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Thinking Ahead on International Trade (TAIT) – 2nd Conference
Climate Change, Trade and Competitiveness: Issues for the WTO

Climate-linked tariffs and subsidies: Economic aspects (competitiveness & leakage) [1]

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Climate-linked tariffs and subsidies: Economic aspects (competitiveness & leakage) – SECOND DRAFT, 1 JUNE 2010

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1 Purpose, Scope and Focus

Would tariffs and subsidies designed to mitigate the impacts of unilateral climate change policies be cost-effective? In common with many policy questions, we have:

- some empirical evidence to answer the question;
- a range of modeling and other theoretical analysis;
- differing opinions; and
- uncertainty.

This paper aims to provide a state-of-the-art review of what economics can contribute to the considerations, explaining the trade-offs that policy-makers need to consider. The paper shows that economics has much to illuminate the debate; but there remains the need to also consider political and practical issues. The paper makes some reference to these but for more detailed discussion the reader should see the other papers in this series, notably Paper 4 (measuring carbon content), Paper 5 (legal issues) and Paper 7 (the synthesis paper).

The title of this paper refers to "climate-linked tariffs and subsidies". This paper discusses the two major options being discussed as responses to competitiveness and leakage concerns:

1. *Border carbon adjustment (BCA)*. BCA would apply a tax, or require the equivalent purchase of carbon emission allowances, on the import of products into a market with a carbon cost. Rebates could also be applied to exports from this market. When applied as a tax, the mechanism is typically referred to as a 'border tax adjustment' (BTA);
2. *Free allowances*. Allowances to emit carbon dioxide and other greenhouse gases can either be granted for free to companies (i.e. are "free allowances") or must be purchased (at auction or on the carbon market).

Whilst these options have characteristics that can define them as "tariffs" and "subsidies" respectively, it is not an exact overlay and it is more precise to refer to them simply as BCAs and free allowances. It would also be possible to propose other "tariffs" and "subsidies" but this paper focuses only on these two measures which are most debated.[1]

In order to measure the cost-effectiveness of implementing BCAs and free allowances, we need to understand what their implementation is aiming to achieve. "Competitiveness" concerns are generally understood to occur at the sectoral level, for example relating to how production or other costs differ relatively between two jurisdictions in response to a certain policy or measure. Thus in the paper and pulp industry, the implementation of an emission trading scheme in the United States would alter the costs of its producers, and hence lower their competitiveness, relative to those in non-regulated

[1] Note that Sectoral Approaches are often considered as a response to competitiveness and leakage concerns. This paper argues that the forms of Sectoral Approaches which could be implemented in practice would have little economic impact on reducing competitiveness and leakage.

jurisdictions (e.g. Germany or Indonesia). In general a loss in competitiveness would result in a loss in market share and/or profit (Reinaud, 2005). "Leakage" is defined as any increase in greenhouse gas (GHG) emissions in foreign jurisdictions that results from climate policies taken in an implementing jurisdiction. It is an issue for environmental policy-makers who fear that it might undermine the environmental effectiveness of their regulations. Competitiveness and leakage are intimately connected and largely follow the same mechanisms, for instance the movement out of a regulated jurisdiction of production in the short term would be a result of a loss in competitiveness and would be likely to result in leakage. The impacts of this production movement could importantly include the loss and relocation of jobs, and there is at least circumstantial evidence that BCAs could be, and free allowances are, implemented in order to support domestic employment.

Whether stated explicitly or not, we must thus consider that one of the aims of implementing BCAs and free allowances is to protect domestic employment, either permanently or by allowing for a slower transition (for example the European Union's Emission Trading System plans to progressively decrease the quantity of free allowances given to eligible industrial sectors over the 15-year period 2012-27). It is appropriate to ask whether there are more effective options to deal with industrial policy issues than BCAs or free allowances, and economic analysis is informative in this regard.

The idea of transition also illustrates the need to consider both the short- and long-term, and the paper undertakes this analysis. Within industry, there are short-term constraints on production and thus relatively limited potential for significant movement of this production. In the long-term, companies can decide where to invest in new plant and plant refurbishment, and hence the potential for the movement of production and of jobs is much higher.

A further commonly-discussed policy aim is to encourage third countries to ramp up their climate change policies and measures. Here there are significant political issues, for instance relating to the UNFCCC negotiations. This paper concentrates only on the economic impacts and finds these are generally minor, i.e. that the implementation of BCAs and free allowances would have only a minor *economic* impact on other countries climate change actions.

Concerns about changes in competiveness and job losses are probably as old as trade itself. Regulation does move forward at different paces between jurisdictions, and the creation of 'pollution havens' has been a concern for at least forty years. Policy-makers thus have experience on which they can draw, for example the Montreal Protocol on Substances that Deplete the Ozone Layer. This paper analyses what lessons can be drawn from these, noting that the scale of the markets considered, and market-specific issues, can vary considerably compared to climate change considerations.

2 Structure of the Paper

There is some empirical evidence of the effects of unilateral climate change policies, and the paper first reviews the evidence from the main schemes implemented to date which have resulted in carbon prices. Section 3 then moves on to discuss useful analogues outside climate change – those relating to environment in particular, and to labour, subsidy reform and industrial restructuring more generally.

Specific examples where leakage was raised as an issue are then analysed – the Montreal Protocol and US Superfund – along with an analysis of the considerations of the key considerations and conclusions of the WTO's Working Party on Border Tax Adjustment, which reported as far back as 1970.

The second part of the analysis concerns the potential economic impacts of BCAs and free allowances. *Section 4* firstly reviews the economic theory and then considers how this can be applied in practice and the significant uncertainties that result. It then considers the economic impacts of free allowances and BCAs in detail, before comparing them. It ends by looking at their economic ability to incentivize abatement activity in other jurisdictions, a policy aim often presented as a key rationale.

Conclusions, in the form of key messages for policy-makers, are drawn in *Section 5*. These feed into the general conclusions drawn in the synthesis paper (Paper 7 of this series).

3 Empirical Evidence

There is very little direct empirical evidence of the impacts of climate change policies. The starting point of the analysis now presented is that there is a carbon price in a particular economy. This could result from cap-and-trade schemes whereby trading of allowances results in the carbon price, but the imposition of a carbon tax would lead to a largely analogous situation (the principal difference being that there would be certainty, and no volatility, of carbon prices under a tax scheme).

This section reviews the impacts from the implementation of the two most significant markets to date – the European Union's Emission Trading System (EU ETS) and the allowances generated by the Kyoto Protocol's Clean Development Mechanism (CDM) – before considering what can be learned from analogous policies and regulations which have been applied outside climate change. The policies and regulations selected for discussion all relate to unilateral actions that have given rise to fears of leakage of production or emissions.

3.1 Climate change policies and measures

The lack of empirical evidence is largely because of the relative novelty of climate change policies and measures. Because of the wide range of drivers of economic actors' behaviour, the interpretation of what empirical impacts have been directly caused by climate change policies and measures is uncertain. No climate change BCA has yet been implemented.

3.1.1 EU ETS

The EU ETS was implemented in 2005. It regulates roughly half of the EU's emissions of carbon dioxide, from the electricity generation and energy-intensive industrial sectors. It imposes absolute limits – i.e. independent of their production levels - on CO_2 emissions from around 11,000 individual installations. These installations must surrender allowances covering their actual verified emissions, which can be made up of their original allocation of emissions and any they have purchased from the market. Those with excess allowances can sell into the market.

Within the first two phases of the EU ETS (2005-7 and 2008-12 respectively), allowances were almost exclusively granted to installations based on their historical emissions (in technical terms, using "grandfathering"). Auctioning of allowances was limited by the EC to a maximum of 5% and 10% respectively, although the EU's Member States generally took up little or none of this option. Prices of allowances have varied across the range €0-30/tCO_2 over the period to date. An indicative average price is of the order of €15/tCO_2.

The EU ETS has thus created a market price for carbon for about half the EU's emissions, but has granted free allowances at close to the total emissions actually released into the atmosphere. Therefore the interpretation of the empirical analysis must decide on what it considers to be the effects the granting of free allowances - did companies take account of their potential sales value (opportunity cost) when making decisions on abatement, did they ignore them or was it somewhere between the two? The economic arguments are discussed in detail in Section 4. Empirical analysis of the impact of the EU ETS on abatement must thus be interpreted with reference to the impacts of the free allowances on companies' decision-making.

Ellerman and Buchner (2008), basing results only on the first year of the EU ETS (2005), conclude that there was both over-allocation and abatement. Di Maria, Anderson and Convery (2009) back up this conclusion for the EU ETS's pilot phase (2005-7), adding that "emissions over the pilot phase being approximately 12 Mt CO_2 (0.2%) higher than they would have been in the absence of the EU ETS."

