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A distributive analysis of the impact of CO2 tax in Spain

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Abstract

The establishment of a harmonized carbon tax is becoming one of the most important fiscal policy proposals in order to reduce carbon dioxied, which is one of the main contributors to greenhouse gasses. In this paper we evaluate the distributional impact in the tax burden of implementing a CO2 excise tax in Spain. Our main conclusion is that adding a carbon tax in the indirect structure of the Spanish Tax System would not significantly affect the current regressivity of excise taxes.

Keywords: energy policy, environmental taxes, distribution.

JEL Classification: C33, D58, H30.

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1. Introduction

The European Union together with the US after the new Obama Administration took over are ahead of the world in the compromise of reducing enviromental pollution in the medium term.[1] The European Union (EU) climate and energy policy has recently set ambitious targets for 2020 in order to make member countries reduce their CO2 emissions. In particular, the EU's climate and energy policy has recently set the following ambitious targets for 2020: 1) cutting greenhouse gases by at least 20% of 1990 levels (30% if other developed countries commit to comparable cuts), 2) increasing use of renewables (wind, solar, biomass, etc) to 20% of total energy production (currently ± 8.5%), 3) cutting energy consumption by 20% of projected 2020 levels - by improving energy efficiency.

The idea of considering fiscal policy as an adequate instrument to foster changes in energy production to less polluting systems stems from the early nineties in the European Union. In fact, it was first legally developed in the Resolution of the Council for Energy and Enviromental issues of the 29th october 1990.[2] In principle, the EU's main weapon in tackling climate change is the 2005 emission trading scheme established most recently following the directions of the Kyoto protocole in Directive 2003/ 96/CE. However, since recent times the European Comission is intensely working on the best way to improve the schem which, in practice, has been proved to have a number of drawbacks. Further, while there is an EU agreement to reduce emissions by 20% relative to 1990 levels by 2020, rising to 30% in the event of a global deal on emissions, the empirical evidence on the evolution of the share of green taxes on total receipts is clearly declining. In fact, Johnson, Leicester and Levell (2009) show that in the UK between 1997 and 2009 green taxes as a share of total receipts fell from 9.5% to 7.9% and are now about a 3% of GDP where fuel duty is three quarters of the total (it fell from 3.3 to 2.8 percent of GDP in the same period). In the same fashion, many EU

[1] "Global warming is happening because of large amounts of energy that humans produce and use. As our energy needs grow, so too does our dependency on fossil fuels (oil, natural gas and coal). These fuels – all with high CO2 emissions – now account for some 80% of EU energy consumption. A major turnaround in energy use and production is vital for the EU to achieve its targets and fight climate change. The EU's action will therefore address key areas such as electricity and gas markets, energy sources, consumer behaviour and closer international cooperation." (http://ec.europa.eu/climateaction/eu_action/index_en.htm)

[2] In fact, it was first legally developed in the Resolution of the Council for Energy and Enviromental issues of the 29th october 1990.This resolution had the aim to reduce CO2 emissions in 2000 to those of 1990. The relevance of his resolution is the fact that, from then onwards, fiscal policy is seen as of special relevance in fighting climate change.

countries have reduced the weight of environmental tax receipts in proportion of GDP from 1997 up to 2007.

In this setting, the establishment of a harmonized carbon tax is becoming one of the most important fiscal policy proposals in order to reduce carbon dioxied, which is one of the main contributors to greenhouse gasses. The so-called “carbon tax” is the most well-known market-based incentive mechanism: a Pigouvian indirect tax on burning of fossil fuels in proportion to their carbon content which would have the advantage of providing substantial additional fiscal revenues to member countries.

Carbon tax is an environmental tax levied on the carbon content of fossil fuels (natural gas, coal and petrol) which is released when these are burnt. The tax can be implemented by taxing the burning of fossil fuels in proportion to their carbon content. A carbon tax is a Pigouvian indirect tax that should equal the marginal damage cost of pollution, i.e. the marginal cost of emitting one extra tonne of carbon at any point in time. As Pearson and Smith note the difference of market-based incentive mechanisms such as taxation compared to other solutions is that additional fiscal revenues are obtained. Indeed, in the particular case of carbon tax, revenues could be substantial.

However, this tax may have undesirable effects on the redistributive impact of member countries’ fiscal systems given that, generally, the proportion of income destined to energy consumption is relatively large in low income groups compared to high income groups. Most recently, Callan *et al.* (2008) suggest “in contrast with other policy instruments, a carbon tax has the distinct advantage that it generates revenue that can be used to even out undesired side-effects of greenhouse gas emission reduction”. Thus, as the negative effects of a carbon tax are generally concentrated in the lower income groups, making carbon tax regressive, the use of, at least part of the revenue, on social welfare payments may play in favour implementing a carbon tax policy. In particular, the system’s progressivity may be furtherly improved if carbon tax revenue, or at least part of it, is used to allow for changes in other taxes or to redesign social transfers. This may play in favour of making the carbon tax policy neutral and therefore help in sustaining the proposal as politically acceptable.

