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5. Mitigation and adaptation to climate change

5.1 Introduction²³

Climate change produces significant social and economic impacts in most parts of the world, thus global action is needed to address climate change.

In this chapter, the different possibilities of mitigation are explored from different points of view, and analyse the possibilities of adaptation to climate change. First, substantial reduction of GHG emission is needed, on the other hand adaptation action must deal with the inevitable impacts. According to the assessment of the chapter, it is essential that coordinated actions be taken at an EU level. In our argumentation, a macroeconomic model is used for the cost- benefit analysis of GHG gas emissions reduction. The GHG emission structure is analysed on European and global level.

Even in the case of a successful mitigation strategy there rest the long-term effects of climate change which will need a coherent adaptation strategy to be dealt with. Although certain adaptation measures already have been taken, these initiatives are still very modest, and insufficient to deal with the economic effects of climate change properly.

5.2 Why should we deal with climate change?

According to the Intergovernmental Panel on Climate Change Assessment Report the increase observed in global temperatures is very likely to be a consequence of the increase of greenhouse gas concentrations. Therefore, on a larger scale, human actions have an effect on on the ocean warming, continental average temperatures and wind patterns (IPCC, 2007). According to cited report, a further increase of 1.8 to 4 °C of global expected average surface temperature can be expected. (There are different scenarios but they all coincide in that temperatures will keep rising.)

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If we would like to assess the damages caused by climate change and the benefits of mitigation, we must take into consideration market and non-market damages as well. In the case of market damages, welfare impacts should be studied. As a result of the rise of temperature and the scarcity of goods, there will be significant changes in price structures and the quantity of certain goods.

Some sectors such as agriculture, forestry, water supply, energy supply are particularly affected by climate change. Such impact is quite difficult to be quantified. For instance, in agriculture land prices or rent can be good indicators. However in the case of products, substitution effect must be taken into account. So-called non-market damages are lot more difficult to estimate. There are considerable welfare costs from lost biodiversity and harmed ecosystems and there are utility losses from the less favourable weather (Nordhaus, 2007).

The following flowchart represents the contribution of the different sectors to climate change. According to the data of the World Resources Institute the most important contributors to GHG emission are the energy sector, transport, agriculture, and land use, including forestry.

A rise in prices will result in lower demand and in a decrease in GDP. Climate change produces substantial costs to the world economy. According to the key study, the Stern Report elaborated in 2007, the costs of climate change sum up to the 5% of the global GDP.

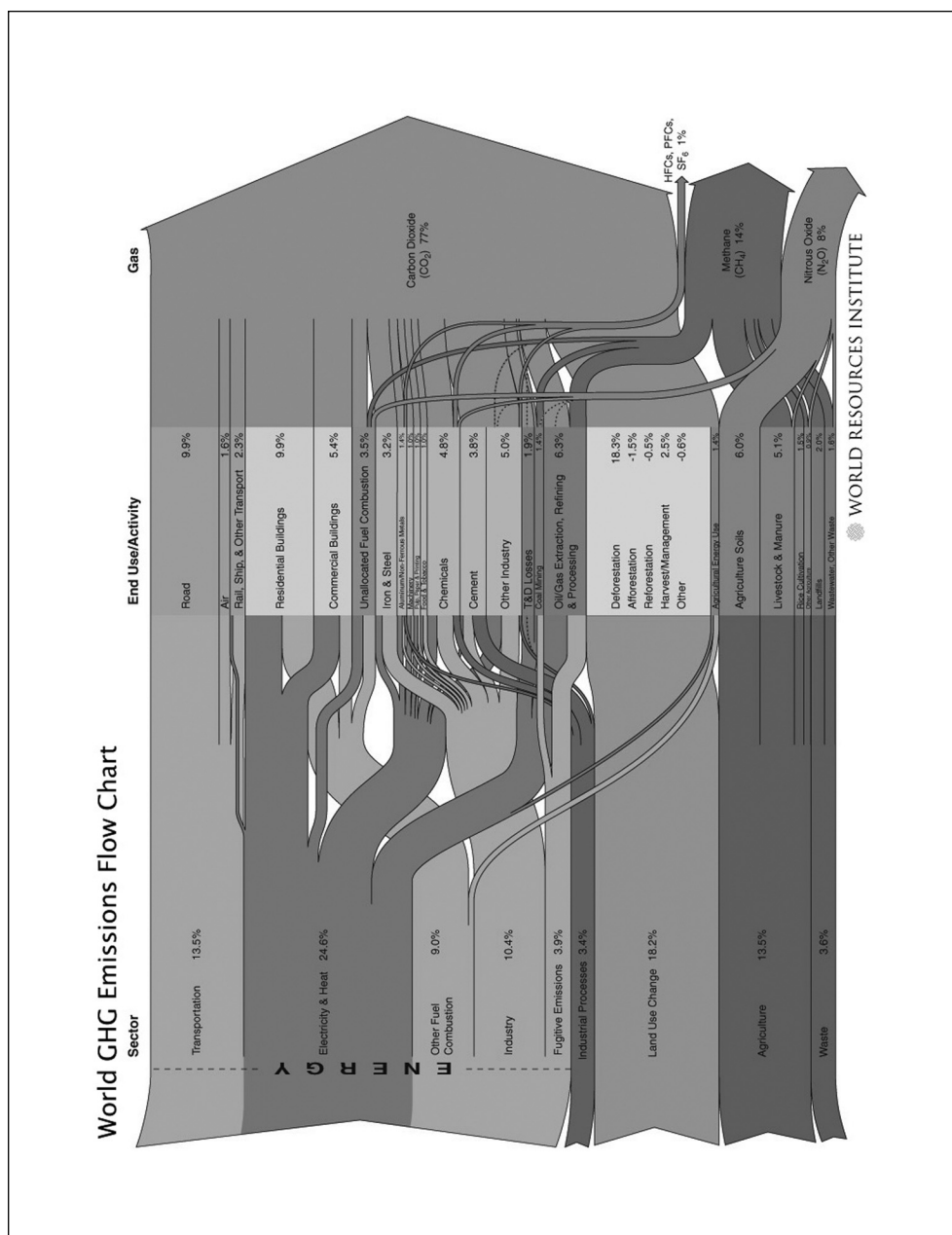
There are various commitments of the states. The first and the most important is the Kyoto Protocol. The EU has committed itself to a reduction of 8% of the emissions from 2008 to 2012 compared to the 1990 levels.

