CECILIA 2050

OPTIMAL EU CLIMATE POLICY

Choosing Efficient Combinations of Policy Instruments for Low-carbon development and Innovation to Achieve Europe's 2050 climate targets

International competitiveness and markets

The current policy mix (Task 2.8)

Funded by the European Union

SEVENTH FRAMEWORK PROGRAMME

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LIST OF ABBREVIATIONS

ARE	Abatement Resource Effect
BCA	Border Carbon Adjustment
CC	Carbon Content
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CER	Certified Emissions Reduction
CGE	Computable General Equilibrium
COP	Conference of the Parties
CSP	Concentrated Solar Power
EEG	Erneuerbare-Energien-Gesetz (German Renewable Energy Act)
EER	Effective Exchange Rate
EITE	Energy Intensive Trade Exposed
ERU	Emissions Reduction Unit
ETR	Environmental Tax Reform
EUA	European Union Allowance
EU ETS	European Union Emission Trading System
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GW	Giga Watt
JI	Joint Implementation
Mt	Mega ton (million tonnes, billion kg)
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PV	Photovoltaic
REER	Real Effective Exchange Rate
RES	Renewable Energy Sector
RCA	Revealed Comparative Advantage

R&D	Research and Development
RTB	Relative Trade Balance
SME	Small and Medium-sized Enterprises
ULC	Unit Labour Cost
UNFCCC	United Nations Framework Convention on Climate Change
USD	US dollar
WTO	World Trade Organization

1 Executive summary

For the European Union, competitiveness is a central element in its 2020 Strategy. The dedication to the competitiveness of EU industry is enshrined in the European Treaty. While sustainability and protection of global climate system are also central elements, EU and Member State climate policies have often led to the fear of a loss of competitiveness by energy-intensive industries, and consequently of carbon leakage. Carbon leakage and loss of competitiveness are the main arguments against ambitious climate policies in industrialised countries. Modest mitigation targets have gone hand in hand with policy packages intended to protect sectors at risk of carbon leakage.

This report provides an analytical framework of competitiveness, and discusses indicators of competitiveness. Two important messages are: there are various channels in which environmental policies can affect the competitiveness of firms, both in positive and negative ways; indicators measure determinants or consequences of competitiveness, but as yet there is no complete theory that tells us how to select the most important determinants and consequences and how determinants and consequences are exactly related.

Econometric studies that have estimated the consequences of the EU ETS with real data have so far not revealed any evidence of carbon leakage and loss of competitiveness in sectors considered at risk of carbon leakage, such as cement, aluminium, and iron and steel.

The current climate policy mix in Europe greatly contributed to the emergence of the global 'carbon' market, presently worth about € 114 billion, and also to the emergence of the global market for renewable energy technologies, presently worth about € 180 billion. EU industry has a strong position in the global market of renewable energy technologies, but the recent take-over of China as the leading country in solar PV shows how fragile a dominant position can be in industries featuring fast technological progress.

2 Introduction

This report assesses the effects of the current policy mix on international competitiveness and markets. The report firstly provides an analytical framework of competitiveness, largely based on work of the Organisation of Economic Co-operation and Development (OECD) and the European Commission. Secondly, it provides a comprehensive review of literature on the relationship between climate policy and industrial competitiveness, with a focus on Europe. Thirdly, the report assesses the effects of the current policy mix on emerging international markets, such as the international 'carbon' market and the international market for renewable energy technologies. The report provides empirical information but also discusses methodological and empirical challenges of identification and measurement of the effects of policy mixes on competitiveness and markets.

3 Competitiveness – analytical framework

3.1 Introduction

"*Competitiveness is an elusive concept, much studied by business theorists and much invoked by politicians and commentators, but frequently dismissed as irrelevant or unimportant by economists. Krugman (1994) famously called it a dangerous obsession in his critique of the first Clinton administration's flirtation with industrial policy. By contrast, Michael Porter of Harvard Business School has highlighted competitive advantage as the key to superior performance by firms, industries and economies as a whole. (See Porter, 1990). In part through his influence, many agencies now monitor national competitiveness, ranging from the World Economic Forum, which publishes an annual Global Competitiveness Report, to national bodies such as the U.S. Council on Competitiveness (www.compete.org) and the Irish National Competitiveness Council (www.forfas.ie/ncc). These have produced much useful data and a great deal of helpful commentary, but mainstream economic theorists have for the most part paid little attention*." (Neary, 2006, p.3).

In the above citation, J.P. Neary of the International Monetary Fund sketches the uneasy relationship between the concept of 'competitiveness' and economic theory. Perhaps somewhat surprisingly, competitiveness is not a basic concept in economic theory such as 'efficiency' and 'utility', and any theories on competitiveness are not grounded in rigorous economic theory. Despite its somewhat suspect theoretical status, competitiveness is a very important concept in practical political and business affairs and a key concept in Europe's 2020 Strategy.

The term 'competitiveness' has been used in numerous studies, reports and articles and underlies economic policies. However, this concept is difficult to define and susceptible to ambiguities. As observed by Ekins and Speck (2012), the meaning of competitiveness varies with the level at which it is being considered. In this vein, OECD defined competitiveness at three levels (Adams, 1997):[1]

- At the firm level: ability of a firm to sell goods and services in the market and stay in business.

[1] There are also alternative definitions of competitiveness by the OECD and the EU (Ekins and Speck, 2012), but they are fairly similar.

- At the sector level: aggregate competitiveness of firms that operate within a given sector in an economy, compared to international rivals.
- At the national level: ability of a country to increase its economic standard of living.

According to the OECD, it is useful to think about competitiveness as ability. Ability is difficult to gauge (or measure); what we measure are determinants (productivity) or consequences (stock value; volume of activity; market share; trade flows; trade and investment flows and growth at the national level). These determinants and consequences are called 'indicators' of competitiveness.

3.2 OECD analytical framework

OECD (2010) describes linkages between environmental policy and competitiveness and presents an analytical framework (Figure 1). In this analytical framework, a distinction is made between two channels in which environmental policy (instruments) can affect a firm: 1) Environmental policy may influence the environmental performance of a firm and this may have consequences for its competitiveness. For example, energy savings policies may require the firm to invest in energy-saving equipment, produce savings in input costs, and result in a positive image among its stakeholders. This may all, directly or indirectly affects a firm's competitiveness. 2) Environmental policy may have competitiveness impacts that arise directly from the policy itself rather than from the improvements in environmental performance. This is for example the case when a firm's pollution is taxed or when the firm is obliged to buy emission permits, but does not change its environmental performance. It may also be the case that a rigid environmental policy is more expensive for the firm than would have been the case if the firm would have been allowed to improve its environmental performance by itself. This may be the case if the policy imposes technology standards on the firm.

A certain policy measure may affect the firm's competitiveness through both channels. The net effect of positive and negative effects of both channels determines the final competitiveness effect on the firm, and, in the aggregate, on the sector.

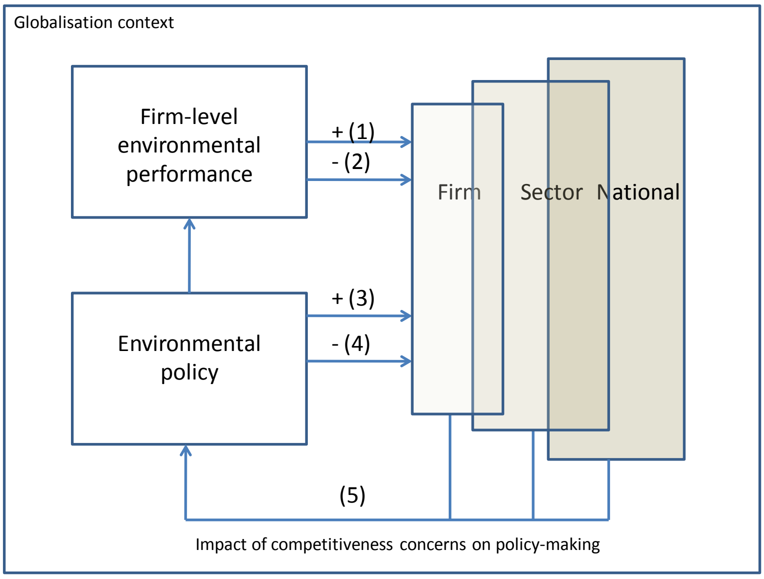


Figure 1 Analytical framework on the linkages between environmental policy and competitiveness

The following positive and negative effects of policies, indicated by ±(#) in Figure 1, on competitiveness can be distinguished:

+(1) Improvements in environmental performance may:

- Improve resource efficiency, reduce waste, and hence improve the overall efficiency of the firm (Porter and van der Linden, 1995; Ambec and Lanoie, 2008).
- Improve stakeholder relations and hence reduce transaction costs with stakeholder groups. A good environmental reputation may also improve the firm's ability to attract the best employees and may be reflected in a lower price for capital and insurance.
- Allow for product differentiation so that an 'eco-premium' can be earned in the market, for example through eco-labelling (Ambec et al., 2008).
- Improve market access to markets or buyers with high quality standards [e.g. ISO 14001 certification]. An increasing number of companies is assessing their suppliers' environmental performance (Ambec et al., 2008; Johnstone et al., 2007).
- Create new business. For example in the context of REACH new business in 'expert services' of companies such as Ciba and BASF was created (Lorenz et al., 2008).

-(2) In contrast, improvements in environmental performance may also:

- Increase direct production costs (Jaffe et al., 1995).
- Reduce productivity in more subtle ways, for example through less efficient processes and practices, switching costs, early retirement of capital assets, and the crowding-out of more productive investments and management resources (Jaffe et al., 1995).
- In some case, have adverse impacts on perceived product quality, e.g. organic fruit.

+(3) Policies may have a direct positive impact on competitiveness by:

- Creating new demand, especially for the Environmental Goods and Services (EGS) sector.
- Raising rival's costs, e.g. the impact of a carbon tax on the competitiveness of a hydropower producer (Reinhardt, 1999).
- Improving environmental quality. This may for example reduce the input costs of drinking water manufacturing firms, or stimulate tourism with a positive impact on the competitiveness of the associated tourism industry.

-(4) In contrast, policies may have a direct negative impact by:

- Reducing demand, e.g. demand for chlorine by the Montreal Protocol.
- Increasing input prices, e.g. the effect of the EU ETS on electricity prices.
- Increasing transaction costs for negotiating, monitoring, measuring, and reporting.
- Introducing new cost elements: taxes, charges, expenditures for emission permits.
- Reducing productivity through barriers to entry, lock-in of capital, delay of investment and development due to uncertainty on future regulation (Shadbegian and Gray, 2005).

+(5) Finally, anticipated or observed impacts on competitiveness may feedback to the design or implementation of the environmental policies.

Table 1 below summarises the potential positive and negative impacts of environmental policies on the competitiveness of firms through both channels of influence.