In this paper our aim is to analyze how much different income and expenditure deciles and different types of households would pay if a carbon tax was established in Spain. For this purpose, we examine in detail the distribution of the tax burden using information from the Spanish Household Budget Survey (*Encuesta de Presupuestos Familiares*) for 2008. As a future extension, our idea is, making use of a tax-benefit model, to provide results on the impact of different alternative policies that may compensate the impact on fiscal progressivity of existing and the new tax by either changing other tax rates for low income households or increasing certain social welfare transfers.

2. Evidence and previous results in the literature

In economics, the relevance of the literature on tax incidence was largely fostered by the seminal work of Harberger (1962). He presented an analysis of the general equilibrium incidence of corporate income tax on firm utility and his work provided the formal basis for subsequent general equilibrium analysis of the incidence of other taxes on individual utilities. In any case, tax incidence can also be evaluated in other dimensions such as that related to the different impact of a tax on consumers living in different geographical areas (geographical tax incidence) or those situated at a variety of points in the consumption or income distribution (distributive tax incidence).

Regarding the results within the literature on the distributional analysis of energy and carbon taxes we find that most authors suggest that these taxes tend to be regressive.[3] As noted in Callan *et al.* (2008) among the first papers on the matter is Poterba (1991) who shows that implementing a gasoline tax in the US using data from the US Consumer's Expenditure Survey and assuming a zero demand for fuel elasticity is slightly regressive.[4] Similarly, Pearson and Smith (1991) obtain an analogous result for a group of European countries like France, Germany, Italy, The Netherlands, the UK, Ireland and Spain. However, these authors underline that their findings support the idea that the dimension of the tax burden (relative to resources) on the poor compared to that of the rich is significantly different between countries. Indeed, while in most of the countries they analyse the tax would be weakly regressive, in the UK and Ireland the dimension of the tax burden on the poor is particularly large (especially in the case of

[3] Note that in this paper we only refer to the distributional direct effects of a carbon tax and avoid measuring the indirect distributional effects of taxes on industrial outputs on final consumers and on capital, labour and natural resources.

[4] Note that the demand for energy has not responded strongly to price changes so, in general, one could conclude that energy has low demand elasticity and thus the cost of reducing emissions will be higher than otherwise.

Ireland). Barker and Köhler (1998) update this work using more recent data and draw similar conclusions. In the case of Spain, Pearson and Smith (1991) show that, using data from 1988, household spending on energy in this country, in the same way as in Italy, France or Germany is only weakly related to household income.

3. The Spanish tax system: green taxes

Environmental taxation in Spain is becoming a field of particular interest in policymaking in recent years, even if still in a heterogeneous and diffuse way. In fact, up to now, the central government tax policies on the matter are rather limited. The most important environmental component in central government taxation is the so-called *Tax on specific transport vehicles* which is integrated within a large list of other excise taxes. This tax is levied on the acquisition of vehicles favouring the purchase of those with lowest environmental damaging emissions. Apart from this tax, only a few other tax reliefs could be identified to be focussed on encouraging good practices in this matter, examples of these are the current tax credit in Corporate Tax for firms who invest in environmental protection, or the tax credit for transport coupons in Personal Income tax.

Green taxes have been significantly more developed at the regional level. Focusing on emissions, Andalucía, Aragón and Galicia have set taxes on carbon dioxide (CO2), nitrogen oxides (NOx) or sulfure oxides (SOx). These taxes are directly levied on the facilities responsible for the emissions, and are quantified through direct measurement. In this sense, most of these taxes are not coordinated with the regulations of the European Regime of emission rights, and they generate, in many cases, a duplicity of instruments in the fight against climate change. In general, these taxes revenue power is generally scarce, while it is often linked to enviromental actions.

4. A methodology for analysing the distributional impact of a CO2 tax

As Labandeira *et al.* (2009) note, economists have traditionally focused on the consequences of public intervention on economic efficiency while the distributional effects of a certain public policy often have a key role in determining its acceptability and therefore its applicability. The aim of distributive incidence analysis is to determine how the fraction of household income destined to pay a carbon tax, the tax burden, changes as household income or expenditure increase. If this fraction is decreasing with income or expenditure carbon tax will be regressive while if it is proportional carbon tax will be neutral. Poterba (1989) and Fullerton and Metcalf (2002) underlined that the adequate measurement of the tax burden is difficult because the annual tax burden may largely differ from what a consumer will support all along the life cycle. Thus, as Agostini and Jiménez (2009) underline the use of consumption data together with income data is a good alternative in order to reduce the relevance of annual income instability and it, implicitly, allows for incorporating the effects of individual differences on asset accumulation which may influence consumption but may not be captured by income. In fact, Fullerton and Rogers (1991) compare life cycle with annual incidence of taxes and obtain that income taxes are less progressive and consumption taxes are less regressive if one chooses life cycle approach instead of an annual approach. However, these authors underline that life cycle tax incidence analysis should be a complementary approach to an annual tax incidence one given that statistical data on incomes and expenditures is not usually measured in long periods of time.

