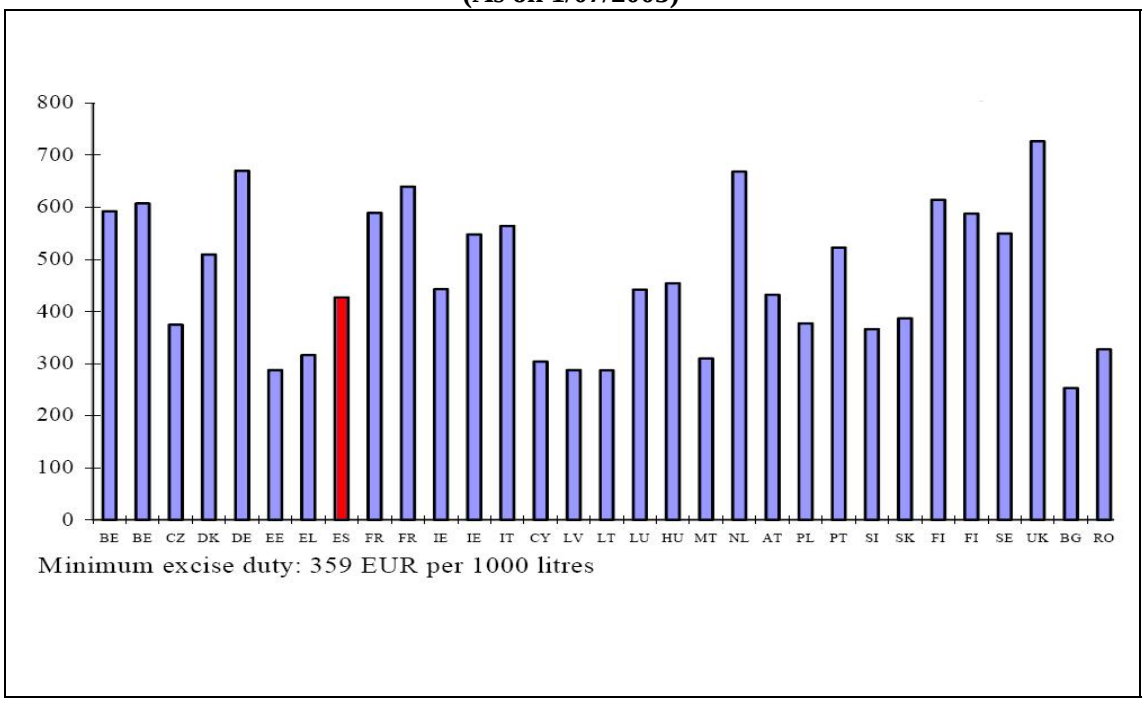
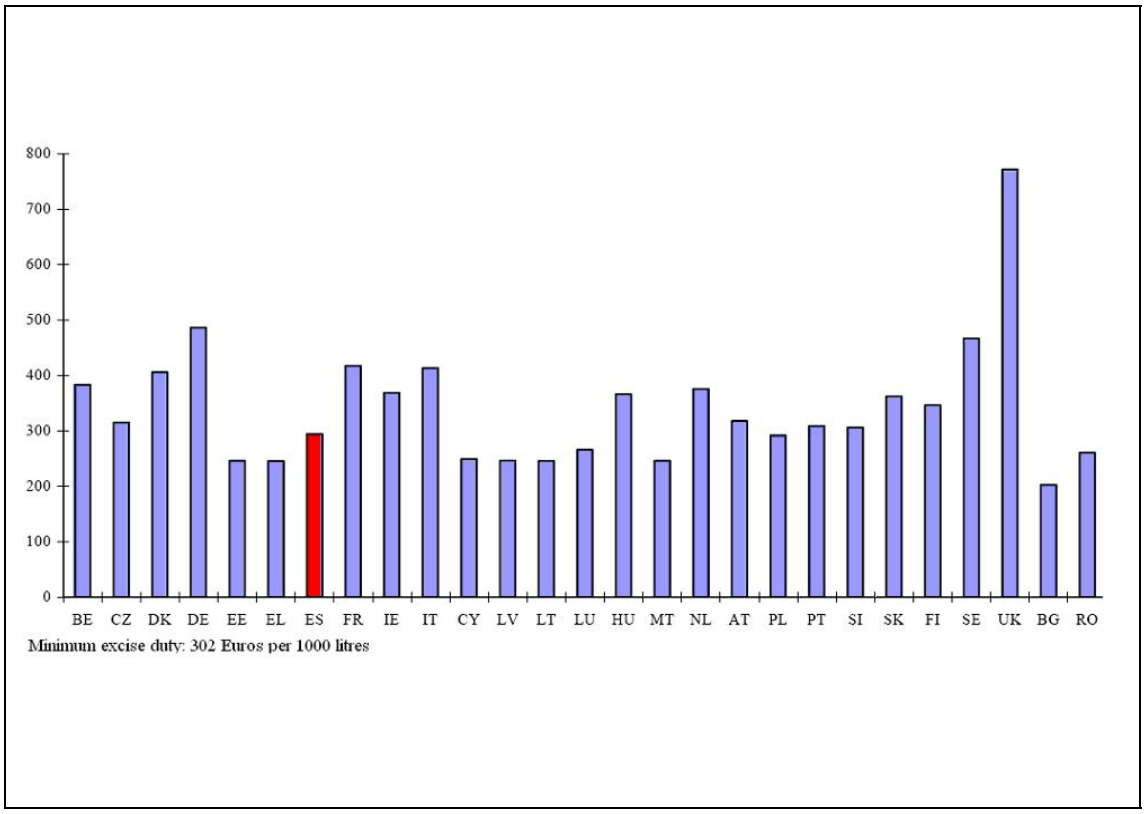
Figure 1
Unleaded Petrol Excise Duty Rate
(As on 1/07/2005)