The EU made an ambitious plan of reducing emissions by 20% up to 2020, in the future, an alleged post-Kyoto agreement would project a reduction of 30% whereas on the long run, a reduction of 50% would be necessary by 2050.

How to achieve these ambitious plans? There are different policy options to take for governments. Possible economic instruments are with regard to market-conform government measures: the introduction of energy/emissions taxes, setting up of GHG emissions trading schemes. Other, rather redistributive options are the adoption and the diffusion of low-carbon technologies, and the introduction of efficiency standards and labelling systems.

Each of these measures aim at changing the incentives of the economic actors, which is very hard, even impossible on the short run. Therefore, these policies must set such market conditions that give motivations for companies to comply with the environmental regulations.

Figure 1 Wolrd GHG Emission Glow Chart



Source: WRI, <http://cait.wri.org/figures.php?page=/World-FlowChart>

Moreover, the public good nature of climate (Nordhaus, 2002) must be emphasized, which implies per se the free rider problem (Tulkens, 1998). This circumstance makes it difficult to a great extent to build a policy framework that would be effective, i.e. that would cover all emitters. The consequence is that if policy makers would like to increase the efficiency of these instruments, they should apply efficient monitoring systems, which would result in enormous monitoring costs but which, at the same time as a consequence of information problems, could never be effective enough to prevent free riders. The existing policy instruments assessed below suppose the existence of a perfect financial market, where price functions as a perfect indicator.

All mitigation policy instruments must meet the following objectives: be cost-efficient, promote and facilitate innovation, diffuse GHG emission reducing technologies and be flexible to be able to respond to changes in the economy.

5.3 Building a macroeconomic model

When policy makers would like to choose between different policy instruments, they should base their choice on impact studies of each measure. When modelling climate change mitigation, we must get the proper indicators to measure the impacts.

As an overall indicator, we can study changes in GDP, which however can be distorted. GDP does not reflect changes in externalities, cannot capture the increase in the security of supply and other secondary benefits that cannot be quantified. Non-market evaluated activities are also out of the focus of an analysis that considers only changes in GDP.

Changes in employment are even more difficult to assess. On one hand a shift in technology, and the reduction of the production results in the decrease of real wages, and possibly in employment.

On the other hand, from carbon intensive sectors, there can be a shift of the labour to the green economy where there are new potentials of investment and growth. The possibilities of the expansion of green employment depend on many things and must be further analysed in detail.

There are two main factors to be studied: Cost effects and innovation promotion.

Price and cost effects

Below, it will be described a model argued by Lintz (Lintz 1992, pp 34-38), which is based on neoclassical assumptions. It is assumed that quantitative restrictions on GHG emissions are applied. Therefore the use of fossil fuels must be reduced. This will change the cost structure of companies, increasing the cost burden. This will result in lower real wages and a substitution effect to other input products. The potential output is reduced if we consider that companies are profit maximizers. According to this approach, a new equilibrium can be reached with full employment in the case of flexible labour market. This model has some preconceptions that are rather simplifying. A clear distinction must be made between short, medium and long term effects.

