Cost effectiveness of a combination of instruments for global warming: a quantitative approach for Spain

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There is a considerable body of research about the use and design of market instruments for mitigating greenhouse gas emissions. However, discussion of the combination of instruments and their possible interactions is in its infancy. This paper proposes a specific combination of instruments (an emission allowance market such as the one already in place in Europe for energy-intensive sectors and a tax on CO2 for the rest) and analyses the effects of four possible distributions of mitigation objectives. We also analyse what happens if the tax on CO2 is replaced by other closely related taxes. Our findings suggest that a combination of market instruments is needed if emissions are to be reduced cost-effectively. However, it is essential to design the right combination of instruments to prevent costs from becoming excessively high.

Key words: Environmental policy instruments, CGE models, cap and trade, CO2 tax, climate policy.

JEL Classification: D58, H21

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1. Introduction

Climate change (CC) is an environmental problem with major economic and political implications. The European Union (EU), whose climate policy is one of the most advanced in the world, recently announced a package of measures with the following objectives for 2020: to reduce greenhouse gas emissions by 20% on 1990 levels, to reduce energy consumption by 20% via energy efficiency and to increase energy production from renewable sources to 20%. This package, known as "20-20-20", is based on three specific lines: (1) a policy of promotion of renewables; (2) improvements in the design of the European CO2 market (EU ETS), which has been up and running since 2005; and (3) the principle of "shared effort" so that sectors not covered by the emissions trading market (non-ETS sectors) such as transport, the residential sector, agriculture and waste also make an effort to reduce emissions (Gallastegui and Galarraga 2010) . To that end, the European Commission has set binding targets for non-ETS sectors. For instance, in the case of Spain the target is a reduction of at least 10% on 2005 levels. Although the Commission sets the targets for non-ETS sectors it is Member States that ultimately implement the relevant policies, and they have the freedom to choose the most suitable instruments for attaining the targets set.

This paper investigates mitigation costs when a combination of more than one market instrument is used. Specifically, the combination of an emission trading market for ETS sectors and a tax on CO2 for non-ETS sectors is analysed. The specific research questions posed are the following: 1) what impact will different rules of distribution of mitigation efforts between ETS and non-ETS sectors have?; and, given that states have the power to decide on policies for non-ETS sectors, (2) what would happen if the tax on CO2 were replaced by a tax on energy, on oil or on electricity?

2. Scenarios

For the first research question the following four rules for distributing the burden of emission reduction are proposed:

1. Cost-effective distribution (CED): marginal costs of production are distributed equally among sectors. This minimises overall mitigation costs.

2. Egalitarian distribution (ED): half the mitigation target is to be met by ETS sectors and the other half by non-ETS sectors.

3. Proportional-emission distribution (PED): efforts are distributed in proportion to emissions. Since the ETS sectors in our case account for 44% of emissions, they would be expected to make 44% of the total effort.

4. Proportional-output distribution (POD): efforts are distributed in proportion to output. In our case the ETS sector accounts for 10% of output, and would therefore make 10% of the total effort.

These distribution rules are very common and have been applied (or at least defended) in many contexts by different groups, sectors and countries. For instance, all these rules have been suggested for climate policy in designing National Allocation Plans (see, for instance, Sijm et al 2007 and Arto et al 2009) and in fishery policy design, for sharing out the total allowable catch among countries (see, for instance, Gallastegui, Iñarra & Prellezo 2002).

For the second research question the paper explores the possibility of taxing CO2 emissions indirectly as follows:

1. Tax on energy: this involves a tax on consumption of coal, oil and gas levied on non-ETS sectors (including consumers). It does not take into account the carbon content of each fossil fuel, so the tax rate is the same in all three cases.

2. Tax on oil: this is a tax on oil consumption, levied on non-ETS sectors (including consumers).

3. Tax on electricity: this is a tax on electricity consumption, levied on non-ETS sectors. Although the consumption of electricity does not entail direct emissions of CO2, electricity production is fossil-fuel-intensive.

3. The Model

Mitigation costs are estimated by applying a static version of a general equilibrium model to the case of Spain (for full details see González-Eguino 2010). Such models capture interdependencies between the economic agents and incorporate direct and indirect impacts, plus the substitution effects of changes in price.

