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Twenty years of carbon taxation in Europe: some lessons learned

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Whereas the project for implementing a national carbon tax in France has been postponed sine die, other European countries have already been using this tool at a national level for about twenty years. The need to regulate diffuse emissions so as to achieve European objectives for reducing emissions seems to suggest that the carbon tax could come back on top of the political agenda in a near future.

This note intends to examine the main questionings in relation to the subject as well as the evaluations carried out by the various European countries that have already adopted this tool. Therefore, it is through the experience of Northern countries (Finland, Denmark, Sweden and Norway), Switzerland and Ireland that the authors analyze the issues at stake here and the mechanisms linked to carbon tax implementation. The future role of environmental taxation, the choice of the tax rate and of its evolution, the definition of the tax base, the way carbon tax revenues are used or the way issues of equity, competitiveness and coexistence with the EU ETS are handled; all these questions are tackled here in the light of different European experiences that constitute genuine fields for experimentation, from which one can draw many valuable lessons.

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Summary

Traditionally, economics textbooks describe two ways of pricing greenhouse gas emissions: taxation, as first proposed in the 1920s by the British economist Arthur Pigou; and allowances markets, the theoretical foundations of which were laid in the 1960s by Crocker and Dales, following the pioneering work of Coase. These two methods are generally presented as alternatives, whose respective merits must be weighed up before one or other approach is adopted.

In the real world, extending carbon pricing seems to lead to hybrid systems in which allowances markets and carbon taxes are obliged to coexist. Allowances markets are an instrument best suited to regulating emissions concentrated in large industrial plants. Taxation is the preferred instrument for pricing sources of diffuse emissions in a given area.

Europe is in this respect a unique testing ground. The European Commission published a first draft of a carbon tax on industrial emissions in 1990. Since unanimity is required in Europe for tax issues, the project came to nothing. But following this setback, some countries went ahead with it anyway inside their borders, as was the case with Sweden, Finland, Norway and Denmark and, more recently, Switzerland (2008) and Ireland (2010). As from 2005, Europe simultaneously developed the CO2 emissions trading scheme, which has become the indispensable benchmark for emissions allowances markets.

This note seeks to draw lessons from this varied experience in implementing national carbon taxes. The first two sections examine the issues of carbon taxation in the context of development of tax systems and consolidation of public finances. Sections three and four ask about the right way to define the various carbon taxes and to align them with the area covered by the market. Sections five and six discuss how to achieve the objective of a single carbon price in a context where there are two instruments. The final section examines the practicalities of using carbon tax revenues, and discusses the conditions for obtaining what economists call an economic “second dividend” subsequent to the introduction of a carbon tax.

To avoid any possible confusion, we should add that the “carbon tax” concept used in this note refers only to taxes putting a price on carbon within an economic area. The observations we make and the conclusions we draw are in no way transferable to border adjustment mechanisms, which are sometimes wrongly called border carbon taxes by some commentators.

1. The evolution of fiscal systems and environment taxes

In the context of the globalized economy, competition among countries to reduce tax rates risks leading to a tax-cutting race in which all countries lose out. A better way of reconciling taxation and competitiveness is to focus on the structure of tax and social security payments so as to favour taxes having the least negative impact on economic activity. From this perspective, taxing pollution through environmental taxation is an interesting approach, although one still little practised by the industrialized countries.

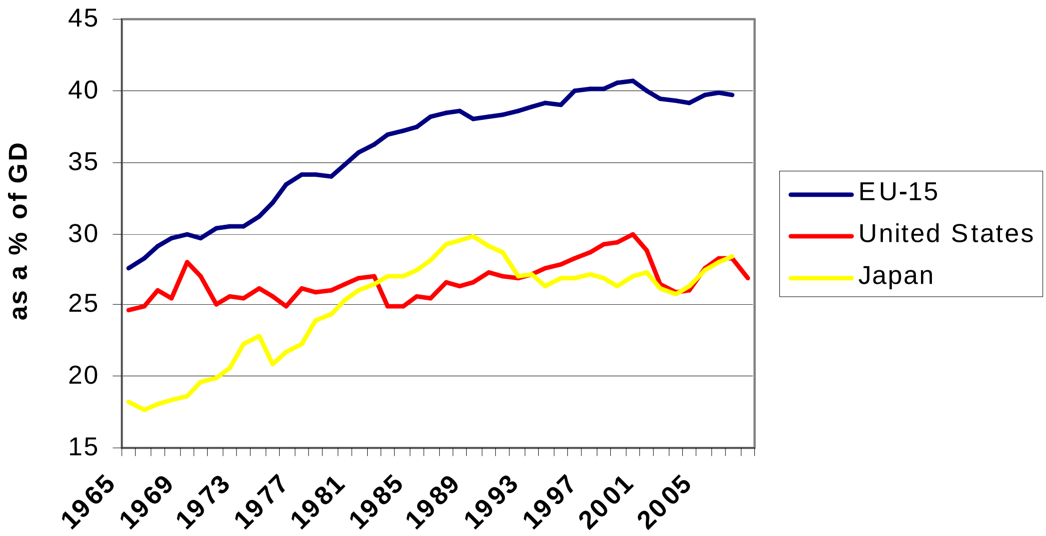
1.1. The level of tax and social security contributions

According to the OECD definition, tax and social security payments consist of all “existing payments made by all economic agents to the public administration sector […] if such payments result not from the decision of the economic agent who makes them but from a collective process […] and if these payments do not involve any direct exchange”. Taxes and social security contributions account for the greater part of this amount.

Tax and social security systems have undergone many changes over the past fifty years. One major trend, however, is evident in all industrialized countries: an increase in the overall rate of these payments during the period of rapid growth following World War 2 up until the end of the 1980s.

This increased levy on the economy originated in the need for additional funds for governments whose area of intervention had grown: the financing of infrastructure, growth of social security systems, ageing populations and the implementation of economic policies.

Growth of the rate of tax and social security payments between 1965 and 2007 (Graph 1)



Source: OECD data

From the 1990s, these rates stabilized and in some cases fell slightly. A number of contributory factors may be seen here: questioning of the role of the state, the attainment of a maximum contribution threshold, and protecting the competitiveness of businesses and the economic attractiveness of national territories. Among the various factors, the globalization of economies seems to have played a key role. As well as these structural factors, there have also been situational factors: in the United States, for example, the onset of the 2008 economic and financial crisis sharply reduced some taxes that were particularly sensitive to the economic situation – corporation taxes and property gains tax – which led to a reduction in tax revenues and a rapid deepening of the public deficit.

Faced with this situation, there is a strong temptation for governments to enter a race to the bottom by engaging in bidding wars in pursuit of "competitive" tax rates. Yet in the longer term, this spiral risks ending in negative outcomes for all concerned: if every government applies the lowest possible tax rates, a situation can arise in which fiscal revenues are lower all round, with no government benefiting from a significant increase in the attractiveness of its national territory or the competitiveness of its companies. Moreover, tax havens and tax optimization strategies tend to reduce the tax base and hence the revenues derived from it. These strategies, that range from fully legal circumvention through to highly dubious practices, reduce, sometimes considerably, the tax revenues collected by the various governments1.

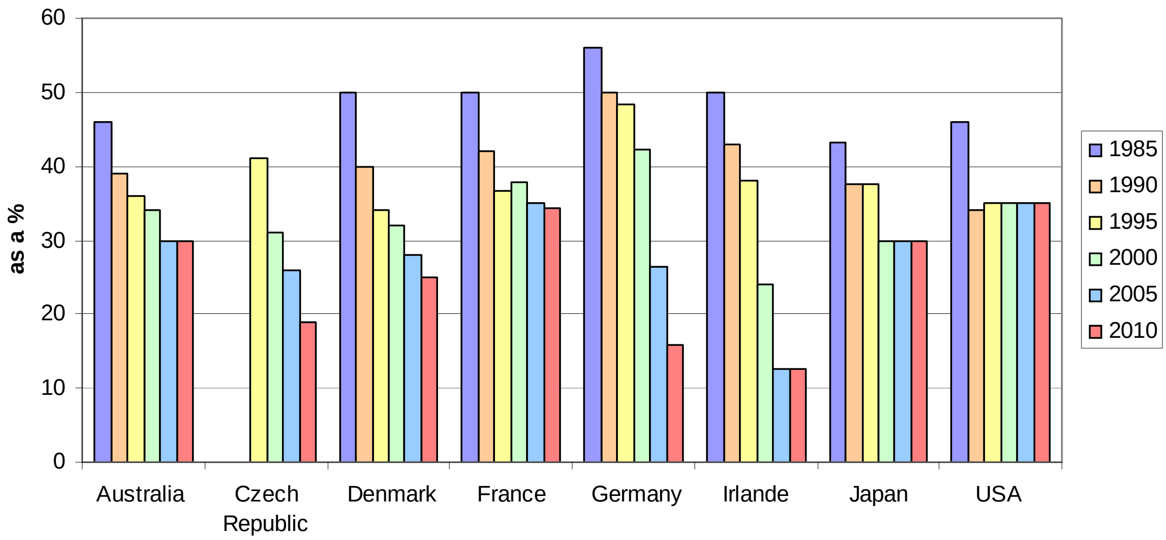
A more advantageous way of balancing tax payments and national competitiveness is to alter the tax structure so as to reduce the negative impacts on economic activity.

[1] The Council of Europe report dated 6 April 2001 attempts to quantify the proportion of the economies of tax havens linked to tax fraud: this represents 5-25% of potential tax revenues in the developed countries. For France, a figure of 15-20 billion euros has been put on the loss of tax revenues due to the existence of tax havens.

1.2. The structure of tax and social security payments in international competition

Taxation has a considerable impact on corporate competitiveness as well as on the location decisions of foreign firms. In a globalized economic context characterized by heightened competitiveness, the tax burden on labour and capital has become an element in the competition between national economies. Thus some countries, such as Ireland, have reduced taxes on the factors of production with the aim of attracting companies and capital. More generally, it is striking to note the almost universal reduction of the taxation of corporate profits over the past 25 years in industrialized countries (Figure 2).

