

# How to Fight Climate Change Mixing a Carbon Tax and Subsidies to Renewable Energy: Lessons from Spain

Miguel Buñuel

Departamento de Economía y Hacienda Pública

Universidad Autónoma de Madrid

Francisco Tomás y Valiente, 5. 28049 Madrid. Spain

miguel.bunuel@uam.es

## ABSTRACT

Climate change policy can be enhanced by a carbon tax. However, this tax has been strongly rejected by most Spanish stakeholders given that Spain traditionally had rates of inflation and energy intensity higher than the average of the EU countries. Our simulation of the effect of the carbon tax on sector prices shows that, besides the direct effect on the price of fuels, the only high price effect would occur in the electricity sector. The prices of this sector are already subject to an upward pressure because of the need of repaying the tariff deficit. This deficit is the difference between the revenues raised by the electricity sector (affected by the traditional use of regulated tariffs by governments to lower inflation) and the costs assigned to the sector (many of them, like the feed-in tariffs that subsidize renewable energy, not directly related to the production and distribution of electricity). In order to make a carbon tax feasible in Spain, we propose that the subsidies to renewable energy are paid by the National Budget. Our calculations also show that the net effect of the tax and removing feed-in tariffs from the costs of the electricity system could probably lead to a reduction of electricity prices. Therefore, the fear of inflation from implementing a carbon tax in Spain should be overcome.

*Keywords:* carbon tax, climate change, tariff deficit, renewable energy, energy policy, inflation.

Clasificación JEL: H23, Q48, Q54.

## 1. INTRODUCTION

If we focus on the main gas causing the anthropogenic enhancement of the greenhouse effect, carbon dioxide (CO<sub>2</sub>), the best fiscal instrument for fighting climate change is a carbon tax. A carbon tax is a tax on fossil fuels whose tax rate depends on the carbon content of each fuel. Given that the relationship between CO<sub>2</sub> emissions and the carbon content of each fossil fuel is nearly proportional, a carbon tax is equivalent to a tax on CO<sub>2</sub> emissions.

A carbon tax was already proposed by the European Commission (EC) in the late 80s of the last century, although in a mixed formulation as a tax on energy and carbon (EC, 1991). The EC's proposals never succeeded, but many European countries enacted their own carbon taxes. Following Finland in 1990, Norway and Sweden in 1991, and Denmark in 1992, many other countries are implementing or have passed legislation on carbon taxes. In the case of Spain, the central government has always rejected the introduction of a carbon tax. However, some regional governments have introduced their own taxes on CO<sub>2</sub> emissions.

One of the main arguments used by Spanish stakeholders to strongly reject a carbon tax is that Spain traditionally had rates of inflation and energy intensity higher than the average of the EU countries. Therefore, it is argued that any increase on energy taxation would have adverse inflationary effects.

The problem of energy prices in Spain is especially controversial in the case of the power sector, given that since 2000 governments have used the setting of consumers' electricity tariffs as a means to containing inflation. As a result, the so called "tariff deficit" arisen. This deficit is the negative difference between income from electricity tariffs paid by consumers and the costs that the electricity system must pay. At the same time that governments kept prices artificially low, it also mandated that the electricity system paid for many costs that are unrelated to the production, transportation, and distribution of electricity, such as the feed-in tariffs that subsidize renewable energies. The tariff deficit is financed by power companies, and recognized to them as a collection right. The repayment of these rights is another cost that the electricity system must pay, so that future consumers

are somehow subsidizing current consumers (and current consumers are paying the subsidization of past consumers).

The subsidization of renewable energy has been blamed as the main reason for the difficulty to reduce and eventually eliminate the tariff deficit in Spain. The government seems to support this thesis, given that most of the cost savings implemented through the regulatory measures introduced since 2010 come from reducing the feed-in tariffs for renewable energy. Hence, there is an obvious conflict between recent Spanish policies to contain the tariff deficit and environmental objectives, since the promotion of renewable energies is a central element of any policy to mitigate climate change.