Reinaud (2008) concludes that the first phase of the EU ETS did not provide any evidence of a different impact - leakage. Hintermann (2010) concludes for a review of the EU ETS that "while prices were not initially driven by marginal abatement costs, this inefficiency was largely corrected after the accounting of 2005 emissions in April 2006." Yu (2009) finds that the profitability of Swedish firms in 2005 and 2006 was independent of whether they had received under- or over-allocation. Similarly, Anger and Oberndorfer (2007) conclude "our econometric analysis suggests that, within the first phase of the EU ETS, relative allowance allocation did not have a significant impact on firm performance and employment of regulated German firms."

What can we conclude from this somewhat disparate set of analyses and conclusions? It is firstly clear that empirical analysis is at an early stage. There is some evidence that the pilot phase of the EU ETS did not have a significant impact on either firms or GHG emissions. Considerable uncertainty is also indicated, raising the spectre that we may not get high quality empirical analysis, even if there is much better data in the future (Wooders, Reinaud and Cosbey, 2009).

3.1.2 CDM

Much of the reductions from the CDM have been generated from projects destroying or reducing the use of GHGs other than CO_2. Within the industrial sector, the vast majority of options have been concerned with some form of increased generation of electricity. For the cement and iron and steel sectors, we see very similar effects – over 200 projects at validation or registered stages; projects dominated by China and India; clear focus on capturing waste gases or heat using technologies and techniques which are generally industry standard in modern plants and in developed countries.

Thousands of papers analyzing the perceived successes or failures of the CDM have been published. The analysis of success hinges on 'additionality' – has the CDM led to the development of projects additional to what would have happened anyway? Strictly speaking, CDM projects should demonstrate financial additionality, i.e. the inclusion of carbon credits (CERs) should be the critical factor in moving a project from non-economic status to economic. In reality, this is a very difficult distinction to make. Non-economic factors may also result in additionality, for example increased higher management attention because of the existence of a scheme such as the CDM or increased interest from banks to lend capital.

Analysing the impacts of the CDM (and indeed of any scheme which results in a carbon price) needs to take into account whether, and to what extent, a carbon price can incentivize abatement of emissions. Clearly the higher the price, the higher the incentive. But there is also a growing literature that contends that carbon prices alone are unlikely to incentivize abatement in mature, energy-intensive sectors. Baron, Buchner and Ellis (2009) state that “earlier work has shown that a sectoral crediting baseline alone is not likely to trigger changes at the level of individual emitters; a set of policy instruments would be needed for that purpose … these policy instruments may be included in the country’s LEDs.” [low-emission development strategy]. They add that moving from a project to a sectoral baseline would make it more difficult to create incentives for individual investors. Wooders et al. (2009), reviewing the steel sector, conclude that complementary policies would be needed in addition to carbon prices in order to deliver abatement in the steel sector in China and India. Ellerman and Buchner (2008) argue the contrary – that “other MBIs [market based instruments] have proven to create incentives for abatement, as shown by the experiences in Europe”.

3.2 Lessons drawn from policies and measures outside climate change

3.2.1. Environment

While there is little direct evidence of the impacts of climate-related regulations on competitiveness and leakage, there being too little in the way of time series data yet, research dates back over two decades into the hunt for the so-called pollution haven effect: the question whether high environmental standards in one jurisdiction will lead to a relocation of industry or a diversion of investment to other, low-standard, jurisdictions. This research is surveyed here, as it has some value in allowing us to draw out broader lessons that also apply to climate-related research problems.

The vast majority of the literature to date looks at firm behaviour within the US, since data is available at the state level for measures of economic performance and environmental strictness. Studies use a variety of approaches but the basic inquiry asks how some indicator of competitiveness (e.g., net exports, inward or outward FDI, plant closures or births, employment or output) is affected by some matrix of factor endowments (e.g., human and physical capital, resource endowment, energy costs, infrastructure) and other variables, including some measure of jurisdiction-level environmental regulations (e.g., state resources devoted to compliance, existence and stringency of specific types of legislative controls, attainment status under those regulations, fines levied for non-compliance).

The literature seems to divide into three related but distinct combinations or manifestations of the basic question:

- Do environmental regulations reduce market share (expressed in terms of reduced exports and increased imports in the regulated sectors)?
- Do environmental regulations negatively affect investment decisions (expressed in terms of increased outward FDI, reduced capital stock or reduced inward FDI in the regulated sectors)?
- Do environmental regulations cause regulated firms to relocate to lower standard jurisdictions?

After the definitions offered in Copeland and Taylor (2004), this last supposition is the pollution haven *hypothesis*, whereas the first two types of impacts would be evidence of the pollution haven *effect*.

A host of early studies, mostly undertaken during the 1990s, found that the impacts of regulatory strictness seemed to be minimal, especially as compared to other factors such as proximity to markets, natural resource input availability, labour costs, quality of human resources, political risks, macroeconomic stability, adequate legal regimes (including intellectual property rights, contract law, investment law, an independent judiciary), infrastructure (communications, energy, transportation).[2] Low and Yeats (1992), in a typical finding, calculated environmental regulatory compliance costs at an average of 2-3% of total costs (though they ranged higher in some sectors). The conclusion seemed to be that there was no significant pollution haven effect – that environmental regulations did not have any significant influence on plant location, investment or market share.

More recent work, however, has highlighted methodological weaknesses in the "first generation" of analyses.[3] Among the problems identified are:[4]

- Because almost all of these studies used cross-sectional data rather than panel data, they were unable to control for characteristics specific to particular sectors and countries—differences that might have explanatory power for the different investment and locational decisions (problem of unobserved heterogeneity). Such characteristics might include, for example, a link between dirty industries and natural resource use (meaning a reluctance to move away from those resources)[5], or between dirty industries and capital intensity (meaning that moving would be a relatively costly proposition)[6], and would result in underestimated pollution haven effects for those sectors.
- A related problem is that many studies aggregated industry figures, or global trade figures, to calculate overall responsiveness to environmental policies. To the extent this is done, it masks the presence of strong pollution haven effects in particular sectors, or for particular types of countries, assuming a large number of other sectors/countries with weak effects.[7]

[2] For comprehensive surveys of the early literature see Jaffe, Peterson, Portney and Stavins, (1995) and Brunnermieir and Levinson (2004). For individual studies from this time period finding few pollution haven effects, see Bartik (1988, 1989); Kalt (1988); McConnell and Schwab (1990); Low (1992); Tobey (1990); Lucas, Wheeler, and Hettige (1992); Friedman, Gerlowski and Silberman. (1992); Birdsall and Wheeler. (1993); Levinson (1996); Mani, Pargal and Haq (1996); Eskeland and Harrison (1997); van Beers and van den Bergh (1997); List and Co (2000).
[3] See, in particular, Brunnermeier and Levinson (2004); Copeland and Taylor (2004); and Levinson and Taylor (2008).
[4] See Cosbey and Tarasofsky (2007).
[5] Such an effect is found in Ederington, Levinson and Minier (2003).
[6] This effect is suggested by Cole and Elliot (2005).
[7] Sectoral over-aggregation is an obvious and straightforward problem. Obscuring country-specific characteristics in global trade analyses is perhaps less so. Ederington et al. (2003), for example, found an insignificant average

- Most studies assumed that environmental policy was exogenously determined. But if there is some way in which abatement costs are linked to environmental policy (e.g., policy makers set tougher standards for big polluters and more lenient standards for insignificant ones), then if there is a pollution haven effect, it will be to some extent offset by these linkages, and will be underestimated (problem of endogeneity).[8]

The most recent 15 years' work has attempted, with varying degrees of success, to address these problems, and much of it has found a statistically significant pollution haven effect in some sectors.

In that group of studies, those looking at terms of trade effects – the first question posed above – find that increasing environmental regulatory costs do impact trade flows.[9] Levinson and Scott (2008), looking at trade patterns between the US and its NAFTA partners from 1977 to 1986 found that industries whose abatement costs increased most also experienced the most significant increases in net imports. On average, they find that 10 percent of total increase in trade volume can be attributed to regulatory costs over the period. SQW Ltd. (2006) summarizes two studies that seem to show that trade effects will depend in part on the regulating country's factor endowments and on how intensively the industry uses that factor. For firms that intensively use a scarce factor of production (e.g., timber), even marginal tightening of environmental regulations will have an impact on market share. Firms that use that factor intensively in countries that have abundant stocks will not be so significantly affected by regulation.

