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WHY EUROPE IS NOT CARBON COMPETITIVE

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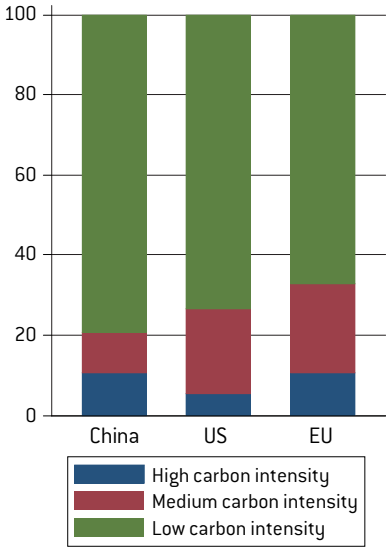
SUMMARY Europe specialises more than its main global competitors in industries with relatively high carbon emissions, such as minerals and chemicals, rather than in high-tech industries and services . This would have a real effect on Europe's competitiveness in a world regulated by carbon pricing schemes such as the EU's Emissions Trading Scheme – even if other blocs apply them as the EU does. Furthermore, in the absence of fair and undistorting carbon pricing schemes worldwide, there is a real risk that business will resort to regulatory arbitrage which will entail a shift in where emissions take place – but no reduction in global emissions. In any case, the issue of which economies are 'carbon competitive' will gradually become a much bigger part of the global trade conversation.

Carbon intensity: the EU's export mix contains a higher percentage of high carbon-intensity goods than the export mixes of China or the United States



Source: Bruegel

POLICY CHALLENGE

Europe's climate change policies should have as their primary goal the fight against climate change. But they should also minimise the economic impact of carbon pricing schemes and avoid introducing competitive distortions through sectoral 'carve-outs' from common rules and 'grandfathering' of permits to pollute. Because it is more vulnerable than other economies to carbon pricing, as a result of the relatively high carbon-intensity of its export mix, the EU must i) ensure that carbon abatement mechanisms allow emissions to be cut at the lowest cost; ii) reduce competitive distortions by pushing for widespread use of carbon pricing schemes; and iii) avoid trade-skewing sectoral 'carve-outs' from such schemes at national level.

1. CLIMATE CHANGE POLICIES AFFECT COMPETITIVENESS

CLIMATE change policies introduce a new factor into the determination of global competitiveness. Climate change policies, in particular carbon pricing schemes (see Box 1), imply additional costs for firms. Some sectors are more affected than others. Potential competitive distortions are bound to rank high on government agendas when implementing climate changes policies.

One of the main issues is the asymmetric application of climate change policies. Europe has committed to an ambitious climate change agenda and has introduced a comprehensive carbon pricing scheme. Companies in Japan are also subject to a cap-and-trade system in which they buy and sell carbon credits. The United States and China, meanwhile, do not price carbon. This clearly puts European products at a competitive disadvantage.

'Europe's economies are less carbon competitive than generally pictured.'

But this is not the only concern. As pointed out by the Stern Review (2006, chapter 11), 'even where action is taken on a more uniform collective basis, concern remains that different countries will be affected differently' by carbon pricing policies owing to their respective competitive advantages and product specialisation. Countries specialised in services will be less affected by a carbon price than countries specialised in the production of steel and aluminium. This policy brief[1] deals with this subject: how does a country's specialisation determine the impact of carbon pricing on competitiveness?

Countries specialised in carbon intensive products might be tempted to exclude some sectors from carbon pricing schemes (via sectoral exemptions or generous grandfathering of emission permits) or not to implement carbon pricing schemes at all, thus undermining the objectives of climate change policies and introducing competitive distortions.

How this challenge is addressed is crucial for the effectiveness of climate change policies. The export mix represents 'what a country does best' in the world and this is difficult to change. This policy brief identifies those countries that are specialised in carbon intensive products and are thus more exposed to carbon pricing policies and proposes what should be done to reduce exposure of countries to carbon pricing policies in the least distorting way.

