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6. Carbon pricing: theory and practice

6.1 Introduction

Carbon pricing policy is a fundamental humanly devised theoretical and practical cornerstone in the fight against climate change. It involves short term and long term policies, theoretical and practical considerations. A quantitative global stabilisation target range for the stock of greenhouse gases in the atmosphere is needed, because it is an important and useful foundation in the shaping of a comprehensive climate pricing policy. A global stabilisation target range is obviously a long term policy to control climate change and events ensuing excessive increase in temperature.

Setting long term objectives in the fight against climate change are substantial in avoiding catastrophic consequences therefore short term policies, which aim advances in emission reductions, have to be consistent with the pre-defined long term stabilisation goals. Short term policy reaction means using price-driven instruments like taxes and tradable quotas. These instruments allow broad flexibility in the parameters of emission reduction, and provide opportunities and incentives where-with the cost of mitigation and abatement can be kept down. Taxes and tradable quotas give the flexibility in how, where and when emission reduction can be accomplished thereby reaching agreements between states and companies may result an appropriate and environment-conscious emission scheme, that can fit into the long term objectives.

In defining price-driven instruments one major problem emerges even: How to define an applicable price for carbon emissions? A significantly lower price can be resulted by excessive emission so it is ineffective, and a significantly higher price can also be ineffective because it hinders the development of industrial production imposing substantial cost on companies. That is why the price signal should reflect the marginal damage that caused by emissions. Over time if the damages caused by emission increase as the stock of greenhouse gases in the atmosphere grow, the paid price should also rise along with it.

In theory, price-driven instruments as prices and tradable quotas could establish a common price signal across countries, sectors and industries. As from the above mentioned thought reveals setting an implicit price and leave market-base mecha-

nism to operate alone can be misleading. There can also be a role for regulation aware of the misleading phenomenon of price signals. In practice, tradable quota systems may be the best way of creating a common price signal across countries. Both taxes and tradable quotas have a favourable characteristic that they have the potential to raise public revenues.

Towards the end of the introduction we have to focus on another critical issue. The global distribution of emitted greenhouse gases is fairly unequal among countries and sectors. Equity should have to play a central role to securing a global agreement on carbon emission pricing. In compliance with the Kyoto Protocol, participating developed countries have committed to reduce emissions but this reduction in emissions is not necessarily sufficient. A comprehensive company-level multilateral trading scheme only exists in the European Union, which makes cost-effective the emission reductions.

In the following we would like to demonstrate some theoretical considerations in connection with carbon pricing policy. We start with a short description of the greenhouse-gas externality because it is obviously elemental part of the pricing problem. Then we focus on the carbon pricing policy in theory and in practice. We discuss the debate on how to choose between prices versus quantities and then we continue with tradable allowances.

6.2 Greenhouse-gas externality

Describing the climate change as a negative externality is more complicated than a simple pollution. Varian (2005) in his well-known microeconomic book partly mentions an environmental problem, exactly the pollution vouchers problem, in the chapter of externalities. *“Everyone wants a clean environment ...as long as someone else pays for it. Even if we reach a consensus on how much we should reduce pollution, there is still the problem of determining the most cost-effective way to achieve the targeted reduction”* (Varian 2005, pp. 636). This quotation highlights some crucial consideration with the negative externalities of the environment. First of all a very hard-to-answer question: who wants to pay for it? According to the standard microeconomic argumentation nobody wants to pay for it because the economic rational behaviour of a human is a profit maximising, so nobody wants to pay for it. Secondly, a better question is that who should pay for it. The principle is unequivocal, the emitter pays always. Thirdly, how can we determine the most cost-effective way? And last but not least who determines the target that we should achieve?

So many questions evolve when we are thinking about a simple microeconomic problem. When the whole climate change is in the focus a far more greenhouse-gas externality features have to be addressed, Stern (2009) gathered the most important ones:²⁴

- Climate change is a global externality, as the damage from emissions is broadly the same regardless of where they emitted, but the impacts are likely to fall very unevenly around the world;
- The impacts of climate change are not immediately tangible, but are likely to be felt some way into the future. There are significant differences in the short-run and long-run implications of greenhouse gas emissions. It is the stock of carbon in the atmosphere that drives climate change, rather than the annual flow of emissions. Once released, carbon dioxide remains in the atmosphere of up to 100 years;
- There is uncertainty around the scale and timing of the impacts of climate change and about when irreversible damage from emission concentrations will occur;
- The effects are potentially on a massive scale.