A number of recent studies using panel data look at the investment impacts – the second question posed above. They seem to agree that regulatory costs can and do influence investment patterns, particularly for heavily polluting firms.[10] Greenstone (2002) found that in the first 15 years after rules were introduced to more heavily regulate highly polluting US counties, those counties (relative to others) lost approximately 590,000 jobs, $37 billion in capital stock, and $75 billion (1987$) of output in pollution intensive industries. Zhang and Fu (2008), in a study that attempts to control unobserved heterogeneity, and for the influence of agglomeration and factor abundance among others, finds that strong environmental regulations have a significant and negative impact on FDI into provinces in China. Dean, Lovely and Wang (2005), using an equally robust model, look at environmental levies on water pollution as a proxy for environmental strictness, and examine the behaviour of foreign equity joint ventures in China by province. This type of investment is in fact affected by pollution levies, but not as expected. OECD investors actually favour jurisdictions with higher charges. On the other hand, investors in high-polluting industries from Macao, Hong Kong and Taiwan were significantly deterred by

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effect of US environmental regulations on international trade flows. But there was a significant and positive relationship between those regulations and trade flows specifically with low-income and low-standard countries – a result that had been obscured by the fact that by far most US trade occurs with high-standard OECD partners.

[8] Ederington and Minier (2003) modelled environmental regulation as an endogenous variable and found a strong estimated effect on trade flows.

[9] See Ederington and Minier (2003); Ederington, Levinson and Minier (2003); Cole and Elliott (2003); Levinson and Taylor (2008).

[10] See Henderson, (1996); Kahn (1997); Becker and Henderson (2000); List and Kunce (2000); Greenstone (2002); Keller and Levinson (2002); List, McHone and Millimet (2003); Dean, Lovely and Wang (2005); Zhang and Fu (2008).

high levies.[11] The authors suggest that these results may derive from the less advanced (more polluting) technology used by these latter investors. One could also imagine the OECD investors being attracted to what they saw as a proxy for good governance.

On the third question posed above – the pollution haven hypothesis -- many of the studies that have addressed this question have been failed to adequately account for other explanatory factors.[12] A few recent studies that try to control for previous errors, however, seem to find little evidence of regulation-driven migration of industry.[13] Elliot and Shimamoto (2008) look for evidence of Japanese relocation to its ASEAN trading partners in response to strict environmental regulations, but find none.

The key lesson to be drawn from this body of work is that there are competitiveness impacts associated with environmental regulation, that in most cases they are moderate, but not in all cases. Several of the surveys cited above found that unobserved heterogeneity was a problem, as was over-aggregation of sectors. The key here is that firm and sectoral characteristics matter a great deal when we consider the competitiveness impacts of environmental regulations. These results seem to be generally in line with the analysis and literature to date on the impacts of climate-related regulations.

3.2.2. Labour

There have been decades of research devoted to answering the question: can countries with low labour standards or enforcement gain competitive advantage and thereby alter trade flows?[14] Much of this was undertaken in the 1990s, as a rise in the importance of developing country exporters caused concerns for developed country analysts. As well, the expansion of the EU gave rise to a flurry of analysis focused on "social dumping" from the newly acceded states. This section will survey the evidence for a so-called "race-to-the-bottom" in labour standards, and in closing will consider what we can say about the effectiveness of instruments to address any such dynamic.

It is important to note at the outset that the subject of analysis is labour standards, as opposed to wages. Divergence in the latter is accepted by most to be a legitimate element of comparative advantage, except where they have been manipulated by unfair labour practices – taking us back again to standards as a focus of concern.

Most analysis focuses on the core labour standards as propounded by the International Labour Organization (ILO):[15]

- Freedom of association and the effective recognition of the right to collective bargaining;
- Elimination of all forms of forced or compulsory labour (e.g., prison or indentured labour);
- Effective abolition of child labour; and
- Elimination of discrimination (sexual, racial, etc.) in respect of employment and occupation

[11] The authors note the importance of heterogeneity – these results would have been lost if they had not separated out the investing firms by home country.
[12] This is the clear conclusion of the seminal literature survey in Copeland and Taylor (2004).
[13] See SQW Ltd. (2006); Elliot and Shimamoto (2008).
[14] An excellent survey of the literature to that point is Brown (2000).
[15] ILO Declaration on Fundamental Principles and Rights at Work (1998).

The evidence to date is somewhat mixed on the influence of these standards on competitiveness. OECD (1996) found no significant correlation between freedom of association/collective bargaining and measures of export performance, either overall or within the labour-intensive export stream. Rodrik (1996) looked at the ratio of textile and clothing export to total exports, asking how that ratio was affected by a broad index of indicators for labour standards. He found no significant correlation, except for the case of child labour in relatively poor countries. Maskus (1997), using graphical models, similarly found no significant correlations between core labour standards and price competitiveness in export markets.

Busse (2000) argues that we should expect to find quite different impacts across the range of different standards. The use of child and coerced labour, for example, increases the labour pool and decreases wages, and should therefore lead to more exports of unskilled-labour intensive goods. Discrimination against women and other potentially valuable labourers would have just the opposite effect. And the impacts of restrictions on the ability to bargain collectively should be indeterminate. His empirical results bear out all these arguments, with the exception that they show competitive advantage resulting from restricting union rights.

Liu, Xu and Liu (2004) use a survey approach to gather data on wage-related standards in China (such as compliance with official overtime and minimum wage), using an OLS regression find that, for foreign-invested firms, they are significantly and positively correlated with standards in the home countries. This would seem to rule out the "race-to-the-bottom" hypothesis; firms in high standards countries should, by that hypothesis, be seeking out low-standard labour jurisdictions.

Several analysts explore the types of instruments available to address competitiveness and leakage concerns with respect to core labour standards. Basu (1999) cautions that a ban on imports made with child labour will simply result in a two-track system of production in the home country, with child labourers diverted to potentially less attractive production for domestic consumption. The same sorts of arguments have been made with respect to the effectiveness of border carbon adjustment (see Houser, Bradley, Childs, Werksman and Heilmayr, 2008).

Flasbarth and Lips (2003), using GTAP modelling, explore the impacts of bans and tariffs to punish violators of the ILO core standards. They estimate that a tariff increase of 50% reduces welfare in the punished countries by an average of 0.5 – 1 percent, noting that historically the threat of removal of GSP benefits amounting to less than that -- 0.5 – 0.6 percent – was sufficient to motivate changes in practice in about half the countries surveyed. On the other hand they find a "social clause" within the WTO to be particularly ineffective. They also calculate the trade impacts of a prohibition on child labour to be insignificant.

Several analysts warn that endogeneity is a problem. That is, labour standards are considered by all the models to be exogenously determined. In fact, there are good arguments for those standards to be considered endogenous. It might be, for example, that exporter industrial policy involves simultaneously attracting investment, promoting exports and pressuring workers in violation of some core labour standards. In that case, we would observe a correlation between low standards and increased exports and investment, and might mistakenly assume that the former was causing the latter. None of the studies reviewed addressed this methodological problem.

Most studies seemed to find that violating core labour standards had little or no impacts on trade or investment flows, but the results are still not entirely satisfactory – the problems of unobserved heterogeneity and endogeneity are problems here, as they are for the studies looking for pollution haven effects. While some analysts found tariffs and bans potentially effective, others (e.g., Maskus (1997), Busse (2000)) caution that the problems of implementation may be too serious in relation to the minimal gains to be had.

3.2.3. Subsidy reform and industrial restructuring

Section 1 introduced the idea that industrial policy may provide at least a partial rationale for the implementation of BCAs, free allowances or other measures designed to protect domestic industries. It also adds the idea that using carbon policy in this indirect manner is unlikely to be the best policy option.

The industries which can make the best claims for protection – cement, steel, aluminium, basic organic chemicals, etc. (see Section 4.3 for details) – share many characteristics: they are energy-intensive; economic plant sizes are large, and so capital costs of new plant are very high; demand and product prices tend to follow the economic cycle; plants have large numbers of employees in concentrated locations, typically with large supply chains.

The industries are often regarded as having strategic importance by policy-makers, who offer them support. The OECD Steel Committee has categorized 26 types of subsidies that have been or are being used in their industry, covering the whole cycle of the industry (GSI, 2009):

1. Investment promotion measures;
2. Assistance to ailing enterprises;
3. Trade-related support measures.

Not all these subsidies are being used at present, and there use is only in certain countries at certain times – for example, the consolidation of steel manufacturers into groups larger than national champions has reduced the close relationships industry and government used to have, and trade-related support has not been used in the EU for two decades. Nevertheless there is evidence that governments will tend to supply industries they consider of strategic interest and that are "too big to fail". Recent support to the airline and auto industries in the US and elsewhere, including through the use of stimulus packages, confirms the trend.

The record of government support to industries has been mixed. Hufbauer and Goodrich (2002) argue that the steel sector support measures implemented in the United States over the period 1968-2001 were ineffective, in that they did not create an internationally-competitive industry. Looking specifically at import restraint measures being considered by the US' ITC (International Trade Commission) in 2002, they conclude "the cost of import restraints to domestic steel users, per job saved in the steel industry, would run at about $500,000 per job per year. The total number of jobs saved in the steel industry would be less than 10,000. Protection could cost many times this number of US jobs in downstream user industries." The Global Subsidy Initiative's case study on the reform of subsidies to the Polish coal sector (Wojciech, 2010) showed that attempts to retain jobs by supporting uncompetitive parts of the industry did not work. Reform became possible when it was decided to address workers' welfare issues directly through large payments generally covering several years' salary payments.