Table 1 Linkages between environmental policy and competitiveness

Impacts of improved environmental performance		Direct impacts of environmental policy	
Positive	Negative	Positive	Negative
Improved resource efficiency	Increase in production costs	Creating demands for the firm's outputs	Reduced demand for the firm's output
Improved stakeholder relations	Reduced productivity	Raising rival's costs	Increasing input prices
Product differentiation	Adverse impacts on perceived product quality	Improving environmental quality	Imposing transaction costs
Improved market access			Imposing new cost elements on a firm
The creation of new business			Adversely affecting productivity

Source: (OECD, 2010)

3.3 Competitiveness in EU legislation

For the EU, competitiveness is a central element in its 2020 Strategy. The European Commission (EC, 2010) sets out the EU’s approach to integrated industrial policy under the motto “putting competitiveness and sustainability at centre stage”. The dedication to the competitiveness of EU industry is enshrined in the European Treaty (Box 1).

Box 1 Article 173 of the Treaty on the Functioning of the European Union

Article 173

(ex Article 157 TEC)

1. The Union and the Member States shall ensure that the conditions necessary for the competitiveness of the Union's industry exist. For that purpose, in accordance with a system of open and competitive markets, their action shall be aimed at:

— speeding up the adjustment of industry to structural changes,

— encouraging an environment favourable to initiative and to the development of undertakings throughout the Union, particularly small and medium-sized undertakings,

— encouraging an environment favourable to cooperation between undertakings,

— fostering better exploitation of the industrial potential of policies of innovation, research and technological development.

In order to assess the impacts on industrial competitiveness of proposed EU policies, the Commission’s 2009 Impact Assessment Guidelines, include a set of competitiveness-related questions. For further guidance, the Commission has developed a ‘competitiveness proofing’ toolkit for use in Impact Assessment (EC, 2012a). Box 2 presents the recommended step-wise approach to assess impacts of proposed policies on the competitiveness of EU firms. It starts with establishing the rationale for competitiveness screening for the specific policy under consideration. If this rationale can be found, it proceeds with a qualitative screening to get an indication of the size and severity of the impacts. If the qualitative screening gives reasons for concern, a quantitative assessment is proposed. In accordance to the provisions of the EU Treaty (Box 1), special attention is paid to the impacts on the competitiveness of small and medium-sized enterprises (SME).

Box 2 A step-wise approach to ‘competeveness proofing’ in EU Impact Assessment

Step	Question/Action
Getting Started	
1	Does your IA require specific analysis of impacts on sectoral competitiveness?

2	How deep should we go?
Qualitative screening	
3	Which are the affected sectors?
4	What is the effect on SME competitiveness?
5	What is the effect on cost and price effectiveness?
6	What is the effect on the enterprises' capacity to innovate?
7	What might be the effect on the sector's international competitiveness?
Quantifying the impacts: data sources	
8	Provide evidence on the structure and performance of the directly affected sector(s)
8a	Take stock of existing sectoral studies and ex-post evaluations
8b	Update existing data
9	Provide data evidence on indirectly affected sectors
10	Quantify additional compliance and/or operational costs related to the assessed initiative
11	Quantify the expected impacts on the capacity of affected enterprises to innovate
12	Quantify the expected impacts on affected sector's international competitiveness

Source: (EC, 2012a)

3.4 Indicators of competitiveness

The European Commission publishes an annual report on European competitiveness (EC, 2012b) in which it describes trends in the competitiveness of EU industrial sectors, illustrated by a number of indicators. As was pointed out above, competitiveness is best understood as an ability. Ability itself is difficult to measure. Indicators of competitiveness are determinants or consequences of this ability.

The annual report on European competitiveness presents sector-level indicators of competitiveness. Indicators that focus on the determinants of competitiveness are growth rates of labour productivity (per person and per hour worked), and unit labour costs (ULC), which is simply the ratio of labour costs to output. A somewhat more complex indicator in this category is the Real Effective Exchange Rate (REER). To explain this indicator, we start with the (nominal) Effective Exchange Rate (EER) for country *j*. The EER is the geometric mean of all bilateral (market) exchange rates of the currencies of competitor countries ($e_{k,j}$), weighted by the importance of the competitor countries (w_i):

$$EER_j = \prod_{k=1}^{N} (e_{kj})^{w_k}$$

The Real Effective Exchange Rate (REER) is the EER adjusted by some similarly weighted measure of relative prices or costs. Using unit labour costs (ULC) the formula for REER becomes:

$$REER_j = \prod_{k=1}^{N} (\frac{ULC_j}{ULC_k} e_{kj})^{w_k} = \prod_{k=1}^{N} (\frac{ULC_j}{ULC_k})^{w_k} * \prod_{k=1}^{N} (e_{kj})^{w_k}$$

Indicators that focus on consequences include simple indices of production and employment, and the indices of relative trade balance, and revealed comparative advantage.

The relative trade balance (RTB) for sector *i* measures net exports of a country (exports *X* minus imports *M*) as share of the total trade of that country (exports *X* plus imports *M*) in a certain period. In formula:

$$RTB_i = \frac{(X_i - M_i)}{(X_i + M_i)}$$

Revealed comparative advantage (RCA) of sector *i* of country *j* measures its relative exports (exports X_i as a share of total exports $\sum X_i$) against the relative exports of sector *i* of a reference group of competitor countries *k*. In formula:

$$RCA_{j,i} = \frac{\frac{X_{j,i}}{\sum X_{j,i}}}{\frac{X_{k,i}}{\sum X_{k,i}}}$$

The indicators that focus on the determinants of competitiveness only measure quantifiable factors and not the non-price factors such as the quality of the workforce, infrastructure, innovative capacity, and the legislative, fiscal and regulatory environment, that can also affect the competiveness of firms, sectors, and nations (Ekins et al., 2012). Cost-based indicators have a limited ability to predict how overall competitiveness will change if one cost item, say an environmental tax on energy, is increased. This is especially true in the longer term when firms can optimally adjust to the tax. As will be discussed in greater detail in the next chapter, there is no simple relationship between cost-based indicators of competitiveness (e.g. unit energy costs) and consequences of competitiveness as measured by, for example, relative trade indices (Miltner and Salmons, 2009; Kee et al., 2010).

The indicators that focus on the consequences of competitiveness show important trends, but it is difficult (and often impossible) to identify causal relationships with determining factors. A practical problem, especially with international trade data, is that the product classification that is used for recording trade flows is not appropriate for the questions that are being asked from the data. The traditional classifications are based on industrial sectors but do not, as a rule, distinguish between conventional and 'green' goods and services. This is further discussed in Chapter 5.

4 Climate policy and international competitiveness

4.1 Introduction

Climate policies will remain sub-global in the years to come, and unilateral or regional policies, including regulations, subsidies, carbon taxes and carbon markets, have emerged as some industrialized countries (particularly the EU and some Member States) decided unilaterally to reduce their emissions. The top-down global Kyoto approach is shifting towards a bottom-up architecture with different CO_2 prices (Rayner, 2010; Weischer et al., 2012).

In a world with uneven climate policies, the carbon price differentials across regions modify production costs and may shift the production of energy-intensive goods from carbon-constrained countries to countries with laxer climate policy. Since a decrease in emissions in one part of the world leads to an increase in emissions in the rest of the world, this phenomenon is referred to as carbon leakage.

The Pollution Haven effect, that is, the migration of dirty industries to countries with less stringent regulations, is one of the most contentious debates in international economics (Taylor, 2005). A major difference exists between local pollutants, which constitute the overwhelming part of studies in the pollution haven literature, and CO_2. CO_2 is a global stock pollutant: the geographic location of emissions does not matter. A production shift would then reduce the environmental benefits of the policy while potentially damaging the economy.

In the context of growing globalisation, environmental policies can also have a strategic role. The fierce competition to attract foreign direct investment or the threat of industrial relocation could lead to a 'regulatory chill' or even a 'race-to-the bottom', depending on the willingness of countries to downgrade environmental standards.

Indeed, the fear of carbon leakage and loss of competitiveness in energy-intensive industries are the main arguments against ambitious climate policies in industrialized countries. Modest mitigation targets have gone hand in hand with policy packages intended to protect sectors at risk of carbon leakage (mainly cement, iron and steel, aluminium and oil refineries). In the European Union Emission Trading System (EU ETS), the biggest carbon pricing experiment so far, tradable allowances are distributed free of charge for these sectors. In the US, the Waxman-Markey proposal, which was adopted by the House of Representatives in 2009 but not by the Senate, would have introduced a nationwide carbon market with measures to face these issues: allowances distributed freely on the basis of current output (output-based allocation) and border carbon adjustment (BCA). The latter, aimed at 'levelling the carbon playing field', is widely discussed among politicians, business leaders and academics. However, it is often considered as protectionism disguised as green policy (Evenett and Whalley, 2008) among developing countries, and its compatibility with the rules of the World Trade Organisation remains contentious. The political outcome of its implementation is highly uncertain. BCA may increase the incentives of third countries to join the abating coalition but may also create international friction and lead to tit-for-tat trade retaliations (Bordoff, 2009; IIFT, 2010). The recent setbacks of the inclusion of aviation in the EU ETS are a reminder that any attempt to regulate emissions outside a country's jurisdiction is extremely problematic: foreign airlines and governments complained about this inclusion, which pushed the EU to cancel the inclusion of international flights, pending a debate at the International Civil Aviation Organization.

This Chapter provides a literature review on competitiveness and carbon leakage issues from an economic, political and legal perspective. First, Section 4.2 gives the definitions of the main terms involved. Section 4.3 discusses positive impacts on competitiveness and foreign abatement. Section 4.4 provides an evaluation of the carbon leakage risk, distinguishing ex ante Computable General Equilibrium (CGE) modelling from ex post econometric studies. Section 4.4.3 synthesises the results. Section 0 examines the policies aimed at reducing carbon leakage and competitiveness losses with an emphasis on Border Carbon Adjustment. Section 4.5 concludes.

4.2 Definitions

4.2.1 Carbon leakage

While competitiveness concerns and carbon leakage are often associated, they are two distinct phenomena. Carbon leakage is the increase of emissions in the rest of the world when a region implements a climate policy, compared to a situation where no policy is implemented (Quirion, 2010). It can be measured by the leakage rate or leakage-to-reduction ratio, which is the rise in emissions in the rest of the world divided by the abated emissions in the region that has adopted a climate policy. A 50% leakage-to-reduction ratio means that half of the mitigation effort is undermined by the increase of emissions in the rest of the world, and not the misguided interpretation that 50% of emissions have 'leaked' in the rest of the world. If this ratio is under 100%, emissions have decreased on a global scale, so the policy is environmentally beneficial. A ratio above 100% is theoretically possible, because the carbon intensity of CO_2-intensive products can be higher in the rest of the world, but has only been found in one outlier model (Babiker, 2005). Estimates of leakage rates are typically in a range of 5%-20% depending on many factors (see below).