In order to measure progressivity we first show the distribution of the tax burden by deciles. In a second step we assess progressivity graphically through the comparison of the tax burden concentration curve and the income or expenditure concentration curve. Both of these curves are plotted against the cumulative proportion of the sample ordered by income or expenditure level on the x-axis. On the y-axis we plot both the cumulative proportion of tax burdens, that is $L_{TB}(p)$ and the cumulative proportion of income or expenditure $L_{INCOME}(p)$ or $L_{EXP}(p)$. These graphs are useful for detecting departures from proportionality and identifying their location in the distribution of the tax burden but just this visual analysis becomes difficult when a variety of comparisons are to be made given that it is not possible to undertake a cardinal comparison of tax burdens related to different carbon tax proposals. In this context, we find that it is also useful to calculate a summary index of progressivity. For this purpose we calculate two of the most widely used indices to measure progressivity which are directly related to the graphical method we have described above: the Kakwani index (see Kakwani, 1977).[5] The Kakwani index is defined as twice the area between a tax burden concentration curve and the income or expenditure Lorenz curve and is calculated as (see Lambert, 1993):

[5] Following Lambert (1993) the minimal requirement of a progressivity index is that if the tax schedule is changed such that a measure of local progression increases at every income level, and if the pre-tax income does not change, then progressivity should increase. The Kakwani index fulfils this minimum requirement.

$$\rho_T^K = 2\int_0^1 [L_X(p) - L_T(p)]\,dp = C_T - G_X$$

where C_T is the concentration coefficient of the tax burden and G_X is the original income or expenditure Gini coefficient. In particular, we can compute the concentration coefficient as:

$$C_T = \left[\frac{2\,\mathrm{cov}(T_i, R_i)}{\mu}\right]$$

where T_i is the individual tax burden, μ is its mean and R_i is the *i*th individual's fractional rank according to the income or expenditure distribution. As Lambert (1993) shows another interesting index of this kind is that proposed by Suits (Suits, 1977). This index can be seen as a modified Kakwani index where the distances between concentration curves are weighted in each percentile by a factor before integrating. Weights are equivalent to the relationship between income in the percentile and mean income. An attractive property of the Suits index is that its value lies between -1 and 1 (the former being the case when the poorest person pays all the tax, extreme regression, and the latter when the richest person does, extreme progression) while the limits of the Kakwani index depend on the inequality of pre-tax income. The maximum value of the Kakwani index is $-(1+G_X)$ in case of maximal regression and $1-G_X$ for maximal progression. Thus, in the limit, ρ_T^K ranges from -2 to 1. A negative number indicates regressivity so that $L_T(p)$ lies inside $L_X(p)$ which implies that the tax burden is less unequally distributed than income or expenditure. A positive number indicates progressivity so that $L_T(p)$ lies outside $L_X(p)$ which implies that the tax burden is more unequally distributed than income or expenditure.

5. The impact of changes in low income household tax rates or revenue recycling on income distribution: An empirical application

5.1.1. The impact of carbon taxes on revenue and progressivity

One of the main reasons that strengthen the green tax reforms is the double dividend, that is, the revenue received from taxes aimed at environmental protection, is then used to offset other tax burdens already existing such as the reduction of the personal income tax or social contributions. In this section we will focus on simulating several several carbon taxation scenarios in the Spanish context. Our aims here are is both to measure the expected revenue increase due to the changes in the tax system and to estimate the regressive effects of indirect taxation. The revenue increase obtained from the different reforms could, for example, be used to diminish the tax burden of the personal income tax, improving efficiency (distortion reduction) and equity (progressivity due to revenue redistribution).

5.1.2. Current regulation and simulated reforms

The Spanish regulation puts the carbon consumption down to two indirect ways of taxation. On the one hand the VAT rate is 18% in 2010 (reference year for simulation comparisons) but also additional payments are mandatory such as 433,79 € per 1000 liters of unleaded petrol; 431.92 € for unleaded petrol of 97 I.O or higher, 400,69 € for other unleaded petrol, and 307 € for diesel. It is easy to see that all these are *ad quantum* excise duties.

Apart from these two taxes and, depending on the region, an additional tax, also *ad quantum*, is set for trade retailers. In this case, we have decided to add up 24 € per 1000 liters of carbon, although this decision can be changed by regional governments. Therefore the final expression used to modify carbon prices due to the taxation effect is:

Final price=(price without tax+tax due to retailer trade+ excise duty tax)*(1+VAT rate)

It can be easily seen that any changes on specific carbon taxation increases VAT revenue, although VAT rates are not modified, just by making excise duties part of the VAT tax base.

In the European Union, the current debates on optimal environmental tax reform suggest an increase on carbon tax taking into account CO_2 emissions. Following other countries' experiences as well as the most likely future proposal we have finally decided to simulate a new excise duty (which would be included in the existing excise duty) with the following figures: 1, 8, 17, 20, 27, 32, 45 and 100 € per Ton of CO2 emission[6].