In this context, the renewable energy industry and environmental organizations advocate the introduction of the so-called “green cent”, a surcharge on the tax on hydrocarbons to contribute to the financing of renewable energy. The advocates of the “green cent” point out that, while the price of electricity in Spain is above the European average, transport fuel prices are quite below the average European prices. On the opposite side, the hydrocarbon industry fiercely opposes the “green cent”, arguing that it is unreasonable that consumers of a product (liquid fuels) bear the costs of financing a different product (electricity produced from renewable sources), and this would result in artificially low (and therefore inefficient) prices of electricity.

This article tries to establish the most efficient and equitable way to address the relationship between climate change policy and the fear of inflation in Spain, especially in relation to the price of electricity. The next section discusses a carbon tax as the central element for climate change policy in Spain, and presents a proposal for setting such a tax. The third section analyzes the effects on sector prices of the carbon tax proposed, using input-output analysis. The last section presents the conclusions.

## **2. A CARBON TAX IN SPAIN**

### **2.1. The financing of renewable energies and climate change policy: A “green cent” vs. a carbon tax**

The development of renewable energies is imposed by Directive 2009/28/EC, which requires that at least 20% of Spain’s total energy consumption in 2020 comes from

renewable sources. Renewable energy generates positive externalities, such as increasing energy security and avoiding other polluting emissions besides greenhouse gas emissions. Since renewable energies benefit society as a whole, their costs should not be financed only by electricity consumers. As previously noted, the proposal of establishing a “green cent” addresses this issue by suggesting a surcharge on the taxation of liquid fuels earmarked to the financing of renewable energies. However, this still seems unfair; only energy consumers would bear the costs, instead of all the population in general. Hence, it seems that the fairest solution is transferring the cost of the feed-in tariffs that subsidize renewable energy to the Public Budget.

Moreover, the proposal of a “green cent” should also be rejected because earmarking tax revenues for particular purposes is generally inefficient. Earmarking only means adding an additional restriction to the problem of designing an optimal fiscal policy, and therefore it cannot produce a better policy than without earmarking (McCleary, 1991; Teja and Bracewell-Milnes, 1991; OECD, 1996; O’Riordan, 1997). Therefore, we conclude again, now from the efficiency point of view, that spending on renewable energy should be financed from general revenues from the Public Budget.

Additionally, a “green cent” is not the best taxation policy for mitigating climate change. The best fiscal instrument for climate change policy is a carbon tax because it provides the necessary incentives to promote energy conservation; substitution of fossil fuels with high carbon content by fossil fuels with less carbon content; and replacement of fossil fuels by renewable energies. The revenue of a carbon tax should not be earmarked to any particular purpose, but it can contribute to offsetting in all or part the effect on public deficit of financing renewable energies through the Public Budget.

Introducing a carbon tax faces the problem that almost half of the CO<sub>2</sub> emissions are already subject to the EU Emissions Trading System (EU ETS) for greenhouse gases. There are two extreme options for the coexistence of both instruments. The first is to allow the overlapping of a carbon tax and the EU ETS without attenuating the burden for those emitters subject to the EU ETS. Since this approach implies a double payment for CO<sub>2</sub> emissions, it can be legally unfeasible. The second option is that the emitters subject to the

EU ETS are exempted from paying the carbon tax, which is the easiest alternative to reconcile both instruments. Between these two extreme possibilities, there are intermediate options:

1. Allowing taxpayers to deduct the amounts paid for the purchase of EU ETS allowances.
2. Exempting polluters subject to the EU ETS from paying the carbon tax if the price of allowances is above the tax rate, but taxing them for the difference if the tax rate exceeds the price of emission rights.
3. Establishing reduced rates and/or tax exemption emission limits for taxpayers who are also subject to the EU ETS. This option can be highly desirable if tax benefits are properly designed. For example, the emissions resulting from the use of best available technologies for each industrial process could be set as the tax exemption limit for taxpayers subject to the EU ETS.

## **2.2. Defining the taxable event and the taxable base**

The taxable event of the proposed carbon tax is making use of fossil fuels. The consumption by the most energy intensive sectors, exposed to international competition, could be exempted. These sectors would be subject only to the EU ETS. The tax base is the weight of the carbon in the fuel.