Carbon leakage occurs through two main channels: the competitiveness channel and the international fossil fuel price channel (Dröge, 2009). The root of the competitiveness channel is that the cost of compliance gives a comparative disadvantage for regulated firms vis-à-vis their competitors. This change of relative prices can lead to a change of the trade balance (less exports and more imports). In the short term, this would correspond to a change of the utilisation rate of existing capacities (operational leakage), while in the long term, it would correspond to a change in production capacities (investment leakage). These changes induce a shift of production, and then of emissions, from the regulated part of the world to the unregulated part of the world.

Besides, abating countries almost necessarily have to cut their fossil fuel consumption, which drives down the international prices of carbon-intensive fossil fuels: coal, oil and, perhaps even more, non-conventional fossil fuels (Persson et al., 2007). This decrease in prices reduces the net cost of climate policies in fuel-importing abating countries since a part of abatement is borne by fossil fuel exporters who lose a part of their rents. However it leads to a rise of their consumption in countries with less stringent policies. Because of international energy markets, the shrink in consumption in one region involves an increase in consumption in the rest of the world, causing carbon leakage through the international fossil fuel price channel. Yet two caveats are in order. First, CO_2 capture and storage (CCS) does not reduce fuel consumption. Quirion et al. (2011) show that for this reason, CCS brings down carbon leakage compared to a climate policy providing the same abatement without CCS. Second, the world oil market is dominated by OPEC, and alternative assumptions about OPEC's behaviour lead to opposite results regarding leakage through the oil market, which can even become negative (Böhringer et al., 2013).

The same reasoning applied to the whole world but with two temporal periods is known as the Green Paradox (Sinn, 2008; Eisenack et al., 2012) which could be considered inter-temporal leakage: a rising CO_2 price would be seen as a future resource expropriation by fossil fuel owners who would then increase resource extraction. Yet, although the mechanism of the Green Paradox is well understood, its quantitative importance decreases when realistic features are included in the models (Gerlagh, 2010).

Despite the overwhelming importance of the competitiveness channel in the climate policy debate, in virtually all models including the two channels, the international fossil fuel price channel predominates (Gerlagh and Kuik, 2007; Fischer and Fox, 2009; Weitzel et al., 2012; Boeters and Bollen, 2012).

4.2.2 Competitiveness

At a firm or sectoral level, competitiveness can refer to 'ability to sell' or 'ability to earn'. Competiveness as 'ability to sell' is the capacity to increase market share, and can be measured through indicators involving exports, imports and domestic sales (Alexeeva-Talebi et al., 2012). Competitiveness as 'ability to earn' is the capacity to increase margins of profitability, and can be measured with indicators involving some measures of profit or stock values. Distinguishing these two notions is useful since the same climate policy can have different impacts on both. For instance, distributing free emission allowances based on historic data only, as is the case in the US SO_2 ETS (Schmalensee, 2012), increases the ability to earn but not the ability to sell, since an operator can close a plant and continue to receive the same amount of allowances. Hence, only competitiveness as ability to sell may generate leakage.

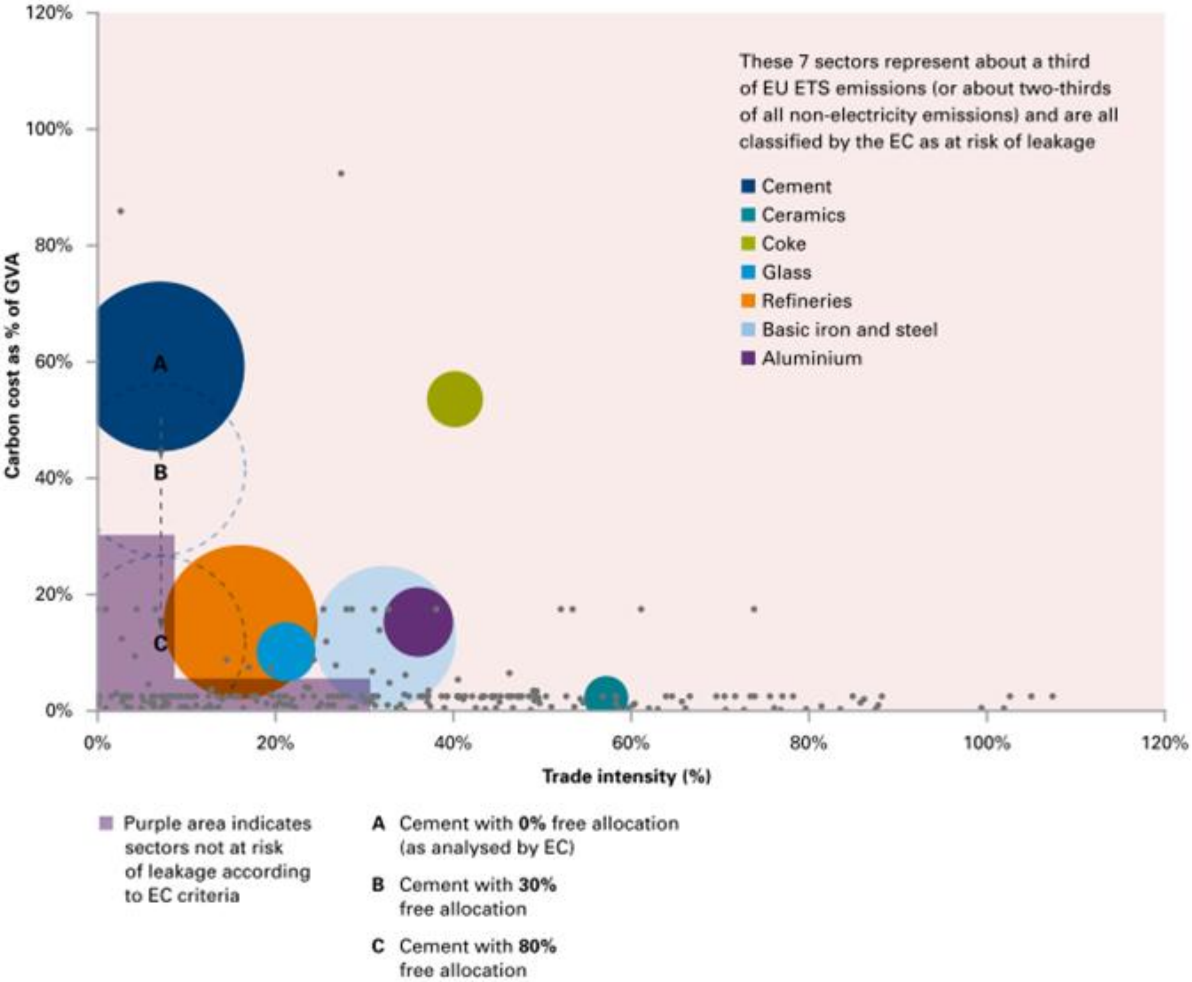
The notion of competitiveness at the national level is controversial, and is considered meaningless by some economists, such as Paul Krugman (1994). The main indicator is the balance of trade, that is, the difference between the monetary value of exports and imports, but an increase in the balance of trade may result from many factors, some of which are completely unrelated to the competitiveness of domestic firms, like a contraction in domestic demand.

Whether climate policies have to protect competitiveness at a national level or at a sectoral level is a legitimate question. EU ETS sectors contribute 40% of EU emissions, but less than 5% of its Gross Domestic Product (GDP) and an even smaller share of its jobs (Ellerman et al., 2010). The sectors at risk of carbon leakage (see below) account for slightly more than 1% of GDP in the UK (Hourcade et al., 2007) and 2% in Germany (Graichen et al., 2008). However, they account for a much higher share of Greenhouse Gas (GHG) emissions so protecting their competitiveness in order to limit leakage cannot be discarded prima facie.

4.2.3 Sectors at risk

All sectors do not face the same risk of carbon leakage. The risk is higher if the carbon cost is high and the international competition is fierce. Hence, in the attempt to classify sectors exposed to carbon leakage, two indicators are generally used, one measuring the carbon cost and the other the trade intensity. For the EU ETS, the carbon cost is measured by the value at stake, defined as the carbon costs relative to the gross value added of a given industrial sector. The trade intensity is measured by the ratio in values between imports plus exports and the EU total market size. A sector is considered at risk if one or both of these indicators is above a certain threshold (see Figure 1). The most vulnerable sectors, usually gathered around the common denomination of Energy Intensive Trade Exposed (EITE) sectors, include iron and steel, cement, refineries and aluminium.

Figure 1 Sectors classified 'at risk of carbon leakage' in Europe



Source: Carbon Trust 2010. The size of the circles is proportional to the sector emissions.

The EITE sectors are well-organized and constitute a strong lobby that has managed so far to influence climate policies. Indeed, all climate policies have provided more favourable rules for these sectors compared to others. In addition, these 'specific rules' are generally more favourable in the final amendments than in first drafts (CEO, 2010). The classification of sectors in itself (which sectors are at risk and which are not), because of its economic impacts, is subject to political and academic controversy and face strong industrial lobbying (Cló, 2010; Martin et al., 2012).

4.3 Positive impacts of climate policies on competitiveness and abatement in foreign countries

Though the political debate has focused on the negative impacts of climate policies, some authors argue that at least in some sectors or firms, stringent environmental regulations can force firms to be more efficient in their processes, and then more competitive. This is referred to as the Porter hypothesis (Porter et al., 1995), which is highly controversial but has been corroborated in Europe by a recent econometric study (Costantini and Mazzanti, 2012).

Further, it is possible to highlight two mechanisms symmetrical of carbon leakage and competitiveness losses: climate spillovers and first mover advantage.

Environmental regulations foster innovation and generate technological progress in GHG savings technologies (Newell et al., 1999; Jaffe et al., 2002; Dechezleprêtre et al., 2008; Dechezleprêtre et al., 2011). Diffusion of these technologies reduces emissions in non-abating countries and then creates negative leakage, or positive climate spillover (Gerlagh et al., 2007; Di Maria and Werf, 2008; Golombek and Hoel, 2004; Bosetti et al., 2008). There is empirical evidence of climate spillovers, especially in energy-saving technologies (Popp, 2002), but also in renewables. Feed-in tariffs in Denmark, Germany and Spain generated a massive induced technical change in wind and solar technologies (Peters et al., 2012) and are thus in part responsible for the spectacular development of windpower capacities in China, which became the world leader in terms of windpower installed capacities, shifting from 2.6 GW in 2006 to 75 GW in 2012 (Roney, 2013).

Another, yet even more difficult to quantify source of negative leakage is the international diffusion of climate policies: implementing any new policy involves some risks, and observing climate policies in other countries allows reducing these risks and possibly avoiding some mistakes. Just as the EU has closely observed the US SO_2 cap-and-trade to set up the EU ETS, subsequent ETS developments have benefited from the EU ETS experience. The same stands for other climate policies such as renewable subsidies (especially feed-in-tariffs pioneered by Denmark and then Germany) and energy efficiency regulations.