We can draw two main conclusions from these and similar analyses. First, that keeping ailing industry going can be expensive without guaranteeing to create sustainable, competitive companies. Second, it seems that welfare payments to displaced workers are a key need for reform – this is clearly not possible to deliver using free allowances or carbon markets.

3.3 Lessons from multilateral agreements and WTO adjudications

There have been historical attempts to use or consider trade measures to deal with the problems of leakage and competitiveness. This section surveys three of those. The first is a multilateral environmental agreement: the Montreal Protocol. The second is a piece of domestic legislation: The US Superfund Act. And the third is an attempt by the contracting parties of the GATT to come to grips with border adjustment.

All three cases merit some exploration to see whether some lessons can be drawn about the use of border measures in the climate context.

3.3.1. The Montreal Protocol

The Montreal Protocol on Substances that Deplete the Ozone Layer, a protocol to the Vienna Convention for the Protection of the Ozone Layer (hereinafter the Montreal Protocol and the Convention, respectively), was signed in 1987. It was designed to reduce the emissions of a set of global pollutants – substances that deplete the ozone layer. Its central feature is a list of controlled substances, which Parties commit to phase out in a staged manner by given dates. Developing countries with low per-capita emissions (Annex 5 countries) are given longer timetables, and were eventually supported by a fund (the Multilateral Fund for the Implementation of the Montreal Protocol) to assist them in the technological transformation that the Protocol effectively demanded.

Since its entry into force the Montreal Protocol has been the subject of six successive rounds of adjustments to its schedules, accelerating the phase outs as viable alternatives to ozone-depleting substances (ODS) are discovered. It has also been broadened by the inclusion of new substances, in four successive rounds of amendments to the Protocol to which Parties have the option to accede. The Montreal Protocol is widely regarded as one of the most successful multilateral environmental treaties; in 1986 total consumption of chlorofluorocarbons (CFCs – the key group of ODS) was at 1.1 million tonnes, and by 2006 this had come down to about 35,000.[16]

The protocol contains three types of trade measures:

[16] UNEP (2008:5). The units used in these figures are ozone-depleting potential tons – an aggregate of many types of CFCs weighted by their ozone depleting potential.

- It restricts trade in controlled substances, banning their import from non-Parties (Article 4.1 – effective 1990), and their export to non-Parties (Article 4.2, effective 1993). (As per Article 4.8, non-Parties that can prove that they have taken actions equivalent to those required of Parties can be treated as Parties.)
- It drew up a list of goods that contained controlled substances (Annex D), and Parties not objecting to this list must ban the import of those goods from non-Parties effective 1992.
- It required the Parties to determine the feasibility of banning the import of goods made with, but not containing, ODS. If it *were* feasible, the list was to be handled just as the list of products containing controlled substances. It was determined that the range of covered products would be huge, the amounts of ODS used would be relatively small, and the technical challenges involved in determining whether ODS had been used in manufacturing would be extremely costly, if not insurmountable. As such this sort of trade restriction was not adopted, but the Parties directed (in 1993) that this assessment be regularly revisited.

The trade measures were put in place for two reasons. First, they were designed to operate as incentives for countries to join the treaty. Trade in ODS, products containing them and products that used them in production was significant, and non-Parties stood to lose lucrative export markets. Second, they were designed to prevent leakage of production to non-Parties. The protocol's national schedules for phase out (control measures) cover both production and consumption, and if domestic reductions could simply be augmented by imports from non-Parties, the phase out targets for consumption would be unattainable. Obviously the two objectives are closely related; to the extent that leakage is prevented, there is incentive for non-Party exporters to become Parties.

The trade provisions are widely acknowledged to have been effective. Several countries openly stated that they were compelled to accede to the protocol in order to preserve their markets.[17] Membership among ODS consumers and producers is almost complete, with 196 Parties ratifying as of May 2010. Neither Brack (1996) nor OECD (1997) found any evidence of leakage to low-standard jurisdictions. There exists nothing in the way of analysis of the cost effectiveness of the protocol's trade provisions, though there is a wealth of such analysis covering the Protocol overall.

Are there lessons here for the climate change regime? Certainly the measures taken had as one of their objectives preventing leakage, and in that sense they resemble border carbon adjustment. We need to be cautious, however, in transplanting the successful use of trade measures in the protocol to the climate regime.[18] A key difference between the two is that the protocol contains commitments to reduce consumption as well as production, meaning trade *must* be controlled or the integrity of the entire regime is compromised. The climate regime accounts for emissions on a production basis only. As such controlling trade may be a matter of national economic concern, but it is not fundamentally necessary for the design of the international climate regime.

Another important difference is the sheer magnitude of the economic activity at risk of leakage. In 1987, the year the protocol was signed, US companies sold just over $500 million (current US dollars)

---

[17] Brack (1996:57) reports that this was the case for Myanmar.
[18] Cosbey (2008); Zhang (2009).

per year in CFCs.[19] Let's assume (generously) that 100% of this production was vulnerable to leakage under a regime without trade measures. By contrast, most analysis of sectors vulnerable from climate change measures turns up much higher figures. Hourcade, Demailley, Neuhoff and Sato (2007) estimate that sectors totalling just under 1% of GDP are at risk in the UK, and other studies return similar figures. If we apply the 1% figure to US GDP in 1987--admittedly a back-of-the-envelope technique—we can estimate the production of industries vulnerable to climate-related leakage at $47.4 billion, or almost a hundred times as high as the leakage potential from CFC producers.[20] The US in 1987 being the predominant producer of CFCs (29% of global production), we can expect that the ratio would be even more stark in most other economies.[21] And the vulnerable sectors in the climate change context could easily be defined much more generously than the 1% figure, as has been done in the EU's third phase ETS.[22] It could thus be argued that some sort of measures to deal with leakage are much more urgently needed in the climate context. But it could also be argued that the limited nature of the protocol's measures makes them inherently more manageable, and less politically divisive.

Finally, the Montreal Protocol applied restrictions to substances, or to products that contained them. It did not apply them to goods manufactured using those substances – a mechanism that would bear much closer resemblance to the proposed BCAs in the climate regime. Notably, the parties did so in recognition of the almost impossible methodological challenges involved, relative to the slim potential benefits to be derived. As noted above, however, in the climate change context since we have noted an order of magnitude greater potential leakage, the potential benefits of prevention would be much higher.

In the end, the Montreal Protocol offers an example of successful use of trade measures to achieve environmental goals by preventing leakage. But its applicability to the use of BCA in the climate regime is not perfect; the fundamental need for the measures is not the same, and the scope of applicability would be much wider. The lessons concerning methodological challenges are, however, certainly salient.

3.3.2. The US Superfund Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), more commonly known as Superfund, was enacted by the US Congress in 1980. The centrepiece of the act was a set of taxes that, over its first six years, paid over $1.5 billion into a trust fund for the cleanup of abandoned or uncontrolled hazardous waste sites. Superfund was amended in 1986 by the Superfund Amendments and Reauthorization Act (hereinafter, the Superfund Act).

The taxes in the Superfund Act included two taxes that had existed in the previous Act: an excise tax on petroleum and a tax on certain feedstock chemicals. And it included two new taxes: a broad-based

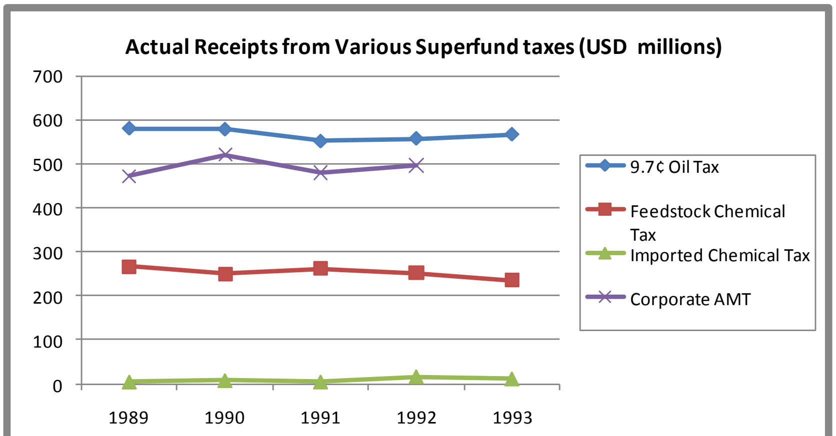
[19] OECD (1997:6) (citing Cook, 1996). CFCs are covered in Annex A, Group I. Annex A Group II covers halons – a much more limited group primarily used in fire extinguishers. Annex A was the list of controlled substances covered under the original Montreal Protocol.
[20] US GDP in 1987 at current dollars was $4,736.4 billion (US Bureau of Economic Analysis, National Economic Accounts, Table 1.1.5: GDP).
[21] UNEP (2005), Table 1: Data on Production of CFCs.
[22] See Section 4.3 for more details.

corporate income tax and a tax on selected imported goods that had been made from the domestically taxed feedstock chemicals.