Evolution of the standard rate of corporation tax between 1985 and 2010 (Graph 2)



Source: OECD data base

However, the tax burden directly on the factors of production (capital and labor) accounts for the bulk of tax revenue. In France, for example, it makes up three-quarters of total government revenue (including social contributions). The situation in many states is therefore difficult: they are looking for tax revenue to finance expenditure that for the most part cannot be cut back but face the constraint of supporting the competitiveness of many companies and the risk of loss of potential revenue.

In order to reconcile the enhancement of economic competitiveness and the maintaining of public revenue, an overhaul of tax systems with a view to reducing the tax burden on the factors of production in favour of a new tax base is often advocated. In this context, the development of environmental taxation has undoubtedly an innovative role to play.

1.3. Fiscal reform and environmental taxation

Environmental taxation covers taxes whose base consists of physical units that have a detrimental effect on the environment. The primary objective of such taxation is to change the behavior of actors by putting a price on the environment. It is not, as often perceived by the public, a matter of generating additional revenue so as to increase public spending on environmental protection. The question of the use of proceeds of environmental taxes is still subject to debate.

The exact scope of environmental taxes is not easy to establish. Take the example of the TIPP (Taxe intérieure sur les produits pétroliers): this tax was not originally created because of environmental concerns, and its base is the energy content of fuels rather than the polluting unit. Strictly speaking it does not fall within the scope of environmental taxation. In a broader view, such taxation may be defined as all the tax measures whose base has a proven, positive impact on the environment: on this basis, the TIPP must obviously be included. It was this broad view which was adopted by the OECD and Eurostat, and which we use here.

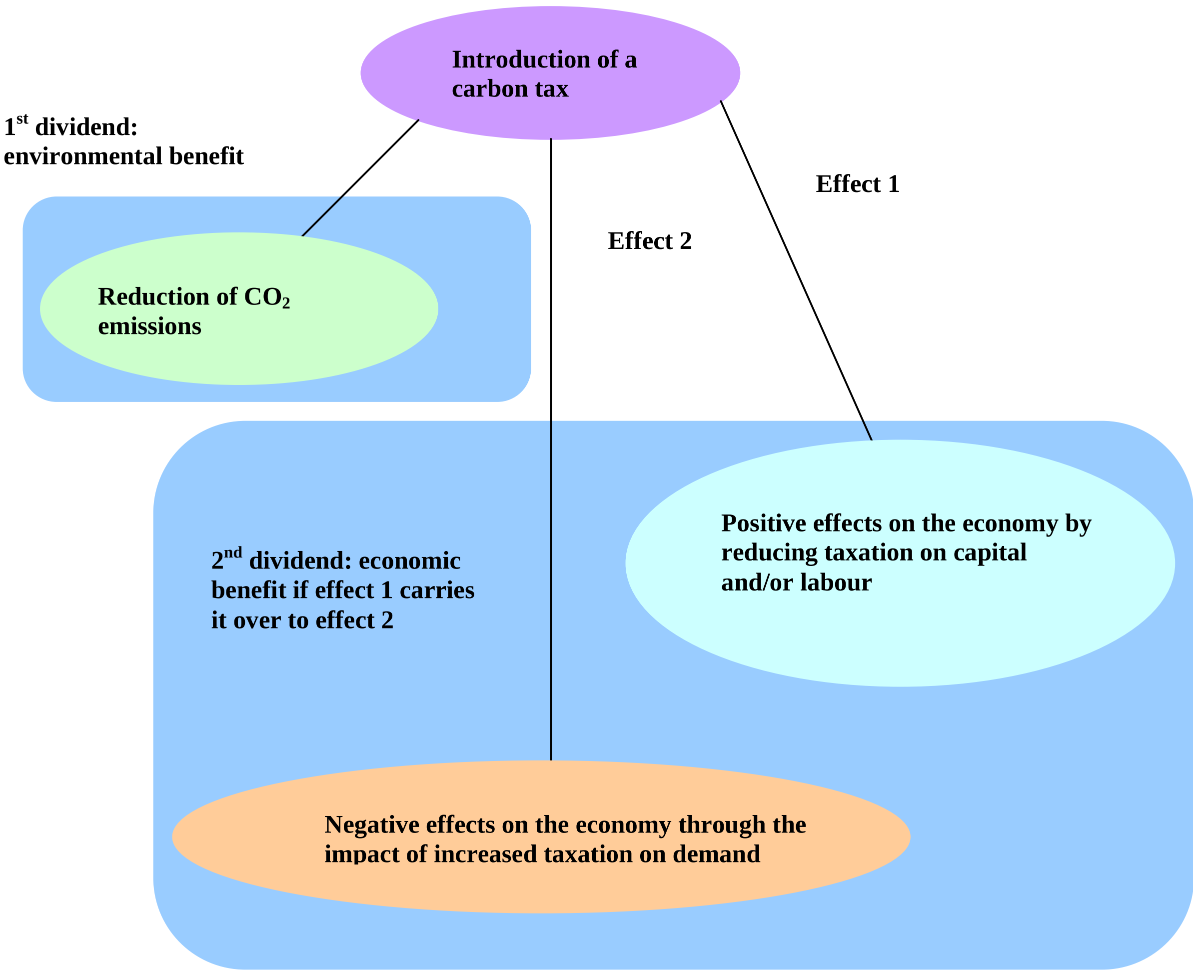
The purpose of an environmental tax is to encourage agents to adopt modes of production or consumption that are more environmentally friendly. If this goal is achieved, it will lead to an erosion of its base – which raises the question of sustainability of the tax revenue if the tax rate does not change quickly enough to offset the erosion of the base.

Economists usually analyze the impact of an environmental tax through the concept of the "double dividend". The first dividend aimed at is the environmental benefit linked to the incentive effects of environmental taxes. The second comes from benefits in terms of employment or business, generated by lower taxes on the factors of production, which may authorize the introduction of the new environmental tax.

The introduction of a tax on CO2 emissions associated with the use of fossil fuels increases the cost of burning such fossil fuels. It thus weighs on consumers, as their expenditure on fuel increases. This increase in tax on consumption has a negative effect on the economy. But this new tax source can be used to reduce taxes on labor and/or capital. The second impact has beneficial effects for the economy.

The various taxes and charges do not all have the same negative effects on the economy: they can be said to be "distorting" to a greater or lesser. Thus if we increase a slightly distorting tax to reduce another that is viewed as more distorting, an economic benefit is obtained, since the new tax structure has fewer negative effects on the functioning of the economy. To maximize the chances of benefiting from a double dividend, revenue from an environmental tax should be used to reduce the taxes, charges and contributions that are most distorting for the economy in question. The economics literature deals extensively with the question of whether or not this second dividend actually exists. Most studies on this subject conclude that there is a second dividend, but that its scale is limited (Goulder 1995).

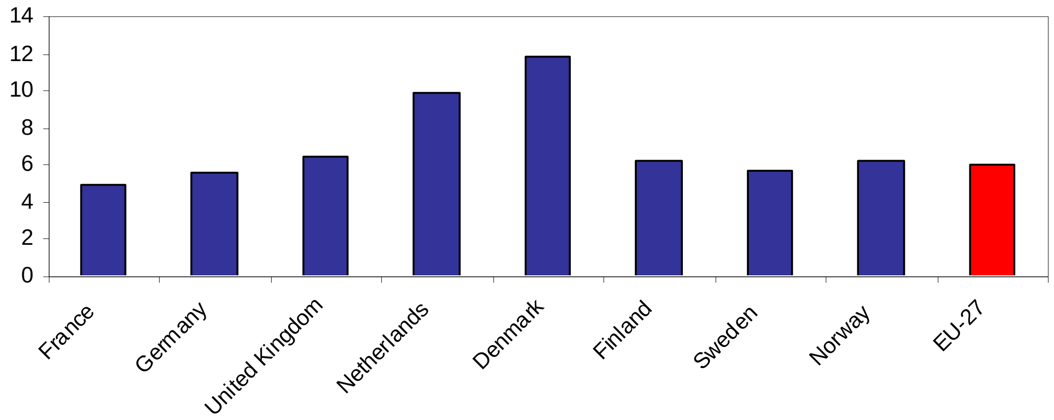
The double dividend (Figure 3)



1.4. Environmental taxation in practice

Despite all its potential interest, environmental taxation remains little used in the industrialized countries. Taking the broad definition used by international organizations that includes indirect taxes on energy, the proportion of environmental taxation to total tax revenues is no more than 10% even in those European countries where it has been most developed. If one takes out the indirect energy taxes based primarily on fuel, this proportion falls fourfold or more.

Proportion of environmental taxes to total tax revenues in 2008 as a % (Graph 4)



Source : Eurostat 2010

It is, however, interesting to note that some countries have already embarked on the path to significant tax reforms by reducing the tax burden on labour in favour of traditional indirect taxes and environmental taxes (Box 2). In so doing, they have tried to put into practice the recommendations of environmental economists seeking to obtain a “double dividend”.

Example of fiscal reforms in Sweden and Denmark (Box 1)

Following its 1991 tax reforms, Sweden reduced income tax by a total of €9.5 billion (4.5% of GDP). Average tax rates were reduced by 30% or as much as 50% on high incomes. This reduction was partially covered by an increase in VAT on energy products and the introduction of taxes on CO_2 and SO_2. More recently, between 2001 and 2007, the “Green tax shift” programme led to a reduction of income tax (on low and moderate incomes) of €1.34 billion and a reduction in social security contributions of €220 million, offset by an increase in revenues from the carbon tax and taxes on energy. Similarly, the increase in revenues derived from these taxes led to a reduction in labour taxes of €7.4 billion between 2007 and 2010.

Using the same approach, Denmark has, since 1993, reduced the marginal income tax rates, which has led to a reduction in tax revenues amounting to 2.3% of GDP. This loss has been partially offset by additional revenues from environmental taxation (1.2% of GDP).

These reforms, which are very limited geographically (northern European countries), could be extended if in future taxation were to be used more to engage in action to counter climate change.

2. Specific issues related to the carbon tax

Action in the face of climate risk requires tackling a large number of sources of greenhouse gas emissions, with a benefit for the climate that is totally independent of where and in what form emissions reduction occurs. Such action gives economic instruments a special role, through the imposition of carbon taxes or through allowances markets, for which Europe has until now been the main testing ground.