Finally, Fullerton et al. (Fullerton et al., 2011) have recently identified a new mechanism generating negative leakage, which they label the Abatement Resource Effect (ARE). The intuition is that when a climate policy reduces emissions in one part of the economy, it may draw factors of production away from other, carbon-intensive activities. The authors show that if this effect is strong enough, an economy may exhibit negative net leakage in response to the policy change. While the possibility of negative leakage through this mechanism is not disputed, Carbone (2013) as well as Winchester and Rausch (2013) have recently assessed the ARE in more complex models and conclude that the negative leakage due to the ARE is more than offset by positive leakage mechanisms.

Technological knowhow in climate-related technologies gained by domestic firms could be used to capture market share in emerging markets (first-mover advantage). If other countries join the abating coalition, these firms have a comparative advantage vis-à-vis their competitors. This ability to gain market share by being the first to develop a technology is the first mover advantage. Emerging in models (Summerton et al., 2012), it could be considered a long-term competitiveness factor. The clearest case concerns the EU wind industry, which is the dominant supplier in all word markets except China, due to the already mentioned feed-in-tariffs implemented in the 1990s. However, while Germany benefited from a first-mover advantage in the Photovoltaic (PV) industry until 2011, the German PV industry has since been largely surpassed by China, showing how fragile a dominant position can be in industries featuring fast technical progress (Kazmerski, 2011).

4.4 Evaluation of carbon leakage

4.4.1 *Ex ante* studies

Climate change mitigation policies are diverse and include various forms of regulations, subsidies, carbon taxes and emission trading systems (ETS). Yet carbon leakage has mostly been assessed for ETS and carbon taxes. There is extensive literature assessing *ex ante* carbon leakage from hypothetical carbon taxes or ETS that can be traced back to Felder and Rutherford (Felder and Rutherford, 1993). The majority of these studies rely on Computable General Equilibrium (CGE) models (Böhringer et al., 2012b; Mattoo et al., 2009; Fischer and Fox, 2012; Dissou and Eyland, 2011; Lanzi et al., 2012; Balistreri and Rutherford, 2012; Kuik and Hofkes, 2010; Peterson and Schleich, 2007), while global structural econometric models are also used (Lutz and Meyer, 2009). To asses sector-specific rates of leakage partial equilibrium models are used (Gielen and Moriguchi, 2002; Mathiesen and Maestad, 2004; Monjon and Quirion, 2011; Demailly and Quirion, 2006; Demailly and Quirion, 2008).

CGE models, which simulate the behaviour of entire economies, are pertinent to study the effect of policies on trade in different sectors (Kehoe et al., 2005) but they generally rely on more aggregated data (almost exclusively the Global Trade Analysis Project database) that may hide impacts on more specific sectors (Siikamäki et al., 2012; Alexeeva-Talebi et al., 2012). Moreover, most CGE models feature a zero-profit condition so cannot assess competitiveness as ability to earn. An exception is Goulder et al. (2010) whose model features capital adjustment costs, which implies that capital is imperfectly mobile across sectors and allows the model to capture the different impacts of policy interventions on the profits of various industries. Assessing a hypothetical federal ETS in the US, the authors conclude that freely allocating fewer than 15% of the emissions allowances generally suffices to prevent profit losses in the most vulnerable industries. Freely allocating all of the allowances substantially over-compensates these industries.

While CGE models are usually calibrated on a limited set of data (often only one year), structural econometric models employ a richer set of time series data. While CGE models derive behavioural assumptions in production and consumption almost directly from micro-economic theory, structural econometric models can derive their assumptions from empirical evidence. While this is a serious advantage, it also makes them very dependent on good data (and efficient estimation techniques) which perhaps explains the relative scarcity of such models, especially at the world level. Partial equilibrium models often do not take account of all intersectoral linkages and lack macroeconomic closure, but they can provide rich descriptions of technological possibilities and market structure that can make them an appropriate tool to study sector-specific leakage (e.g. leakage from the steel sector).

These models provide a wide range of estimations for leakage and competitiveness losses (as ability to sell). First, results depend on scenario hypotheses: the bigger the abating coalition, the smaller the leakage rate while the more ambitious the target, the higher the leakage rate. Linking carbon markets within the abating coalition (Lanzi et al., 2012), authorizing offset credits (Böhringer et al., 2012b) or extending carbon pricing to all GHG (Ghosh et al., 2012) increases economic efficiency and then reduces leakage. Second, the models are very sensitive to two sets of parameters: fossil fuel supply elasticities (for the international fossil fuel price channel) and Armington elasticities (for the competitiveness channel) (Monjon et al., 2011; Alexeeva-Talebi et al., 2012; Balistreri et al., 2012). The former indicate to what extent a decrease in fossil fuel demand reduces the fuel price, while the latter represent the substitutability between domestic and foreign products.

A recent comparative study of 12 different models gave the most robust results so far (Böhringer et al., 2012a). The estimate of leakage is 5-19% (mean 12%) when Annex I countries (except Russia) abate 20% of their emissions through carbon pricing without taking any measure to protect EITE sectors. The loss of output in these sectors is 0.5%-5% (mean 3%) in the coalition and an output gain of 1%-6.5% (mean 3%) is observed in the rest of the world. Some results of leakage estimates can be seen in Table 2.

Table 2 Leakage rate estimates in the literature

Article	Abating Coalition	Target	Sectors and Gases Covered	Leakage Ref	Leakage BCA	BCA Features
Böhringer et al. 2012	Annex I except Russia	20%*	All sectors CO_2	5-19% (mean 12%)	2-12% (mean 8%)	Foreign CC Export Rebates EITE sectors
Ghosh et al. 2012	Europe	20%*	All sectors (incl. Agri)	12%	-8%	Foreign CC Export Rebates
Lanzi et al. 2012	Annex I	Kyoto*	All sectors CO_2	4%	-17%	Foreign CC Export Rebates
Böhringer et al. 2012	Annex I except Russia	20%*	All sectors	Böhringer et al. 2012	Annex I except Russia	20%*
McKibbin and Wilcoxen 2009	US	Price instrument ($20 in 2010 to $50 in 2050)	All sectors	3%	-30%	China CC Only imports
Peterson and Schleich 2007	Annex I	Kyoto	All sectors	25%	23%	Domestic CC
Kuik and Hofkes 2010	Europe	Price instrument (20€)	EU ETS sectors	11%	10%	Domestic CC Only imports
Winchester et al. 2011	Annex I except Former USSR	31% (US)	All sectors	10%	7%	Domestic (US) CC Only imports
Mathiesen and Maestad 2005	Annex I	Kyoto	Steel only (partial equilibrium)	26%	-18%	Foreign CC Export rebates
Monjon and Quirion 2011	Europe	15%	EU ETS sectors (partial equilibrium)	11%	-4%	Foreign CC Export rebates EU ETS (except electricity)

Source: authors

4.4.2 *Ex post* studies

For *ex post* analysis, CGE models, structural econometric models, and econometric time series analysis can be used. The first studies assessing empirically the impacts of environmental regulations on trade dealt with local pollution issues (Kalt, 1988; Tobey, 1990; Grossman and Krueger, 1991; Jaffe et al., 1995). They showed little evidence to support the 'pollution haven' effect: their estimates of the impact of environmental regulations on trade flows were either small or insignificant. However, recent studies have shown some evidence of the pollution haven effect in small proportions (Dean et al., 2005; Levinson and Taylor, 2008). Paradoxically, dirty industries seem less vulnerable, because of capital intensity and transport costs (Ederington et al., 2003). The empirical validity of the pollution haven effect continues to be contentious in the debate regarding international trade and environment (Kellenberg, 2009). Nevertheless a massive environmental relocation has never been observed.

Environmental tax reforms (ETR, i.e. carbon taxes whose revenues are used to cut other taxes, mostly on labour income) established in some European countries offer another natural experiment to empirically treat these questions. Kee et al (2010) analyse the evolution of imports and exports in energy-intensive industries, comparing countries which did and did not implement a carbon tax. The authors find a statistically significant negative impact on exports of a carbon tax only in the cement sector while, strangely enough, they find a positive impact on exports in the paper as well as iron and steel sectors. No statistically significant impact was found on imports for any sector. Miltner and Salmons (2009) found that, out of 56 cases (seven countries and eight sectors studied), the impact of ETR on competitiveness was insignificant in 80% of the cases, positive in 4% and negative for only 16%. However, EITE sectors benefited from exemptions and lower taxation rates, which may explain why more negative impacts were not observed. If ETR didn't prove harmful for these industries, they had a positive impact on economic wealth, giving empirical arguments for the double dividend theory (Barker et al., 2009; Barker et al., 2011), e.g. a taxation shift from labour to pollution may stimulate economic growth as well as reducing pollution (Goulder, 2002; Bento and Jacobsen, 2007).

Aichele and Felbermayr (2012) econometrically assessed the impact of having an emission target under the Kyoto Protocol (i.e. being a developed country and having ratified the Protocol) on CO_2 emissions, the CO_2 footprint[2] and CO_2 net imports, using a differences-in-differences approach on a panel of 40 countries. To account for a potential endogeneity bias (the fact that countries with an expected low or negative growth in emissions may be more likely to have ratified the Protocol) they use the International Criminal Court participation as an instrumental variable for Kyoto ratification. They concluded that countries with a Kyoto target reduced domestic emissions by about 7% between 1997-2000 and 2004-2007

[2] The CO_2 footprint equals domestic emissions plus CO_2 net imports, i.e. domestic emissions plus emissions caused by the production of imported products, minus emissions caused by the production of exported products.

compared to the countries without a target, but that their CO_2 footprint did not change (CO_2 net imports increased by about 14 %). These results imply that domestic reductions have been fully offset by carbon leakage. However two caveats are in order. First, China became a member of the WTO in 2002, just when most developed countries ratified the Protocol. Since most CO_2 net imports are due to trade with China (Sato, 2013), the rise in net imports may well be due to China WTO membership rather than to Kyoto. Second, apart from those covered by the EU ETS, countries with a Kyoto target haven't adopted significant policies to reduce emissions in manufacturing industry. Hence, if Kyoto had caused leakage (through the competitiveness channel), it should show up on the CO_2 net imports of countries covered by the EU ETS rather than of countries covered by a Kyoto target; yet the authors report that EU membership does not increase CO_2 imports, when they include both EU membership and the existence of a Kyoto target in the regression. This conclusion invites to look more directly at the impact of the EU ETS.

The studies focusing on the EU ETS, the largest carbon pricing experiment so far, have not revealed any evidence of carbon leakage and loss of competitiveness in sectors considered at risk of carbon leakage, such as cement, aluminium, and iron and steel (Reinaud, 2008; Ellerman et al., 2010; Sartor, 2012; Quirion, 2011; Branger and Quirion, 2013a). More studies will undoubtedly be conducted in the following years, for the EU ETS and the other carbon markets that have emerged, as more hindsight will be provided. So far, the empirical results are in sharp contrast to the 'exodus of EU industry' claimed by the European Alliance of Energy Intensive Industries (Oxfam International, 2010).