The equivalence between *ad quantum* rate in terms of CO2 emissions and liters consumption is described in the following table:

Simulation (excise duty added to the existing)	Euro cents per litre of petrol	Euro cents per litre of diesel	Average euro cents per litre of carbons
Reform 1: 1 € per Tn of CO2	0,208	0,230	0,219
Reform 2: 8 € per Tn of CO2	1,668	1,839	1,753
Reform 3: 17 € per Tn of CO2	3,544	3,908	3,726
Reform 4: 20 € per Tn of CO2	4,169	4,598	4,384
Reform 5: 27 € per Tn of CO2	5,628	6,207	5,918
Reform 6: 32 € per Tn of CO2	6,671	7,357	7,014
Reform 7: 45 € per Tn of CO2	9,381	10,345	9,863
Reform 8: 100 € per Tn of CO2	21,846	22,990	21,918

5.1.3. Limitations of the study

The limitations of our study are related to data and tools availability. An ideal simulation should analyze the taxation of petrol and diesel for every economic agent (families and firms), and should take into account the effect that taxes generate on their decisions. The available data, for now, forces us to restrict the focus on households. Besides, we do not have separate information about the kind of hydrocarbons that are consumed, so that we impose the same taxation for dieses and petrol, even if we are conscious that the taxation is different. The eight alternative simulations have been made using the Indirect Taxation Microsimulator developed by the Spanish Institute for Fiscal Studies, which includes VAT and excise taxes. We aim to measure the "day-after" effects, given that non response is included in family consumption decisions.

[6] Since the simulation tools in the IEF let the user define an *ad quantum* and an *ad valorem* component, the previous figures are recalculated from € per Tn of CO2 emission to euro cents per litre and they are included as an extra *ad quantum* excise duty. To do so one must bear in mind that petrol density is 680 gr per litre, and diesel density, 850. Also, 1 kg of petrol produce emissions of 3,065 kg of CO2 (1 kg of diesel produce emissions of 2,705 kg of CO2)

Further, all results are within a partial equilibrium since they refer to effects in the short run and are restricted to a particular sector.

5.1.4. Results

Results are subdivided in three gropus:

a) Effects on total revenue
b) Effects on progressivity
c) Evolution of effective tax rates

a) <u>Effects on total revenue</u>

We start discussing the results refered to revenue changes due to CO2 tax. The eight simulated reforms (R1 to R8) generate an increase in tax revenue. This effect is caused by the direct increase in excise tax and by an indirect effect in VAT revenue as excise tax is a part of VAT tax base. Even with no modification of tax rate in VAT, due to the broader tax base, there is an extra tax revenue in VAT which ranges from 0,02% in the least demanding reform (R1) until 2,05% in the last one (R8).

The amounts of extra revenue obtained by VAT are showed in Table 1. The second column presents the total VAT revenue in 2010 and assuming the alternative simulated reforms in excise tax and no change in VAT. The third column presents the absolute value of the extra revenue, and the following, the relative value of the change.

Table 1. Extra revenue (€) in VAT due to reforms in excise tax.

VAT	Tax revenue	Extra revenue	% Increase over previous simulation revenue	% Increase over 2010 revenue
IVA 2010	42.935.644.160			
IVA+R1	42.944.442.368	8.798.208	0,02%	0,02%
IVA+R2	43.006.021.632	70.377.472	0,16%	0,16%
IVA+R3	43.085.197.132	149.552.972	0,35%	0,35%
IVA+R4	43.111.591.936	175.947.776	0,41%	0,41%
IVA+R5	43.173.171.200	237.527.040	0,55%	0,55%
IVA+R6	43.217.158.144	281.513.984	0,65%	0,66%
IVA+R7	43.331.522.560	395.878.400	0,91%	0,92%
IVA+R8	43.815.378.944	879.734.784	2,01%	2,05%

The effect of changes in hydrocarbons tax generates also an increase in revenue more important than VAT, what is expected, given that this is a direct effect and the VAT effect was indirect. The amounts are presented in Table 2.

Table 2. Extra revenue (€) in Excise Tax in the alternative simulated reforms in excise tax

Excise Tax	Tax revenue	Extra revenue	% Increase over previous simulation revenue	% Increase over 2010 revenue
2010	8.883.836.928			
R1	8.932.711.424	48.874.496	0,55%	0,55%
R2	9.274.830.848	390.993.920	4,22%	4,38%
R3	9.714.698.240	830.861.312	8,55%	9,30%
R4	9.861.320.704	977.483.776	9,91%	10,94%
R5	10.203.440.128	1.319.603.200	12,93%	14,77%
R6	10.447.811.584	1.563.974.656	14,97%	17,51%
R7	11.083.175.936	2.199.339.008	19,84%	24,62%
R8	13.771.257.856	4.887.420.928	35,49%	54,71%

The percentage of increase in tax revenue is much more important considering the direct effect on the excise tax that on VAT, both comparing with the previous simulation and the reference situation (year 2010). Table 3 presents the aggregated information on tax revenue for both taxes: hydrocarbons and VAT.

Table 3. Total extra revenue (€) on VAT and excise tax in alternative reform simulations on excise tax.

Excise Tax and VAT	Extra revenue	Tax revenue	% Increase over total revenue	% Increase over 2010 revenue
2010	0	51.819.481.088	0%	0%
R1	57.672.704	51.877.153.792	0,11%	0,11%
R2	461.371.392	52.280.852.480	0,88%	0,89%
R3	980.414.284	52.799.895.372	1,86%	1,89%
R4	1.153.431.552	52.972.912.640	2,18%	2,23%
R5	1.557.130.240	53.376.611.328	2,92%	3,00%
R6	1.845.488.640	53.664.969.728	3,44%	3,56%
R7	2.595.217.408	54.414.698.496	4,77%	5,01%
R8	5.767.155.712	57.586.636.800	10,01%	11,13%

b) Effects on progressivity

The effects on progressivity measured here are derived exclusively from the indirect tax structure, given the non-response assumption. If that were the case, an additional effect due to the fact that households change consumption decisions facing new prices should be added. The change in the proportions of consumption of different goods would alter the paid amount of VAT and hydrocarbons tax. Separating this effect, the main conclusion is that any of the reforms leaves unaltered the concentration curves of VAT and the modified excise tax. This perpetuates a regressive system.