2.1. The existence of a common standard facilitates carbon pricing

One of the difficulties of introducing environmental taxes concerns the enormous diversity of natural sources to be safeguarded. For example, protecting biodiversity has, like action to counter climate risk, become one of the great planetary environmental causes2. But the introduction of economic instruments to protect biodiversity is hampered by the lack of a common yardstick. How do we enhance the biodiversity of a hectare of primary forest in the tropics? And how do we compare this value to that of a hectare of temperate or boreal forest?

As has been well documented in the work of the Intergovernmental Panel on Climate Change (IPCC), anthropogenic causes of climate change can be reduced to a single common and uniform standard: a tonne of CO2. Human activity results in the release of six greenhouse gases whose build-up in the atmosphere threatens the stability of the climate. Once released into the atmosphere, these gases have very long life, which leads to their accumulation over time. To limit the risks of climate change, we should aim at reducing the overall amount of human emissions. In addressing climate risk, it is of no importance where and in what form the emissions occur: the reduction of a tonne of CO2 emissions in Amazonia makes exactly the same contribution as that obtained in Europe or Asia or anywhere else in the world.

Greenhouse gases other than CO2 emitted by humans can be easily incorporated in this common measurement unit thanks to the work of the IPCC, which produces correspondence tables on the warming potential of the various greenhouse gases3. The existence of this unit of measure is an advantage for setting up economic instruments to combat global warming, all the more so in that the public authorities are faced with a multitude of emission sources, with very different abatement costs depending on the circumstances. But the economic benefits of a carbon tax versus a regulatory approach are all the greater since there are considerable differences between the cost functions of the various actors obliged to reduce their emissions (see Box 3).

It is for this reason that taxation on greenhouse gas emissions is, at present, one of forms of environmental tax most likely to develop. Its potential is considerable: as Perthuis points out, the introducing a 20 euro tax on all the world's greenhouse gas emissions would generate additional revenues of about €900 billion. This is equivalent to India's GDP or 10 times the figure provided by governments for development aid!

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[2] The two key international conventions on biodiversity and climate change – the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC) – were, moreover, signed at the same time at the summit the 1992 Rio Earth Summit.

3 The tonne of CO_2 equivalent (teqCO_2) is the most frequently used measurement unit for greenhouse gas emissions. Equal quantities of the various greenhouse gases associated with human activity (CO_2, CH_4, N_2O, HFC, PFC, SF_6 etc.) do not all have the same warming power. Carbon dioxide (CO_2) was chosen as the common standard (for example, one tonne of CH_4 heats the atmosphere more than 25 times as much as the same quantity of CO_2: therefore 1 tCH_4 = 25 tCO_2e).

This dual context – multiple emission sources and the existence of a common standard – explains why economic instruments, taxes and allowances markets, have played a major role from the first stages of action to address climate risks.

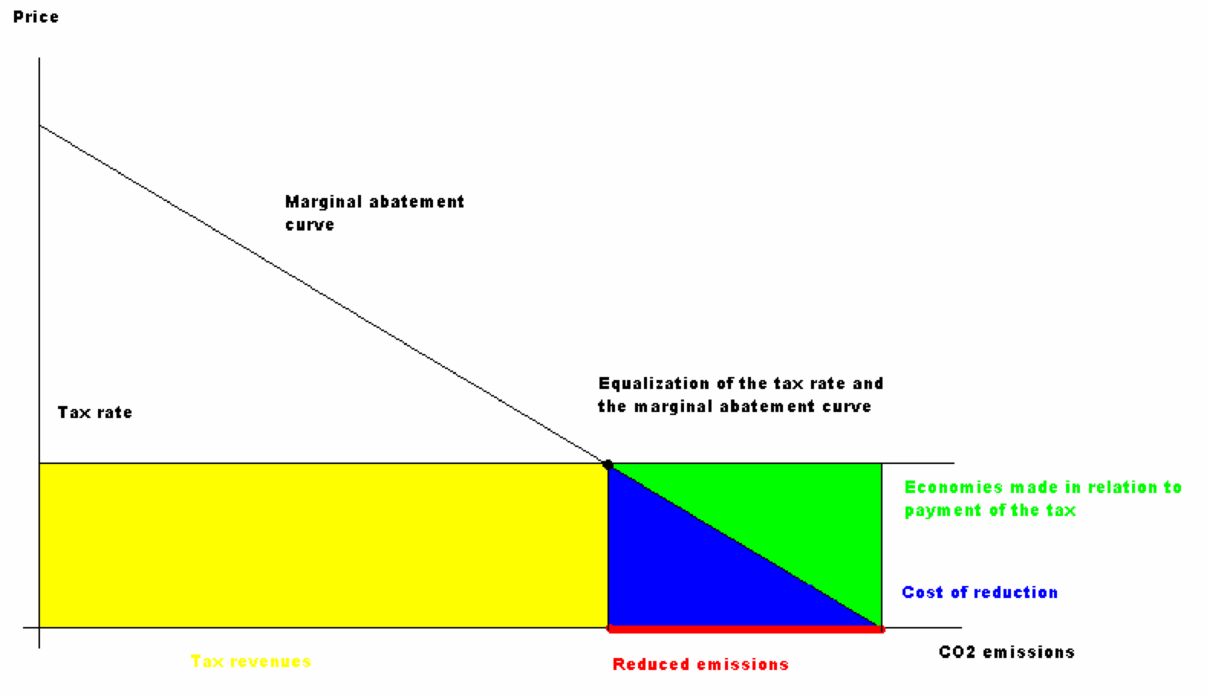
What is the environmental impact of a carbon tax? (Box 2)

A carbon tax aims to assign a price to CO2 emissions. It base is composed of CO2 emissions. Its rate, expressed in tonnes of CO2 emitted, sets their price. A carbon price alters the relative prices of goods or energy sources on the basis of their carbon content. This change in relative prices helps orient economic actors toward modes of production and consumption that generate less carbon.

If economic agents are rational, the environmental impact of a carbon tax is strictly identical to that of an allowances trading system which puts a price on CO2 emissions through their cap. In practice, the emergence of a carbon price has an established environmental effect if the various agents have alternative technologies and energy sources and have the financial means required to change their behaviour. Globally, it is more advantageous to introduce a carbon tax (or an allowances market) than regulation if the economic agents have different marginal abatement curves: reductions will be made by those agents for whom such reductions are less costly – which allows the cost of action for society to be optimized.

The incentive mechanism is that if an agent has to pay a tax (or an allowance in a cap-and-trade system) of 20 euros per tonne of CO2 emitted, it is in his interest to make all investments (technology changes, switching to alternative energy sources, improving energy efficiency, etc.) that cost him less than 20 euros per tonne of CO2 avoided. He thus saves the difference between the tax he would have paid without making the investments and the cost of the investment. Actors who continue to emit CO2 are those for whom the possibilities of reduction are more expensive but who are more likely to "improve" their emissions: only those agents who make sufficient profit from their activity to cover the cost of the tax – in the absence of cost-effective potential emissions reduction investments – are able to continue emitting. If the price of carbon increases with time, it may become prohibitive for all agents and may lead to a decline in emissions, and therefore revenue from the carbon tax!

The functioning of a carbon tax (Graph 5)



Source: C. de Perthuis, 2010, "Et pour quelques degrés de plus…", Chapter 7.

2.2. A brief history of carbon pricing

The first attempts to price greenhouse gas emissions date from the early 1990s4. They took the form of a European Union communiqué proposing the introduction of a harmonized tax on CO2 emissions originating from European industry. This proposal gave rise to extensive controversy. Countries such as Spain and Greece opposed the project because of their lower level of industrialization. Britain fought it on the grounds that tax decisions are based on national sovereignty. Since unanimity is required in the EU for tax issues, the project was dropped, but it encouraged some Nordic countries to commit themselves unilaterally to the adoption of a domestic carbon tax.

Internationally, significant progress was made towards carbon pricing, following the signing of the Kyoto Protocol in 1997. To help meet commitments by industrialized countries to cap greenhouse gas emissions, flexibility mechanisms were established, including an international market for carbon allowances. At the same time, Europe introduced its own CO2 emissions trading scheme, which since 2005 has capped the emissions of more than 10,000 industrial installations, representing nearly 50% of the EU's CO2 emissions. The European CO2 emissions trading scheme is by far the largest carbon market in the world, the other main pillar being the trading of carbon credits from the project mechanisms introduced by the Kyoto Protocol. But other quota markets are currently being developed in some U.S. states, Asia (Korea, China, Japan) and New Zealand and Australia.

This growth in allowances markets in no way nullifies the debate on carbon taxation. At a theoretical level, economists agree that taxes and allowances markets have exactly the same effects in the highly stylized world of perfect competition. But in a world dominated by uncertainty and imperfect information, the debate continues between supporters of taxation and supporters of cap-and-trade systems5. In practical terms, the question is primarily to see how taxes and allowances markets can complement each other to extend the signal price of carbon in real economies.

From this angle, Europe provides a unique experimental laboratory. First, the Scandinavian countries and Finland introduced a carbon tax into their fiscal system during the 1990s, well before the establishment of the European emissions trading scheme. Although they decided to adopt their domestic carbon taxes at the time of implementation of the EU trading scheme, none of them chose to opt out of it. More recently, other countries have endeavoured to introduce a domestic carbon tax. Two have done so successfully: Switzerland in 2008 and Ireland in 2010. France failed in its attempt in 2010, seemingly with political interference up the highest levels of state.

Despite its richness, this experimental laboratory appears to have been relatively little studied. Yet we can draw a number of lessons relevant to the debate on extending carbon pricing. We shall now do this, going successively through questions in relations to the tax base, the tax rate and the use these revenues may be put to.

[4] D. Ellerman, C.De Perthuis, F.Convery, 2010, "Pricing Carbon", chapter 1, p9 and following.

[5] See for example M.Weitzman, 1974, "Prices vs. Quantities", Review of Economic Studies, 41, pp. 477-491.

3. Defining the carbon tax base

In regard to the tax base, the recommendation of economists is quite simple: the broader the carbon tax base, the higher the revenues generated by its implementation and the smaller the risk of unwanted adverse effects. In practice, however, existing systems reduce the tax base by excluding non-CO2 gas emissions from agriculture. There are also exemptions, generally in order to make the new tax more acceptable.