The next section of this policy brief analyses the relative carbon

BOX 1

CARBON PRICING SCHEMES: TAXES AND CAP-AND-TRADE

Policymakers presently have two main options when regulating carbon dioxide and other emissions: taxes and cap-and-trade.

An example of the former is the United Kingdom's climate change levy (CCL), introduced in 2001. This is a tax on gas, liquefied petroleum gas, and electricity consumed by industrial, commercial and public sector users. Electricity generated from renewables and some more environmentally-friendly means of energy consumption are exempt. The scheme also includes compensating measures, such as social security payment rebates, to protect the competitiveness of UK firms. The UK government says the CCL will result in annual carbon reductions of 2.5 million tonnes by 2010. Other EU countries, including, prominently, Denmark and Sweden, have similar levies specifically targeting carbon emissions.

Cap-and-trade schemes involve setting a cap on greenhouse gas emissions, allocating certificates to cover the amount of desired emissions, and requiring the industrial plants to buy additional certificates for excess emissions or to reduce their emissions. The world's largest cap-and-trade scheme is the EU Emissions Trading Scheme (ETS), which began trading in January 2005 and covers industrial installations representing around half of the EU's annual CO2 output. Similar trading schemes exist in some US states and in non-EU European countries such as Norway. The Australian government proposed a scheme in mid-2007 and a bill proposing a cap-and-trade scheme is currently being discussed by the US Congress.

Tax and cap-and-trade schemes can overlap with companies being effectively double-charged for their emissions. The European Commission opened state aid investigations against both Denmark and Sweden in late 2006 over plans to exempt companies covered by the EU ETS from national carbon taxes. As emissions certificates are largely given free to ETS participants, the Commission argued, companies are not financially penalised by the ETS unless they exceed their emission caps, whereas tax reductions could contravene the EU's Energy Tax Directive.

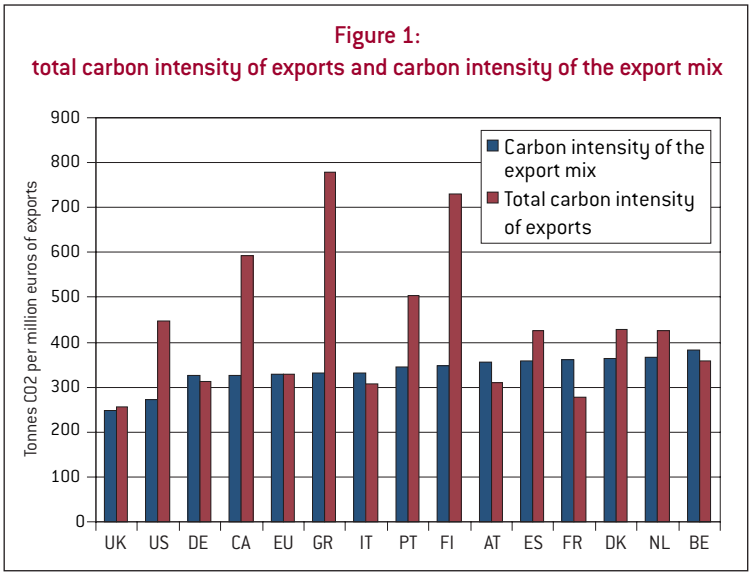
[1] *Acknowledgements: I am very grateful to Emanuele Ciriolo for his excellent research assistance, to Stephen Gardner for his comments (and for Box 1) and to other colleagues at Bruegel for their extensive comments and suggestions.*

intensity of Europe's exports. The third section compares Europe's export mix with those of its main rivals and explains why it is important. The fourth section examines the scope of carbon pricing schemes and why gaps in such schemes matter, in particular for Europe. The final section makes concrete policy suggestions.

2. THE CARBON INTENSITY OF EUROPE'S EXPORTS

The carbon intensity of exports is the amount of carbon dioxide emitted per export unit. Calculating it requires an evaluation not only of the emissions derived from the production of the product itself, but also the carbon dioxide emitted in the production of the inputs used to produce it. That is, not only the direct carbon emissions but also the indirect emissions.