## **2.3. Choosing the tax rates**

The best approximation to the optimal tax rate of a carbon tax is the marginal damage caused by CO<sub>2</sub> emissions, but uncertainty about this damage makes that any estimate should be taken with caution. There are large differences among the most cited traditional estimates of marginal damages. For instance, while Azar and Sterner (1996) estimated high marginal damages of CO<sub>2</sub> emissions, ranging from 0.257 to 0.583 €/kg CO<sub>2</sub>, Nordhaus (1994) estimated a rather low figure of 0.016 €/kg CO<sub>2</sub>, which he recently reduced further to 0.006 €/kg CO<sub>2</sub> (Nordhaus, 2008). There exists intermediate estimates, such as Fankhauser's (1994) figure of 0.065 €/kg CO<sub>2</sub>. The systematic review of available studies confirms that there is a wide range of marginal damage estimates. For example, Tol (2005) constructs a

probability density function combining 103 estimates from 28 published studies. Converting dollars per ton of carbon in euros per kilo of CO<sub>2</sub>, the median of these estimates is 0.004 €/kg CO<sub>2</sub>, and the average is 0.025 €/kg CO<sub>2</sub>, with a large range of variation. Tol concludes that studies with lower discount rates produce higher estimates and uncertainties, and that the studies submitted to peer review generate lower estimates and uncertainties. Watkiss and Downing (2008) reach similar conclusions about uncertainty and range of estimates, reporting estimates from 0 to more than 0.3 €/kg CO<sub>2</sub>.

A practical approach to setting tax rates could be taking the EU ETS price of CO<sub>2</sub> as a reference, if it were a valid market benchmark. CO<sub>2</sub> prices have fluctuated dramatically since 2008 (leaving aside the experimental first phase, 2005-2007) between approximately 3.5 and 27 euros per ton of CO<sub>2</sub>, that is 0.0035-0.027 €/kg CO<sub>2</sub>. Prices have been much more stable during 2014, staying around 7 euros per ton of CO<sub>2</sub> (0.007 €/kg CO<sub>2</sub>). The EC (2012) projects that carbon prices will be in the range of 10 to 25 euros (2008 prices) per ton of CO<sub>2</sub> at the end of the decade. It is often argued that the big drop in CO<sub>2</sub> prices from their maximum 2008 level is due to the economic crisis, increasing fossil fuel prices, renewable energy policies, and the use of credits from the Clean Development Mechanism. However, Koch et al. (2014) find that these factors accounted for only 10 percent of the price variation. The remaining unexplained 90 percent may probably indicate that the EU ETS is a market ruled by political decisions, real and expected by market participants.

A final reference for choosing a tax rate is what other countries have chosen. For instance, tax rates are 0.01716 €/kg CO<sub>2</sub> in Finland, 0.042 €/kg CO<sub>2</sub> in Sweden, and 0.01344 €/kg CO<sub>2</sub> in Denmark (National Statistical Offices in Norway, Sweden, Finland & Denmark, 2003).

In addition to the tax rate level, we must consider the appropriate time schedule for its introduction. To facilitate the acceptance of the tax and to limit potential negative effects from its rapid adoption, it is desirable that tax rates are initially low but increasing according to a preannounced schedule (OECD, 2001). This is in fact what most countries that have introduced a carbon tax have done (Baranzini, Goldemberg and Speck, 2000). However, Sinn's (2008) "green paradox" seems to suggest otherwise. Sinn proposes that increasing

carbon taxation over time could accelerate global warming by encouraging owners to increase the extraction of their resources in the short term, in anticipation of future tax increases. The relevance of Sinn’s theoretical conclusions seem only applicable to a global carbon tax, and hence they are irrelevant when considering the introduction of a tax in Spain, whose effect on the decisions of resource owners would be zero. Moreover, Edenhofer and Kalkuhl (2011) show that Sinn’s theoretical result occurs only in certain circumstances and can be avoided by using an appropriate system of allowances.

Given all of the above, we make the following proposal. The tax rate in the year of introduction would be 0.005 €/kg CO<sub>2</sub> (5 €/t CO<sub>2</sub>). It would be increased each year by 0.002 €/kg CO<sub>2</sub>, so that after 10 years came to 0.025 €/kg CO<sub>2</sub> (25 €/t CO<sub>2</sub>). The annual update should take into account inflation to make it a real increase of 0.002 €/kg CO<sub>2</sub>. This proposal would introduce low, but appropriate price signals, while decreasing potentially adverse economic effects through the long period of tax rate increases.