3.1. Agriculture and forestry emissions

A first observation in relation to the carbon tax base emerges from an examination of the existing systems in Europe: the exclusion of emissions originating from agriculture and forestry. This exclusion has scarcely any theoretical justification from an economic standpoint. Moreover, studies conducted in this area suggest that there is considerable potential for emissions reduction at a reasonable cost in the agricultural sector (De Cara, 2011). This situation results from a combination of two factors.

- In practical terms, the inclusion of agriculture and forestry is hampered by technical problems resulting from uncertainties in the calculation of emissions from these sectors. These uncertainties complicate the calculation of an indisputable base and make the implementation of control and audit systems costly. In addition, taxing emissions from agriculture and forestry requires contacting a very large number of economic units of modest size, hence the high costs of implementation.
- As well as the above-mentioned difficulties, there are often problems arising from the considerable lobbying power of farmers6.

This restriction of the tax base is found largely in the European CO2 allowances market, where only emissions arising from energy production were capped during the first two stages and industries subject to caps cannot use forestry credits issued under the Kyoto protocol to be in compliance.

[6] In France, these emissions were not, for example, included in the debate on the carbon tax during the July 2009 public consultations prior to the publication of the Rocard report. Furthermore, the farming industry obtained an exemption from taxation on its energy-use emissions when the project was voted through in Parliament at the time of the debate on the Finance Law.

The different sources of anthropogenic greenhouse gas emissions and carbon taxation (Box 3).

Globally, it is estimated that nearly two thirds of the greenhouse gases released into the atmosphere come from the use of fossil fuels. Within this total, the three main emission sources are, in descending order of magnitude, electricity generation, transportation and the use of buildings. These emissions may calculated with great precision once the quantity and quality of fossil fuels are known, which is the case in most countries.

A little less than a third of global emissions of greenhouse gases come from agriculture and forestry. The emissions from tropical deforestation or degradation are the world's second largest source of CO2, just after those from electricity generation. Agriculture is the main source of emissions of the two major greenhouse gases other than CO2: methane and nitrous oxide. Unlike those resulting from the use of fossil energy, agricultural and forestry emissions are known very imprecisely.

Carbon taxes, as they are conceived at present in Europe, are directed exclusively at CO2 arising from energy production/use.

For more details, please consult the Chaire Economie du Climat website "Chiffres clefs sur les émissions de gaz à effet de serre" (tab "outils")

3.2. Taxing upstream or downstream?

Once the tax base is reduced to the total CO2 emissions from energy, there arises a practical question of primary importance: should the carbon content of every product and service consumed in the economy be taxed or should a method be used that taxes CO2 upstream of production and distribution? The intermediate method of taxing CO2 at the point of combustion, adopted in the European emissions trading scheme, is little suited to diffuse emissions.

The first method involves applying the tax "downstream", i.e. on finished products. It would mean taxing each product according to the CO2 emissions generated by its production and distribution. The tax would therefore directly augment the selling price of all goods. This method would have the advantage of establishing a clear and readable price signal. However, it is difficult to apply, for a number of reasons. First, methods for calculating the carbon content of different goods and services remain difficult to establish. Then there is the question of the extent of the emissions to be taken into account for the tax (for example, should we include emissions from transporting products?). Finally, care must be taken to avoid double counting. From this standpoint, some people have advocated the introduction of a CAT ("Carbon Added Tax"), along the lines of VAT. But its implementation would require the establishment of genuine carbon accounting at a microeconomic level, the implementation costs of which seem prohibitive as soon as one includes areas such as transportation, housing and agriculture, where overall emissions are the aggregate of a large number of diffuse sources.

The second solution is to tax emissions "upstream" through the carbon content of fossil energy sources measured at a point upstream of the production/distribution chain. This method has the advantage of being very simple to implement. Indeed, emissions from the use of each fossil energy source are precisely known. Moreover, in most industrialized countries, there already exist energy taxation systems and therefore an administrative infrastructure that can be directly mobilized to introduce a tax on carbon from energy sources. This is why up until now the upstream approach has been adopted by all countries that have introduced a taxation system for carbon from energy sources.

One final point: some people argue that taxing carbon has the same economic and environmental effects as taxing energy. But this would be true only in a purely theoretical case in which a country uses a single energy source or several sources all having the same carbon content. In practice, taxing energy aims at rationalizing the use of energy regardless of its carbon content; whereas taxing carbon aims additionally to encourage people to economize on the use of high-carbon energy in favour of the energy producing less or no carbon (see Box 5).

Carbon tax or energy tax? (Box 4)

Several European countries combine a carbon tax with a tax on energy. A carbon tax in the strict sense is a tax which targets the use of energy based on CO2 emissions, while an energy tax applies to the amount of energy used. This system has been used to combine a pollution tax, which seeks to cut down pollution, with a resource tax, which sends a signal as to the rarity of the resource. Thus Sweden, Denmark and Finland have introduced dual taxation on the use of fossil fuels: one part of the tax relates to energy consumption, the other to CO2 emissions. This dual base has the advantage that it targets linked objectives. The energy tax encourages users to reduce their energy consumption, among things by increasing energy efficiency (one of the three objectives of the EU 2020 energy and climate package), thereby lowering emissions indirectly. The carbon tax encourages the use of non-carbon energy. This tax base has the advantage of creating additional incentives to achieve more than one objective (reducing emissions, improving energy efficiency).

3.3. The size of the tax base: from theory to practice

In theory, a carbon tax should be levied as widely as possible to be effective. It should therefore apply to all emission sources (hence all fossil fuels)7 and to all agents: the broader the tax base, the fewer sources of low-cost potential emissions reduction are left cost outside its reach, and therefore the greater the reduction of the total cost to society. In addition, a comprehensive base avoids the risk of "carbon leakage" that can result from an increase in carbon emitting energy sources by agents from outside the tax base.

However in practice, it seems difficult to apply such a base when the tax is introduced. The experience of European countries that have adopted a carbon tax reveals the existence of exemptions that have reduced the base of emissions subject to the standard rate of the tax. Often justified by the need at the outset to achieve a consensus for the introduction of the tax (especially when it involves a parliamentary vote), experience indicates that these exemptions tend to persist over time.

One justification for eroding the carbon tax base is the need to take into account the vulnerability of some economic agents. It is appropriate here to distinguish between two types of agents: households and businesses.

In general, existing carbon tax schemes do not deal with households through exemption but through compensation, using traditional social transfer or tax mechanisms to cushion the negative impact of the carbon tax on the solvency of the most vulnerable. The main choice here is between general compensation and compensation targeted at the most vulnerable households. The French carbon tax project foresaw general compensation in the form either of a “green cheque” distributed to all households or of a reduction in income tax. Ireland adopted compensation, which applies only to the 20% of Irish households benefiting from the allowance for energy poverty, revalued at the time of the introduction of the carbon tax.

[7] In point of fact, only fossil energy would be taxed since renewable energy and nuclear energy do not emit carbon (although they are taxed indirectly for the emissions linked to the construction and decommissioning of installations (such as the construction of a wind turbine)).

The issue of vulnerable agents: rate, base or redistribution? (Box 5)

The economic situation of some agents may warrant setting an exemption system. Several options are available, depending on whether one chooses to act through a rate, a base of the use of tax revenues.

Acting through the tax rate involves applying a reduced rate to certain categories of agent or certain types of energy source. The use of tax rates differentiated by economic sector is, for example, standard in the countries of northern Europe, which have always been very careful about the impact of carbon taxation on competition.

One can also simply exclude vulnerable agents from the tax base. This solution is generally used in the case of “sensitive” professions that are particularly exposed, such as road hauliers or farmers.

A third option is to redistribute, on a fixed sum basis, part of the tax to low-income households and to companies facing excessive competition. This type of offsetting fully retains the incentive of the carbon price. Indeed it is based on a decision as to the use of tax revenues.

Although the first two solutions are able to deal with the problem of vulnerable agents, they weaken the price signal that the tax is supposed to provide by allowing certain agents to avoid it. This is why economists recommend the use of the third mechanism in the case of vulnerable agents.

The use of total or partial exemptions from the carbon tax for companies is on the other hand a relatively widespread practice in Europe. It is reflected in a rather complex array of rates differentiated by economic sector or by the type of fuel used, which is not conducive to making the carbon price signal easily readable. Since these exemption systems can vary over time, they also affect the foreseeability of this price signal in the productive sector.

Apart from vulnerable agents, there can be other reasons for providing exemptions. The wish to develop certain types of energy or to facilitate the substitution of an energy source with another that is more carbon efficient explains why not all fossil energy sources are taxed or why they are taxed differentially (see Table 1). In addition, some specific uses of fossil sources may be exempt: for example, Denmark partially exempts the purchase of natural gas and fossil fuels used exclusively to produce renewable energy thereafter.

Fossil fuels subject to carbon taxation (Table 1)

	Denmark	Sweden	Finland	Norway	Switzerland	Ireland
Coal	•	•	•		•	
Diesel	•	•	•	•		•
Electricity (consumption)	•					
Heavy heating oil	•		•	•	•	•
Petrol	•	•	•	•	•	•
Natural gas	•	•	•	•	•	•
LPG	•	•		•		

Source: Data from OECD and the environment ministries of the countries concerned

There are two further reasons that may cause the public authorities to reduce the carbon tax base: the search for voluntary agreements, and the existence of the European CO2 emissions trading scheme.

Some countries provide an opportunity to industries or companies to partially or entirely avoid the tax in exchange for a voluntary reduction of emissions. This is particularly the case in Sweden and Switzerland. Thus Swiss companies may be exempted from the tax if they agree to reduce their emissions either by measures taken in the company itself or by the acquisition of surplus emission rights from other exempt firms or the purchase of emission reduction certificates abroad. If the company fails to honour its commitment, it must pay the tax plus an additional amount as a penalty. These systems have the advantage of making the company aware of its responsibilities or serving as a means of mobilizing actors in it.