A possible but not necessary decrease on the short run can be attributed to higher input costs, however on the long run, after a technological change was made, the initial production will be changed, thus production can even rise compared to the ex ante state. In Lintz's analysis it is also assumed that the starting point is Pareto optimal. However, if we assume that the starting point is suboptimal, the introduction of a climate change mitigation instrument will not result in the reduction of the GDP.

Hence, we should state that current production schemes are not efficient enough, and efficiency can be ameliorated. In the case of the economics of climate change, the free lunch hypothesis of Michael Porter can be used (Porter, 1990). There are so called No-Regret Potentials i.e. economic actors can find cost-efficient saving potentials. If companies, as a result of an increased cost burden caused by GHG emissions restrictions, are obliged to look for and activate unused efficiency potentials, or innovate to reduce costs, and as a result, achieve competitive advantage, then mitigation policy has reached its objective (Porter, 1995). A well-directed environmental protection policy can therefore encourage innovation, investment in R&D and the diffusion of low-carbon technologies (Ambec & Lanoie, 2008).

“The notion is that the imposition of regulations impels firms to reconsider their processes and hence to discover innovative approaches to reduce pollution and decrease costs or increase output.” (Berg and Holtbrügge, 1997, p.200)

Nevertheless the picture is not quite clear, yet there are many factors to be considered. The former model represents companies as rational economic agents; however, decision making processes are rather complex to be able to decide easily how companies will act in such circumstances. As it was mentioned before, a distinction must be made between short and long term. We must refer here to the principal-agent problem. Investing in new technologies needs high R&D costs therefore it only turns to be positive, beneficiary after a while (as suggested in product life cycle theory). As a consequence, there is a trade-off between short-term and long-term

objectives. Innovate and be more competitive on the long run or pay dividends, get a higher profit on the short term.

Company decisions are, to a great extent, affected by former experiences, sunk investments in green economy, environment-friendly production or they are distorted by future uncertainties.

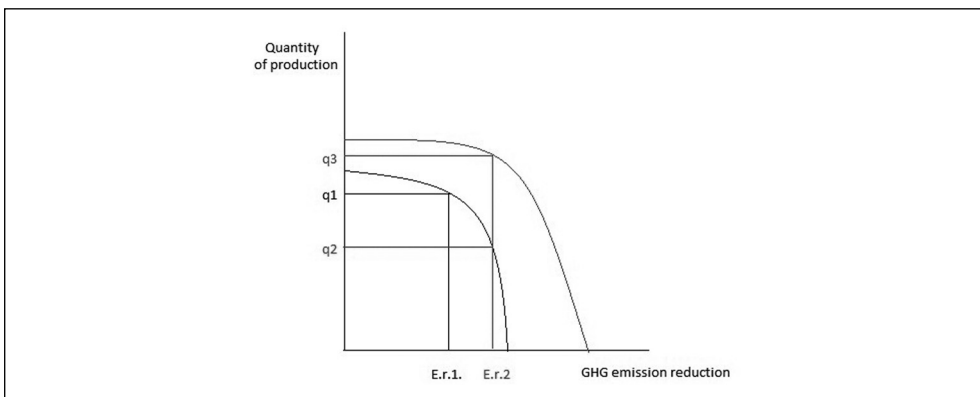
Innovation promotion

As the aforementioned Lintz model suggests, GHG emission taxes will increase costs for companies, thus will result in a decrease in the GDP. On the contrary, we assume that additional, well-selected financial burdens are expected to foster a swift in technologies, promote investments in new technologies, innovation. Therefore, it will result in a shift of the production frontier curve.

In the following figure it can be seen that on the short run, further reduction of GHG emissions will result in a decrease of production (q_2), while on the long run, motivated by profit maximization, the company will invest in R&D and develop new production techniques. Technological changes will move the production frontier right, and extend production capacities. Production, with the same amount of GHG emission will increase significantly.

In theory, this can be an impressive model that proves the legitimacy of GHG emission reduction policies. Empirical studies, however, do not agree totally with these assumptions.

Figure 2 The shift of the transition curve as a result of climate investments and technological change



Source: Author

If an increase in investment volume and an increase in economic growth can be observed, it does not necessarily mean that investments in GHG emission reduction contributed to experimented growth.

According to empirical studies, an increase in green investments when it is about end-of-pipe systems will not result in economic growth, while production-integrated environmental protection may contribute to growth.

Below, a detailed assessment is given on four policy instruments.