The reason why the different simulated reforms do not alter the progressivity of the system is that the concentration curve of a tax which payment depends exclusively on a fixed proportion on the consumption on petrol or diesel does not change if the households are examined the day after the reform and do not incorporate any change in their consumption. It is important to remember that the tax on hydrocarbons depends exclusively on how many liters of diesel or petrol are consumed (*ad quantum* tax), and the concentration curve accumulates the proportion of paid tax ordering households according with an ATP criterion (income or equivalent income). The proportion measured over the total revenue also depends on the *ad quantum* component, so that there is no effect if consumption is not altered.

Table 4 shows the value of Kakwani índices calculated to determine the effects on progressivity of VAT changes and CO2 tax in each simulated scenario. The effects are calculated separately for each tax. The measure of Ability to Pay (ATP) is obtained using household equivalent income[7].

Table 4. Gini, Kakwani and concentration indices (considering all households).

		Kakwani
Gini equivalent income	0,30038	
Concentration VAT 2010 and reforms R1 to R8	0,1987	**-0,1017**
Concentration hydrocarbons 2010 and reforms R1 to R8	0,1966	**-0,1038**

Table 5. Gini, Kakwani and concentration indices (considering households with positive consumption of hydrocarbons)

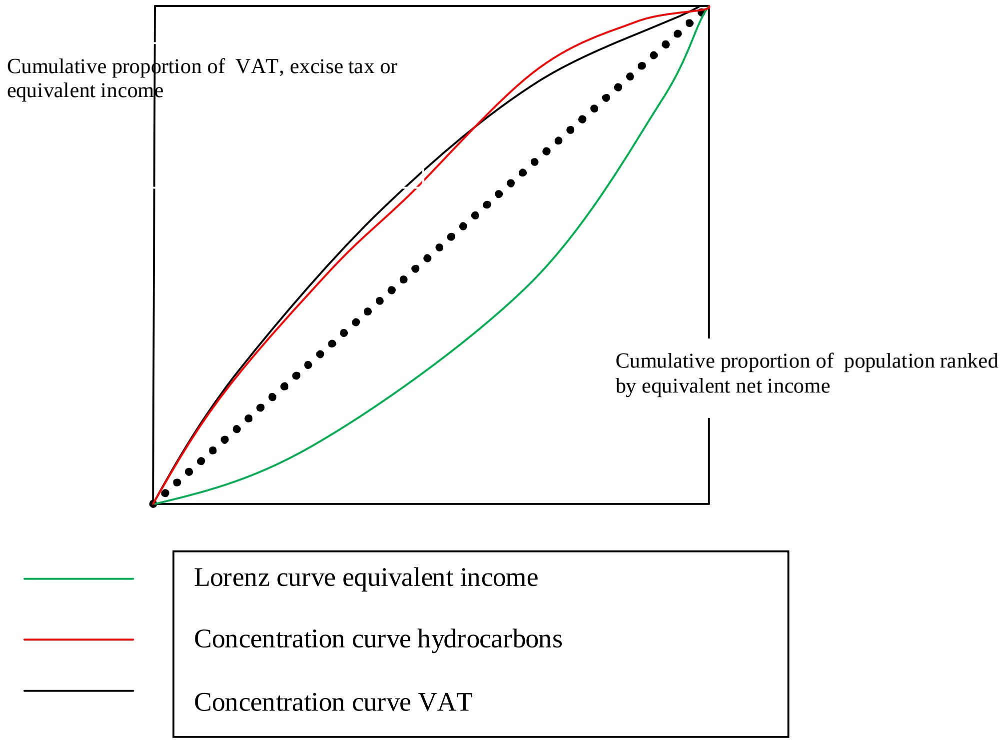
Gini equivalent income	0,28769	Kakwani
Concentration hydrocarbons 2010 and reforms R1 to R8	0,1163	**-0,1841**

[7] The Spanish Household Budget Survey gives the monthly net income, which is elevated to a year multiplying by 14. The conversion to equivalent income is achieved by dividing by $N^{1/2}$, being N the household size.

Derived from data in Table 5, we can see that VAT tax changes are regressive, as showed by the value of the Kakwani index: -0,1017. Nevertheless, the effect of considering the extra payment on VAT derived from excise tax on hydrocarbons for any of the simulated reforms (R1 a R8) does not modify the position of the concentration curves. The existent regressivity in 2010 is maintained in the successive reforms. The direct effect of hydrocarbons excise tax is also regressive, as showed by a Kakawani index of -0,1038. This effect is maintained for any of the simulated reforms, and it is increased when focused just on population whit presents a positive consumption of hydrocarbons (Kakwani= -0,1841).