Finally, the existence of the European CO_2 emissions trading scheme, covering the main high emissions industrial installations, has led all EU countries to introduce specific rules to allow national carbon taxes and the new market to coexist. This particular point merits further discussion.

4. Should companies subject to caps be included in the carbon tax base?

The relationship between national carbon taxes and the European emissions trading scheme poses a double challenge: on the one hand a mechanism for pricing carbon by the market has to exist alongside a pricing mechanism by the tax, and on the other the European rules governing the market have to converge with national rules. Basic economic analysis suggests that one has to avoid superimposing the two mechanisms while installations subject to caps within the national carbon tax base are excluded. The choices made by European countries that have introduced a carbon tax tend to conform to this rule.

4.1. The basic economic mechanisms

From the economic standpoint, the cap-and-trade system differs firstly from taxation in that the price of carbon is not directly set in advance by a public authority: it follows from the scarcity that was imposed by the authority in setting the cap. A second difference between the two systems is the way of distributing value created by the introduction of an emissions price. In a cap-and-trade system where allowances are provided free of charge, the value of the allowances distributed is recovered by the public authority – which comes close to the mechanism of a tax system where the tax is set by the market.

Comparison of an emissions cap-and-trade system and a carbon taxation system (Table 2)

	Allowances market	**Carbon tax**
Target	Emissions volume set	Price set
Management cost	High	Moderate
Signal prix	Determined by the market: variable and sometimes volatile	Determined administratively: stable
Revenue generated by the mechanism	Revenue if auctions / allowances sold	Tax revenue
Constraint	Flexible constraint depending on allowances allocations in the case of free allocation	Same constraint for all agents, except exemptions or differentiated rates
Implementation	Qualified majority required in the EU	Unanimity required in Europe
Effectiveness	Lowers emissions reduction costs	Lowers emissions reduction costs

To understand the economic impact of the overlap of the two systems, an important point should be noted: although the allocation of allowances is free, allowances themselves are never free, as long as a sufficient scarcity constraint generates a price for CO2 in the market. An interesting parallel may be drawn with property: in European countries, most housing owned by households is passed on through inheritance. But it would not occur to anyone to say that an inherited property is a free good. Yet it is this kind of mistake that observers often make in claiming that CO2 allowances in the European market are free because of the way in which they are allocated.

A detailed analysis of the economic impact of the superimposition of the European cap-and-trade system with national carbon taxes is provided in Appendix I. Three basic mechanisms emerge.

- The environmental effectiveness of such a superimposition is non-existent: the fact that there is an overall emissions cap, fixed in advance at a European level, does not mean that the inclusion in the carbon tax base of installations subject to caps contributes to the emission reductions obtained. Companies subject to tax operating under caps will indeed make available additional allowances that companies in those countries which have not introduced a carbon tax will be able to use (see Appendix for more details).
- The economic effectiveness of such a superimposition is negative since the principle of the single carbon price no longer applies. Making allowances available lowers the equilibrium on the European market. Companies in countries that have not introduced a carbon tax therefore increase their emissions, while companies in countries with both a carbon tax and an allowances market reduce them. Since these two shifts offset each other, the overall amount of emissions reduction does not change. But the cost of these reductions has increased due to the dual nature of the price of carbon introduced by the superimposition of the tax and the market.
- Financial transfers and the possible risk of loss of competitiveness are to the country's disadvantage, including those companies subject to caps within the national carbon tax base.

Basic economic analysis thus shows that the inclusion of companies subject to caps within the national carbon tax base does not improve the overall environmental performance of the system, and lowers its economic efficiency. The costs of this weakening are borne by the country that has introduced the carbon tax. Let us now look at the trade-offs that have been adopted in reality.

4.2. Arrangements in practice

Two cases must be distinguished, depending on whether the countries concerned introduced their carbon tax before or after the launch of the European cap-and-trade system.

Switzerland and Ireland both chose to separate the carbon tax base from the area covered by emissions allowances trading. In Ireland, the carbon tax base, in all energy CO2 emissions, exactly complements industrial emissions subject to the European cap-and-trade system. Switzerland introduced two national carbon pricing mechanisms, each with a separate base: one based on tax and the other on transferable emissions rights.

France is a unique case in regard to the linkage of a carbon tax and the allowances market, revealing the communication problems between lawyers and economists. Following the recommendations of the Rocard report, the carbon tax project adopted by Parliament in the autumn of 2009 exempted from the carbon tax those companies covered by the European cap-and-trade system. But this project was challenged by the Constitutional Council on the grounds that exemption of companies subject to caps ran counter to the principle of equal treatment under the law[8]. The Council therefore wanted emissions from installations subject to caps to be included in the national carbon tax base.

In the countries of northern Europe that introduced a carbon tax before the European cap-and-trade system, arrangements have been made on a case-by-case basis to address the issue of the overlap between the two instruments. In Denmark, installations subject to caps are exempted from the carbon tax. In Sweden, the electricity sector is not subject to the carbon tax. Non-electric sectors benefit from low rates and are expected to be completely exempted from domestic carbon taxation by 2015.

Norway is a special case, since it joined the European emissions trading scheme in early 2008. Specific rules enabling the national carbon tax to coexist with the allowances system were instituted. In some cases, such as offshore oil and gas, the sector continues paying a carbon tax, but at a rate that was halved when the allowances system was introduced. In other industries, the carbon tax rate applies at rates that have been reduced to a greater or lesser extent, depending on the intensity of international competition.

With the exception of Norway, the various European countries that have chosen to establish a national carbon tax are therefore focussing on a linkage of taxation and the allowances market in which the respective bases of the two mechanisms are separate.

But avoiding the overlap between the two mechanisms only addresses part of the question. The question still arises as to the level at which carbon tax will be set and its link with the price which reflects the balance between supply and demand for allowances on the market. Since half the CO_2 from energy is covered by the market, should the carbon tax rate be set independently of the price indicated by the market?

[8] For more details, see Christian de Perthuis “Quel avenir pour la taxe carbone en France ? Les choix économiques après la censure du Conseil Constitutionnel” Futuribles N°361, March 2010.

5. How is the initial carbon tax rate chosen?

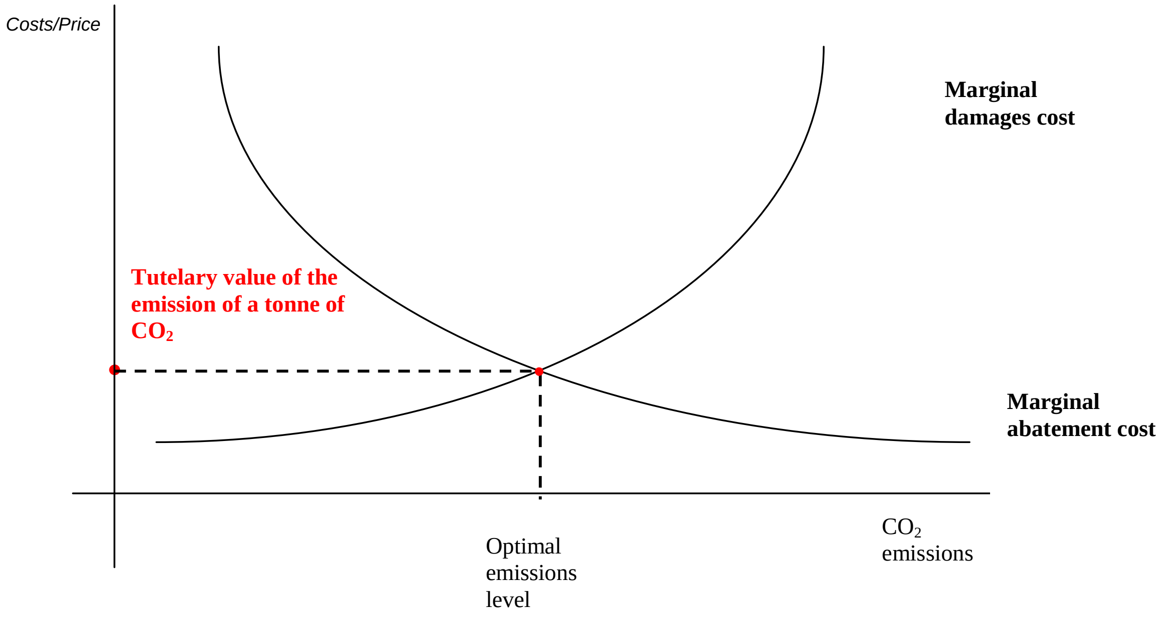
With the introduction of a carbon tax, the question arises as to what the initial rate should be. Economic theory provides methods that are not easily applied to carbon taxation. Since 2005, another reference point needs to be taken into account: the price of CO2 traded on the European carbon market, which was used in particular by the legislating authority in the Irish and French projects.

5.1. Cost-benefit analysis

In any question of environmental taxation, one essential reference point is the economist Arthur Cecil Pigou. In the 1920s, Pigou noted a market failing arising from not taking certain externalities into account. An agent generating negative externalities results in a cost to society that is higher than what the agent has to carry privately. For example, a company that pollutes does not take account in its own costs of the pollution costs to the community. Pigou recommended the introduction of a government tax to eliminate the gap that the agent's action generates between the social cost and the private cost. The tax thus functions as a corrective to the failing of the market, which does not take the social cost of the externality into account. The "polluter pays" principle is appropriate here, since, to be optimal, economic logic requires that the tax rate for the "polluter" should reflect the cost of the consequences of its activities for society as a whole. We also speak of the internalization of the externality, for the introduction of the tax gives a price to the externality that will be included in the various agents' economic calculations.

This approach is also referred to as cost-benefit analysis, since the optimal tax rate allows the marginal benefit that society acquires from the reduction of damage to be compared with marginal cost to society of cleaning up the pollution. The latter depends on the technical possibilities for acting on emissions. The former corresponds to a collective preference that reflects the willingness to pay: the greater the value society places on environmental protection, the more the marginal benefit curve increases and the higher the carbon tax for the same emissions reduction cost function (see Graph 6).