This last tax is of particular interest for the discussions on BCAs, since it aimed to adjust at the border to level the playing field between domestic and foreign producers. It taxed 113 imported chemical substances containing or using the taxed 42 chemicals covered under the feedstock chemical tax – the so-called chemical derivatives. The intent was to impose a tax that would be equivalent to what the foreign manufacturer and suppliers would have paid had they been subject to the feedstock chemical tax. It may be, as far as the authors know, the only border tax adjustment that has ever been used to prevent leakage.

Was it effective in doing so? That is difficult to judge. There do not seem to have been any analyses aimed at answering this question. On its face it doesn't appear that the level of the charges would have translated into particularly strong signals. The chemical feedstock tax itself was assessed at a maximum of 2 percent of 1980 wholesale value, and the tax applied to chemical derivatives would be some fraction of that – a function of the amount of the taxed chemical used or contained in the final product.

These sort of cost levels fall well below what is considered vulnerability in the carbon leakage literature. And as Figure 3.1 indicates, the overall revenues from the tax on imports were very small relative to those collected on petroleum products, chemical feedstocks and corporate taxes. At the end of the day, the border adjustment in the Superfund Act may have been aimed at preventing circumvention of the taxes, and the leakage that would imply, but the underlying taxes themselves were not aimed at changing corporate behaviour so much as they were aimed at raising money – the desire to avoid saddling US taxpayers with the cleanup costs of the Superfund sites was strongly in evidence while the bill was being debated. Such a tax is quite different from the sort of taxes or charges being contemplated to address climate change, which to be effective must be set at a level that will impel behavioural changes. As such, while the BTA in this case may have prevented some small amount of leakage (but almost certainly not via the investment channel), it is not a particularly good analogy for BCA.



Source: Lazzari, 1996, Table 1

3.3.3. The GATT Working Party on Border Adjustments

The Working Party on Border Adjustments was established by the GATT Council in 1968 to examine the existing GATT provisions with respect to border tax adjustment (BTA), the current practice of BTA by the contracting parties, and the effect of that practice on international trade. The initiative to a large extent came from the United States, which had a Presidential mandate to look at the adjustment practice of its trading partners. At the time many nations had complex internal tax structures (though some, such as the European Communities, were transitioning to value-added taxes) including cascading, turnover and one-stage taxes combined with excise taxes. Border tax adjustment was increasingly being used to lessen the tax burden on exports, and "level the playing field" by imposing it on imports. This was in line with the accepted destination principle of taxation, in which goods are taxed in the jurisdiction of consumption, but the US and others argued that the manner of application was opaque and inadequately disciplined by the rules of the GATT.

The Working Party's mandate, though it was not stated in so many words, was to help determine whether changes were needed to the rules of the GATT and to make recommendations as appropriate to the Council. Between 1968 and 1970 it held twelve meetings and issued several meeting reports, two interim reports and a final report.[23] One of its key conclusions with relevance to BCA was that taxes applied to products were eligible for BTA.[24] Examples of such taxes include sales taxes, excise taxes and value-added taxes. In tax policy literature these are known as *indirect* taxes; they are collected for the government by actors who are not directly impacted by the tax. There was also a convergence of views that some taxes not applied to products were not eligible for BTA. The report mentions social security charges, whether on employers or employees, and payroll taxes. In tax policy literature these are known as *direct* taxes; they are levied directly on those that will pay them.

A third category of taxes—so-called *taxes occultes*—occupied a sort of grey area. These were defined as consumption taxes on equipment, auxiliary materials and services used to produce or transport taxable goods. The report gives the examples of taxes on advertising, machinery, transport and energy. These goods and services are used in the production and sales of a good, but are not physically incorporated in the final product, and were not typically captured by cascading or turnover taxes. There was no agreement on how such taxes should be treated, and no will to debate further on the point in light of the low volume of complaints about them. The mention of taxes on energy as a *tax occulte*, however, has spawned debate on whether BCA might occupy similar territory, since some forms of BCA can be thought of as a tax on the GHG emissions produced by energy inputs.

The discussions of the Working Party addressed three major issues, all of which have some relevance for BCAs:

- The economic basis for the legal distinction between direct and indirect taxes
- The issue of regulatory differences and their potential trade effects under BTA
- The methodological challenges of BTAs in practice

On the first issue, some contracting parties (notably the US and Japan) argued that there was no economic basis for allowing adjustment on indirect taxes, but not on direct taxes. The question was

[23] See the final report: GATT (1970).
[24] To be strictly accurate, there was, according to the report, a "convergence of views" around this proposition. (*Ibid*., para. 14)

never settled, but at the end of the day "most members" of the Working Party were satisfied that the distinction rested on the fact that indirect taxes can be forward shifted such that the burden falls almost completely on the consumer, while direct taxes were argued to be at best only partially passed along to the consumer, with the costs typically "born by entrepreneurs' profits or personal income."[25]

More recent analysis seems to argue that there is no basis for the distinction made by the Working Party. Hufbauer (2006) argues that the distinction may have been historically true, when the most common form of direct tax was property tax, and the most common indirect taxes were excise taxes on luxury goods and "sin" goods such as alcohol and tobacco. But modern taxes on corporate profits, for example, simply did not exist when the principled distinction between direct and indirect was established in the 19th century. In today's world there is little empirical support for the position adopted by the Working Party, nor was there in fact during its tenure in the mid-20th century. The incidence of any given tax depends not so much on whether it is direct or indirect, but rather on market conditions (openness of the economy, degree of concentration in the market, availability of substitutes, etc.). Daly's (2005) survey of the literature for the WTO leads him to conclude that the empirical evidence suggests "that the distinction between direct and indirect taxes on business for purposes of ... adjustment has become rather blurred, [and] a review of WTO rules in the regard might be warranted."

What are the implications for BCAs? If we accept that the only reasonable distinction between taxes that can be adjusted and those that cannot is the degree to which they are built into the price of the final good (i.e., subject to cost pass through), then we need to examine the impacts of climate regulations on the price of goods to determine their eligibility for adjustment – a fairly difficult but manageable proposition. If we instead abide by the understanding as laid down in the Working Party report (which, for what it's worth, has uncertain legal force), then a carbon tax, it seems clear, would be little different than a sales or excise tax in its tendency to be forward shifted. A requirement to purchase offsets as part of a cap and trade scheme is a somewhat more complex proposition but, if administered properly, might amount to much the same thing.

Of course this is not the end of the story, since economics is not the only lens through which BCA should be viewed; there are separate arguments about the WTO compatibility of BCAs on legal grounds. But it seems entirely arguable that according to the discourse of the Working Party, BCA could be considered not a *tax occulte*, but rather in the same category as indirect taxes.

The second big issue tackled by the Working Party was the impacts of BCA in the context of structural regulatory differences. The US and others argued that BTA, since it was applied predominantly to direct taxes, distorted trade between countries with different tax structures. To illustrate, using a two-country model: Country A relies completely on direct taxation, while Country B relies completely on indirect taxation. If Country A uses BTA, it removes all the tax burden from the pricing of its exports to Country B, whose domestic producers will suffer competitive disadvantage. Similarly, Country B's exports to Country A will be saddled with an adjustment that imposes the full burden of Country A's taxation, in effect resulting in double taxation. Country B is not able to use BTA to offset these effects.

[25] GATT (1969, p. 4).

This argument seems to have been rejected by most of the delegates. The final report notes that the GATT distinctions were coherently drafted, and represented more than just the codification of existing practice. They were, most Working Party members argued, aimed at achieving trade neutrality, and had served this purpose “appropriately” for more than twenty years. The arguments here, while they represent the majority view, are weak on substance, but in the end they prevailed.

The same sorts of issues are being raised in the context of BCAs. It has been argued that one of the key difficulties is the issue of comparable action.[26] That is, if Country A addresses climate change entirely with a carbon tax, and Country B addresses it entirely with energy efficiency measures, and the same final effect is achieved, wouldn’t BCA by Country A constitute something like double taxation of Country B’s exports? And wouldn’t rebating the tax to Country A’s exports constitute trade-distorting support?