Figure 1:
total carbon intensity of exports and carbon intensity of the export mix



Source: Bruegel (see Box 2).

The total carbon embodied in exports differs significantly across countries (see Figure 1). UK, France, Italy, Austria and Germany

BOX 2
DETERMINANTS OF THE CARBON INTENSITY OF EXPORTS

Three main factors determine the total carbon intensity of exports:

1) The composition of the export basket, ie what a country exports or the *export mix*. The larger the share of carbon intensive products (such as cement or aluminium) the higher the carbon intensity of exports. This is the subject of this policy brief.
2) The way electricity is produced, ie the *electricity mix*. Electricity is one of the main inputs of many industries responsible for a large share of total carbon emissions. The way electricity is produced is therefore an important factor in determining the direct and indirect carbon intensity of any product. Electricity generation from fossil fuels such as coal or gas is more carbon intensive than hydro- or nuclear power[2].
3) Finally, the way products are produced, ie the *technology mix*: there are different ways to produce a product by using different production processes and combinations of inputs (energy amongst them). Some ways are more carbon intensive than others[3].

The export mix only partially explains the differences in the carbon intensity of exports across countries (see Figure 1). The technology and electricity mixes are responsible for the rest. Both these factors and the interaction of all three elements explain the difference between the total carbon intensity of exports and the carbon intensity associated with the export mix (which is illustrated in Figure 1).

For some countries, the technology mix plays an important role in explaining carbon intensity. This is for example the case for non-metallic mineral products in Spain and Portugal, transport in Denmark, the Netherlands and Portugal, and paper products in Finland. Such sectors emit substantially above the European average. Canada's industry is in general more carbon intensive than EU industry.

The energy mix determines the higher carbon intensity of exports from Greece, the US and Finland. France, Austria and Belgium rely on nuclear power (France and Belgium) or hydro-power (Austria) and have a less carbon intensive electricity mix than the EU average (thus in general their energy intensive sectors emit relatively less carbon).

[2] Unfortunately emissions of the electricity, gas and water supply sectors are aggregated in our data. We use such emissions as a proxy for emissions of the electricity sector.

[3] The data covers 26 sectors. The granularity of the data does not allow us to distinguish whether the emissions of any of the 26 sectors in any two countries differ because they use different technologies or because they produce different goods within the same sector.

have a relatively low level of carbon intensive exports while Greece, Finland and Portugal have a high level of carbon-intensive exports. Surprisingly, the level of emissions embodied in US exports is similar to that of some EU countries such as Spain. Despite the carbon intensity of the US economy overall (in terms of carbon emissions per unit of GDP), US exports are closer in terms of carbon content to EU's exports[4].

The total carbon intensity of exports (See Box 2) is determined by the composition of the export basket (ie the *export mix*), the combination of inputs and the technology used in the production process (the *technology mix*); and the way electricity is produced (the *electricity mix*). Here we isolate the impact of the export mix by determining its carbon intensity.

The role of the export mix in determining the carbon content of exports can be isolated by evaluating the carbon content of producing each country's export profile *using the same technology and electricity mix*. We use EU total (direct and indirect) emissions per sector to evaluate the carbon content of different countries' exports[5]. In this way, we remove the impact of different technologies and a different energy mix and concentrate on the carbon intensity of the export mix (see Box 3 for details).

3. WHY EUROPE'S EXPORT MIX MATTERS

Europe's exports are very diversified (see Baumann and Mauro, 2007): Europe exports capital, research and labour-intensive goods. This contrasts with the US and Japan, which are more specialised in research-intensive exports. China and other emerging economies specialise in labour-intensive products. In addition, China's exports are becoming increasingly research intensive. Russia has an export specialisation in capital and raw materials intensive goods.