Equilibrium price of carbon in a cost-benefit analysis (Graph 6)



In practice, this type of cost-benefit analysis is very difficult to apply when a carbon tax is introduced. Estimating the damage caused by the emission of a tonne of CO2 today is a particularly perilous exercise. First, such damage results from the total accumulation of emissions in the atmosphere. The cost associated with the emission of a tonne of CO2 by an agent varies according to whether other agents do or do not release greenhouse gases. One therefore has to put forward hypotheses in regard to emissions on the basis of a scenario that includes all agents. Moreover, such damage will occur over a very extended period and with a great many uncertainties, as climatologists regularly remind us. It is therefore necessary to take these uncertainties into account and to use a discounted rate the choice of which will have a major impact on the social value to be given carbon today.

Because of this complexity, the cost-benefit approach yields very different results depending on the hypotheses adopted. Should we, for example, begin at 68 euros a tonne, as suggested by Nicholas Stern in his celebrated Review published in 2007 or at 7 euros as recommended by Nordhaus in his latest book?

5.2. Cost-effectiveness analysis

The cost-effectiveness approach involves choosing the amount of the tax such that it will achieve a previously set emissions reduction goal. It adopts a more pragmatic approach aimed at attaining predetermined emissions reduction targets in the most economically efficient manner. Technically, the relevance of this method relies on the ability to reliably approximate the price elasticity of demand for fossil fuels and the elasticities of substitution between different energy sources. While progress has been made in this area, the evaluation of these elasticities is a difficult exercise because they can vary over time and among different economies. In practice, applying the cost-effectiveness method to specific targets for reducing greenhouse gas emissions can therefore lead to rather wide evaluation ranges depending on the hypotheses adopted.

Nevertheless this approach can provide guidance to the public authorities when they set a long-term reduction target. For example, by drawing on the work of this kind, the Rocard report recommended starting the carbon tax with a rate at the bottom of the range estimated by economists in order to achieve a fourfold reduction of greenhouse gas emissions in France by

2050. But, as noted in the next paragraph, this figure was not adopted by the government, which preferred using the price given by the European CO2 emissions trading market.

Evolution of European standard carbon tax rates (Table 4)

Country	Finland	Norway	Sweden	Denmark	Switzerland	Ireland
Year tax introduced	1990	1991	1991	1992	2008	2010
Standard rate at outset in euros/tonne	1.2	43	23	13	8	15
Rate of carbon tax in January 2010	20	43	108	13	24	15

Source: OECD and national sources

5.3. Use of the EU emissions trading market price

While the application of economic theory can provide reference points for establishing the initial rate of the carbon tax, another approach has been available since the introduction of the European CO2 emissions trading scheme. The intersection of supply (the authorized cap) and demand (emissions) for allowances on this market can generate a price. This price constitutes a useful reference point. First, this market price emerges as a signal embodying a large amount of information: the level of the constraint on the industrial sector, expectations of future prices, the marginal cost of emissions reduction, and so forth. This information seems in fact to be as relevant as a value conventionally defined by the government on the basis of economists' figures, which do not spontaneously converge to a single value.

Referring to the market price also more or less maintains a single carbon price for both industrial actors subject to an emissions cap and other actors subject to the carbon tax.

It was these two reasons that the French authorities did not follow the recommendations of the Rocard report and used a starting price for the tax of 17 euros per tonne of CO2, consistent with the prices pertaining on the European market. The same reasoning was used in Ireland, where the carbon tax was introduced at the price of 15 euros per tonne to reflect the market rate.

But to ensure overall consistency, rules still need to be laid down to ensure that long-term trajectories are in line with the objectives of reducing emissions in the economy as a whole. But these rules are not easy to construct, because the economy includes both manufacturers operating in the allowances market and other agents subject to the carbon tax.

6. How is the carbon tax rate changed over time?

A issue that is at least as important as the choice of the initial tax rate concerns the trajectory of this rate over time: the carbon tax is effective only if the price of carbon alters the long-term expectations of agents in inducing the investment needed to "decarbonize" the economy. In the European institutional context of the co-existence of taxes and market this raises the question of the long-term management of this hybrid system.

6.1. An upward trajectory alters agents' expectations

A low starting level – the rate of 17 euros for the French project resulted in a price change at the pump that was less than the price differentials between different filling stations in the same city – is not a barrier to the environmental effectiveness of the tax, if it follows an upward trajectory over time. Starting with a low rate that gradually increases even offers a number of advantages. For this facilitates the social acceptability of the new tax and:

- allows emissions reductions running from the least to the most costly to be achieved, by gradually extending the range of economically viable reduction investments (Shapiro 2007);
- leaves companies time to develop alternative technologies and to make these available to all economic actors, who will be gradually able to change their behaviour.

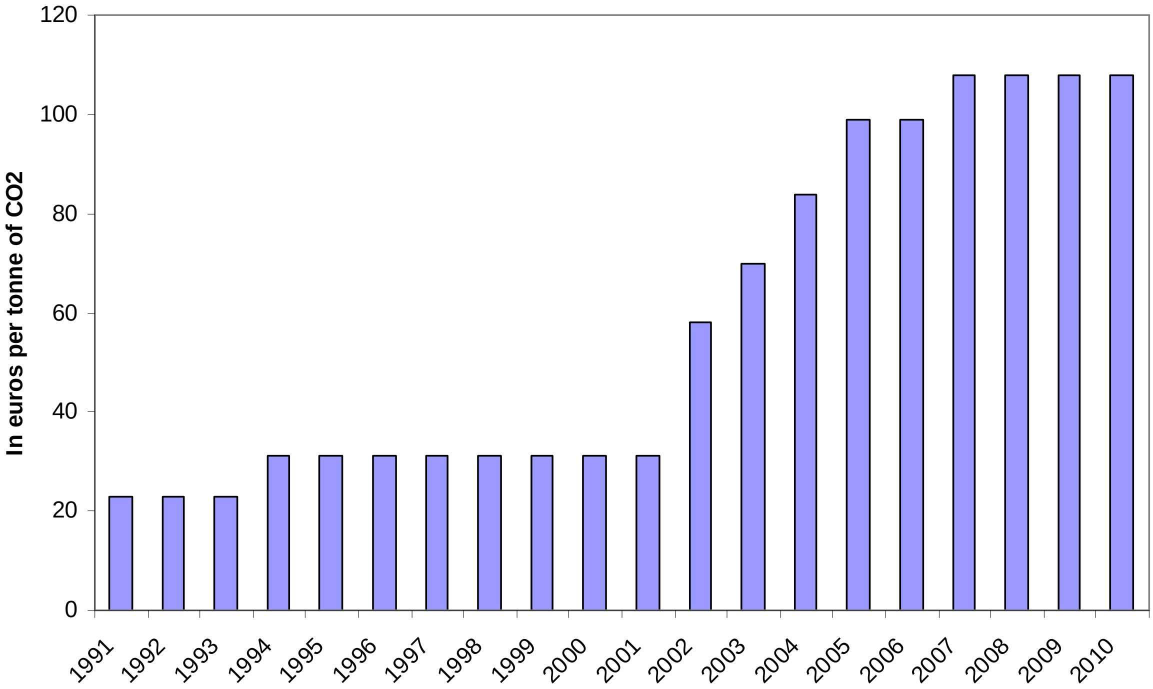
There is thus a strong consensus around the fact that the carbon tax rate should increase and the agents subject to this tax should anticipate this increase from the start. Such an increase has in fact been observed in most countries that have instituted carbon taxation. Thus, from a rate of €23 /tCO_2 in 1991, Sweden went to a rate of €108/tCO_2 in 2010. Similarly, in all other European countries where a carbon tax has been in place for some time, the rate has followed an upward trajectory.

Evolution of European standard carbon tax rates (Table 4)

Country	Finland	Norway	Sweden	Denmark	Switzerland	Ireland
Year tax introduced	1990	1991	1991	1992	2008	2010
Standard rate at outset in euros/tonne	1.2	43	23	13	8	15
Rate of carbon tax in January 2010	20	43	108	13	24	15

Source: OECD and national sources

Evolution of standard carbon tax rate in Sweden from 1991 to 2010 (Graph 7)



Source: OECD data

Examining the trajectories of carbon tax rates in Europe brings out two groups of countries with different practices: on the one hand, countries that have not explicitly programmed an upward tax rate trajectory, such as Norway and Ireland; and on the other, countries that have in the medium term programmed the way in which the rate will change over time, such as Denmark and Sweden. This choice is a tricky one from the standpoint of implementing economic policy. In addition, programming rate movements may face institutional barriers: in France, the finance law is enacted on an annual basis and does not authorize the tax rate to be set for future years.

The two standard advantages of establishing an upward trajectory of the rate in advance are the extension of agents' time horizon and the institutional credibility of the mechanism.

- Extending agents' time horizon and reducing uncertainties in regard to the future rate of the tax makes it easier to plan investment. A clearly specified evolution of the rate has the advantage of encouraging actors to invest in long-term emissions reduction projects. This improves the environmental effectiveness of the tax.
- Such a program also strengthens the institutional credibility of the measure. If the increase is enshrined in law, it is more difficult to reverse it. However, the question of the sustainability of the measure is crucial: if it is not credible, agents will adopt a "wait and see" attitude and will not make emissions reduction investments.

Conversely, the prior specification of future rates risks eliminating the government's room for manoeuvre in regard to fluctuations in fossil fuel prices and general economic conditions. Moreover, there is a risk that the projected path does not correspond to the intended environmental objectives because of imperfect information available to the legislature at the outset.

This is the reason why it is advantageous to establish an institutional process that provides for periodic dynamic review of carbon prices according to the degree to which the objectives have been attained. Such a mechanism has, for example, been implemented in Switzerland. It provides for an upward revision of the carbon tax whenever the CO_2 emission reductions observed in the economy lag behind the planned target (see Box 7). Such a mechanism entails adopting a cost-effective approach that dynamically adjusts to the way the economy reacts to the introduction of carbon pricing.