The above mentioned characteristics have to be involved into an appropriate policy response to climate change. Stern (2009) mentions four ways in which negative externalities can be approached taking into consideration the standard theory:

- A tax can be introduced so that emitters face the full social cost of their emissions so a carbon price can be established that reflects the damage caused by emissions;
- Quantity restrictions can limit the volume of emissions, using a “command and control” approach;
- A full set of property rights can be allocated among those causing the externality and/or those affected (in this case including further generations), which can underpin bargaining or trading;
- A single organisation can be created which brings those causing the externality together with all those affected.

The first approach reflects a kind of Pigouvian tax. Pigou (1920) wrote that taxes can establish a marginal cost to polluters which is equal with the marginal damage caused by the pollution. A Pigouvian tax can be a good solution for climate change externality if we know the optimal level of pollution. If we do not know the optimal level the tax cannot be appropriate. But if we knew the optimal level of pollution we could just tell the companies involved in the system to produce exactly and not have to care about the taxation scheme at all.

²⁴ The list of the key features of greenhouse-gas externality is made upon the list of Stern (2009, pp 352-354.) with some own supplements.

The third approach refers to the Coase-thesis. The state intervention is unnecessary because the markets always reach the social optimum. And this is independent from the fact who disposes with the property rights.

The fourth implication is also worth for mentioning it. Meade (1951) brought into public awareness his idea to create a single organisation that deals with the opposition of those who cause the externalities and who suffer damages from it. The present situation of the climate change emission reduction lacks of a globally institutionalised form, but in the near future a global regime may be established to fairly control the global greenhouse gases emissions.

6.3 Carbon pricing policy in theory

Theoretical assumptions relating carbon pricing policy can be separate into two different groups. The first group is the command-and-control approach of the problem which does not provide enough flexibility to meet objectives. The second policy is a market-based one which is enough flexible to meet objectives and contains incentives for companies to create more effective and sustainable instruments contributing to the evolution of environment. Beyond these two policy Fazekas (2009) mentions a third policy that refers to decentralised regulation. Table 1 shows the three different environmental policy instruments: direct regulations (command-and-control policy), indirect regulations (taxes and tradable quotas) and decentralised regulation instruments.

The command-and-control policy measures for reducing the emissions are prescribed by the government. These obligatory regulations do not provide enough flexibility for other policy measures. In general, the direct regulations limit the amount of greenhouse gases emissions into the environment. Examining the companies: the command-and-control regulations are independent from the costs of a single company thus the costs are shared equally among companies. Usually it applies common norms or particularly performance or technology-based ones. Stavins (2001) called the command-and-control approach to conventional regulation approach. Stavins particularly criticised that holding all firms to the same target costs can be too expensive and counterproductive.

Table 1 Environmental policy instruments

direct regulation	indirect regulation	decentralised regulation
normatives	taxes	voluntary agreements
ban	charges	environment marketing
licensing process	subvention	ISO, EMAS and environmental standardisations
monitoring	tax allowance	eco-audit
sanctions	tax exemption	eco-label
fines	public loans	BAT ²⁵
standards	credits	BATNEC ²⁶
	tradable quotas	implementation incentives
		environmental insurance
		information-based measures

Source: Kerekes – Szilávik (2001)

Indirect regulations are managing price-driven instruments and as we above mentioned these can be determined by a market-based way. Stavins (2001, pp 5.) pointed out a definition: “*Market-based instruments are regulations that encourage behaviour through market signals rather than through explicit directives regarding pollution control levels or methods.*” and he continued his consideration “*tradable permits or pollution charges, are often described as “harnessing market forces” because if they are well designed and implemented, they encourage firms (and/or individuals) to undertake pollution control efforts that are in their own interests and that collectively meet policy goals.*” Stavins broadly expressed in his definition the fundamental benefits of the market-based instruments against the old-fashioned command-and-control regulations. The most significant advantage of the indirect regulations is that the emissions reductions can be achieved in the least burdensome way from the perspective of the society. Price-driven instruments can be divided into two different groups – the first one is quantity-based instruments, for example tradable quotas or norms, the second one is price-based instruments, for example taxes, state subventions and other charges. The most widespread instruments are the taxes and tradable quotas.