#### 2.4. Tax rates, tax base, and potential revenue

The proposed tax is only an approximation to a tax on CO<sub>2</sub> emissions, since it excludes from the taxable event emissions not derived from fossil fuels. In the opposite direction, the levy would tax the carbon incorporated into goods produced with fossil fuels in their non-energy uses, although not converted into CO<sub>2</sub> emissions. To correct these deviations, we conduct a detailed study (it can be obtained from the author) that allows us to calculate the tax base and proposed tax rates in monetary units per unit of fuel type. Based on the average data of CO<sub>2</sub> emission factors for fuels used in combustion activities, we can calculate the average tax rates for liquid, solid and gaseous fuels, as shown in Table 1.

**Table 1: Average carbon tax rates by fuel (in euros per gigajoule)**

Type of fuel	CO <sub>2</sub> emission factors (t/TJ)	Tax rates (€/GJ)	
		Minimum rate	Maximum rate
Liquid fuels	73,37	0,37	1,83
Solid fuels	98,78	0,49	2,47
Gaseous fuels	56,19	0,28	1,40

*Source:* Ministerio de Medio Ambiente (2008) and own calculations.

We can be more precise, stating the specific tax rates for each fuel in euros per cubic meter at standard conditions (Nm<sup>3</sup>) in the case of natural gas, and kilo in the case of other fuels. For this purpose, as shown in Table 2, we use the emissions inventory data on the lower heating value (LHV) of each fuel per physical unit, which allows us to calculate CO<sub>2</sub> emission factors for these physical units, deriving eventually tax rates.

**Table 2: Carbon tax rates by fuel type (euros per physical unit of measure for each fuel)**

Fuel type	CO <sub>2</sub> emission factors (t/TJ)	Physical unit	GJ <sub>LHV</sub> /unit	CO <sub>2</sub> emission factors (t/unit)	Tax rates (€/unit)	
					Minimum rate	Maximum rate
Natural gas	56,00	m <sup>3</sup> N	0,03849	0,00215544	0,01077720	0,05388600
Fuel oil	76,00	Kg	0,04018	0,00305368	0,01526840	0,07634200
Gasoil	73,00	Kg	0,04240	0,00309520	0,01547600	0,07738000
Generic LPG	65,00	Kg	0,04550	0,00295750	0,01478750	0,07393750
Propane	63,60	Kg	0,04620	0,00293832	0,01469160	0,07345800
Butane	66,20	Kg	0,04478	0,00296444	0,01482218	0,07411090
Coal	98,78	Kg	0,03000	0,00296342	0,01481712	0,07408558

Source: Ministerio de Medio Ambiente (2008) and own calculations.

Given the exemptions that we consider appropriate, as discussed above, we classify emissions in taxed emissions, and not subject to the tax or exempt (this classification and its details can be obtained from the author). Applying the minimum (or initial) and maximum (or final) tax rates to the taxable income, we estimate the potential tax revenue: 1,300 million euros in the year of introduction of the tax, which could rise to 6,600 million after the transition period of 10 years. The potential revenue is significantly reduced if the electricity sector, already subject to the EU ETS, is exempted: 800 and 4,000 million euros, respectively. Note that these estimates are based solely on the emissions of the inventory year, and, therefore, are static. In the event that the tax is introduced gradually, as proposed, it is expected that the tax will generate positive environmental effects, reducing emissions at the end of the transition period, and hence reducing also the taxable base and revenues. Of



course, many other factors, whose modeling is beyond the scope of this paper, would affect emissions; some would have a positive effect, such as economic growth, and others would produce negative effects, such as increased energy efficiency not caused by the tax.

## **2.5. Deductions**

Two types of deductions are proposed:

1. Deduction from the tax liability of the full amount paid to acquire CO<sub>2</sub> emission rights by companies subject to the EU ETS, if they were not exempt.
2. Deduction from the tax base of carbon not emitted from non-energy uses of fuels. This deduction can be calculated applying to industrial production the factors on carbon incorporation to industrial products, which are used in preparing the official inventory of emissions.