The third major issue addressed by the Working Party discussions was the risk of unfair treatment through inadequate methodology. This came up repeatedly throughout the discussions in various places, and is obvious as a concern in the questionnaire that was circulated to garner background information for the Working Party’s deliberations.[27] Essentially the concern was that the complexity of the calculations and inadequacies of methodology would lead to exports being overcompensated and import overcharged. Lack of transparency was an underlying and related concern. Troubling scenarios mooted in the questionnaire and the discussions include:

- Mechanisms by which domestic producers are able to avoid domestic tax burdens, which are not in turn available to foreign producers at the point of adjustment;
- Averaging of tax burden across product groups for the purpose of calculating the final impact of a cascading tax, in such a way as to make the final effect discriminatory against foreign producers in certain sectors;
- Adjustments to foreign producers based not only on their F.O.B. prices, but on C.I.F. or duty-included prices – a practice that would overcharge foreign producers relative to domestic producers;
- Adjustments based on cascading or turnover taxes that do not cover intra-firm purchases. This would bias the adjustment charges in favour of vertically integrated sectors, and against goods from any foreign sectors with a relatively low degree of vertical integration.
- Lack of agreement over which sorts of taxes can be adjusted (this concern overlaps with the first major issue discussed above). The US document asks, for example, whether countries are adjusting for property taxes or inventory taxes.

This discussion also finds resonance in the debates over BCAs. Cosbey (2008) frames the issue as one of administrative feasibility, in effect asking whether it is feasible to administer a fair BCA given the methodological complexity involved. If there is a lesson in the Working Party discussions for the BCA context, it is the value of proactive discussions to come to agreement on best practice, on shared methodologies, on starting assumptions, as a way to avoid divisive disputes further down the line. The

[26] See, for example, Wooders, Reinaud and Cosbey (2009).
[27] The questionnaire was based on a document produced by the US, reproduced as Annex B of the meeting report of 8-11 Oct. 1968.

Working Party did not completely succeed in this respect—consensus was not possible in a number of areas—but it still stands out as one of the most noteworthy efforts at this sort of proactive open dialogue in the history of the GATT/WTO. Similar efforts in the context of BCAs are being undertaken by the broader policy community, but as yet not in any constructive way by the governments involved.[28]

3.3.4. Conclusions

The Montreal Protocol and the US CERCLA (Superfund) legislation constitute perhaps the only experience we have of border measures implemented to address leakage concerns, and thus bear some analysis.[29] Likewise, the GATT Working Party on Border Adjustment process is valuable as the only multilateral attempt to come to grips with some of the underlying principles that should guide the use of such border measures.

One of the stark messages of the analysis was the difference in magnitude of the past measures and what might transpire under a regime of border carbon adjustment. Generous estimates of the potentially vulnerable economic activity under the Superfund, and under a US carbon scheme, varied by a factor of almost 100. Clearly the stakes are higher in the case of carbon.

Nonetheless, trade measures used in both the Superfund and the Montreal Protocol seem to have been successful in achieving their objectives, though there are key differences between both of those instruments and any conceivable BCA. It is remarkable, however, that there seems to have been little or no cost-benefit analysis to assess the use of the measures in either the case of the Superfund or the Montreal Protocol. In that sense, history has little guidance to offer us as we contemplate the use of border measures for climate change.

Methodology stands out as a considerable concern, as highlighted in the discussions of the Working Party, and in the Montreal Protocol's rejection of coverage for goods produced with, but not containing ODS. The Working Party stands out as a commendable multilateral attempt to agree on methodology, albeit in a limited way. Clearly some agreement on best practice would be helpful in the practice of both border carbon adjustment and free allocation of allowances, given the significant potential for poor design, and the significant impacts on traded goods.

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[28] A multi-stakeholder effort to draft guiding principles for BCA has been ongoing since 2009, supported by representatives from IISD, WRI, Climate Strategies and other IGO and research network participants. The possibility and desirability of such guidelines is argued in Wooders (2010).

[29] Other such measures currently exist in the form of standards. California and British Columbia (Canada) have laid down standards that dictate the acceptable carbon footprint of electricity and fuel imports – an attempt to preserve the integrity of their respective internal standards.

4 Potential Economic Impacts

What are the impacts of differential carbon costs on economies? And how would these be altered by granting allowances for free or by implementing border carbon adjustment?

This section reviews the evidence to answer these questions. Again, there is little empirical evidence, so to a large extent we must rely on theory and results from simulation models. Policy-makers must also be concerned with practicality – if they decide to respond to competitiveness and leakage concerns, these responses must be implementable. Constraints regarding what type and quality of data is available – and, more fundamentally, whether we can divine from this data the impacts of differential carbon costs from the many other policies and measures affecting industrial decision-making – are a key consideration governing responses.

This section includes both theoretical and practical considerations as it builds up a picture of the potential economic impacts of differential carbon costs and the responses to them, over seven steps:

1. Economic impacts of carbon costs on an economy;
2. Influence of the allocation methodology employed (auctioning, free allowances, output-based allocation);
3. Sectors at risk of competitiveness and leakage impacts;
4. Economic impacts of options to reduce competitiveness and leakage impacts;
5. Economic impacts in non-regulated countries;
6. Implementation issues.

4.1 Economic impacts of carbon costs on an economy

Section 3.1 concluded that there is at present little empirical evidence allowing us to establish the economic impacts of carbon costs, and that even if there were better data, we may not be able to distinguish the independent impacts of carbon costs from other drivers. We must therefore rely heavily on theory.

4.1.1 Basic theory

The starting point of the analysis, and one which illustrates several key economic points, is the basic theory behind how supply and demand would be affected by the implementation of a policy or measure which resulted in a 'carbon cost' in a single market. This carbon cost could be the result of a carbon tax or from a market, most simply one for carbon allowances. Figure 4.1 provides two very simple schematics of the impacts – adding in a carbon cost 'c' raises the price 'P' that suppliers are willing to sell their products at for all quantities 'Q'. The supply curve thus gets shifted upwards (from curve S_0 to S_1). Demand for the product is assumed to be price-dependent, and hence the quantity consumed therefore decreases (from Q_0 to Q_1).

We can make a number of calculations based on the movement of the market equilibrium under these diagrams. The first of these is how the 'producer surplus' – the difference between suppliers' revenues and costs, a simple indicator of profit – would alter. A very widely used indicator in the literature is the ability of suppliers to 'pass-through' of costs, i.e. how much of the extra costs of carbon to suppliers can be passed through in the form of higher market prices to consumers. In both diagrams, the pass-through cost ('f', i.e. P_1 minus P_0) is lower than c, showing that the firm is not able to pass-through 100%. Even if the pass-through rate were 100%, the industry would still lose producer surplus (profit) because it would be selling less product. Thus if a government wished for whatever reason to maintain an industry's profit, it may need to compensate at a rate corresponding to higher than 100% of cost pass-through.

Figure 4.1: Pass-through of carbon costs under full competition versus monopoly, facing variable marginal costs and linear demand (Sijm et al., 2008)

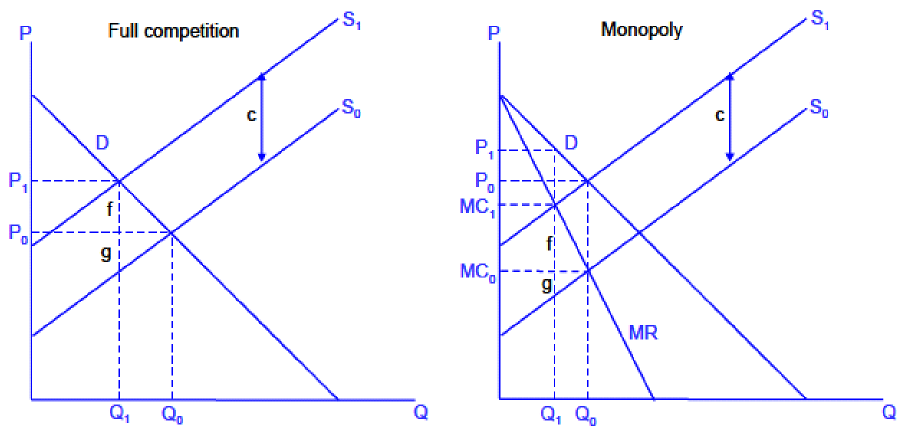


Figure 2.6 *Pass-through of carbon costs under full competition versus monopoly, facing variable marginal costs and linear demand*

Note: S_0 is the supply (i.e. marginal cost) curve excluding carbon costs, while S_1 includes carbon costs. D is the demand curve, while MR is the marginal revenue curve.

4.1.2 Difficulties in applying the theory

If the diagrams shown in Figure 4.1 were accurate representations of markets, then it would be simple to calculate the expected impacts of carbon costs on industrial sectors. There are however a range of difficulties and uncertainties in the application of theory, which are now briefly described.

Linkages to the wider economy

To calculate the effects on the economy as a whole would require the linkages between the sector and the rest of the economy to be assessed. These linkages are many and can be complex – computable general equilibrium (CGE) models are generally used for such considerations, and the results from a review of them is presented in Section 4.4.3.