The position of VAT tax burden and excise tax on hydrocarbons concentration curves, and the Lorenz curve of equivalent income illustrate, graphically, the previous conclusions:

Graph 1. Lorenz curve of equivalent income. Concentration curves of VAT and excise tax.



The Lorenz curve of equivalent income lies below the diagonal, while the concentration curves of VAT and excise tax lie above the diagonal (almost coincident) given the regressivity of the system.

c) <u>Effects on Average Effective Tax (AET)</u>

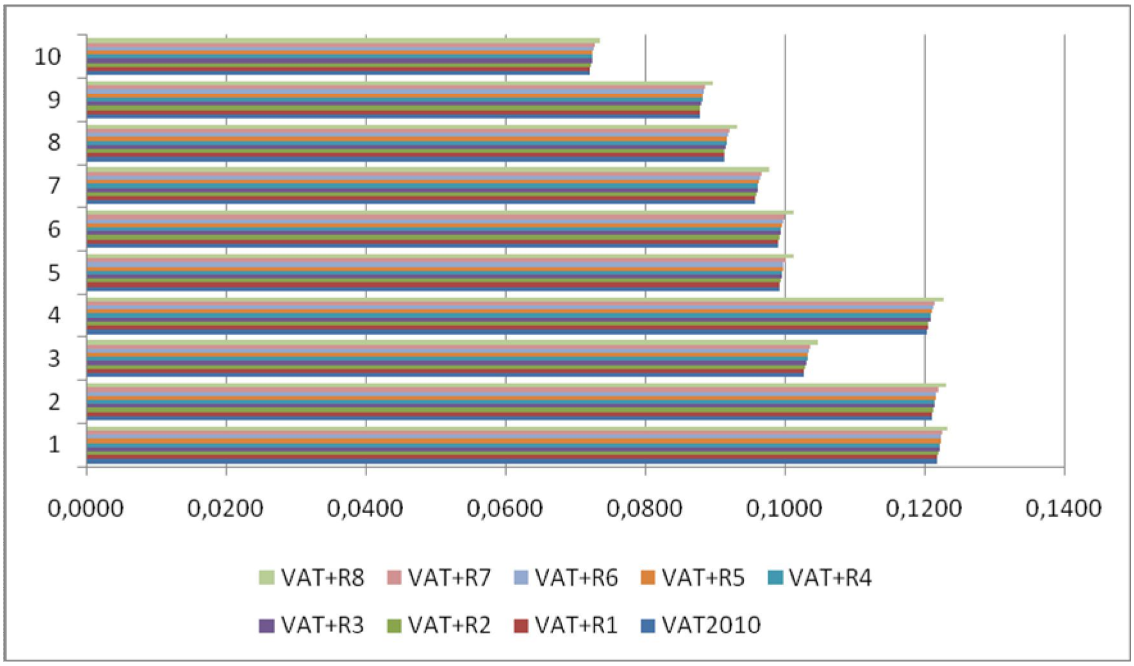
In the interest of explaining the regressivity of the system, we calculate and plot effective tax rates for VAT and hydrocarbon tax along the equivalent income deciles. The effective tax rate is calculated by dividing the annual amount of tax paid (VAT or excise) by the annual income or equivalent income.

Table 6.1. Effective tax rate calculated on income. VAT 2010 and simulated reforms R1 to R8.

Decile	VAT2010	VAT+R1	VAT+R2	VAT+R3	VAT+R4	VAT+R5	VAT+R6	VAT+R7	VAT+R8
1	0,1219	0,1219	0,1220	0,1221	0,1222	0,1223	0,1223	0,1225	0,1234
2	0,1210	0,1210	0,1212	0,1214	0,1214	0,1216	0,1217	0,1220	0,1231
3	0,1028	0,1028	0,1029	0,1031	0,1032	0,1033	0,1034	0,1037	0,1047
4	0,1204	0,1204	0,1206	0,1208	0,1209	0,1210	0,1212	0,1215	0,1228
5	0,0991	0,0992	0,0993	0,0995	0,0996	0,0997	0,0998	0,1001	0,1012
6	0,0990	0,0990	0,0992	0,0994	0,0994	0,0996	0,0997	0,1000	0,1011
7	0,0957	0,0957	0,0959	0,0961	0,0961	0,0963	0,0964	0,0967	0,0978
8	0,0912	0,0913	0,0914	0,0916	0,0916	0,0918	0,0919	0,0921	0,0932
9	0,0878	0,0878	0,0879	0,0881	0,0882	0,0883	0,0884	0,0886	0,0897
10	0,0721	0,0721	0,0722	0,0723	0,0724	0,0725	0,0726	0,0728	0,0736
Total	0,1005	0,1005	0,1007	0,1008	0,1009	0,1010	0,1011	0,1014	0,1025

In Graph 2 we plot the same information, and it is clearly showed how the deciles who face higher effective taxes are the first, the second and the fourth ones. Also, the average effective taxes are lower and decreasing for all the deciles from the fifth, considering higher income.

Graph 2.1. Average effective tax rates by income deciles.