Source: European Union (2005a)

Figure 2
Gas Oil Excise Duty Rate
(As on 1/07/2005)



Source: European Union (2005a)

Table 1
Excise Duty on Energy Products (2005)

	Leaded Petrol (per 1000 litres)	Unleaded Petrol (per 1000 litres)	LPG (per 1000 litres)
Minimum excise duty adopted by the Council on 27-10-2003 (Dir. 2003/96/EC)	421 €	359 €	302 €
Spain	428.79€	<97 oct. I.O. 395.69€ ≥97 oct. I.O. 426.92€	293.86€

Source: European Union (2005a)

Table 2
Expenditure elasticities, by group of goods

Expenditure group	Mean	Percentile 90	Percentile 99
1. Food and non-alcoholic beverages	0.629	0.776	0.849
2. Alcoholic beverages	0.663	0.857	0.948
3. Tobacco	0.809	0.914	0.955
4. Clothing and footwear	1.139	1.070	1.041
5. Housing	0.793	0.876	0.922
6. Furniture and household equipment	0.944	0.966	0.984
7. Gas	0.691	0.846	0.930
8. Medical and pharmaceutical products and services	1.059	1.026	1.010
9. Fuel	1.246	1.128	1.073
10. Private transport services	1.201	1.093	1.045
11. Public transport	1.015	1.006	1.002
12. Communications	0.864	0.922	0.961
13. Leisure, entertainment and holidays	1.437	1.228	1.146
14. Education	1.300	1.114	1.048
15. Consumer durables	1.488	1.178	1.065
16. Other goods not listed above	1.275	1.137	1.040

Note: Population values

Table 3
Own-price elasticities, by group of goods

Expenditure group	Mean	Percentile 90	Percentile 99
1. Food and non-alcoholic beverages	-0.242	-0.513	-0.647
2. Alcoholic beverages	-0.332	-0.714	-0.894
3. Tobacco	-0.874	-0.940	-0.966
4. Clothing and footwear	-0.647	-0.827	-0.904
5. Housing	-0.814	-0.869	-0.899
6. Furniture and household equipment	0.506	-0.096	-0.556
7. Gas	-0.571	-0.784	-0.899
8. Medical and pharmaceutical products and services	-0.815	-0.921	-0.970
9. Fuel	-0.817	-0.911	-0.955
10. Private transport services	-1.853	-1.398	-1.198
11. Public transport	-1.003	-1.001	-1.001
12. Communications	-0.980	-0.987	-0.992
13. Leisure, entertainment and holidays	-0.668	-0.857	-0.931
14. Education	-0.123	-0.670	-0.865
15. Consumer durables	-1.570	-1.233	-1.109
16. Other goods not listed above	5.411	2.186	-0.062