4.4.3 Synthesis

Ex ante modelling studies vary in their results because of policy scenarios (size of the coalition, abatement targets) and some crucial model parameters (Armington elasticities for the competitiveness channel, and oil supply elasticities for the international fossil fuel channel). A meta-analysis of recent studies which details the role of these factors is provided in Branger and Quirion (2013b). In the absence of BCA, most of these studies suggest leakage rates in the range of 5-20%. Conversely, *ex post* econometric studies have not revealed empirical evidence of these issues. Why such a difference?

In the first place, the empirical evidence on carbon leakage and international competitiveness in both *ex ante* studies and in *ex post* econometric analysis is not (yet) strong. Second, effects of carbon taxation are always in practice compensated by 'policy packages'. Because of carbon leakage and competitiveness concerns, sectors at risk in the EU ETS received allocations free of charge while in every case of CO_2 tax, they benefited from lower tax rates or exemptions. In addition, aluminium producers and other electricity-intensive industries, protected by long term electricity contracts, have not always suffered the pass-through of carbon costs to consumer by electricity companies (Sijm et al., 2006). Moreover, in the case of the EU ETS, the CO_2 price has been below €14 for the majority of the time since the launch of the system, arguably too low a value to entail noticeable impacts.

Further, empirical studies have focused so far on *operational leakage* and not *investment leakage* (change in production capacities), which could be studied through the analysis of foreign direct investments. Over time, new carbon markets are launched and time series get longer, giving more room for empirical research. However, assessing the 'true' impact of asymmetric carbon pricing will always be hampered by the compensation measures aimed at reducing competitiveness losses.

Another reason for the gap between *ex ante* predictions and *ex post* analysis could be that models generally do not (or only vaguely) take into account positive aspects of climate policies, such as climate spillovers and first mover advantages.

More research understandings of the positive aspects of climate policies would be useful when exploring the climate and competitiveness linkages. There is also a need for better empirical validation of economic models, and their key parameters and behavioural assumptions. Policies to address leakage and competitiveness concerns

The elaboration of policy tools designed to 'level the carbon playing field' has led to an extensive body of literature. One can classify these measures in three broad categories: a global approach, levelling down the cost of carbon and border adjustments (Dröge, 2009; Grubb and Counsell, 2010). Each of these categories has many variants and a combination of different tools could also be considered. The next sections discuss their specific features, pros and cons. None of these instruments seems to be a 'magic bullet' to address economic efficiency, equity and practical feasibility concerns (Böhringer et al., 2012b). Some argue that policies to address this problem should be sector-specific (Dröge, 2009; Grubb et al., 2010), but so far tools that have actually been implemented or considered to address competitiveness and leakage concerns only distinguished sectors 'at risk' from the others: see Table 2 for Europe (EU ETS phase II and III), the US (Waxman-Markey amendment), Australia (Clean Energy Legislative Package), the California ETS and the New Zealand ETS.

4.4.4 Global approach

The first-best solution would be the existence of a uniform carbon price allowed by international climate agreements and flexibility mechanisms. However, because of the negative perspective of international climate negotiations, this option seems highly unlikely until at least 2020[3]. A pragmatic alternative would then be to embrace cooperative sectoral approaches (Houser, 2008; Zhang, 2012; Hamdi-Cherif et al., 2011) but much confusion remains regarding what they should be. Developed countries favour the form of industry targets and timetables, and diffusion of performance standards, thus addressing leakage and competitiveness concerns. Conversely, developing countries such as India are suspicious of the imposition of binding targets through sectoral approaches and interpret sectoral agreements as a catalyst for technology transfer (Meckling and Chung, 2009).

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[3] The goal of international negotiations is to sign international agreements before 2015 that would be implemented after 2020.

4.4.5 Levelling down the cost of carbon

Levelling down can be achieved through investment subsidies, sectoral exemptions or free allocation of permits, so as to decrease or even suppress the carbon cost for targeted sectors. All are equivalent to subsidies, and are then subject to the agreement on Subsidies and Countervailing Measures of the World Trade Organization.

Exempting the most vulnerable sectors was implemented in Norway (Bruvoll and Larsen, 2004) and Sweden (Johansson, 2006) when their carbon taxes were introduced. It solves the competitiveness and leakage concerns but at a substantial economic cost (Rivers, 2010; Böhringer et al., 2012b): since emissions in these sectors will not be reduced, to reach a given aggregate target, more abatement must take place in the others, including less cost-effective options.

Instead of auctioning, three main options for allocating free allowances have been considered: historic, output-based and capacity-based allocation (used in the EU ETS). These free allocation methods induce side effects: in order to prevent competitiveness issues, other distributional and cost-effectiveness issues are created. In case of historic and capacity-based allocation the ability to pass-through carbon costs creates windfall profits for the operators of covered installations (Sijm et al., 2006; Morris, 2012). Nevertheless, simulations indicate that output-based allocations seem more efficient to counteract leakage and protect industrial competitiveness while assuring political acceptability (Quirion, 2009; Rivers, 2010).

4.4.6 Border adjustments

Border Carbon Adjustments (BCA) consist of reducing the carbon price differentials of goods traded between countries, inspired by measures in place for Value Added Tax. Based on theoretical grounds to improve the cost-efficiency of subglobal climate policies (Markusen, 1975; Hoel, 1996), BCA were also considered a way to ‘punish’ the US for free-riding the Kyoto Protocol (Hontelez, 2007). Later, the US incorporated BCA in the Waxman-Markey amendment, aiming mainly at Chinese products (van Asselt and Brewer, 2010). However the fierce criticism of China and India led President Obama to dissociate the US administration from this proposal (declaring “We have to be very careful about sending any protectionist signals”, (Broder, 2009)). Among the advocates of BCA, one can cite Paul Krugman (2009), who argues that BCA are “a matter of levelling the playing field, not protectionism”.

Many technical points are to be considered for the implementation of BCA (Cosbey et al., 2012; Monjon and Quirion, 2010), which are not inconsequential technical details, but would determine the viability of this option under international laws:

• *Covered sectors*. There is a general consensus that only sectors at risk should be covered by the scheme; however, the classification of sectors at risk may be controversial (for example for the third phase of EU ETS, see (Cló, 2010; Martin et al., 2012).

• *Covered countries*. Country exceptions may occur, for example, for Least Developed Countries for equity purposes or, as in the Waxman-Markey bill, for countries that have taken ‘comparable action’ on climate policies. However climate policies are so various, being a mix of carbon pricing, regulation and subsidies, that comparing different climate policies is not easy. One can distinguish two principles: 'comparability in effectiveness' as in the WTO Shrimp-Turtle dispute or 'comparability of efforts' as in the Common but Differentiated Responsibilities principle.

• *Inclusion of indirect emissions*. Taking into account the indirect emissions from electricity consumption is relevant for industries with high electricity costs, such as aluminium, but highly complicates the calculation of adjustment factors. The energy mix differs among countries, and calculation of emissions from electricity consumption is contentious, because of differences between marginal and average specific emissions.

• *Inclusion of export rebates*. They are useful to level the playing field also in third countries markets, but their WTO compatibility is not guaranteed.

• *Carbon content*. One can consider four options: exporter's average emissions, home country's average emissions, self-declaration or best available technology (BAT) based on benchmarks. A reliable knowledge of the carbon content of every foreign product seems out of range because of information asymmetry and administrative costs. To avoid a WTO challenge because of discrimination, these estimations should be rather conservative, which favours benchmarking on the best available technology, or a choice between home country's average emissions and self-declaration (Ismer and Neuhoff, 2007).

• *Legal form of the adjustment*. The adjustment could take the form of a tax or of an obligation to surrender allowances. The origin of these allowance is to be determined (home region or under UNFCCC, with the possibility or not to come from offset credits).

• *Use of revenues*. The share of revenues between the importing country, the exporting country and an international body to be designated is crucial and may be the biggest levy of political acceptability. Many have argued that these revenues could be used to finance clean technology transfer or adaptation through a Green Climate Fund (Godard, 2009; Grubb, 2011; Springmann, 2012).

• *Timing*. A period of good faith could be offered to third countries before the implementation of such measures. Clear conditions for phasing out must also be decided.

Among all these features, some are incorporated as scenario alternatives in models, such as the covered sectors (Ghosh et al., 2012; Peterson et al., 2007; Mattoo et al., 2009; Winchester et al., 2011), the inclusion of indirect emissions (Monjon et al., 2011), the inclusion of export rebates (Lanzi et al., 2012; Fischer et al., 2012; Bednar-Friedl et al., 2012), the carbon content (McKibbin et al., 2008; Kuik et al., 2010) and the use of revenues (Boeters et al., 2012; Rivers, 2010). However, both technical difficulties and administrative costs (as input-output matrices for carbon content are 'available' in models) and legal challenges (as they go beyond energy-economy modelling) are under-evaluated in these models.

Border adjustments are effective to reduce leakage through the competitiveness channel (but obviously not leakage through the international fossil fuel price channel): in model simulations, the leakage rate decreases by about 10 percentage points on average (Böhringer et al., 2012b). They are also very effective to protect competitiveness but they shift a part of the mitigation burden to developing countries (Bao et al., 2013). With a CGE model, Mattoo et al. (Mattoo et al., 2009) find that strong BCA imposed by US would depress India and China manufacturing exports between 16% and 21%. However, it must be remembered that China will in all likelihood consume domestically more than 98% of its steel production[4] and 99% of its cement production[5]: the effects of BCA on Chinese production would then be very small.

BCA might conflict with the Principle of Common but Differentiated Responsibilities of the UNFCCC (Dröge, 2011). Its effect on international negotiations is unclear: they could be used as a 'strategic stick' to force other countries to join the abating coalition (Lessmann et al., 2009), but they could also trigger a trade war because of 'green protectionism' suspicions (IIFT, 2010). For example, China strongly opposes BCA and claims that energy-intensive exports are already taxed (Voituriez and Wang, 2011). Climate coalition countries have an incentive to deviate from the optimal carbon tariff rate to change their terms of trade (Weitzel et al., 2012), and even with good-quality data, there is room for judgement discretion in carbon content estimation and hence disguised protectionism (Holmes et al., 2011).

Some argue that the 'carrot' of technology transfer would be more effective than the 'stick' of BCA (Weber and Peters, 2009). Further, the benefits of internal improvements of emission trading systems within the abating coalition like linking markets and extending sectoral coverage could outweigh those of BCA (Springmann, 2012; Lanzi et al., 2012).