Table 1 Policy instruments addressing climate change

Policy instrument	Cost-efficiency	Promotion of innovation	Technology diffusion	Flexibility	Address market imperfections
GHG emission taxes	Relatively High monitoring costs and tax collection costs income for the states	YES Gives incentives to invest in R&D to reduce emissions	YES Foster diffusion of low-carbon technologies	YES Easily implemented, can be adjusted to economic changes possibility of harmonization	NO Rests the information problem which entails monitoring difficulties
Emission trading schemes	NO large transaction and monitoring costs, no perfect permit market	Partly high price volatility, uncertainties	Partly high price volatility, uncertainties	Partly differentiation can be made, difficulties in choosing price cap, difficulties in incorporating new countries.	NO asymmetric information, monitoring is difficult, transaction costs
CAC approaches	NO, lag in cost and result costs are not immediately visible	Low does not give innovation and adoption incentives	Low no incentive to introduce more efficient technology than obliged	NO do not accommodate to changes	Partly cover segments not address by market instruments
Technology-support policies	NO market distortion, large initial R&D spending	YES corrects innovation failures	YES corrects technology diffusion failure	NO do not accommodate to changes	Partly addresses innovation failures

Source: author

GHG emission taxes

From the point of view of cost-efficiency, there exists a double dividend from introducing CO₂ emission taxes. The income generated by the tax can be “recycled” and reinvested in CO₂ reducing technologies. This might be the most cost-efficient, and market-conform instrument of mitigation action (Parry, 2000).

On one hand, it gives strong incentives for companies to introduce new technologies that would reduce GHG emissions and increase productivity at the same time. On the other hand tax revenues can be used to finance green investments.

Other advantage of this instrument is its flexibility. Flexibility can be considered at a national level: taxes can be adjusted to economic cycles, or changes in demand. At an international level, it is easy to introduce and harmonise emission taxes in two countries or in a group of countries. Tax schemes and rates can be adjusted, and thus, climate policy can be more effective. Nevertheless, at a European level it is rather controversial that a unique carbon tax could be introduced, considering that tax schemes are not identical at all, and although the same GHG emission tax would be introduced in all EU countries, the effect of this measure would vary from country to country in function of the existing tax scheme and interaction with other policies.

Policy makers can opt for a swift form taxes on labour to ecological tax. That would diminish the costs of GHG reductions and would be less distortive; however, its success would depend on existing tax system (Parry et al., 2000)

However, there are some circumstances that influence its applicability. First it is hard to build up public support for a tax. And the application of a tax in itself cannot assure that companies invest in new low-carbon technologies if they can shift increased costs on consumers. In many cases emitters have monopolistic power therefore they are able to adjust prices to maximize their profits. As in the case of all taxes, monitoring and tax collection costs must be taken into account, which means that transaction costs are quite high.

According to an empirical research by Blackman and Harrington (2000), GHG emission taxes can be applied in developed countries, however in lower income countries institutional capacities are not ensured to enforce an emission tax (Routledge, 2004). Therefore transaction costs are higher than the possible revenues from such taxes. The fact of high carbon intensity would mean huge costs for the private sector in developing countries, what deters them from introducing such taxes. This entails the problem of the internationalization of GHM emission taxes.

It is also true that for the time being there is no strong need for a large international harmonization of emission taxes or to set up a new international institution. We also have to distinguish between public and private companies, yet the former

does not have profit maximization as priority, they have laxer budget constraints, and as a consequence, they do not have enough motivation to invest in R&D, innovations, and technological changes. In private companies there are more incentives to reduce costs and to compete with quality standards.

Emissions trading schemes

The introduction of this measure reflects an administrative approach to address climate change. A central authority introduces a ceiling for the amount that can be emitted. Companies, usually willing to overstep this limit, are obliged to obtain more permits.

The cost-efficiency of this instrument is less proven. Permits should be fully auctioned, and there should be no uncertainty with regard to emissions trade. If a perfect emission permit market existed, emission trading would perhaps do better, however we are quite far from this. Transaction costs are much higher than in the case of emission taxes, and pricing is a lot more difficult. Implementation and monitoring, due to the absence of yet existing infrastructure, will produce much higher costs for states.

It also distorts market dynamics: modifies entry and exit circumstances, and provides monopolistic benefit for emitters, whose emission is financed by consumers.

Internationalization could be a solution to achieve higher cost-effectiveness, but existing schemes do not allow being optimistic about it. It is not as flexible as a tax, which can be easily moved to an international level, or even to incorporate new participant countries.

Political support can be achieved by “grandfathering”, i.e. by granting permits for free to some existing emitters (Böhringer – Lange, 2008).