Dynamic adjustment of the tax: the example of Switzerland (Box 6)

An innovative carbon tax evolution mechanism has been developed in Switzerland, where a tax charged on CO_2 emissions from fossil fuel use (excluding heating oil) was introduced in 2008. Switzerland, like other European countries, has set emissions reduction targets and an associated emissions trajectory to attain them. The regulatory mechanism has, from the time of the introduction of the tax, planned for an upward adjustment if the emissions reduction targets are not met. The initial tax rate, 8 euros per tonne of CO_2, remained unchanged in 2009, since the country achieved its emission reductions targets in 2008. However, emissions rose in 2009, which led to an automatic adjustment from 8 to 24 euros per tonne as of 1 January 2010. So each year, if emissions are lower than the threshold required by the trajectory, the rate does not vary; however, if emissions exceed the threshold, the rate increases to a predetermined value. This way of managing the rate has the advantage of being transparent and clearly links the tax to its main objective of reducing emissions. In these circumstances it is easier for political leaders to implement the rate increase, because it depends on objective factors duly calculated by the Federal Office for the Environment.

But to target the overall efficiency of the system, the dynamic process of reviewing the constraint would need to be implementing in regard both to the revision of caps in the emissions trading market and to the rate of carbon tax in the diffuse emissions sector.

6.2. How should the hybrid tax/market system be managed in the longer term?

Management of the tax/market in Europe comes up against a scale-related institutional problem: the European level is predominant for decisions on the market and the national level for carbon taxes. The European Union would therefore have much to gain from the emergence of unified carbon taxation managed on the basis of the common objective of emissions reduction. In such a system, the search for economic efficiency would require aiming for a single price in the respective adjustments of the allowances cap trajectory and the tax rate for actors not included in the emissions trading scheme.

In the absence of such a system, countries that have chosen to introduce a national carbon tax have to make pragmatic decisions that allow them to conform to a greater or lesser degree to the single price rule.

Sweden extended its domestic carbon tax and increased its rate in seeking to apply the single price principle to two separate areas: the retail price paid in the final stage by households (slightly more than 100 euros per tonne in 2009) and the wholesale price paid by companies which is generally considerably lower (23 euros per tonne) and closer to the CO_2 allowance market price. Companies subject to the European emissions trading scheme are completely exempt in the case of electric power generation. In the other sectors, they pay a “preferential” rate of 15 euros, but are due to be removed from the tax base in 2011. This system works well, but raises processing difficulties for small companies, because of the dividing line between the two tax schemes.

Norway updated its domestic tax system for CO_2 emissions when it joined the European emissions trading scheme in 2008. It also obtained a special dispensation from the Commission that allowed it to allocate up to 100% of allowances by auction in some sectors as from 2008. The choices it made varied according to the sector. In the oil and gas sector, installations are subject both to caps (with 100% auctions) and to taxation (the rate is halved when the cap-and-trade system comes into force). In other sectors, industrial companies subject to caps are required to pay carbon taxes that vary according to the sector and sometimes include substantial exemptions, as in the case of the timber industry.

These very pragmatic choices enable the countries concerned to combine taxation and the allowances market while continuing to capitalize on the internal advantages of carbon taxation. These advantages primarily concern environmental objectives, but also the economic gains that may result from the redistribution taking effect through the greening of taxation.

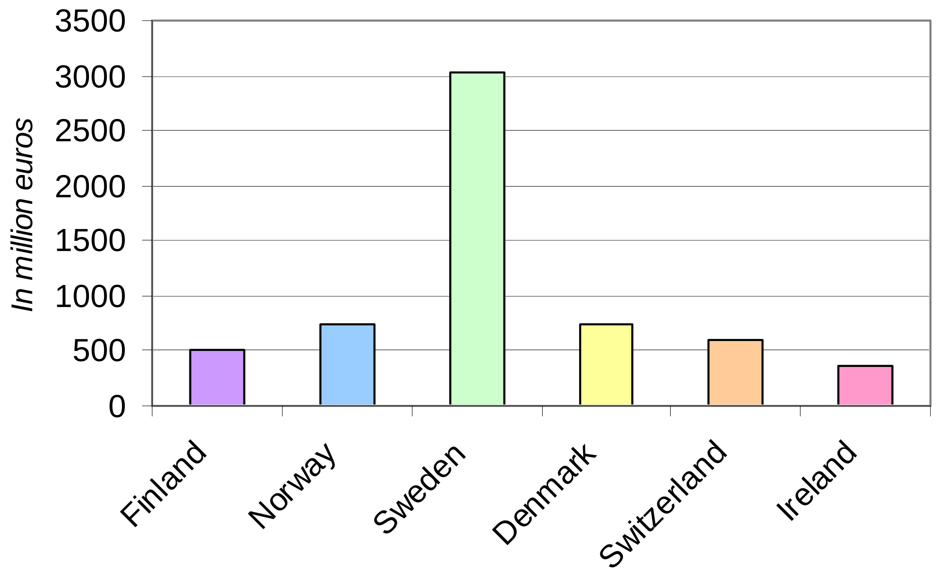
7. How should the revenues be used?

Apart from Sweden, revenues from carbon taxes represent a very small proportion of the GDP of the countries concerned. Decisions made on the use of these revenues have attempted to reconcile the objectives of fiscal consolidation, reduction of other taxes and the financing of low carbon investment. They seem to have had beneficial effects on economic activity, confirming ex post the existence of an economic “second dividend”. The big question now is how to sustain the dividend, since the primary objective of a carbon tax is its self-destruction through the decarbonization of the economy.

7.1. Revenues from carbon taxes

In most countries, tax revenues generated by the carbon tax are modest. In 2010, they represented a total of around €500 million in each country taxing carbon, with the exception of Sweden where the state collected about €3 billion. Overall, carbon taxation in Europe produced revenues of around €5.5 billion in 2010, less than 0.005% of total government income in the countries making up the European Union. By way of comparison, the auctioning of CO2 allowances represented a sum of about €1.1 billion in 2010, but is expected to generate annual revenues of more than €15 billion from 2013.

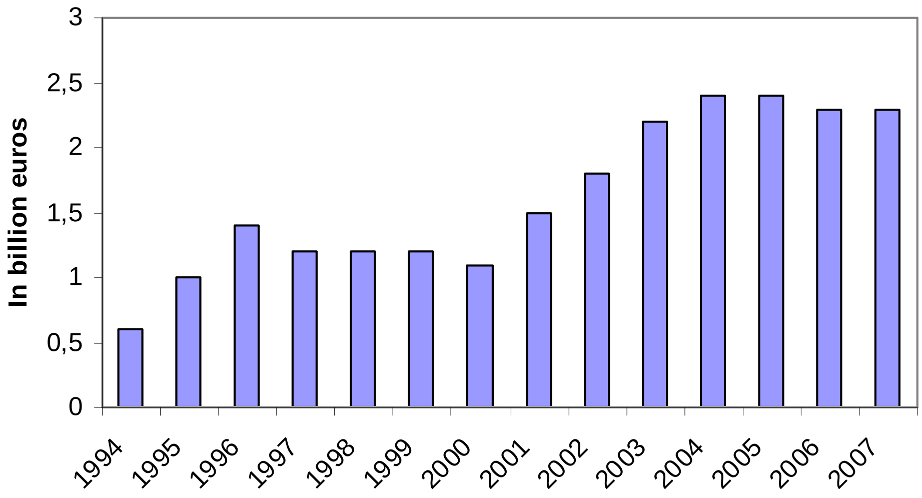
Forecast revenue from carbon taxes in 2010 (Graph 8)



Source: Environment ministries of the countries concerned

Since the beginning of the 1980s, the overall revenue from carbon taxes has, however, increased in Europe. On the one hand, higher rates pertaining in most countries that have introduced carbon taxation has increased the yield from this tax. This is particularly the case in Sweden, where the revenue from the carbon tax increased substantially between 2001 and 2005, the period during which the European CO2 cap-and-trade scheme was being launched. Moreover, the overall carbon tax base has been enlarged by the arrival of new countries – first Switzerland, then Ireland.

Evolution of carbon tax revenues in Sweden (Graph 9)



Source: Swedish tax office (2008)

7.2. Four ways of using the revenues

The use of revenues from carbon taxation may be grouped into four types. The first two involve offsetting the carbon tax by subsequent cuts in other taxes paid by households or businesses. The third allocates this revenue to the general budget to help reduce deficits. The fourth uses the revenue to fund or encourage further actions designed to combat greenhouse gas emissions. As shown in the table below, countries have generally chosen to combine several uses, with none of them putting "all their eggs in one basket".

Use of revenues from carbon taxes in Europe (Table 5)

	Denmark	Sweden	Finland	Norway	Switzerland	Ireland
Green cheque or lump sum compensation for households	•	•	•		•	•
Reduced levies on labour or capital	•	•			•	
Consolidation of fiscal revenues		•	•	•		•
Revenue allocated to the environment	•	•			•(*)	

(*) From 2011 only *Source: Environment ministries of the countries concerned.*

The respective weights of the various uses reflect different priorities arising from the great variety of economic and political contexts encountered.

- Targeted or lump sum compensation for households. Such compensation may be systematic and take the form of "green cheques" as is the case in Switzerland where the same lump sum is returned to each resident. This mechanism facilitates the social acceptability of the tax but restricts other possible uses for it. That is why Ireland chose to limit household compensation by targeting it toward the 20% of the population receiving energy poverty assistance payments. The countries of northern Europe do not much use this type of explicitly household-oriented compensation. Sweden has nevertheless offset some of the cost of the carbon tax by reducing other indirect taxes paid by households, and Denmark has reduced marginal income tax rates.

- Reduced contributions by labour or capital. This type of reduction corresponds most directly to economists' recommendations aimed at generating a "second dividend" to boost economic activity. It has been practised extensively in Sweden and Switzerland to reduce companies' overall wage bills.
- Consolidation of fiscal revenues. In practice, payments to national budgets have been the primary use of revenue derived from carbon taxes in Europe. For Sweden and Ireland, this reflects the similarity of the acute economic and financial crises during which the carbon tax was introduced. In both cases, the governments concerned needed to mobilize additional public funds to make good a deficit exacerbated by the need to bail out their battered banking systems.
- Allocating funding for environmental policy. This type of use, which is generally better understood by the public, is often recommended by environmental organizations in order to put incentive systems for reducing emissions of greenhouse gases to twofold effect. It has been relatively little used in Europe, except in Denmark where 40% of revenues from the carbon tax have been allocated to the funding of emissions reduction. In Switzerland, all of the carbon tax was returned to households and businesses until 2010, but a third has been spent on financing emission reductions since 2011.