The most controversial aspect of this measure is its compatibility with the WTO, which has led to extensive literature on the subject (Biermann and Brohm, 2004; Goh, 2004; Frankell, 2005; De Cendra, 2006; Bhagwati and Mavroidis, 2007; van Asselt and Biermann, 2007; Ismer et al., 2007; Pauwelyn, 2007; Green and Epps, 2008; Sindico, 2008; Quick, 2008; Bordoff, 2009; Low et al., 2011; Zhang, 2012). If there is a consensus among legal experts, it is that all the technical points discussed above are key for BCA's WTO consistency. The shrimp-turtle case teaches us that the exception regime of the WTO can rule, that this institution takes seriously into account the attempt to conclude international agreements before implementing trade measures (Tamiotti, 2011), and that flexibility was the cornerstone of WTO dispute panel decisions (Zhang, 2012). However the degree of legal complexity of BCA is far beyond a simple ban on shrimps.

The setbacks of the inclusion of aviation in the EU ETS show us that countries are deeply reluctant to relinquish some of their sovereignty, especially when financial consequences are

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[4] In 2007 (and, respectively, 2011), China produced 489 Mt (resp. 684 Mt) of steel and exported 50 Mt (resp. 13 Mt). Therefore China consumed 90% of its production in 2007 and 98% in 2011 (source http://www.issb.co.uk/asia.html). Steel production is expected to boom whereas exportations are expected to stay in the same level.

[5] China produced 2 Gt of cement in 2011 and exported 15,6 Mt in 2009 (we suppose the exports in 2011 have the same magnitude), meaning that China consumed 99% of its production. source http://www.globalcement.com/news/itemlist/tag/China and http://www.articlesbase.com/business-articles/chinese-cement-industry-realized-the-sales-of-cny-50072-billion-in-2009-1937146.html

at stake. Then, BCA implementation would probably involve a strong diplomatic and economic response, especially from the developing countries.

International institutions state that free trade has a role to play in climate policies by promoting clean technology transfer and suppressing murky subventions to dirty sectors, but remain ambiguous concerning the legality of BCA (World Bank and UNEP, 2007; WTO and UNEP, 2009). The joint UNEP-WTO report (WTO et al., 2009, p.89) reads: “the general approach under WTO rules has been to acknowledge that some degree of trade restriction may be necessary to achieve certain policy objectives, as long as a number of carefully crafted conditions are respected”. Legal experts are also divided on the subject, the bottom line of most analyses is that legal acceptability and political feasibility of BCA would depend on the specific designs of such measures (Tamiotti, 2011). There is no guarantee of the legal success and political acceptability of BCA, but two features would help. First, in-depth discussions with third countries to identify the potential points of conflict, rather than unilateral imposition of trade measures, are desirable (Low et al., 2011). Second, flexibility must be a central piece of the policy package, which could mean allowing third countries national ‘comparable action’ instead of systematic border carbon pricing.

Even with all these legal precautions, one can reasonably assume that, if BCA were to be implemented, third countries would publically condemn it as ‘green protectionism’ or ‘eco-imperialism’ (Dröge, 2011). WTO and UNFCCC share the unpleasant fact of being bogged down in international negotiations blockage (the next step of the Kyoto Protocol for UNFCCC, and the Doha round for WTO), and a clash between climate and trade regimes would be detrimental to both global trade and climate agreements.

If BCA are not likely to be implemented in the following years, they will undoubtedly be considered more and more, as abatement targets gaps are growing among countries. A ‘weak’ version of BCA, based on best available technologies benchmark with the handing back of revenues, would seem the most preferable option, offering less vulnerability to a potential WTO dispute and giving certain compensations to other countries (Godard, 2009; Ismer et al., 2007).

4.5 Conclusion

The reality for the foreseeable future is that climate policies will remain sub-global. Different mitigation targets among countries are legitimate under the Principle of Common but Differentiated Responsibilities (Zhang, 2012), but too uneven climate policies are less efficient if they cause carbon leakage and are unlikely to survive the national policy-making process if they entail significant competitiveness losses. These concerns are among the main arguments against the implementation of stringent climate policies in industrialized countries. How worrying are they?

Ex post studies have not shown significant evidence of leakage to date, but arguably the climate policies implemented so far may have been too moderate to allow measurement of such effects. *Ex ante* studies indicate a leakage in the range of 5 to 20% in case of unilateral climate policies without measures to mitigate leakage. However, the induced diffusion of climate-friendly innovations generates abatement even in regions without climate policies, which may well compensate for leakage. Thus, leakage is clearly not a convincing argument against climate policies, although it invites actions to complement carbon pricing with specific measures in order to maximise their efficiency.

Is competitiveness a more convincing argument against climate policies? Carbon costs matter, but they are one factor out of many (capital abundance, labour force qualification, proximity to customers, infrastructure quality, etc.) contributing to the competitiveness of an industry (Monjon and Hanoteau, 2007). Massive environmental relocations in case of stringent policies announced by Energy Intensive Trade Exposed (EITE) trade associations are not realistic: because these industries are very capital-intensive, they are less prone to relocation in general compared to 'footloose' industries (Ederington et al., 2003). In the case of the EU ETS, competitiveness concerns have led to an over-allocation of permits, a generous use of offsets from the Clean Development Mechanism and Joint Implementation and finally a crash in carbon price. At this time the European Commission is struggling to tackle the growing structural supply-demand imbalance. The modest proposition of back-loading 900 million of allowances was adopted by the European Parliament only after an initial rejection, mainly for competitiveness reasons[6]. Hence, competitiveness, which was called a "dangerous obsession" for macroeconomic policy by Paul Krugman (1994), may be so for climate policy as well.

That said, because of the influence of EITE industries in the policy process, specific measures to protect these sectors are part of every realistic policy package. Moreover, they may allow countries in the abating coalition to raise the ambition of their climate policy, and also extend the size of the climate coalition, as they would lessen the incentives of free-riding. Simply exempting these sectors is too costly to be justifiable: since emissions in these sectors would not be reduced, more abatement should take place in the others, including less cost-effective options. On purely economic grounds and from the point of view of the abating coalition, economic analysis favours the implementation of BCA, but from a legal and diplomatic point of view, the situation is much less clear-cut. If properly discussed with emerging economies, a BCA based on best available technology benchmarks, with revenues earmarked for climate-related projects in developing countries, may be the best solution. A fall-back option is to distribute free allowances in proportion to current output of EITE industries (output-based allocation): although less cost-effective, it could be an acceptable compromise between efficiency and feasibility. However, just as free allowances based on historic or capacities, the option implemented in the EU ETS, it could generate massive lobbying and competitive distortions since every industry tries to receive as much allowances as possible. Besides, the

[6] The spokesman for Conservative MEPs declared: " We fear [backloading] will (…) encourage further carbon leakage, and undermine much-needed market predictability as the EU economy strives to find a way out of the economic crisis" (source: http://www.guardian.co.uk/environment/2013/apr/16/meps-reject-reform-emissions-trading), arguments mainly taken from the position of the Alliance of Energy Intensive Industries (source: http://www.cembureau.be/sites/default/files/documents/AEII%20Position%20on%20the%20Commission%20proposal%20to%20back-load%20EU%20ETS%20allowances.pdf)

WTO compatibility of output-based allocation is not more granted than that of BCA (James, 2009).

5 Effects of the current policy mix on key international markets

5.1 Introduction

The chapter discusses the effects of the current policy mix in Europe on two international markets: the carbon market and the market of renewable energy technologies. The chapter discusses the structure and size of these markets, the importance of the EU and EU companies in these markets, and finally, the contribution of current EU and Member State policies to market development and the competitiveness of European firms.

5.2 Carbon market

The global carbon market consists of a number of regional, national, and sub-national emissions trading schemes (ETS's), the international emissions trading mechanisms under the Kyoto Protocol (Clean Development Mechanism (CDM), Joint Implementation (JI), International Emissions Trading (IET)), other emerging schemes such as Reducing Emissions from Deforestation, Forest Degradation and sustainable forest management (REDD+), and voluntary emissions trading schemes (Ecofys, 2013). Parts of this global market are connected, but market integration is far from complete (Mizrach, 2012).

In early 2013, ETS's around the world cap at least 3.3 $GtCO_2e$/y, or 7% of global emissions (Ecofys, 2013). Table 3 below present an overview of current and emerging ETS's.

Table 3 Overview and characteristics of ETS's

Name of ETS	Start year	Status (I/0)	Cap $MtCO_2e$	Coverage of regional/ national emissions (%)	Remark
EU	2005	I	2250	45	
California	2013	I	163	35	In 2015 coverage will be increased to 395 Mt CO_2e
Kazakhstan	2013	I	168	50	
New Zealand	2008	I	32	50	
RGGI	2009	I	83	20	
Quebec	2013	I	23	30	In 2015 coverage will be increased to 65 Mt CO_2e

Tokyo	2010	I	10	20	
Australia carbon pricing mechanism	2012	I	330	60	
Switzerland	2008	I	3	10	
Beijing pilot	2013	0	N/A	50	
Sjanghai pilot	2013	0	110	45	
Tianjin pilot	2013	0	78	60	
Chongqing pilot	2013	0	N/A	N/A	
Guangdong pilot	2013	0	214	N/A	
Hubei pilot	2013	0	N/A	35	
Shenzen pilot	2013	0	32	40	
Korea	2015	0	N/A	60	
British Columbia	No date yet	0	N/A	N/A	
Turkey	No date yet	0	N/A	N/A	
Ukraine	No date yet	0	N/A	N/A	
Chile	No date yet	0	N/A	N/A	
Brazil	No date yet	0	N/A	N/A	

Source: (Ecofys, 2013)

In financial terms the size of the global carbon market grew from € 11 billion in 2005 to € 176 billion in 2011[7] (World Bank, 2011; World Bank, 2012) after which it contracted by 35% in 2012 for various reasons (see below).

The EU ETS is the "engine of the global carbon market" (World Bank, 2012, p.9). In its third phase (2013-2020) it starts out with an emissions cap of 2,250 $MtCO_2e$, or 73% of the global cap (Ecofys, 2013). It is the dominant and sometimes exclusive market for the Kyoto mechanism credits. The financial value of EU Allowances (EUA) was € 148 billion in 2011 (World Bank, 2012).

The global carbon market was created by the Kyoto Protocol in 1997. But it was the EU ETS, starting in 2005, that truly 'fuelled' the global carbon market. In 2010, the share of the global carbon market primarily driven by the EU ETS was 97% (World Bank, 2011). The EU ETS is also a great field experiment with benefits to global society. The experience gained from the functioning of the EU ETS is used for the development of ETS's and alternative carbon pricing initiatives in other regions and countries (Wråke et al., 2012; Newell et al., 2013).

[7] In nominal value.

The global carbon market faces a somewhat uncertain future. In the first place, there is uncertainty in international policy making. The international community failed to make new binding emission reduction agreements for the second commitment period of the Kyoto Protocol (2013-2020). Instead, the 18th Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) in 2012 in Doha, Qatar, agreed on a timetable and milestones for further negotiations (in the so-called Durban Platform), foreseeing the adaption of an international agreement in 2015, to be implemented in 2020. Only a handful of countries have submitted emissions reduction targets for the second commitment period of the Kyoto Protocol.[8] Other countries have submitted non-binding emissions reduction targets or action for 2020, but it is unclear whether these targets create demand for international carbon credits through new carbon market mechanisms (Ecofys, 2013).