This is a supported instrument in the EU because it is ideal to deal with international competitiveness and also has a distributive effect. The implementation of this measure favours subsidiarity to some extent.

From the point of view of fostering innovation, it is less effective than GHG emission taxes. If we accept the assumption that perfect permit markets do not exist, it is evident that price volatility will be considerable, which could only be reduced if a price floor as well as a price cap would be set. This would contribute to the moderation of price volatility and there would create a more favourable climate for investments in R&D. For the same reason emission trading policy should be predictable, and stable, to don't deter investments.

Command-and-control (CAC) approaches

The market instruments described above cannot address market failures as they are unable to handle information problems and their monitoring is rather difficult. They strongly depend on the institutional capacities of a country. Therefore, there are many segments that are not covered by these instruments. CAC approaches can be efficiently used as a complement.

This instrument aims to set up environmental standards to oblige abatement decisions on companies. These standards can be technology related ones, which dictate companies to use certain low-carbon technology to reduce emissions. Performance standards can also be set up, i.e. an emission target defined with regard to the unit (OECD, 2009).

This is a regulatory and not a market instrument therefore it is inevitable that it would cause certain distortions. It is not flexible, yet it cannot be adapted to different emission and production structures of the companies. It is not able to differentiate the function of the cost structure. (Bourniaux et. al., 2009)

On the other hand, it can address market failures better, and in the case of the inefficiency of market instruments, it can also be a better solution. It is ideal to address information problems. While price elasticity can affect the success of market instrument, CAC approaches can be applied in all situations.

Technological minimum standards are set to be achieved by companies. This measure gives not only an incentive, but also an obligation for emitters to reduce their GHG emission significantly. However in the case of a company that already meets this requirement, it gives no motivation to invest in new, more efficient technologies. A possible hazard is that these standards, by giving no incentives for companies that are already more developed technologically for further innovations, could freeze the current technological level and as a consequence, they are counter-productive. A more adaptive and flexible instrument would be needed, i.e. it would be essential that these standards be revised frequently, and be shaped to the different technological possibilities of firms.

In the case of performance standards, there are more incentives for new innovations. In this case, firms cannot react for emission reduction by reducing production, yet an emission per unit is set. The goal of companies would be to find the ideal technology to increase production without increasing environmental costs.

This instrument can be studied from the point of view of behavioural economics. A motivation map can be elaborated from the drives of companies. Companies are profit-oriented therefore they prefer to take measures that increase benefits. Emitters do not get direct financial benefit from adopting abatement technologies or reduc-

ing emission per unit. Indirectly, however, they can gain a lot from being first movers, and get competitive advantages. Another factor can be that standards, to a great extent, depend from the average performance of companies. Thus, they are not motivated to invent new, more environmentally friendly technologies, because this would make standards increasingly stricter.

For policy makers it contributes to its popularity that no special institutions are needed to introduce it, and it can be easily implemented. However it is difficult to choose appropriate standards on a national level and even more on an international level. Too lax standards will not make a change; too tight ones, however, would be unenforceable.

On an international level, technology standards could be negotiated; however, national interests would be very different and it would be almost impossible to find the smallest sum, and as a result, this would not be efficient enough and would not result in fundamental changes.

Considering European cooperation with third countries, this instrument could be built into these projects and conciliated with technology transfers to developing countries (which are, as we stated above, less willing to introduce emission tax and cannot incorporate to emission trading schemes).

Technology support policies

These policies are designed to address innovation failures and to reduce GDP losses attributed to mitigation policy. Implemented as transfers, they would be far from being cost-effective, yet subsidies would distort market and would not necessarily contribute to a substantial reduction of GHG emission while causing high monitoring costs.

For the same reason, contrary to the suggestions of the OECD report (OECD, 2009), we question the efficiency of an international fund rewarding innovation. Doubtful is the thing that any “grandfathering” would be efficient in economy, and in this case a lot of definition problem would arise, and historically such funds cannot be considered as a success.

In the beginning, R&D investments would mean high initial costs for companies, while the gains will come only later, and they are quite precarious. Policy makers can use fiscal instruments or direct subsidies to promote innovation and foster R&D spending; however these initiatives are not so efficient because innovation necessities do not come from an internal need of the company but it is an obligation from the outside. Therefore, an information problem will arise.

It can be a good complement to carbon pricing, because if there is a price on GHG emission, technology support would canalize innovation in low-carbon, emission-reducing technologies. Otherwise it cannot be assured that companies invest in such technologies and not in energy-efficiency. By spending R&D funds on energy-efficiency, firms will be more competitive, production costs will decrease, and thus, it will be totally beneficiary and rational for them. Nevertheless, an increased energy-efficiency will result in lower carbon prices, and in an increased demand on a global scale.