## **3. INPUT-OUTPUT ANALYSIS OF THE EFFECTS ON SECTORAL PRICES OF A CARBON TAX**

### **3.1. Objective and methodology of the study**

The purpose of this section is to investigate the relative impact on Spanish sectoral prices of introducing the proposed carbon tax. For this purpose, we use an input-output model. Our hypothesis is that the impact of the tax on inflation would be moderate, even ignoring that we expect that the tax contributes to reducing the consumption of fossil fuels. This effect should come from the tax encouraging energy savings and efficiency, as well as the replacement of fossil fuels by renewable energies. As a result, the expected impact on prices should be further reduced (as well as the tax base and the potential revenues). Therefore, not considering these effects in our study implies that we are overestimating the inflationary impact of the carbon tax.

Input-output methods have been widely used in studies of the effects of possible tax reforms on prices in Spain. For example, Labandeira and Labeaga (2002) used them to calculate the CO<sub>2</sub> emissions intensity of the Spanish economy in 1992, allowing them to estimate the effects on prices of various possible carbon taxes. Tarancón, Del Rio and Callejas (2010) also used input-output analysis to calculate the total electricity consumption of 18 manufacturing sectors in Spain and 14 other European countries, identifying the most

sensitive sectors to a rise in the price of electricity. Llop and Pié (2008) use input-output methods to analyze the economic effects in Catalonia of a tax on intermediate energy uses, a reduction of the intermediate energy demand, and the combination of that tax and this reduction.

We use the dual, price version of Leontief's input-output model, with disaggregation of value added and imports. This model can be written as follows:

$$\mathbf{p} = \mathbf{A}'_d \mathbf{p} + \mathbf{A}'_m \mathbf{p}_m + \mathbf{A}_g \mathbf{i}, \quad (1)$$

where  $\mathbf{p}$  is the vector of domestic sector prices;  $\mathbf{p}_m$  is the vector of import sector prices;  $\mathbf{i}$  is the all-ones vector;  $\mathbf{A}_d$  is the matrix of domestic technical coefficients:  $\mathbf{A}_d = \mathbf{Z}_d \hat{\mathbf{W}}^{-1}$ , where  $\mathbf{Z}_d$  is the matrix of domestic inputs, and  $\hat{\mathbf{W}}$  is the diagonal matrix of outputs;  $\mathbf{A}_m$  is the matrix of import technical coefficients:  $\mathbf{A}_m = \mathbf{Z}_m \hat{\mathbf{W}}^{-1}$ , where  $\mathbf{Z}_m$  is the matrix of import inputs; and  $\mathbf{A}_g$  is the matrix of value added coefficients:  $\mathbf{A}_g = \hat{\mathbf{W}}^{-1} \mathbf{G}$ , where  $\mathbf{G}'$  is the matrix of primary inputs. Solving for  $\mathbf{p}$ , the solution of model (1) can be written as follows:

$$\mathbf{p} = (\mathbf{I} - \mathbf{A}'_d)^{-1} (\mathbf{A}'_m \mathbf{p}_m + \mathbf{A}_g \mathbf{i}). \quad (2)$$

Solution (2) allows simulating the impact on sectoral prices of the carbon tax. We only need to compare model (2) at the initial equilibrium and at the after-tax equilibrium. Vector  $\mathbf{p}$ , which is an implicit price index, equals  $\mathbf{i}$  at the initial equilibrium. The carbon tax modifies this equilibrium, producing a new vector  $\mathbf{p}$ . The difference between both vectors is the price increase caused by the tax.

### 3.2. Statistical sources

The data used come from the National Accounts of Spain published by the National Institute of Statistics (Instituto Nacional de Estadística, 2014). In particular, we have used the *Symmetric Input Output Table 2005*, which has 73 industries.