Market Structure

Firstly the rationale for including two diagrams in Figure 4.1 is that the number of firms in the market has a major impact. Expected impacts of carbon costs are very different if there are a small or large number of firms (in the diagram, the limits of the range – perfect competition and monopoly – are illustrated, with the reality for most energy-intensive sectors likely to lie somewhere in between).

The second consideration is how supply and demand should be represented. The Figure includes simple straight lines, based on assumptions that: there are a continuous set of suppliers with progressively increasing costs; the value of the product to consumers declines steadily with increasing quantity. If we assume different shapes for either or both of these curves, then the values of producer surplus, cost pass-through, etc. can be very different (see Sijm et al., 2008). Even if we can decide on the appropriate form of the demand and supply curves, we also need values to describe their slopes: these 'elasticities' are not readily available, and tend to have high levels of uncertainty. And finally there are imperfections in many markets which take behaviour away from theoretical constructs.

Pricing strategies

Firms will follow the theory summarized in the diagrams if they are following profit-maximising strategies based on changes to their marginal costs of production. In certain cases average cost pricing may be used, for example regulated markets such as electricity where governments wish to regulate away from monopoly pricing and retail markets where there are many products (CE Delft, 2010). Whilst profit-maximisation may the optimum strategy over the long-term, pricing to protect or increase market share may be part of firms' behaviour over shorter time periods.

The short- and long-term

If the theory is applied to the short-term case, there is no need to take into account investment costs; in the longer-term, firms must cover investment costs in order to remain in the market. The diagrams presented in Figure 4.1 could refer to a snapshot in time or to an average covering the longer term; the distinction is important.

Conclusions on the difficulties of applying theory

The diagrams presented in Figure 4.1 can be used to project changes to prices, profit, pass-through of costs, etc. resulting from the implementation of a carbon cost to a given market. But the assumptions required, and the quality of the available data, mean that such calculations are subject to major uncertainties. In response to these, commentators such as Richard Baron of the International Energy Agency have called for empirical work to be conducted to take the debate forward. Yet such studies are rare - CE Delft (2010) present their study as being "the first ex-post cost pass-through analysis of several energy intensive sectors that have to comply to the EU ETS".

Without such empirical evidence, and interpretation of the independent impacts of carbon costs, policy-makers are condemned to make their decisions in an atmosphere of major uncertainty, and are thus more likely to adopt a risk-averse strategy.

4.2 Influence of the allocation methodology employed

The analysis so far assumes that a uniform carbon cost is applied to an industry in an economy, through either a carbon tax or the auctioning of allowances under a carbon trading scheme. The situation is complicated if it is decided to compensate industry fully or partially for the extra costs they face under a trading scheme by granting them free allowances. It becomes more complicated as the rules governing the granting of free allowances themselves become more complicated, for example if they include rules governing plant closures and new market entrants. Because there is the possibility of over-compensation, the possibility of 'windfall profit' arises, particularly if there is major uncertainty as to how the market will react and policy-makers exhibit risk-averse behaviour.

The most important current case is the EU's ETS, which has granted free allowances, with limited amounts of auctioning, since its inception in 2005. The economic impact of free allowances under absolute caps is thus the first case considered. Other schemes, notably the US, may use output-based allocation or rebating, and the impacts are discussed in Section 4.2.2.

4.2.1 The impact of free allowances under absolute caps

Absolute caps limit emissions irrespective of the level of economic output – if the firm produces more than was expected, it will either need to increase the efficiency of its output or buy allowances. Under absolute caps there is widespread agreement (amongst many examples, see CE Delft, 2010) that rational firms should take into account the value of the carbon emitted during production – whether allowances are granted these for free, or have bought at an auction or on the market. In economic terms, allowances have an opportunity cost: in simple terms, there is the opportunity to sell them if they are not needed for compliance. A firm which does not take this cost into account is not acting to maximize its profits.

The concept of 'opportunity cost' has some important conclusions for policy design:

i. in the short-term, it implies that granting free allowances is not likely to be successful in reducing competitiveness and leakage impacts. Firms could use their free allowances to reduce their market prices, but this is a sub-optimal economic strategy: they would be better off using them for one or many other purposes;
ii. if firms pass-through carbon costs on the basis of opportunity cost, and receive some or all of these allowances for free, the possibility of 'windfall profit' is raised. This will result if a firm makes more profit than it would have done without the climate change scheme, due to its receiving allowances for free and also being able to charge higher prices in the market;
iii. even if a firm should act independently of how it received its allowances in the short-term, it is clear that in the long-term there is a difference in the financial position of a firm granted allowances for free and one who has paid for them. Identifying how this difference affects a firm's decisions and financial health is a relatively new area for research.

The second and third issues are areas of significant current debate and the arguments and evidence around them are now discussed. But details are also important to impacts. The final part of this section discusses how the impacts of free allowances alter as a function of allocation rules governing new entrants and plant closure.

Over-compensation and the 'correct' level of compensation

Free allowances may be granted for a variety of reasons, including supporting ailing industrial sectors or, as has been one of the reasons in the EU, helping to harmonize allocation between EU Member States. This paper focuses on the economic issues; this section concerns itself with ascertaining whether we can 'establish' a correct level of free allowances which can be granted. Exceeding this level would lead to over-compensation and a windfall to the firms concerned.

In simple terms, there are two steps required in the assessment for a particular industrial sub-sector:

1. establish the increase in production costs the carbon policy would lead to;
2. establish how much of this production cost increase can be passed through to consumers.

Operationalising these two steps is more difficult. The increase in production costs requires: an assumption of what carbon price should be used; the carbon content of the product under consideration; extra costs due to the carbon price of inputs to production, notably electricity; and a financial denominator (production cost, profit or price) to compare the increases to. The largest source of uncertainty is probably the assumption of which carbon price to use, for example the European Commission has used €30/tCO_2 for the majority of its analyses of competitiveness and leakage assessments, although the average market price over the past few years has been nearer to half of this value. The financial denominator used by the European Commission and most academic studies on competitiveness and leakage has been value added (see Section 4.3). Materiality is also a general consideration – thus the EU defines energy-intensive industry as being that where the cost of purchasing energy products and electricity is at least 3% of its production value.[30]

The second step is more problematic. A full analysis requires assumptions on market structure (supply and demand curves) and the exposure to international competition of a product. To this can be added other considerations, for example the relative costs of abatement the sub-sector could access in the regulated economy and elsewhere.

Applying these principles in practice is much more difficult. Box 4.1 indicates the European Commission's proposed methodology for Phase 3 of the EU ETS (2013-20) as of January 2008 (Commission of the European Communities, 2008). After 10 months of investigation, consultation and negotiation, it had been decided that proxy measures of trade intensity and price increase were most appropriate.[31]

[30] In line with the "Energy Products Tax" directive (Directive 2003/96/EC).

[31] With trade intensity defined as (total value of imports + exports)/(total value of turnover + imports) and price increase as (increase in production costs)/(gross value added).

BOX 4.1: Determination of sectors "at significant risk of carbon leakage", revised Directive (proposal as at 23 January 2008)

> "In the determination ... the Commission shall take into account the extent to which it is possible for the sector or sub-sector concerned to pass on the cost of the required allowances in product prices without significant loss of market share to less carbon efficient installations outside the Community, taking into account the following:
>
> (a) the extent to which auctioning would lead to a substantial increase in production cost;
>
> (b) the extent to which it is possible for individual installations in the sector concerned to reduce emission levels for instance on the basis of the most efficient techniques;
>
> (c) market structure, relevant geographic and product market, the exposure of the sectors to international competition;
>
> (d) the effect of climate change and energy policies implemented, or expected to be implemented outside the EU in the sectors concerned.
>
> For the purposes of evaluating whether the cost increase resulting from the Community scheme can be passed on, estimates of lost sales resulting from the increased carbon price or the impact on the profitability of the installations concerned may inter alia be used."

The EU finally set hurdle rates to establish whether a "sector or sub-sector was at a significant risk of carbon leakage" if: the price increase was at least 5% and trade intensity was at least 10%; or, if either the price increase or trade intensity individually was at least 30%. If they were found to be so – and it is widely expected that a very large part of EU industry will meet these conditions – then installations would be awarded free allowances up to the level of the average of the 10% of best EU performers. The total number of allowances granted under the EU ETS would decline by 1.74% per year from 2013, and thus we could expect industry to begin to receive progressively less that the 'best available technology benchmark' at some future date.

So would these rules result in the 'correct' level of abatement? It should firstly be noted that the use of a 'best available technology benchmark' would only correspond to an economically correct level of abatement by chance: one concept is a physical one, the other economic. A benchmark cannot take account of the shape of supply or demand curves or the exposure of a sector to international competition. And the level of benchmark set should not alter the incentive to abate emissions between good and bad performers in the sub-sector – they are all exposed to the same carbon price.