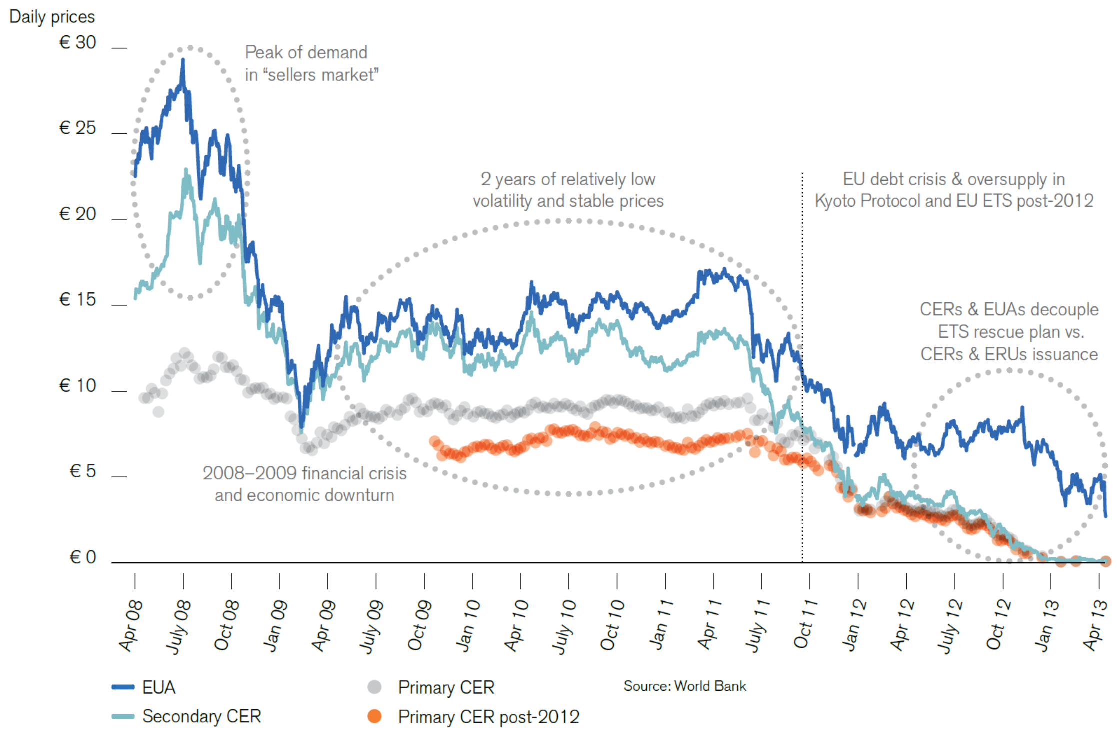
In the second place, there is currently an oversupply of allowances in the EU ETS market. In a market report of the European Commission in November 2012 (EC, 2012c) estimated a surplus of 1.5 to 2 billion allowances at the start of Phase III of the EU ETS. This estimate was later confirmed when emissions data were released in April 2013 (Ecofys, 2013). Some analysts expect that the surplus will persist throughout most or all of Phase III (Ecofys, 2013). The proposal of the European Commission to (temporarily) decrease the surplus by limiting the volume of auctioned allowances in the early years of Phase III (the 'backloading' proposal) was initially rejected by the European Parliament, which adopted it only on the second attempt; at the time of writing, it still has to be negotiated between the Commission, the Council and the Parliament. In addition, new technical requirements for emissions trading in Phase III have effectively decreased the demand for CER's from CDM projects and ERU's from JI projects.

In the third place, there is uncertainty about the future of some carbon pricing initiatives. Analysts expect that Australia's current carbon pricing mechanism will be repealed within a year because of the change of government in Australia. It is uncertain if and by what the current mechanism will be replaced (Parkinson, 2013).

The oversupply of allowances in the EU ETS and the general uncertainty on the future of climate change mitigation has led to a sharp decline of EUA and CER and ERU prices in 2013, as shown in Figure 2. CER prices have hit rock-bottom and their future recovery is uncertain.[9]

Figure 2 Daily EUA and CER prices (2008-2013)

[8] Australia, Belarus, Croatia, EU27, Kazakhstan, Liechtenstein, Monaco, Norway, Switzerland and Ukraine.
[9] Currently (12 September 2013), EUA's are trade for €5.25, CER-futures for €0.61, and ERU-futures for €0.33 at the European Energy Exchange.



Source: (Ecofys, 2013)

5.3 Renewable energy market

The global market for renewable energy and renewable energy technologies is thriving. Annual investment in new renewable energy technology was € 180 billion (USD 244 billion) in 2012. Total renewable energy capacity reached 1470 GW (including hydropower), supplying an estimated 19% of global final energy consumption (REN21, 2013). The largest addition to renewable energy capacity in 2012 was wind power (39%), followed by hydropower (26%) and solar PV (26%) (REN21, 2013). In the EU, renewable energy accounted for 70% of additions to electric capacity in 2012, mostly in the form of solar PV and wind. In Germany, renewables accounted for 22.9% of electricity consumption in 2012 (REN21, 2013).

EU industry has a strong position in the global market of renewable energy technologies, especially in that of modern technologies. The following industry information is from the 2013 *Renewables Global Status Report* (REN21, 2013). Among the world's top ten wind turbine manufacturers in 2012, capturing 77% of the global market, four are European: Vestas (Denmark, #2), Siemens Wind Power (Germany, #3), Enercon (Germany, #4), and Gamesa (Spain, #6). Together, these four European firms capture 37.8% of the world market.

Among the world's leading hydropower technology and manufacturing firms are Alstom (France) and Andritz (Austria). Alstom is also investing in ocean energy industry, through acquisition (Tidal Generation Ltd, UK) and by taking a 40% interest in the Scottish AWS Ocean Energy Ltd.

Spanish companies (Abengoa, Acconia, ACS Cobra, Torresol) dominate the world market of concentrated solar power (CSP) technologies. They have ownership-interest in almost three-fourth of CSP capacity world-wide and more than 60% of capacity under development in early 2013. European firms are also in the forefront of developing innovative technologies for biomass and geothermal energy sources.

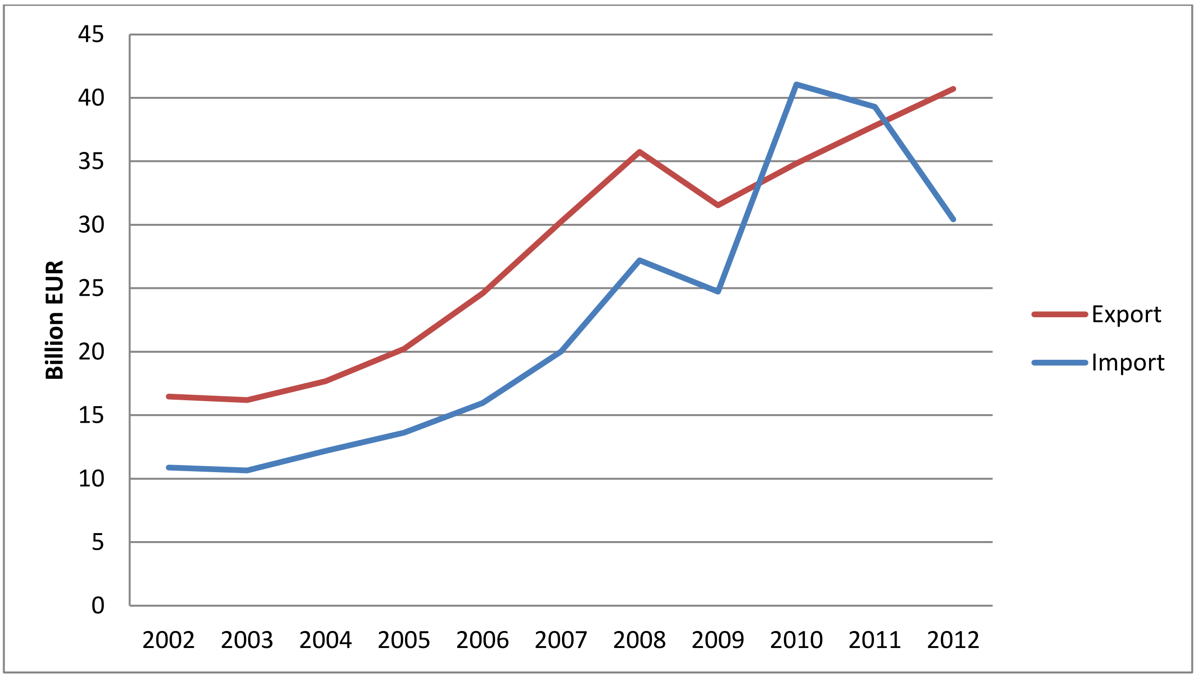
On the world market for solar PV modules, European firms have lost ground in recent years. Increased supply from China and decreased demand due to the economic downturn, drove down prices and margins for manufacturers. Of the top 15 solar PV module manufacturers, capturing 50% of the global market, none is European. Some EU manufacturers went bankrupt or went out of the solar business (Q-Cells, Bosch Solar, and Siemens). In 2012, Asian countries (especially China) accounted for 86% of global production. Of the top 15 solar PV module manufacturers, nine are from China. Cao and Groba (2013) analyse the roles of policy, innovation and markets in the amazing export success of solar PV modules from China.

Europe is the world's largest cross-border investor in greenfield renewable energy projects. Over the period 2007-2011, foreign direct investment (FDI) in renewable energy projects by European multinational enterprises was USD 237 billion, including USD 121 outside of the EU. Total European FDI in renewable energy projects was thereby almost five times larger than that of the second-largest investor, the USA, and 63% of the world total (EC, 2012b).

It is not so easy to find precise data on the external trade performance of Europe in renewable energy technologies and related components. The main – statistical – problem is that the product classifications of trade statistics do not perfectly match renewable energy sector (RES) goods. To get a rough idea of the EU's external trade performance, we made use of a mapping exercise of the International Centre for Trade and Sustainable Development (ICTSD) that identified HS 6-digit product category codes that include RES goods although they may not be restricted to RES goods (Jha, 2009; Vossenaar and Jha, 2010). To give an example, 'ball bearings' under HS 6-digit code 848210 include ball bearings used in the production of wind turbines but also ball bearings used for other purposes. While ICTSD did its best to only select those HS codes that contain at least a 'significant' share of RES goods, the trade volumes are thus inevitably overestimates of the 'true' volumes by an unknown margin.