Note: Population values

Table 4
Ordinary cross-elasticities

	Fuel	Public transport
1. Food and beverages	-0.056	-0.081
2. Alcoholic beverages	-0.023	0.713
3. Tobacco	0.006	0.112
4. Clothing and footwear	-0.520	-0.145
5. Housing.	0.133	0.044
6. Furniture and household equipment	-0.039	-0.308
7. Gas	0.236	0.189
8. Medical and pharmaceutical products and services	-0.122	-0.032
9. Fuel	-0.817	0.029
10. Private transport services	0.148	0.060
11. Public transport	0.122	-1.003
12. Communications	0.193	-0.246
13. Leisure, entertainment and holidays	0.012	-0.142
14. Education	0.146	0.207
15. Consumer durables	0.018	0.429
16. Other goods not listed above	-0.190	0.675

Note: Population values

Table 5
Expenditure shares pre- and post-reform (behavioural impact)

Expenditure group	Initial scenario		Final scenario		%
	Mean	Std. Dev.	Mean	Std. Dev.	variation
1. Food and beverages	0.2016	0.1028	0.2021	0.1028	0.2008
2. Alcoholic beverages	0.0076	0.0146	0.0072	0.0145	-4.7355
3. Tobacco	0.0197	0.0280	0.0195	0.0279	-0.7283
4. Clothing and footwear	0.0738	0.0568	0.0723	0.0567	-2.0492
5. Housing.	0.2347	0.1218	0.2358	0.1218	0.4729
6. Furniture and household equipment	0.0900	0.0555	0.0916	0.0555	1.8504
7. Gas	0.0147	0.0137	0.0147	0.0137	0.0891
8. Medical and pharmaceutical products and services	0.0279	0.0370	0.0278	0.0370	-0.4928
9. Fuel	0.0359	0.0397	0.0363	0.0397	1.2731
10. Private transport services	0.0262	0.0328	0.0263	0.0328	0.6453
11. Public transport	0.0088	0.0162	0.0089	0.0162	1.1678
12. Communications	0.0211	0.0155	0.0217	0.0155	2.9770
13. Leisure, entertainment and holidays	0.1360	0.1009	0.1375	0.1009	1.1107
14. Education	0.0162	0.0287	0.0161	0.0287	-0.5151
15. Consumer durables	0.0670	0.1205	0.0652	0.1203	-2.5890
16. Other goods not listed above	0.0190	0.0279	0.0179	0.0278	-5.4891

Note: Sample values

Table 6
Revenue by groups of goods
(in millions of €)

Expenditure group	Initial scenario		Final scenario		Total revenue variation in %
	excise duties	VAT	excise duties	VAT	
1. Food and beverages	0.000	2068.481	0.000	2073.520	0.24
2. Alcoholic beverages	115.247	215.899	109.177	204.529	-5.27
3. Tobacco	2167.826	525.244	2149.009	520.685	-0.87
4. Clothing and footwear	0.000	2019.747	0.000	1978.184	-2.06
5. Housing.	0.000	0.000	0.000	0.000	0.00
6. Furniture and household equipment	175.196	2427.498	178.576	2474.330	1.93
7. Gas	323.981	355.900	324.165	356.101	0.06
8. Medical and pharmaceutical products and services	0.000	142.330	0.000	141.649	-0.48
9. Fuel	4088.883	1075.105	3907.546	1462.867	4.00
10. Private transport services	0.000	492.527	0.000	495.239	0.55
11. Public transport	0.000	127.832	0.000	0.000	-100.00
12. Communications	0.000	542.919	0.000	560.451	3.23
13. Leisure, entertainment and holidays	0.000	2104.743	0.000	2124.792	0.95
14. Education	0.000	480.043	0.000	477.664	-0.50
15. Consumer durables	672.854	2810.615	659.858	2756.328	-1.93
16. Other goods not listed above	0.000	348.260	0.000	326.458	-6.26