### 3.3. Results of the input-output simulation

With the above data, we can calculate all the necessary matrices and vectors to solve model (2). This allows us to simulate the impact of the tax on sectoral prices in the first period, with the proposed tax rate of 5 €/t CO<sub>2</sub>, and after the transitional period of 10 years,

with the rate of 25 €/t CO<sub>2</sub>. In the absence of input-output data on energy sectors in physical units, we must first convert the rates described in section 2.4 into purely monetary terms, in order to apply them to the values of the actual production and imports of the taxed sectors. Given the limited sectoral breakdown of the input-output table in relation to fuels, it suffices to calculate the tax rates for the categories of liquid, solid, and gaseous fuels. For data consistency and since the last available input-output table is from 2005, we use the data from the 2005 official inventory of Spanish greenhouse gas emissions (Ministerio de Medio Ambiente, 2008). With these data, we determine the percentages of CO<sub>2</sub> emissions accounted by liquid, solid and gaseous fuels over total fuel emissions. We apply these percentages on revenue derived from the proposed tax rates applied on 2005 emissions to estimate the source of this revenue by type of fuel, consistently with data from 2005. Finally, the tax revenue by fuel type is split between domestic production at basic prices and imports of the sectors producing the taxed fuels, in proportion to the percentages of such productions and imports over total supply at basic prices in those sectors. Thus, we estimate how much tax revenue would come from production and how much from imports of those sectors. Expressing those revenues as percentages over the values of total productions and imports, we estimate how the taxes on domestic production and the prices of imports (also taxed) would increase. Obviously, this percentage is the same for domestic production and imports. The result, rounding the estimated percentages, is shown in Table 3.

**Table 3: Percentage increase in taxes on domestic production and import prices as a result of the introduction of the carbon tax, by fuel type**

Fuel type	Percentage increase	
	Applying the minimum rate	Applying the maximum rate
Liquid fuels	4%	20%
Solid fuels	9%	45%
Gaseous fuels	3%	15%

*Source:* Own calculations.

In the absence of further disaggregation, we have to settle with the aggregated and mixed data implied by the sectors in the input-output tables. With this limitation, we assume that the best simulation of the effects of the proposed tax is attained considering as the sectors

from which the taxed fuels come those listed in the following table. It is especially unsatisfactory that a single sector mixes the extraction of crude oil, natural gas, and uranium and thorium. Most of the supply of this sector consists of liquid fuels. Equally unsatisfactory is that another sector mixes coking plants, oil refining, and nuclear fuels. Again, most of the supply of this sector is liquid fuels.

**Table 4: Sectors whose supply at basic prices is assumed the fuels taxed by the carbon tax**

Sectors	Fuel type
Extraction of coal, lignite, and peat	Solid fuels
Extraction of crude petroleum and natural gas. Extraction of uranium and thorium	Liquid fuels
Manufacture of coke, refined petroleum products, and nuclear fuel	Liquid fuels
Production and distribution of gas	Gaseous fuels

*Source:* Own construction.

The percentage increases in Table 3 are added to the tax coefficients of the sectors in Table 4 in the matrix of added value coefficients,  $\mathbf{A}_g$ . Moreover, since all the consumption of fossil fuels would be taxed, energy imports would be taxed too. Therefore, the same percentages of Table 3 are applied to increase the import prices of the sectors in Table 4, adding them in the vector of sectoral import prices,  $\mathbf{p}_m$ , which is initially an all-ones vector. Having modified model (2) in this way, we can solve for the two considered tax rates, obtaining the results for the 73 industries. The results indicate that the effect on sectoral prices of applying the initial minimum tax rate would be quite small. Except in the four sectors that we have assumed to be the source of fossil fuels, and therefore on whose supply we have applied the tax, the price increase is above 1 percent only in the sector of production and distribution of electricity, as shown in Table 5. Thus, the inflationary effect of the tax on the price of other sectors would be very small.

**Table 5: Sectors with the highest price increases caused by the introduction of the carbon tax**

Sectors	Price increase applying	
	Minimum rate	Maximum rate
Extraction of coal, lignite, and peat	9,44%	47,21%
Manufacture of coke, refined petroleum products, and nuclear fuel	7,15%	35,76%
Production and distribution of gas	5,77%	28,85%
Extraction of crude petroleum and natural gas. Extraction of uranium and thorium	4,79%	23,93%
Production and distribution of electricity	1,90%	9,51%
Air and space transport	0,98%	4,91%
Maritime transport	0,76%	3,79%
Chemical industry	0,72%	3,58%
Land transport and pipeline transport	0,64%	3,18%
Extraction of non-metallic minerals	0,62%	3,11%
Ceramic industries	0,48%	2,41%
Extraction of metallic minerals	0,43%	2,14%
Manufacture of cement, lime, and plaster	0,42%	2,10%
Manufacture of glass, and glass products	0,42%	2,10%

*Source:* Own calculations.