Another hazard of this policy is the asymmetric costs for developed countries, which are supposed to cover most of the spending, and offer these technologies as a transfer, for developing countries. At a national level, the whole population will finance R&D investment, while only few inventors will get the benefits. Spread costs, however can be interpreted as an advantage from the point of view of the introduction of this policy.

To sum up, we can say that it is a complementary instrument to carbon pricing, which helps boost innovation and growth and contributes to addressing innovation failures. As a whole, it must only be a secondary measure.

5.4 What an ideal policy mix would be to address climate change?

Pricing GHG emission is inevitable; however, to address its inefficiencies, other, softer policies should be applied. CAC approaches address information problems and technology-support policies to mitigate the production decrease from emission reduction.

A stronger cooperation between the government and companies would be ideal to deepen the relations between the public and the private sector, and also to involve universities and higher education in research activities more explicitly.

The efficiency of a mitigation policy does not depend only on the selection of the convenient instrument, but to a great extent on its integration into other policy areas. For example, a production-supporting agriculture policy would result in greater emission levels, while a favourable trade policy could promote the diffusion of low-carbon technologies (Mattoo et al., 2009).

Probably some institutional changes would also be necessary to enable the implementation of mitigation policies. Stronger legal framework could better enforce emission reduction and could make it easier to monitor compliance with GHG emission-reducing regulations.

5.5 The legitimacy of a European mitigation and adaptation policy

Recent OECD analysis concluded that a particular EU mitigation policy would have, at a world level, negative effects on a global mitigation policy (OECD, 2009). According to the argument of the OECD report, as a consequence of carbon leakages, a separate EU policy could reduce the efficiency of global climate policy.

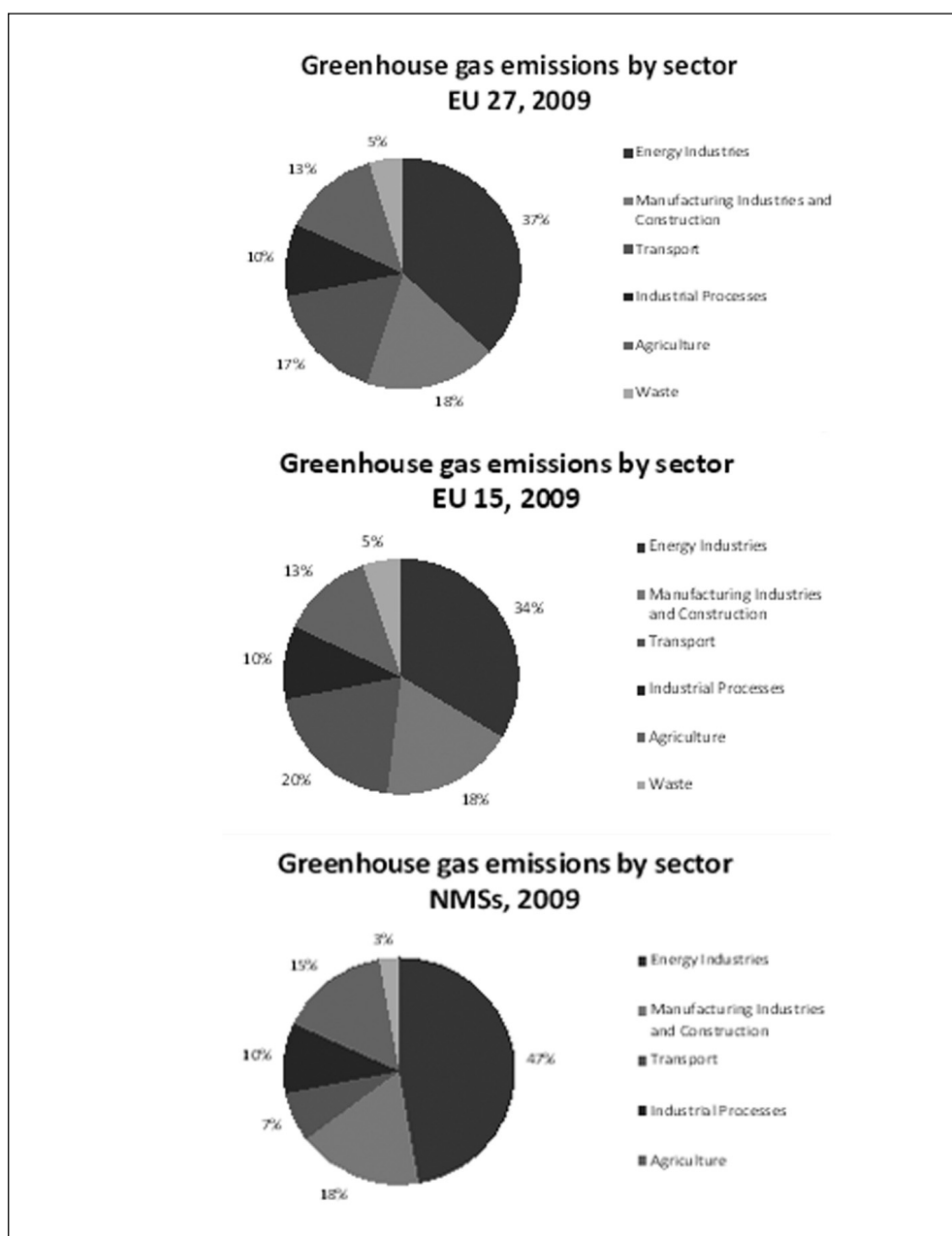
It can be easily proved that if a smaller group of countries applies emission cuts, it will not result in a decrease of emission levels globally because these effects are eliminated by increasing emissions in other regions. Moreover, it may cause larger mitigation costs for the global community.