This can be easily translated in terms of carbon intensities (see Table 1). Capital intensive goods such as mineral products and energy are generally highly carbon intensive. Services and research-intensive goods such as machinery and equipment are low-carbon intensive. Labour intensive goods

BOX 3
METHODOLOGY AND DATA

The total carbon intensity of exports is measured as the amount of carbon dioxide emitted per unit of exports. To calculate it, we base ourselves on input-output (I-O) analysis which allows us to determine how each sector contributes to the production of other sectors. Expanding I-O tables to include sectoral carbon emissions allows us to calculate the total direct and indirect carbon emissions for each sector.

An Environmentally Extended Input Output (EEIO) table is an Input-Output table extended to include environmental data (see European Commission (2006) for an exhaustive account of the EEIO).

We use the most recently available I-O harmonised tables, provided by the OECD, and released in February 2007. These tables refer to the period 1998-2001, and cover 33 countries[6]. Original OECD tables are available on a 41 industry-by-industry basis and are then aggregated in 26 industries in order to fit Eurostat environmental tables. Finally, all monetary data are expressed in the same currency unit, euro 2001.

We use Eurostat 2001 data on carbon dioxide air emissions, broken down into 26 industries[7]. This covers twelve EU15 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain and the UK). Data for 2002 for Canada are provided by Canada Statistics. For the US we use 2002 data provided by the EIOLCA model of the Carnegie Mellon Green Design Institute[8].

The I-O table describes a situation of market balance. Indeed, when supply equals demand, output has to be equal to the sum of intermediate consumption and final consumption. In other words, output (x) should equate to the sum of intermediate demand by other industries (Ax) – where A is the matrix of inter-industry transactions – plus final consumption (y):

$$x = Ax + y$$

Or, rearranging:

$$x = (I - A)^{-1}y$$

The total direct and indirect CO2 emissions are computed by adding the tonnes of carbon dioxide emitted by each sector per monetary unit (Million € 2001) of output (b):

$$bx = b(I-A)^{-1}y$$

[4] See Ahmad and Wyckoff (2003) for a detailed analysis of carbon content of trade. For a more detailed sectoral analysis see eg Demailly et al (2007).

[5] Data are only available for 11 countries. See Box 2.

[6] The sample includes Austria, Australia, Belgium, Brazil, Canada, Switzerland, China, the Czech Republic, Germany, Denmark, Spain, Finland, France, Greece, Hungary, Indonesia, Ireland, India, Italy, Japan, Korea, the Netherlands, Norway, New Zealand, Poland, Portugal, Russia, Sweden, Slovakia, Turkey, Taiwan, the UK and the US.

[7] These are the most recent environmental data for European countries. 2002 data are only available for Denmark, Germany, Netherlands and United Kingdom.

[8] http://www.eiolca.net

Table 1

Direct and indirect carbon intensity

Carbon intensity	Industry
HIGH	Energy; metallic and non-metallic mineral products; refinery
MEDIUM	Chemicals; agriculture and fishing; transport and communications; pulp and paper
LOW	Services; food; machinery and equipment; textiles; rubber and plastics

Figure 2: composition of the export mix (%)