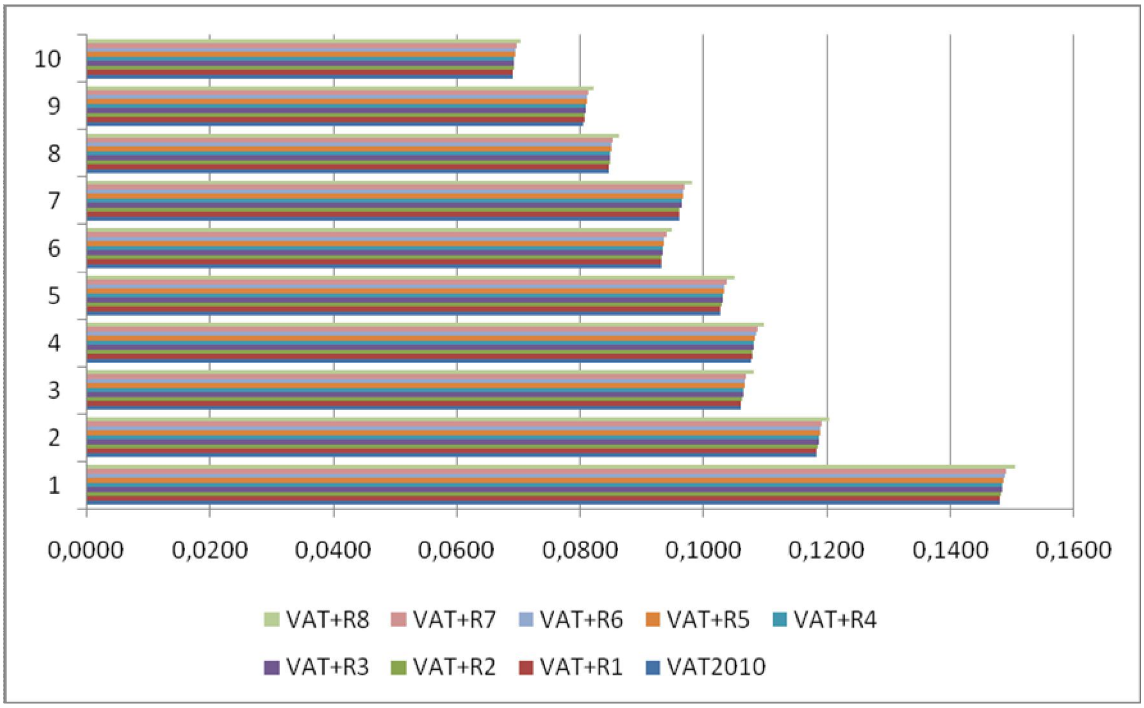
If we undertake the same analysis considering equivalent income, the effects of regressivity are more intense.

Table 6.2. Average effective tax rate calculated on equivalent income. VAT 2010 and simulated reforms R1 to R8.

Decile	VAT2010	VAT+R1	VAT+R2	VAT+R3	VAT+R4	VAT+R5	VAT+R6	VAT+R7	VAT+R8
1	0,1479	0,1479	0,1481	0,1483	0,1484	0,1486	0,1487	0,1491	0,1505
2	0,1182	0,1182	0,1184	0,1186	0,1186	0,1188	0,1189	0,1192	0,1204
3	0,1061	0,1061	0,1063	0,1064	0,1065	0,1066	0,1067	0,1070	0,1080
4	0,1078	0,1078	0,1079	0,1081	0,1082	0,1083	0,1084	0,1087	0,1099
5	0,1027	0,1027	0,1029	0,1031	0,1032	0,1033	0,1034	0,1037	0,1050
6	0,0931	0,0931	0,0932	0,0934	0,0935	0,0936	0,0937	0,0939	0,0949
7	0,0961	0,0961	0,0962	0,0964	0,0966	0,0967	0,0967	0,0970	0,0981
8	0,0845	0,0846	0,0848	0,0848	0,0848	0,0850	0,0852	0,0854	0,0863
9	0,0806	0,0806	0,0807	0,0809	0,0809	0,0810	0,0811	0,0813	0,0823
10	0,0691	0,0691	0,0692	0,0693	0,0694	0,0694	0,0695	0,0697	0,0704
Total	0,1005	0,1005	0,1007	0,1008	0,1009	0,1010	0,1011	0,1014	0,1025

And plotting the results:

Graphic 2.2. Average effective tax rates for VAT 2010 and reforms R1 to R8 by deciles of equivalent income.



In this case, we find a higher average effective tax rate on the first decile than on the rest. The profile of decreasing effective tax rate as equivalent income increases is maintained.

The effect of hydrocarbon excise tax has been calculated just for those households that show a positive consumption in hydrocarbons, and in this other case, the structure of average effective tax rates confirms the regressivity of the system and a similar effect of the different reforms.

Table 6.3. Average effective tax rate calculated on equivalent income. Hydrocarbon excise tax 2010 and simulated reforms R1 to R8.