The decentralised instruments are the third group of carbon pricing, what is described by Fazekas (2009) in a compact form. Decentralised approaches allow to

²⁵ BAT: Best Available Technology

²⁶ BATNEC: Best Available Technology not Entailing Excessive Cost

the stakeholders of the carbon dioxide emissions in general, the stakeholders to the pollution to solve each situation in an individual and unique way. This issue mainly covers those situations when the government has not set regulations or the results cannot be explained by the market. The participants undertake voluntary commitments to improve their environmental performance and they voluntarily over fulfil mandatory requirements.

In theory, there are three different carbon pricing policy from which the market-based or indirect regulations seem to be far more effective and flexible. If we merge the market-based policy measures with the decentralised approach we get to a well-functioning system. This system at the same time applies price signals and incorporates voluntary commitments to exceed mandatory requirements in order to improve the environmental performance. This mixed approach can be a long term solution in reducing greenhouse gases emissions.

6.4 Prices versus quantities²⁷

Since market-based regulations seem to be more applicable in the real world and more favourable for countries and sectors that is why we continue this consideration. If we take a brief look on Table 1, there are several forms of indirect regulations from taxes through subventions to tradable allowances. So the next question is how we can choose the most effective form of market-based regulations. The debate on choosing between taxes and quantities goes back to decades.

In an idealistic world with ideal economic conditions like perfectly competitive markets, perfect information without uncertainty, and no transaction costs, both taxes and tradable quotas can reach the goal of efficient reduction of greenhouse gases emission. Taxes can determine the price of greenhouse gases thus emitters can choose the appropriate scale of emission. And alternatively a quota for global emission can be useful while tradable quotas can originate effective market prices. But the real world is not idealistic there are a lot of impediments which make less effective the two measures. Therefore emerged a debate on whether prices or quantities are optimal in terms of emission reductions.

Hepburn (2006) created five different approaches regarding the aforementioned instruments. The first group emphasise the simple but essential symmetry between prices and quantities. In an idealistic world using quantity or tax measures to control emissions regulations are the same.

²⁷ The heading is based on Weitzman (1974) famous article.

Quantity regulation is the second approach. This is the most common form of regulation and it is often used as command-and-control quantities. Quotas, targets, or specific commands are included. However, there is an important disadvantage of the quantity instruments. We cannot address an appropriate quantity because the appropriate quantity can vary between different countries or companies. Perfect information needed to determine the optimum allocation of quantities which are often unavailable. Hepburn (2006, pp. 230.) emphasised that “*creating a legal scheme involves at least three elements: (i) an aggregate quantity is fixed; (ii) licences are allocated between individuals and firms²⁸; and (iii) a mechanism is established for enforcing compliance with scheme.*”

Price instrument based policy scheme is the third approach. Price instruments can also ensure the efficient allocation between companies and can indeed use to achieve policy objectives. Price instruments have the same problem as quantities, when conditions are uncertain they do not provide that a price target will be achieved. In connection with this problem Hepburn (2006, pp. 230.) mentioned that “*simply because a target is expressed as a price (quantity) does not mean that a price (quantity) instrument has to be employed to achieve it. The last two paragraphs predict some kind of combination of the price and quantity instrument reaching a set of objectives.*”

Hepburn presented two different kind of mixed approaches, these approaches constitutes the fourth and fifth ones. Weitzman (1974) noted that why we have to use a single a single instrument when there is a wide range of mixed instruments. A hybrid instrument is a combination of price and quantity instruments which can be characterised by complexity. The more complex approach of the problem was to ignore these schemes. The most important hybrid instrument is a trading scheme with a price ceiling. The function of this hybrid approach is very simple “*the government can implement a price ceiling by committing to sell licences at the ceiling price, and a price floor can be implemented by a commitment to buy licences at the floor price*” (Hepburn 2006, pp. 230.). Non-compliance is penalised in a tradable-permit scheme. Jacoby and Ellerman (2004) examining a hybrid approach the cap-and-trade system of emissions regulation in the United States, they found when the payment of the penalty is an alternative to compliance, the penalty is equal with the price ceiling.