If restrictive measures on GHG emission are applied only on some countries, the producers of these countries will lose competitive advantages at an international level compared to their foreign competitors. Therefore, if it is possible, they will outsource production or some phases of production to non-participant countries. This means that although in the region where emissions-reducing policy is implemented, GHG emission will decrease, globally there will be no change in emission levels.

The same policy would entail a decrease in the demand for fossil fuels in the region and therefore a fall in prices, which would make these energy sources cheaper, and thus more fossil fuel would be used in non-participant countries. Below, the OECD simulation analysis is used to describe a possible scenario (OECD,2010).

Table 2 Carbon leakage rates

		2020	2050
EU acting alone	CO ₂ only	13.0%	16%
	All GHG	6.3%	11.5%
Region acting	EU acting alone	6.3%	11.5%
	Annex I	0.7%	1.7%
	Annex I + Brazil, India, China	0.2%	0.7%

Figure 3 Greenhouse gas emissions by sector

Source: Eurostat statistical database

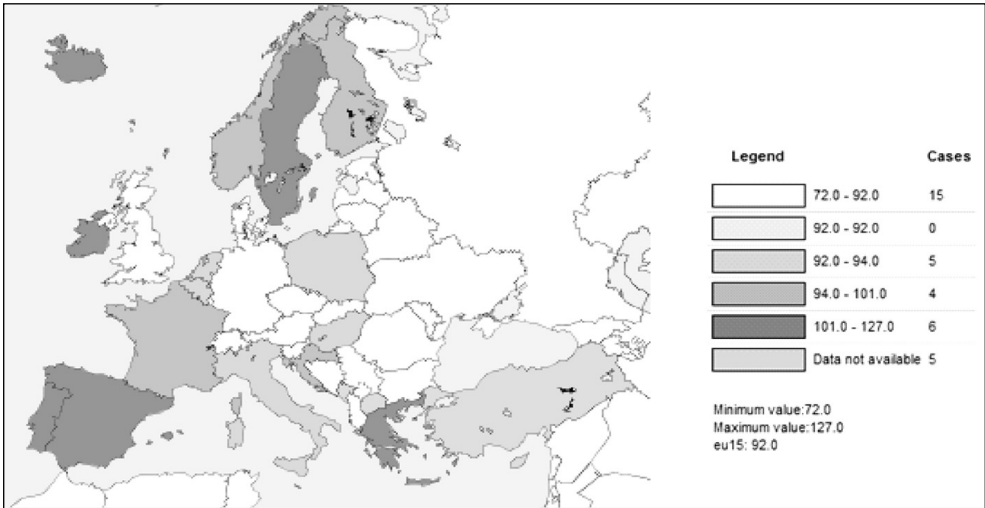
According to this model, in the case of a unilateral 50% reduction of emissions compared to 2005, leakage would be 11.5% of the achieved reduction achieved by the EU. If emission reduction was the same with larger country coverage, carbon leakage would be between 1 and 2% (COM 2010).

However, we argue that policy incentives must rise, and it is not surprising that the first changes can only be implemented in a group of countries and later on, a global institution can be set up. Therefore, an alternative scenario can be conceptualized where GHG reductions are first made in the EU but then global trends follow these initiatives. In this case, although carbon leakages will appear, they will be lower.

Considering the EU's competitiveness in the world, although a unilateral GHG restriction policy would affect production costs negatively, it is still necessary. In this section, we are arguing that, despite undoubted negative consequences, a European climate mitigation and adaptation policy is needed. Climate change affects the different common policy areas in which the EU acts. What is more, mitigation policies are more enforceable through the EU framework.