Bearing this caveat in mind, Figure 3 shows the exports and imports of RES goods by the EU27 over the period 2002-2012, excluding intra-EU trade. The value of exports increased by 147% from €16.5 billion in 2002 to €40.7 billion in 2012 (in nominal currency). The value of imports increased by 180% from €10.9 to €30.4 billion. The EU27 had a trade surplus in RES goods, except for the years 2010 and 2011 when imports rose sharply, surpassing exports. While the development of exports and imports in value terms showed a stable increase up to the year 2008, the financial crisis and its aftermath had a profound effect on trade flows (both exports and imports).

Figure 3 Export and Import of Renewable Energy Sector goods by EU27 in the period 2002-2012 (Euro billion, excluding intra-EU trade)



Source: Own calculations on trade data from COMEXT database

The top five EU member state exporters of RES goods in 2012 were Germany (35.7%), Italy (12.0%), France (8.6%), United Kingdom (6.8%) and Spain (5.5%). The increase of the share of EU exports from Spain (from 2.8% in 2002 to 5.5% in 2012), and to a lesser extent Italy (from 11.6% to 12.0%) are remarkable. Over the period 2002-2012, Germany increased its leading position as a RES exporter (from 32.0% to 35.7%). France and the UK lost some share in RES exports. The share of France went down from 13.6% in 2002 to 8.6% in 2012. The UK share went down from 11.7% to 6.8%.

The export share of the new member states is small but increasing. Overall, the share in exports from EU12 increased from 2.4% in 2002 to 7.5% in 2012. In 2012, Hungary achieved the highest export share among new member states (1.7%), closely followed by the Czech Republic and Poland (1.7% and 1.5%, respectively).

RES imports were increasingly sourced from China. With an import value of € 1.8 billion, the share of China in total RES imports was 16.1% in 2002. With the import value growing to € 13.7 billion, China increased its share in RES imports to 45.2% in 2012.

At current market prices, policy incentives are necessary to increase the share of renewables in national energy mixes. From a welfare-economic point of view, such policy incentives can be justified by the lack of a full internalisation of the external costs of energy production and use that distorts the comparison of the social benefits and costs of different energy sources by the market.

Governments have an array of policy instruments at their disposal. They range from subsidies for research and development (R&D) to disincentives for fossil energy sources and incentives that stimulate the market uptake and penetration of renewables. This has been amply discussed in the literature (see, e.g., Ecorys, 2009; Bahar et al., 2013) and elsewhere in the CECILIA2050 project. But will a successful policy that increases the share of renewable energy in a country's energy mix also stimulate the development of a domestic renewable energy technology supply sector that is competitive on the world market?

Lewis and Wiser (2007) analyse the relationship between policy support and manufacturing success in wind energy technology in 12 countries. They find that in many instances there is a clear relationship between a manufacturer's success in the home market and its eventual success in the global wind power market. Success in the home market depends on policies that support a sizable and stable market for wind power. Feed-in tariffs have so far offered the most successful foundation for wind manufacturing as they can offer a stable and profitable market. Lewis and Wiser further discuss several policy instruments that offer incentives for local manufacturing, such as local content requirements, financial and tax incentives, favourable custom duties, export credit assistance, quality certification, and research, development and demonstration.

Lund (2009) analyses the relationship between policy support and manufacturing success in four different renewable energy technologies: wind, solar PV, solar heat, and biomass-pellets in a panel of 11 countries. Specifically looking at trade success (the balance of imports and exports), Lund confirms the 'home market' effect of Lewis and Wiser for wind energy, but finds the opposite relationship for the other technologies. For solar PV, solar heat, and biomass-pellets, the relative size of the domestic market (in terms of installed capacity) is negatively related to export success (see Figure 4). In the case of biomass-pellets and solar PV even small niche-type domestic markets can lead to exports, in the case of local advantages in manufacturing or production costs.

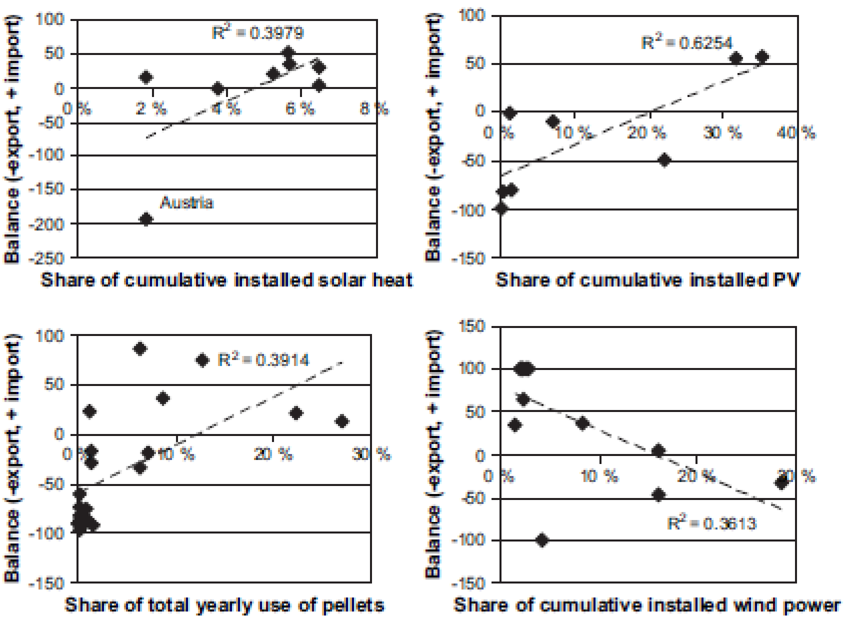


Figure 4 Correlation between total installed capacity expressed as share of world market and export/import in 2005/2006.

Source: (Lund, 2009)

Lund (2009) finds that a strong industrial position in renewable energy technology manufacturing is *either* associated with strong market deployment/home market policy incentives or with a strong industry basis and R&D support. Examples of the former are the German wind power industry, that took off since the EEG feed-in tariff law in 2000, and the more recent increase in the Spanish wind market. Examples of the latter are the PV industry in Norway, that has an insignificant home market and no major deployment policies, but that has created a strong PV industry, and, of course, more recently the huge expansion of the Chinese PV solar manufacturing industry that was, until recently at least, specifically targeting foreign markets (Dunford et al., 2013). Recently, however, Chinese domestic demand is "is just starting to ramp up", according to a research report of Deutsche Bank (Vorrath, 2013), driven by attractive rates of return on solar PV projects resulting from recently announced feed-in tariffs.

Lund (2009) concludes that renewable energy policies can greatly contribute to the expansion of domestic industrial activities even if the initial industrial base is weak, but that investment or R&D support to strong industries in related fields may also be a powerful way to create a competitive renewable energy manufacturing industry, irrespective of the domestic market situation. Several exogenous factors, including timing, size, geography, and general economic factors, influence industrial success.

5.4 Conclusion

As a tentative conclusion on the impact of policy on global manufacturing success is that energy and climate policies matter, but that past experience has shown that there is not one single policy strategy that leads to success but rather that the appropriate policy instrument mix is dependent upon a host of country, industry, and technology-specific factors that can change over time. Integrated research in the area of innovation and geography is relatively young, but it is emerging and could provide new valuable insights into market development and competitiveness of carbon-mitigation technologies (Coenen et al., 2012; Howells and Bessant, 2012).

6 Conclusions

Competitiveness is an ability. At the firm level it is the ability of a firm to sell goods and services in the market and stay in business. At the sector level it is the aggregate competitiveness of firms that operate within a given sector in an economy, compared to international rivals. The aggregate sector includes firms with different levels of competitiveness. The notion of competitiveness at the national level is controversial; in any case, its relationship with trade performance is somewhat opaque. 'Ability' is not easy to measure. Indicators of competitiveness either measure 'determinants' or 'consequences' of this ability. There is no complete theory on competitiveness that identifies the key determinants and how these determinants eventually result in consequences.

Climate policies tend to increase the cost of energy. Unilateral implementation of such policies has led to the fear of a loss of competitiveness by energy-intensive industries, and consequently of carbon leakage. Carbon leakage and loss of competitiveness are the main arguments against ambitious climate policies in industrialised countries. Modest mitigation targets have gone hand in hand with policy packages intended to protect sectors at risk of carbon leakage.

Many *ex ante* (modelling) studies have been carried out to predict the rate of carbon leakage and the loss of competitiveness of energy-intensive and trade-exposed sectors in the case of unilateral policy implementation, also for Europe. At current policy stringency, most of these studies show small to moderate rates of leakage and loss of competitiveness. Recently studies have started to econometrically estimate carbon leakage and loss of competitiveness *ex post*. The studies focusing on the EU ETS, the largest carbon pricing experiment so far, have not revealed any evidence of carbon leakage and loss of competitiveness in sectors considered at risk of carbon leakage, such as cement, aluminium, and iron and steel. More studies will undoubtedly be conducted in the following years, for the EU ETS and the other carbon markets that have emerged, as more hindsight will be provided.

The current climate policy mix in Europe fosters innovation and generates technological progress in GHG savings technologies. Diffusion of these technologies reduces emissions in non-abating countries, creating positive climate spillovers. There is empirical evidence of climate spillovers, especially in energy-saving technologies, but also in renewables. Feed-in tariffs in Denmark, Germany and Spain generated a massive induced technical change in wind and solar technologies and are thus in part responsible for the spectacular development of windpower capacities in China, which became the world leader in terms of windpower installed capacities.

The current climate policy mix in Europe greatly contributed to the emergence of the global 'carbon' market, presently worth about € 114 billion (after a high of € 176 billion in 2011). The prospects of this global carbon market are uncertain. On the one hand, the number of regional carbon markets is growing, especially in Asia, on the other hand, the prices of carbon allowances in some of the main markets (including the EU ETS and the Kyoto flexibility mechanisms) are depressed because of oversupply and lack of demand.

The current climate policy mix in Europe has also greatly contributed to the emergence of the global market for renewable energy technologies, presently worth about € 180 billion. EU industry has a strong position in the global market of renewable energy technologies. Among the world's top ten wind turbine manufacturers in 2012, four are European capturing 37.8% of the world market. European firms are among the world's leading hydropower technology and manufacturing firms and Spanish companies dominate the world market of concentrated solar power (CSP) technologies. European firms are also in the forefront of developing innovative technologies for biomass and geothermal energy sources.

In the world market for solar PV modules, European firms have lost ground in recent years. Increased supply from China and decreased demand due to the economic downturn, drove down prices and margins for manufacturers. Of the top 15 solar PV module manufacturers, capturing 50% of the global market, none is European.

The current climate policy mix has in many ways contributed to the technological knowhow in climate-related technologies by domestic firms that could be used to capture market share in emerging markets. This ability to gain market share by being the first to develop a technology is the first mover advantage. However, Europe (especially Germany) benefited from a first-mover advantage in the Photovoltaic (PV) industry until 2011, the European PV industry has since been largely surpassed by China, showing how fragile a dominant position can be in industries featuring fast technological progress.

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