Multiple instruments compose the last approach. This approach brings another problem. When a country or an authority try to internalise the externalities they do not take into account that one instrument is needed to internalise one externality. An excessive use of a single instrument does not solve the whole problem and if we

²⁸ Hepburn (2006) used individuals and firms in his paper, but it can be easily applicable for climate change with using countries and companies in the scheme.

focus on climate change, a single policy like emission trading system does not reverse the process of global warming. That is why when multiple market failures evolve, single policy measure is not and will not be able sufficient to solve them. Multiple approaches are needed but sometimes these approaches become problematic when they are inconsistent with each other.

The price versus quantity debate can continue with short term and long term considerations. Stern (2009) and Hepburn (2006) both applied the illustration of Weitzman (1974) in the climate change case. Both of them called this situation ‘efficiency under uncertainty’ when substantial uncertainty emerges regarding the timing and scale of climate change impacts. Under such circumstances, price and quantity instruments are no longer equivalent – as in the idealistic state – therefore policy instruments needed to be chosen.

Weitzman’s (1974) analysis, applying to climate change particularly to greenhouse gases reduction, stated:

If the benefits of making further reductions in pollution change less with the level of pollution than do the costs of reductions, prices are preferable. In this situation the marginal damage curve is relatively flat, compared with the marginal abatement cost curve.

- If benefits of further reductions increase more with the level of pollution than do the costs of reductions, quantity measures are preferable than price instruments. With the increase of pollution costs are rising sharply.
- Summarizing Weitzman analysis and completing it with time horizon we get to a more complex solution. This approach claims that in short term time horizon, when the marginal benefits of abatement curve is relatively flat, it is preferable to use prices and in the other case in the long term, when the marginal benefits of abatement curve is steep, it is preferable to use quantity measures.

Figure 1 (a) depicts the case when the marginal benefits of abatement curve is relatively flat and Figure 2 (b) depicts the case when the curve is relatively steep. In the first case the efficiency loss of taxes (ϵ) is smaller than in the second case therefore in the first case it worth using taxes and in the second case it worth changing to quantity measures.

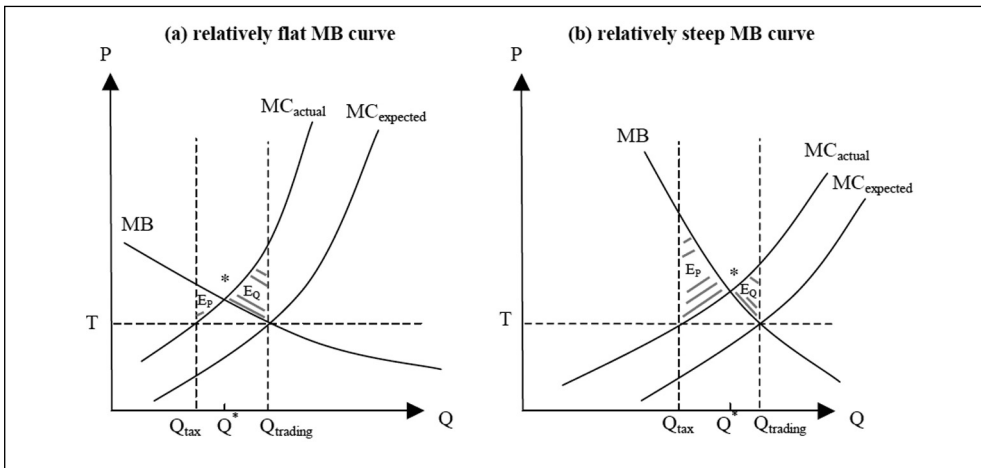
According to Stern (2009), the most efficient instrument in the case of climate change will depend on three assumptions:

- The change of the total costs of abatement
- The change of the total benefits of abatement
- And the degree of uncertainty about the aforementioned two features

As we can make distinction between the impacts of the short term and long term measures in emissions reduction we can set a credible policy goal. Hepburn (2006) and Stern (2009) also emphasise the question of credibility because it is essential to achieve a policy goal. Therefore short term policy outcomes should be consistent with long term policy goals. The short term policy measures should be coherently embedded into a long term policy. In climate change the long term policy goal is to stabilise the concentration of greenhouse gases in the atmosphere. And lastly short term policies provide flexibility in achieving long term policy goals.