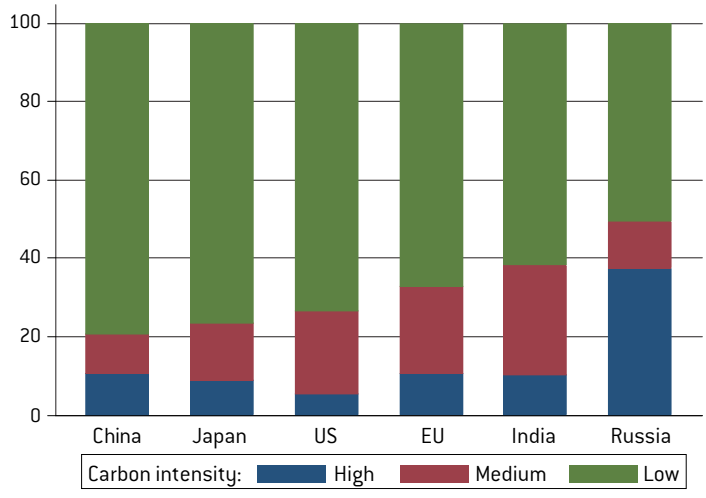
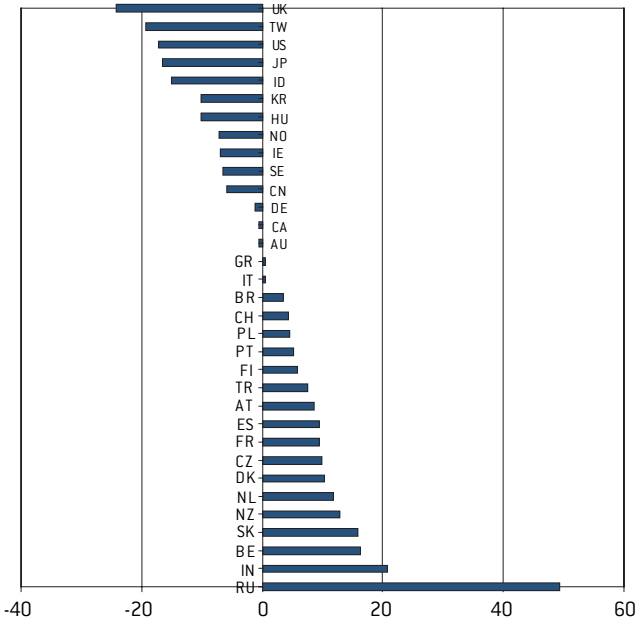


Figure 3: carbon intensity of the export mix (% with reference to EU avg.)



Source for both figures: Bruegel based on OECD and Eurostat. See Box 3.

are low (textiles) to medium (pulp and paper) carbon intensive. Finally, raw materials (agriculture, food, and refinery) have a diverse carbon profile, from low to high.

Putting together the export mix and the sectoral carbon intensity we observe that the EU's exports contain on average more carbon-intensive products than US and East Asian exports. This is due to Europe's higher specialisation in capital intensive goods and lower specialisation in services and research intensive goods (see Figure 2). Highly carbon intensive products, such as metallic and non-metallic mineral products or refinery products, play a smaller role in US exports than in EU exports, while low-carbon products such as services and technology products constitute a larger share of US exports than of EU exports. China and Japan (and other East Asian economies) also have a larger share of technology products with low carbon intensity in their export mix than the EU. In addition, China also exports low-carbon labour intensive products such as textiles.

Interestingly, the carbon profiles of China and India's exports differ substantially. As pointed out by Rodrik (2006), the degree of sophistication of China's exports is higher than that of India's exports, which determines the lower carbon content of China's exports. Despite the increasing weight of services exports from India (eg software), agricultural products still play a prominent role.

Russia's exports are mainly composed of coke and refined petroleum products and metal manufacturing products which are heavily carbon intensive.

In aggregate, how carbon intensive are the export mixes of different countries relative to that of the EU? The carbon intensity of the US export mix proves to be particularly low: more than 15 percent lower than that of the EU (see Figure 3), The export mix of East Asian countries is between six (for China) and 20 percent (for Taiwan) less carbon intensive than the EU. Emerging economies such as Brazil and India have a more carbon intensive export mix than the EU average due to their specialisation in raw materials.

Table 2: export mix and sectoral coverage of carbon pricing schemes

		Carbon intensity of export mix	
		Low	High
Share of emissions covered by current ETS	High	TW JP ID KR HU SE CN DE CA	IT PL PT FI AT CZ SK BE RU
	Low	US UK NO AU IE	ER BR CH IN NL DK NZ GR TK FR

High impact
Medium impact
Low impact

Source: Bruegel. Classification with respect to EU average.

The picture is, however, not homogeneous within Europe: Ireland, Sweden, Hungary and the United Kingdom specialise in technology goods, resulting in low-carbon intensive export mixes. Services also constitute an important part of the UK's exports, contributing to a lower carbon intensity.