Other factor can be that GHG emission structures are very similar in European Union Member States. Analysing the Eurostat data on GHG emissions, we can say that there are no significant differences between the EU 15, and new Member States.

Figure 4 GHG emission compared to Kyoto 1990



Source: Eurostat

The lack of significant differences in emission structures suggests that a common European emission-reducing climate policy might have legitimacy, and should be canalized into common energy, agriculture, and transport policies.

A three-level approach is needed to assess the European climate policy. Carbon pricing, namely GHG emission taxes, may interfere with national taxation. Currently fiscal policy is not part of the common policies and we are far from the existence of a European Economic Governance. However, a stronger European economic coordination would be necessary to have an efficient climate policy.

The first level is the national one. Due to the aforementioned reasons, national policy will rest the dominant one, and European is only a complement. European states have their own targets to meet Kyoto goals, and they also have their own measures. As a whole, they are not wrong, however there is a long way to go.

Second is the EU level. In the traditional EU arguments we can read that, due to “regional variability and severity of climate change” (COM(2009) 147/4) a coordinated EU action is needed to face regional and sectoral disparities and to spread the best practices. The European Union can enforce climate change mitigation measures through common European policies. A broader framework has been elaborated in 2009 in a White Paper on Adapting to Climate Change. The roadmap laid down an ambitious project to harmonize EU Climate Policy, but it seems to be rather a political incentive than a pragmatic Action Plan. A comprehensive strategy is needed, which would include the Transport, Energy Efficiency Action Plans, as well as the reform of the CAP. It is necessary to enhance the EU’s resilience to the impacts of climate change, and to develop well-elaborated plans to promote energy-efficiency, foster innovations in the green economy, facilitate the spread of the use of renewable energy sources, keep up with changes in the global economy, and diffuse low-carbon technologies.

Third, the EU must think globally. To be competitive on the global market, the EU must take advantage of its capacities, and invest in green economy and low-carbon technologies (Berndes - Hansson, 2007).

The actions suggested in the White Paper (COM(2009) 147/4) are the following. First, it would be necessary to raise awareness and to build a knowledge base of the impacts of climate change. A Commission Staff Working Document (SEC (2008) 3104.) set up an European Institute of Innovation and Technology with the task to quantify costs and benefits of adaptation. Within this institution, Knowledge Innovation Communities (KICs – Climate-KIC, KIC InnoEnergy) and EIT ICTLabs have been created, which link higher education, research and business sectors. Then adaptation should be integrated into other policy areas. To successfully integrate adaptation action into sectoral policies it is fundamental to assess

interaction with other policy instruments. This is the case with the Common Agricultural Policy, where fundamental reforms are taking place. The most important priorities are to enhance the competitiveness of the EU and to contribute to the development of rural areas.

CAP, as a whole, is far from being cost-effective. The sustainable production scheme would mean that the whole financing of the agricultural policy should be changed and focused on investments and making production and export structure of the Member States more competitive.

In a post-2013 CAP, a knowledge and invention-based agriculture should be targeted and connected to rural development, which should be separated from social policy, i.e. transfers should be based on investment capacities, technology diffusion.

Nevertheless, plans are only plans if there is no financing behind. According to the Stern Review (Stern Review, 2006) financial constraints are the main barriers to adaptation.

How can the EU handle this problem? In the 2007-2013 Financial Framework (EU Council, 15915/05), adaptation to climate change is one of the most important priorities. In the European Economic Recovery Plan (COM(2008) 800 final) there is a special emphasis on climate change adaptation policy, i.e. the promotion of energy efficiency, fostering the production of green energy and the modernization of the European infrastructure.

An interesting proposition of this paper is the coverage of certain strategic public or private investments by weather-related insurances. This suggestion should be further analysed in the future. The PES (Payment for Ecosystem Services) would be designed to build public-private partnerships to share investments, risks and it would recycle the revenue generated from auctioning allowances (COM(2009) 147/4).

5.6 Conclusion

In this chapter we assessed, that a mitigation and adaptation policy is needed to address climate change. Policy instruments should be selected very carefully, yet they have substantial impact on the real economy, on the GDP, and they have employment effects. Therefore, market-based instruments and complementary, innovation-promoting instruments should be applied to reach a sustainable growth. New motors of economic growth could be detected in the green economy and renewable energy sources, which could foster innovation, contribute to production growth and create employment.

The EU has published many action plans to face climate change, but lacks the appropriate financial instruments and coherence with other common policies. In the future, a more pronounced competitiveness-promoting and innovation-based adaptation policy should be elaborated, together with market-based financial instruments.

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