Helm et al (2003), also, highlighted the importance of credibility but their approach can be reached by the solution to the time-inconsistency problem. Their options that could solve this problem in carbon policy are the followings: reducing the number of objectives, increasing the number of instruments, establishing an international body within a contractual framework or establishing a national body within a contractual framework.

Figure 1 Illustration of Weitzman results



Source: Hepburn (2006), and the original from Weitzman (1974)

6.5 Carbon pricing in practice, the tradable allowances

Emission trading schemes have several benefits. Emissions reduction can occur wherever they are the cheapest. A key benefit of the emission trading system is that it generates transfers between countries automatically because the emission reductions start where the costs are the lowest. Tax harmonisation across several countries

is difficult to achieve especially comparing with the much easier introduction of a trading scheme. And last but not least, emission trading is a very powerful tool in the framework for addressing climate change at an international level.

If we use the Coase-thesis, the polluters always reach the optimum control level of emission. In the emission trading system the main objective of tradable allowances is to equalise the marginal abatement cost of the participants. Marginal abatement cost denotes the cost to decrease the emission with a ton of CO₂. In theory, every participants decrease their CO₂ emissions till the marginal abatement cost will be equal with the unit cost of tradable emission allowances. In practice, there can be differences in the individual marginal abatement cost thus the participants can only reach the optimum with trading instead of decreasing CO₂ emission.

We can made distinction between several types of tradable emission allowances. Sorrel and Skea (1999) emphasised two different systems. The first one is the emission trading system and the second one is the project-based system. Table 2 describes the main characteristics of the two systems. A project-based system can be applied when the authority tries to decrease the emission below a baseline thus only emission reductions can be traded. In practice, this system is embodied in credits to participants to achieve some emission reductions. In the emission trading system all emissions can be traded under strict regulation and participation in the program is mandatory.

Table 2 Tradable emission allowances

Project-based system	Emission trading
Emission reduction credit	Emission allowance
Scheme: 'Baseline and credit'	Scheme: 'Cap and trade'
Applies to emission reductions below defined baseline	Applies to all emissions
Only emission reductions can be traded	All emissions can be traded
Credits are generated when a source reduces its emissions below an agreed baseline	Allowances are allocated by the regulatory authority
May develop incrementally as a means of introducing flexibility into existing regulatory structure	Trading must be built into the regulatory structure from the beginning
Participation in the credit market is voluntary - sources can just meet existing standards	Participation in the program is mandatory - the overall emission cap still applies even if sources do not trade

Source: Sorrel and Skea (1999)

Tradable allowances are not a new feature to environmental policy. Tradable allowances were in practice first used in the United States in the 1970s (Fazekas 2009). Then trading in emissions has been used in the United States since 1995 to reduce emissions causing acid rain (Stern 2009). To meet the Kyoto target emission reduction became more difficult that is why the European Union started to use trading. A 'Green Paper' made by the European Commission was the first comprehensive official document that proposed the use of emission trading system. The EU Emission Trading System²⁹ was launched in 2005, which works on the 'cap and trade' principle, is a landmark of the European Union's policy to fight against climate change and it is a key tool for reducing greenhouse gas emissions. Beyond CO₂ emissions from industrial installations – power plants, combustion plants, oil refineries and iron and steel works, as well as factories making cement, glass, lime, bricks, ceramics, pulp, paper and board – airlines join the scheme in this year and petrochemicals, ammonia and aluminium industries will join the scheme in 2013, when the third period of emission trading launch.³⁰

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²⁹ The EU Emission Trading System operates in 30 countries (the EU 27 plus Iceland, Liechtenstein and Norway).

³⁰ European Commission, Climate Action: Emission Trading System (EU ETS) - http://ec.europa.eu/clima/policies/ets/index_en.htm

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