How do these trade-offs pertain to the search for a "second dividend" as envisaged by economists?

7.3. ***Carbon taxation and the "second dividend"***

As noted in the second section, the search for the "second dividend" involves using all or part of the revenue from the carbon tax to fund reduced levies on labour and capital. In reality, the economic impact of the trade-offs chosen depends on the macroeconomic environment: in a context of fiscal consolidation, the use of the carbon tax to reduce the public debt may be justified, especially because it avoids raising other taxes imposed on the factors of production. Similarly, since the lack of productive investment is a proven cause of unemployment, it may be appropriate to use a portion of revenues from carbon taxes to fund additional investment.

Macroeconomic studies conducted on the basis of the French case provide an ex ante evaluation of these positive effects. They show that in reality two types of effects combine: a foreign trade effect resulting from the fact that the carbon tax brings in proportionally more on imported goods than local products; and a dynamic effect resulting from the reduction of taxes on the productive apparatus (see Box 9).

Carbon taxation and the “second dividend”: evaluations ex ante (Box 7)

Several macroeconomic simulations were conducted by economists from the French Ministry of Finance to test the impact of the introduction of a €9 billion carbon tax (conventionally set to amount to 0.5% of GDP) entirely offset by reductions in other taxes. Three conclusions can be drawn:

A carbon tax offset by a homothetic reduction of all other taxes results in a net positive effect on GDP ranging from +0.2 % (Egée model) to +0.4 % (Mésange model);

The same carbon tax offset by a reduction in taxes on labour (social contributions) and companies (professional tax and corporate tax) has an impact ranging from 0.3% (Egée model) to 0.6% (Mésange model);

In both cases, a specific delaying effect of the use of imported goods on domestic goods leads to an improvement in the trade balance of 0.1 to 0.2 percentage points of GDP.

Simulations carried out with different instruments by a CIRED team led to similar results.

In both cases, the simulations implicitly take place in a scenario where the carbon tax procures stable revenues in term of size over time. Yet the aim of an environmental tax is, ultimately, to get rid of its base. Depending on the elasticity of demand for different energy sources, higher rates may offset the erosion of the base. But for how long? This situation is not without risk to the environmental effectiveness of the mechanism: indeed, it might be tempting for policymakers to maintain a low, and therefore insufficiently incentivizing, rate in order to generate stable public financial resourcesIn both cases, the simulations implicitly take place in a scenario where the carbon tax procures stable revenues in term of size over time. Yet the aim of an environmental tax is, ultimately, to get rid of its base. Depending on the elasticity of demand for different energy sources, higher rates may offset the erosion of the base. But for how long? This situation is not without risk to the environmental effectiveness of the mechanism: indeed, it might be tempting for policymakers to maintain a low, and therefore insufficiently incentivizing, rate in order to generate stable public financial resources.

It will not be possible for some time to carry out an ex post evaluation of the carbon tax in France. However, such an evaluation is possible for Sweden, a textbook case with its twenty years experience of carbon taxation.

In the early 1990s, Sweden suffered a deep recession, with GDP down 5% and unemployment rising by 8 percentage points in the space of two or three years. Public debt rose from 46% to 81% of GDP. The introduction of the tax thus took place in a context of severe economic crisis and deep reform of the tax system.

The introduction of the carbon tax was accompanied by a 50% decrease in energy taxes (€300 million of additional revenue from the combined effect of the two taxes), the general imposition of VAT on energy (€1.6 billion), and a simplification and reduction of taxes on labour (€6 billion).

The tax system has evolved over time. Increased revenues from carbon taxes have led to the continuation of the tax reform process. Between 2001 and 2007, the “Green tax shift” programme reduced income tax (low and middle incomes) by €1.34 billion and social security contributions by €220 million. Similarly, the increased revenue from carbon taxation and energy taxes led to a reduction in labour taxes of €7.4 billion between 2007 and 2010.

Assessing the economic impact of a carbon tax is always tricky, because many factors have shaped economic and social developments. It should however be noted that Sweden’s GDP increased by 48% between 1990 and 2007, while CO_2 emissions were reduced by 9% over the same period. The unemployment rate fell from 9% to 5.6% and OECD competitiveness indicators suggest that the nation’s market share increased slightly during that time.

The introduction and development of the carbon tax in Sweden does not appear to have been a burden on the country's macroeconomic performance – indeed quite the contrary. It mostly probably contributed to obtaining a second dividend, an exact evaluation of which is still to be made. Nor was the Swedish parliament mistaken when in 2009 it voted through measures that will expand the role of carbon taxes until 2015.

8. Conclusion

In theory, a carbon tax is a simple and effective economic instrument for reducing CO2 emissions. Its base should include all carbon dioxide emissions and its rate should be set so that the marginal benefit to society of emissions reduction is equal to the marginal cost of abatement.

In practice, setting up such a system turns out to be much more complex. The social acceptability of the tax, imperfect information, competitiveness management, the existence of other environmental policy measures and political lobbying are all factors that complicate the simplicity of the original concept.

Studying the European experience reveals the many economic, political and social decisions that are made during the introduction of a carbon tax. We have seen that the choice of the base, the rate and the evolution of the rate often deviate from the recommendations of economists. Several lessons can be drawn from observation of the various European initiatives.

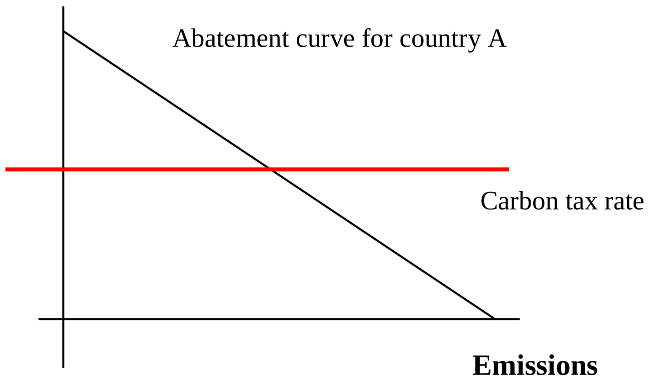
- While some reductions in the base can be justified, they cannot be extended indefinitely because of the risk of reducing the economic efficiency of the system.
- More than the choice of the initial rate – which is often a political decision –, it is the evolution of the rate that determines the effectiveness of the system. This rate should rise over time and be focussed on achieving the environmental goal (the Swiss method is from this standpoint very interesting).
- Effective linkage with the European cap-and-trade scheme needs to be found. A differentiated and complementary base is recommended. Moreover, it seems best to make the price of carbon from the two instruments converge.
- The revenue from the tax may be put to various uses and governments generally adopt a mix between measures to compensate households, subsequent tax cuts and additional measures to finance emission reductions. The main pitfall to avoid is changing the carbon tax into a tax aimed at raising funds to augment national budgets in the long term.

These tradeoffs are difficult to implement at a national level. It is therefore desirable that the question of the introduction of carbon taxation be again addressed at the European level. But the important thing is to take on board the lessons from the various experiments carried out in this area over the last twenty years by the pioneering countries. It is in this regard that the Chair of Climate Economics will be providing in-depth case studies of these countries' experience in its forthcoming series of papers.

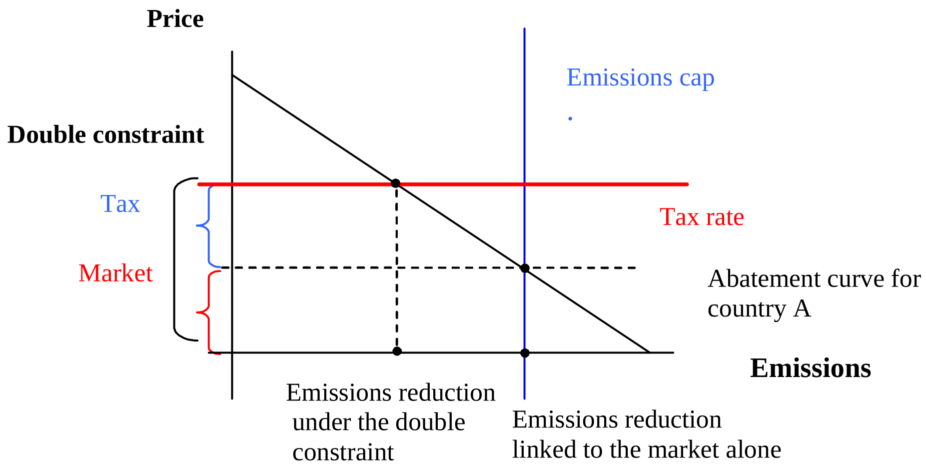
APPENDIX

An illustration: Income transfers under a national carbon tax and an international allowances trading market on a common base

Consider two countries A and B, whose profile and volume of CO2 emissions from industrial sources are similar. Initially, country A introduces a carbon tax that covers all industrial emissions.



In a second stage, countries A and B decide to create an emission allowances trading market for industrial emissions. These emissions are therefore doubly constrained in country A.



The market price is determined by the intersection of the emissions cap set by the authorities and the aggregate abatement curve corresponding to the sum of national abatement curves.

The existence of a carbon tax in country A reduces the allowance price in the international emissions trading market. This is explained as follows: since companies in country A are subject to a double constraint, they will make all those reduction investments whose cost is less than the sum of the tax rate and the allowances price. For a market price of 15 euros and a tax of 20 euros per tonne of CO_2, the company will therefore make all reductions costing less than 35 euros. This overinvestment leads to a situation where companies in country A demand fewer allowances and supply more allowances than they would if they were not constrained by the market, and therefore to a lower allowances price. For the same emissions cap, companies in country B automatically reduce their emissions.

This effect of the carbon tax on domestic market price of emissions is a source of economic inefficiency because the same emissions reduction could be achieved at a lower cost. There is in fact an income transfer from country A to country B. Overinvestment by companies in country A means that companies in country B are subject to weaker constraints (lower market prices) and reduce emissions to a lesser extent.

The problem only arises when a carbon tax is adopted by one country. If all market participants face the same carbon taxation, the income transfer effects disappear. If need be, in order to maintain the economic efficiency of the system, the carbon tax and the allowances market should have separate bases.

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