With regard to the effect on sectoral prices after the transition period of ten years, the inflationary effects would not be excessive either. Again, except for the four sectors source of fossil fuels, the price increase exceeds 5 per cent only in the sector of production and distribution of electricity, where the increase is 9.5 percent, as shown in Table 5. A price increase between 4 and 5 percent only occurs in the sector of air and space transport. Increases between 3 and 4 per cent can be observed in the sectors of maritime transport; chemical industry; land transport and pipeline transport; and extraction of non-metallic minerals. Prices increase between 2 and 3 per cent in the sectors of ceramic industries; extraction of metallic minerals; manufacture of cement, lime, and plaster; and manufacture of glass, and glass products.

#### 4. CONCLUSIONS

Renewable energy is essential for achieving the objectives of climate change policy. However, it is criticized because the feed-in tariffs that subsidize it in Spain hinder the necessary elimination of the tariff deficit that afflicts the electricity sector. This problem could be solved by moving renewable energy subsidies to the Public Budget, although this is not an easy solution, given the current urge to reduce public deficit. Therefore, it is also necessary to raise new public revenues to balance the effect on the Public Budget. A tax on CO<sub>2</sub> emissions could provide an important increase in public revenues. The potential tax revenues amount to 1,300 million euros initially, and 6,600 million euros once the tax rate reaches its maximum level. The latter figure is rather close to the total cost of premiums and incentives for renewables and cogeneration from October 2013 to September 2014, which amounts to approximately 6,400 million euros. The potential revenue is reduced to 800 and 4,000 million euros, respectively, if the electricity sector is exempt. Although this sector is already subject to the EU ETS, it is not necessary to leave it exempt. Instead, the electricity sector can be subject to the carbon tax, but with a deduction from its tax liability equal to the full amount paid to purchase CO<sub>2</sub> allowances.

The main justification of a tax on CO<sub>2</sub> emissions is not rising revenues, but providing powerful incentives for shifting the Spanish economy towards a low carbon economy. This objective is compatible with minimizing any potential economic cost by aiming to the medium-run rise in energy prices through the gradual introduction of the tax. For these purposes, our proposed tax can be summarized as follows:

1. Taxable event: Making use of fossil fuels.
2. Tax base: Weight of the carbon in the fuel.
3. Exemptions: The consumption by the most energy intensive sectors, exposed to international competition.
4. Tax rate: 5 €/t CO<sub>2</sub> in the year of introduction, increasing by 2 €/t CO<sub>2</sub> each year until reaching 25 €/t CO<sub>2</sub> after 10 years.

The simulation of the effect on sectoral prices of the proposed carbon tax indicates no major inflationary effects beyond the direct impact on fuel prices, except for the sector of

production and distribution of electricity. However, this effect would be offset if the premiums for renewable energy cease to be a cost for the electricity system, as we propose. Given that these premiums represent today a percentage of total electricity costs larger than the maximum price increase that we have estimated, the combined effect of the tax and of transferring renewable energy premiums to the Public Budget could actually reduce the price of electricity. Instead of partly balancing public expenditure growth from renewable premiums, part of the carbon tax revenue could be used to reduce other taxes on businesses. In this case, the effect on sectoral prices would be largely mitigated, as well as any negative effect on Spanish competitiveness.

Our simulation does not allow taking into account the proposed exemptions, and hence the effect on sectoral prices is overestimated. Another source of overestimation is that the input-output tables for 2005 reflect a production structure that is more intensive in energy use and CO<sub>2</sub> emissions than the current one. This may be especially important because of the great development of renewable energy in Spain after 2005. Moreover, we should expect that the gradual introduction of the tax will push firms to increase their energy efficiency before tax rates reach their peak. This effect also implies that our results on prices (and revenues) are overestimated. Finally, we should also consider that inflation is currently at historic low levels, and there even exists concerns of deflation. Therefore, the fear of inflation from implementing a carbon tax in Spain should be overcome.