In the case of a quantity-based instrument the emission permit market is simulated by setting a number of permits that is gradually limited exogenously. Permits are thus just one more production factor, and their prices are determined by the equilibrium between their supply and demand. By contrast, in a price-based instrument taxes are gradually increased until the desired emission reduction level is attained. The revenue obtained from both instruments is returned to consumers via transfers so that public spending and income remain constant.

4. Results

This section presents a brief outline of some of the results (for full details see Gallastegui et al 2011). Each scenario simulates CO2 reductions ranging from 5% to 40%. Figure 1 shows the link between CO2 reduction and gross domestic product (GDP) for the various distribution scenarios, and Figure 2 shows the different tax scenarios.

Figure 1. Economic impacts of different ETS/non-ETS distribution criteria

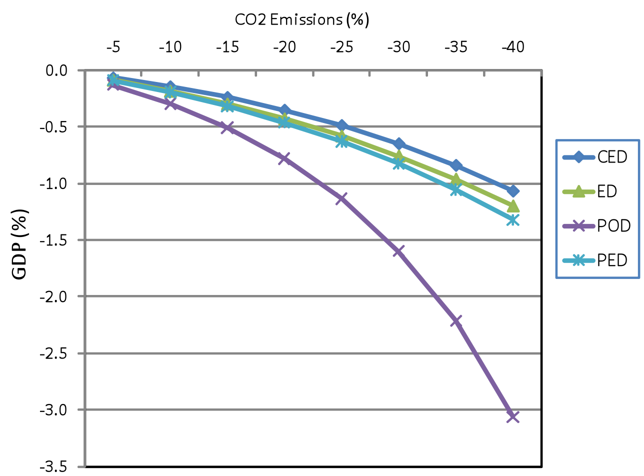
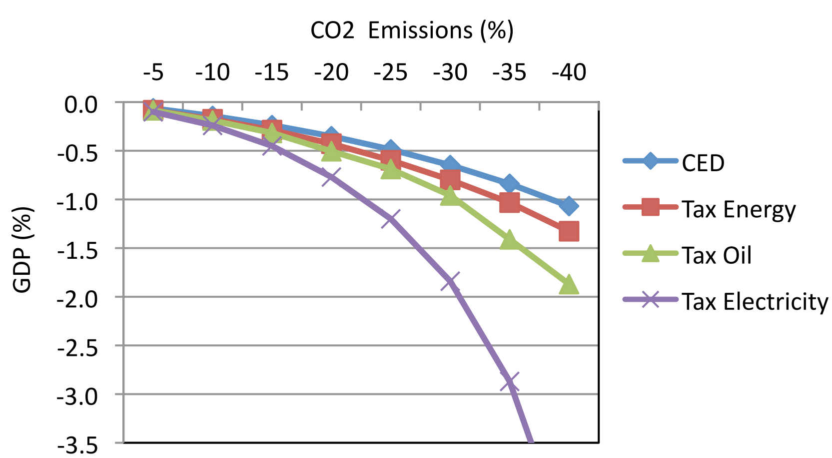


Figure 2. Economic impact of various tax scenarios on non-ETS sectors



5. Conclusions

The results obtained here show that the cost of reducing emissions varies considerably in line with policy design. When effort is shared out between sectors under cost-effective distribution, ETS sectors must make 68% of the total effort for a mitigation target of 20%, leaving non-ETS sectors to make the remaining 32%. This is because mitigation is relatively cheaper in more energy-intensive sectors. This result is a clear, empirical illustration of economic theory: cost-efficient distribution means that the marginal costs of reduction are evened out across sectors and that any distribution that does not allocate effort in this way will be costlier.

Although distribution based on cost effectiveness criteria may be desirable from an economic viewpoint, there are many obstacles to its application. Egalitarian distribution and distribution in proportion to emissions would result in figures not far from the minimum. However, distribution in proportion to output would result in a considerable increase in cost. The same thing can be expected if taxes on CO2 are replaced by other taxes. Taxes on energy and on oil entail higher costs, but their impacts are not very different from those of a tax on CO2. Taxing electricity as a way of reducing CO2 emissions is tremendously inefficient. Climate policy makers are unlikely to implement the more inefficient methods mentioned above, but even so it is important to quantify the potential scale of the losses that would result.

Finally, two potential lines of future research can be pointed out. Following Goulder & Parry (2008), this analysis could benefit from the incorporation of other criteria such as equity or political viability, since it is not only economic criteria that are important in decision-making. And given that there is always some degree of overlap between climate policy instruments, it would be useful to analyse the cost/benefit of such interactions.

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