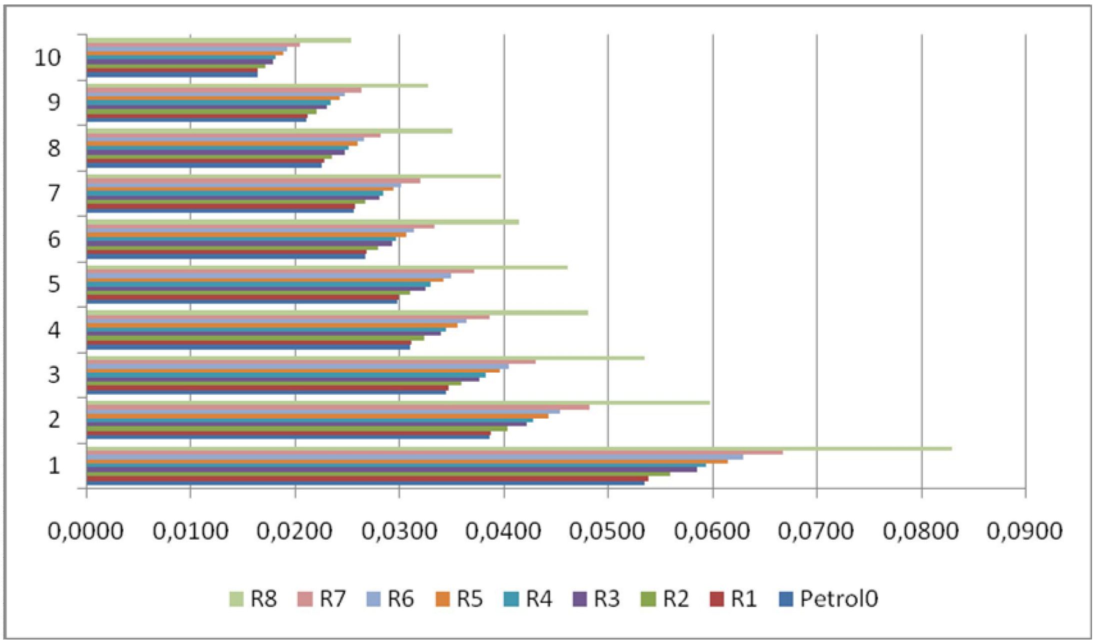
Graphic 2.2. Average effective tax rates of hydrocarbon excise tax 2010 and reforms R1 to R8 by deciles of equivalent income

Decile	Petrol0	R1	R2	R3	R4	R5	R6	R7	R8
1	0,0535	0,0538	0,0559	0,0585	0,0594	0,0615	0,0630	0,0668	0,0830
2	0,0386	0,0388	0,0403	0,0422	0,0428	0,0443	0,0454	0,0481	0,0598
3	0,0345	0,0347	0,0360	0,0377	0,0383	0,0396	0,0405	0,0430	0,0535
4	0,0310	0,0312	0,0324	0,0339	0,0344	0,0356	0,0365	0,0387	0,0481
5	0,0297	0,0299	0,0310	0,0325	0,0330	0,0341	0,0350	0,0371	0,0461
6	0,0267	0,0269	0,0279	0,0292	0,0297	0,0307	0,0314	0,0334	0,0414
7	0,0256	0,0258	0,0268	0,0280	0,0284	0,0294	0,0301	0,0320	0,0397

8	0,0226	0,0227	0,0236	0,0247	0,0251	0,0260	0,0266	0,0282	0,0351
9	0,0211	0,0212	0,0220	0,0230	0,0234	0,0242	0,0248	0,0263	0,0327
10	0,0164	0,0165	0,0171	0,0179	0,0182	0,0188	0,0193	0,0204	0,0254
Total	0,0286	0,0287	0,0298	0,0312	0,0317	0,0328	0,0336	0,0356	0,0443

And plotting the results:

Graphic 2.3. Average effective tax rates of hydrocarbon excise tax 2010 and reforms R1 to R8 by deciles of equivalent income.



The average effective tax rates display a clear regressive pattern for those households consumers of diesel or petrol. The situation is similar after all simulated reforms.

6. Conclusions

Our main conclusion is that adding a carbon tax in the indirect structure of the Spanish Tax System would not significantly affect the current regressivity of excise taxes. This is particularly true if the carbon excise tax is designed just with an *ad quantum* component, which would be added to the current excise tax, demanding a fixed amount per liter of consumption. Despite the fact that a simulated carbon tax would be designed depending on the quantity of emissions of CO_2, the tax rate would be implemented after a conversion, which finally would demand a fixed amount of money per liter of consumption. This is also true if only the effects of the day after are computed. It would be interesting to obtain the elasticities of demand of hydrocarbons in order to include a behavioural effect in our analysis in order to check if there would be susbstitution effects among products facing different taxation and also if there is a decrease in the demand of hydrocarbons.

In any case, one of the objectives pursued by carbon tax (Pigouvian) is attained: to achieve the polluters pay principle, which allows for internalizing the pollution effect. The drawback of the internalizing this effect is that the poorer households are those who support a heavier tax payment, which could be partly solved by changing other taxes or increasing social welfare transfers for households with lower income. The extent to regressivity should be corrected depends also on the priority given to the internalizing effect, this is why the alternative progressivity measures for compensating could be adopted just “partly”. The extra revenue of a CO_2 tax of this kind is not negligible, given that each € per Tn of CO_2 emission allows for an 0,11% extra revenue of VAT and excise tax on hydrocarbons.

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