## REFERENCES

---

- Azar, C., and Sterner, T. (1996): "Discounting and Distributional Considerations in the Context of Global Warming," *Ecological Economics*, **19**(2): pp. 169-184.
- Baranzini, A., Goldemberg, J., and Speck, S. (2000): "A Future for Carbon Taxes," *Ecological Economics*, **32**: pp. 395-412.
- Edenhofer, O., and Kalkuhl, M. (2011): "When Do Increasing Carbon Taxes Accelerate Global Warming? A Note on the Green Paradox," *Energy Policy*, **39**: pp. 2208-2212.
- European Commission (1991): *A Community strategy to limit carbon dioxide emissions and to improve energy efficiency. Communication from the Commission to the Council*. SEC (91) 1744 final, Brussels, 14.10.1991.
- European Commission (2012): *Commission Staff Working Document: Information provided on the functioning of the EU Emissions Trading System, the volumes of greenhouse gas*

- emission allowances auctioned and freely allocated and the impact on the surplus of allowances in the period up to 2020.* SWD (2012) 234 final, Brussels, 25.7.2012.
- Fankhauser, S. (1994): “The Social Costs of Greenhouse Gas Emissions: An Expected Value Approach,” *Energy Journal*, **15**: pp. 157–184.
- Instituto Nacional de Estadística (2014): *Marco input-output*, Madrid: Instituto Nacional de Estadística (accessed on November 2014, <http://www.ine.es/daco/daco42/cne00/cneio2000.htm>).
- Koch, N., Fuss, S., Grosjean, G., and Edenhofer, O. (2014): “Causes of the EU ETS price drop: Recession, CDM, renewable policies or a bit of everything? – New evidence,” *Energy Policy*, **73**: pp. 676–685.
- Labandeira, X., and Labeaga, J.M. (2002): “Estimation and Control of Spanish Energy Related CO<sub>2</sub> Emissions: An Input–Output Approach,” *Energy Policy*, **30**: pp. 597–611.
- Llop, M., and Pié, L. (2008): “Input–Output Analysis of Alternative Policies Implemented on the Energy Activities: An Application for Catalonia,” *Energy Policy*, **36**: pp. 1642–1648.
- McCleary, W. (1991): “The Earmarking of Government Revenue: A Review of Some World Bank Experience,” *World Bank Research Observer*, **6(1)**: pp. 81–104.
- Ministerio de Medio Ambiente (2008): *Inventario de emisiones de gases de efecto invernadero de España años 1990–2006: Comunicación a la Comisión Europea*, Madrid: Ministerio de Medio Ambiente.
- National Statistical Offices in Norway, Sweden, Finland & Denmark (2003): *Energy Taxes in the Nordic Countries*, Brussels: Eurostat.
- Nordhaus, W.D. (1994): *Managing the Global Commons: The Economics of Climate Change*, Cambridge (Massachusetts) and London: MIT Press.
- Nordhaus, W.D. (2008): *A Question of Balance: Weighing the Options on Global Warming Policies*, New Haven and London: Yale University Press.
- OECD (1996): *Implementation Strategies for Environmental Taxes*, Paris: OECD.
- OECD (2001): *Environmentally related taxes in OECD countries: Issues and Strategies*, Paris: OECD.
- O’Riordan, T. (ed.) (1997): *Ecotaxation*, London: Earthscan Publications.
- Sinn, H. (2008): “Public Policies against Global Warming: A Supply Side Approach,” *International Tax and Public Finance*, **15**: pp. 360–394.
- Tarancón Morán, M.A., Del Río González, P., and Callejas Albiñana, F. (2010): “Assessing the Influence of Manufacturing Sectors on Electricity Demand: A Cross-Country Input–Output Approach,” *Energy Policy*, **38**: pp. 1900–1908.
- Teja, R.S., and Bracewell-Milnes, B. (1991): *The Case for Earmarked Taxes*, Londres: The Institute of Economic Affairs.
- Tol, R.S.J. (2005): “The Marginal Damage Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties,” *Energy Policy*, **33**: pp. 2064–2074.
- Watkiss, P., and Downing, T.E. (2008): “The Social Cost of Carbon: Valuation Estimates and Their Use in UK Policy,” *The Integrated Assessment Journal*, **8**: pp. 85–105.