Germany, Finland, Italy and France specialise in technology industries but also have considerable exports of more carbon intensive products (eg paper products in Finland, metal products in Germany and metal products and chemicals in France). Portugal, Italy and Greece are highly specialised in textile products, which have a low carbon content.

The remaining European countries have a rather diversified export mix with a relatively larger share of medium- and high-carbon intensive products such as chemicals, metals and transport and communications. New member states, with the exception of Hungary, also have a relatively large share of high-carbon intensive products in their exports.

To sum up, the EU is on average more specialised in exporting carbon intensive products than trade competitors such as US, Japan and East Asian countries. Thus the EU's export mix (all other things being equal) is more sensitive to carbon pricing schemes than most of its competitors.

4. THE COVERAGE OF CARBON PRICING SCHEMES ALSO MATTERS

Fighting climate change requires cutting carbon emissions. Putting a price on carbon is a way of creating incentives to reduce emissions. There are several schemes in place to price carbon, including carbon tax schemes or the setting of carbon emission quotas together with cap-and-trade schemes (see Box 1).

Such pricing schemes are not usually comprehensive and only cover a number of sectors. For example, the EU Emissions Trading Scheme (ETS) only covers large installations in specific sectors, representing around half of Europe's carbon emissions. These installations include combustion plants, oil refineries, coke ovens, iron and steel plants, factories making cement, glass, lime, brick, ceramics, pulp and paper. These amount to a large share of carbon emitting sectors but other important sectors in terms of emissions, such as agriculture and transport, are excluded.

When determining the impact of carbon pricing, the coverage of any carbon pricing scheme, as well as carbon content, is important. Two countries with the same carbon emissions profile can be very differently affected depending on which sectors cause such emissions. Any international carbon pricing scheme with partial coverage would favour those countries which are specialised in excluded sectors. For example, the scope of the current EU ETS would only cover between 45 and 55 percent of the carbon dioxide embodied in Irish, Danish and US exports, while covering nearly 65 percent in the cases of Sweden, Finland and Austria[9] (see Table 2).

In the (unlikely) hypothetical case that there were a universal carbon pricing scheme with the same coverage as the EU ETS, countries would be affected differently. Countries with a relatively clean export mix such as Germany and

[9] Figures are approximate since the sectors covered by the ETS do not exactly coincide with the sectors in our sample. Also, the ETS does not cover all emissions within a sector but only those from installations above a certain size.

Japan (and other East Asian countries) would be penalised by a scheme with the scope of the current ETS that would cover a large share of their emissions. On the contrary, countries highly specialised in medium carbon intensive sectors such as agriculture (eg emerging economies such as India, and Brazil) and transport (eg Denmark and Greece) which are currently excluded from the scope of the ETS would benefit in relative terms from a scheme with the same coverage as the ETS.

In the case of the US, where the export mix contains fewer carbon intensive products than the EU, a scheme that replicated the coverage of the ETS would encompass a lower share of exports than in the EU. The US export mix would be in a better position than the EU export mix vis-à-vis an ETS-like scheme, given the US's greater level of specialisation in technology products, services and transport, which would be largely excluded from the scope of the scheme.

If transport were included among the sectors subject to carbon pricing (either through a cap-and-trade system or taxation)[10], the resulting scheme would be closer to full pricing of carbon emissions from all sources. Indeed, a scheme including the current ETS sectors plus transport would, for most countries, cover more than 75 percent of emissions. Cross-country differences in impact would thus be narrowed. Expanding the scope of carbon pricing schemes not only increases the efficiency of such schemes in reducing carbon emissions but also reduces the cross-sector distortions created by partial coverage.

The distortions created by partial coverage can be exacerbated by discretionary measures adopted for some sectors by governments. For example, the current EU ETS allows grandfathering of emission permits by governments in a somewhat discretionary fashion and only requires five percent of the permits to be allocated via auctions. This implies that governments can reduce the burden on some sectors by grandfathering a larger number of permits, resulting in identical industries supporting different burdens depending on their location. National grandfathering of emission permits undermines the efficiency of carbon pricing policies and introduces competitive distortions within sectors since industries are 'taxed' differently depending on their location.