Note: Population values

Table 7
Distribution, progressiveness and redistribution indices

	Pre-reform	Post-reform
Gini gross expenditure	0.3178291	
Gini net expenditure	0.3134844	0.3135633
Reynolds-Smolensky index	0.0043447	0.0042658
Average rate	0.1137857	0.1137857
Kakwani progressiveness index	0.0385543	0.0381203
Reordenation income index	0.0006054	0.0006287

Note: Population values

Table 8
Distributive analysis of welfare (in €)

Decile	Expenditure (G)	Initial equivalent expenditure (G_e^0)	Final equivalent expenditure (G_e^1)
1	5793.62	5802.57	5784.69
2	9241.68	9258.84	9224.56
3	11766.52	11790.35	11742.75
4	14150.16	14180.67	14119.74
5	16473.55	16510.83	16436.38
6	19019.09	19064.08	18974.25
7	21979.54	22033.77	21925.49
8	25904.45	25971.40	25837.72
9	31988.39	32075.87	31901.21
10	48288.01	48435.09	48141.48
Average	20460.50	20512.35	20408.83

Note: Population values

Table 9
Distributive analysis of welfare (in €)

Decile	Equivalent welfare change	Static monetary variation	Equivalent variation (EV)	Compensating variation (CV)
1	-17.88	-1.9	8.93	8.95
2	-34.28	-11.06	17.12	17.16
3	-47.6	-17.23	23.77	23.83
4	-60.93	-24.13	30.42	30.51
5	-74.45	-30.32	37.17	37.28
6	-89.83	-35.67	44.85	44.98
7	-108.28	-42.92	54.06	54.23
8	-133.68	-45.93	66.73	66.95
9	-174.66	-50.49	87.18	87.48
10	-293.61	-68.18	146.53	147.08
Average	-103.52	-32.783	51.676	51.845

Note: Population values

Table 10
Atkinson index & King's lambda

ε	Pre-reform		Post-reform		
	Atkinson index	**Initial equally-distributed equivalent expenditure**	**Atkinson index**	**Final equally-distributed equivalent expenditure**	**King's lambda**
0	0.000	17684.529	0.000	17595.281	0.995
0.5	0.081	16245.570	0.081	16167.332	0.995
1	0.160	14862.375	0.159	14794.469	0.995
1.5	0.235	13528.474	0.234	13470.293	0.996
2	0.308	12240.685	0.307	12191.650	0.996
2.5	0.378	11001.856	0.377	10961.349	0.996
3	0.445	9822.922	0.444	9790.189	0.997
3.5	0.507	8722.643	0.506	8696.732	0.997
4	0.563	7723.366	0.562	7703.139	0.997
4.5	0.613	6843.440	0.612	6827.683	0.998
5	0.656	6090.538	0.655	6078.125	0.998

Note: Population values

Table 11
Efficiency analysis

Decile	Equivalent deadweight loss (EDL)	Compensating deadweight loss (CDL)	Relative change in efficiency EDL / R_1	Relative change in efficiency CDL / R_1
1	8.86	8.88	0.00014	0.00014
2	15.78	15.82	0.00014	0.00014
3	22.73	22.79	0.00014	0.00014
4	28.92	29.00	0.00014	0.00014
5	35.15	35.26	0.00014	0.00014
6	41.96	42.10	0.00014	0.00014
7	51.97	52.14	0.00014	0.00014
8	68.07	68.28	0.00015	0.00015
9	91.24	91.53	0.00016	0.00016
10	152.08	152.63	0.00017	0.00017
Mean	51.6.76	51.8.45		

Note: Population values

Table 12
Winners and losers distribution per deciles

Decile	% winners	% losers
1	29.02	70.98
2	36.07	63.93
3	38.68	61.32
4	38.56	61.44
5	36.95	63.05
6	38.34	61.66
7	40.63	59.37
8	44.20	55.80
9	47.06	52.94
10	48.52	51.48

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