'Europe might remain at a disadvantage under a global carbon pricing scheme.'

5. POLICY RECOMMENDATIONS

Europe's export mix contains a larger proportion of carbon intensive products than US and East Asian countries. The US's specialisation in exports of services and research intensive goods makes US exports less vulnerable to a carbon price than the EU's exports. In particular, the US export mix is nearly 20 percent less carbon intensive than the EU average. Equally East Asian countries mainly export technology and labour intensive goods, resulting in an export mix that is between five and 20 percent less carbon intensive than the EU's. This means that Europe should not only be concerned about the impact on its competitiveness of a unilateral carbon pricing scheme, but may also remain at a disadvantage if such a scheme is extended across countries. Of course the story is different for different EU countries. While the UK and Hungary export mainly low-carbon products, other countries such as Belgium and the Netherlands have a more highly carbon intensive export mix.

In addition, the coverage of any carbon pricing scheme determines the share of emissions subject to a carbon price. If schemes are partial they will be inefficient in cutting greenhouse gases and will also allocate the burden unevenly, and those with higher emissions will not necessarily bear the greatest burden. In particular, a carbon pricing scheme with similar coverage to the current ETS would cover on average a larger share of emissions in EU exports than in US exports.

Fighting climate change requires a firm commitment to cut greenhouse gas emissions. However, the impact on competitiveness may create incentives for governments to relax their climate change policies and to 'free ride' on their implementation. This puts climate change policies and their economic impact at the centre of trade negotiations: negotiating Kyoto II becomes an important part of trade policy.

The way to reduce the competitive impact of climate change policies without undermining their effectiveness is not to reduce their scope or to adopt protectionist measures, but to develop efficient carbon markets

[10] The European Commission has proposed including aviation in the ETS from 2011.

with wide sectoral coverage that allow a reduction of the cost of cutting emissions.

Policy developments in this area should take account of:

- **The need for efficient carbon abatement mechanisms that allow emissions to be cut at the lowest cost.** The impact on competitiveness of pricing carbon can be reduced if emissions are cut where is least costly to cut them. This requires not only a well functioning carbon market but also removal of obstacles that hold up investment in cutting emissions in developing countries (where it is least costly), and active promotion of the development of technologies that reduce the cost of cutting carbon emissions. Setting additional targets, such as the biofuels and renewables targets recently adopted by the EU, might undermine the objective of cutting emissions at the lowest cost, while having an impact on competitiveness.

- **Maximum coverage of carbon pricing schemes.** Increasing the coverage of carbon pricing schemes (by increasing the scope of cap-and-trade schemes or through a carbon tax) not only increases the effectiveness of carbon pricing schemes (by covering a larger share of emissions) but also gives more flexibility in cutting emissions across sectors at the lowest cost, and reduces the competitive distortions across countries and sectors. The more sectors included within the scope of carbon pricing schemes, the greater the possibilities for cutting emissions at the lowest cost.

- **Consistent coverage across countries and efficient allocation of emission permits.** Even if the scope of carbon pricing schemes were identical across countries, governments might still be tempted to reduce the burden of such schemes on selected sectors by grandfathering emission permits. Excluding sectors from the scope of carbon pricing schemes or granting free carbon emission permits can reduce the impact of carbon pricing, but also diminishes the effectiveness of carbon mitigation policies, creates distortions across countries and across sectors and reduces the credibility of climate change policies. This heats up the debate about the need for a carbon border tax in order to compensate for the different treatment of the same sector in different countries.

If the allocation of free permits is decided at national level, the outcome is likely to distort production and investment decisions: carbon-intensive industries might adopt such decisions based on the amount of emission permits they are allocated free at each location. Different coverage of carbon pricing schemes across countries and, in particular, the granting of free emission permits at national level introduces trade distortions that may lead to protectionist retaliation.

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