One interesting facet of the EU's considerations has been the acceptance that the electricity generation sector can pass-through all its cost increases, and that it had gained windfall profits in the first two phases of the EU ETS (2005-7 and 2008-12). In contrast, windfall profit was not considered to be an issue for any industrial sector. Given that the 'best available technology benchmark' is likely to be close to average emissions for many sub-sectors, the European Commission's rules are likely to result in windfall profits for many sub-sectors unless cost pass-through rates are low. For example, if the 'best available technology benchmark' was calculated to be 80% of the average emission factor in the sector, a cost-pass through rate of only 20% would be needed to leave average sub-sector income unchanged.

The majority of the academic literature has been based on assumptions of what shapes the supply and demand curves take and their slopes (elasticities). As discussed in Section 4.1.2, it is not straightforward to find a basis for these assumptions. One approach to the problem is to define a full range of scenarios of curve shapes, slopes and numbers of firms in the market and to see how cost pass-through rates are distributed; such an analysis is considered to be unlikely to yield values as low as 20%. CE Delft (2010) have taken an empirical approach to the problem, for seven products in the iron and steel, refineries and chemicals sectors. Their econometric analysis indicates cost pass-through rates of 100% of the opportunity cost for six of the seven products, with a rate of 33% for polystyrene.

There appears to be strong evidence that the EU ETS has over-compensated many industrial sub-sectors during its first two phases (2005-12) and will continue to do so in Phase 3. While it is difficult to set the 'correct' level of free allowances, a lower value than the 'best available technology benchmark' is strongly indicated, for example an assumption that 50% of costs could be passed through. One promising avenue of research may be to add further criteria to the European Commission's current set of two. Ongoing work by Climate Strategies (forthcoming) conducts a 'deep dive' (into specific products) work aims to begin the identification process, although finding robust data on which to firmly base critieria has been shown to be difficult. Perhaps more qualitative considerations, and the acceptance that some sectors may end up getting a better deal than others for whatever reason, is a good approach – whilst it may not be fully robust or equitable, it may be better than the considerable cost resulting from granting many energy-intensive industrial sub-sectors windfall profits.

It is also worth questioning the basis of the European Commission's decision to progressively decrease the level of free allowances granted in Phase 3. If this a recognition that there is over-compensation in the initial years, then why not reduce this allocation? If the driver is industrial policy (the desire to allow affected industry to steadily decline), then it is worth considering whether carbon policy in general and the granting of free allowances in particular is the best policy instrument.

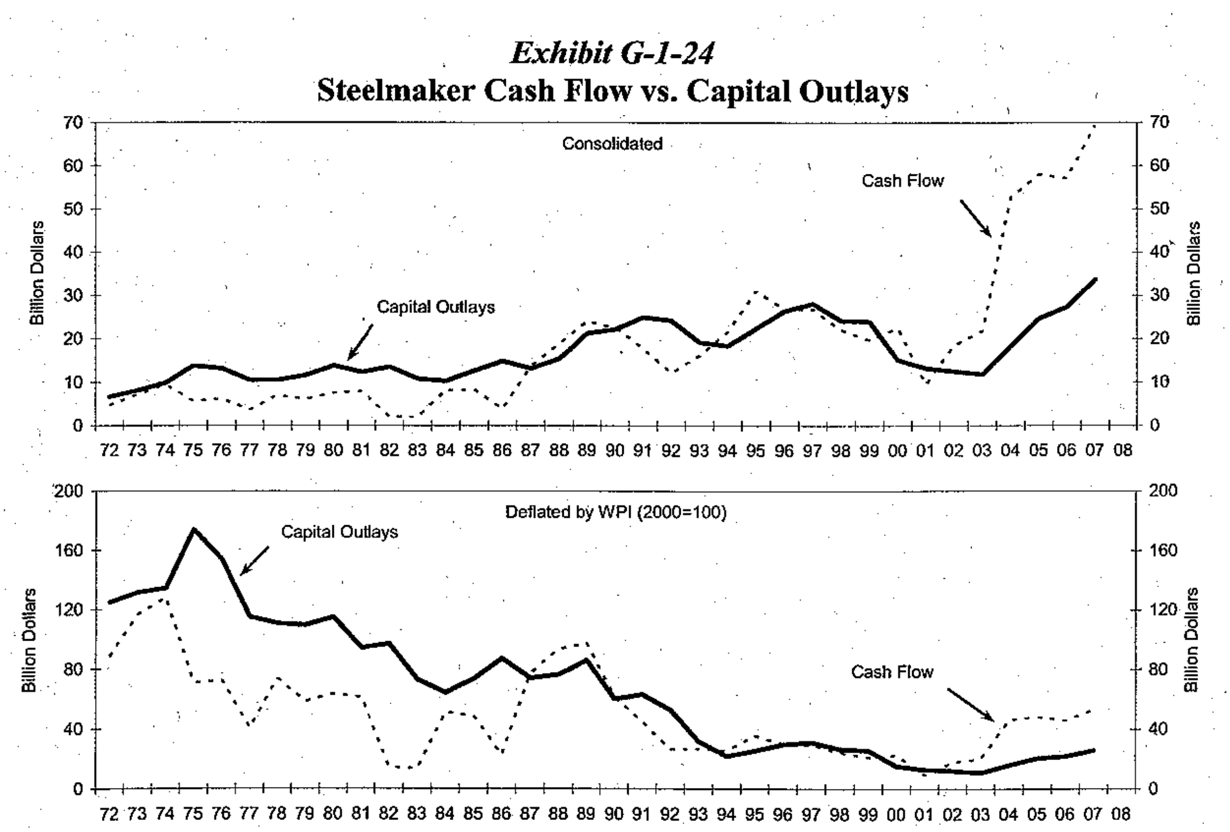
Long-term impacts of granting allowances for free

If we accept the proposition that companies account for the opportunity cost in their short-term decisions, we must then ask what impacts receiving free allowances has in the longer term. This is one of the key open questions within the debate around responses to competitiveness and leakage concerns. It is firstly clear that the wealth of companies is linked to their ability to invest and otherwise expand. Figure 4.2 shows a figure linking steel industry cash-flow with investment (World Steel Dynamics, 2008). The authors of the analysis conclude that there is a strong link between the two, with investment lagging by 1-2 years. This type of relationship gives a starting point for the analysis of the impact of free allowances. For the steel example, World Steel Dynamics (2008) calculate world EBITDA (gross profit) as between \$32-199 billion in the period 2001-09. If all world allowances had to be purchased, and this purchase was at a price of \$20/tCO_2, then this would cost \$50 billion, i.e. 30%-150%

of the industry's gross profit. This appears a significant additional cost, although the level of cost pass-through may significantly reduce its impacts on profitability.

There are also other important impacts, for example a company with a healthy balance sheet will generally be able to borrow money more cheaply than a less healthy one, and can engage in more projects and at higher risk levels. Again the analysis around these is not at all well-developed. We can tentatively conclude that free allowances would be an important determinant of a sector's prospects in at least some sectors. By extension, over-compensation may end up strengthening the very sectors which cause much of the GHG emissions we are seeking to control. Whether this strengthening would increase or decrease their emissions is yet another unknown at present.

Figure 4.2: Cash flow and capital outlays (World Steel Dynamics, 2008)



Comparing the level of extra carbon costs to industry profitability and capital outlays provides useful context but remains only a first stage in from answering the critical question: what would companies do with free allowances? These are essentially like shares – readily convertible, at the prevailing market rate. Whether or not they are subsidies under the WTO (World Trade Organisation) has yet to be tested and is beyond the scope of this paper, but many commentators believe that they are. And the thought that they might be subsidies shows the potential for them to generate 'windfalls'.

So what will companies do with free allowances? There are various options, and little evidence to tell us. Options include using them to:

- support short-term prices. The methodology used by OXERA in the important study for the Carbon Trust (2004) effectively assumes this is the case, although the previous section of this report concludes that the opportunity cost concept will be used by profit-maximising companies;
- build up a firm's 'slush fund' against unexpected future events, including but not confined to stricter carbon policies and measures in the EU. There is anecdotal evidence of companies facing difficulties following the financial crisis cashing-in their free allowances;
- build an investment fund for use in the EU or elsewhere, for new investment or refurbishment;
- be a general contributor to a company's profits and dividends.

Analysis of the steel sector (Wooders, 2010) suggests that, while important, carbon prices are likely to be only very rarely the key determinant of a sector's investment decisions at any specific time. The issue would clearly benefit from further research.

The impacts of allocation rules governing new entrants and plant closure

Emission trading schemes with absolute caps (notably the EU ETS, during Phases 1 and 2, but not as planned for Phase 3) generally include provisions relating to how emissions are allocated to firms based on their previous allocations; that is, how allocation is updated. The schemes also make provisions for new entrants and set rules governing what happens when plants or facilities close.

In many cases a firm will be granted some emission allowances in the future dependent on what its production is in the present. This dilutes the effect of the carbon price signal, because if a firm sees a market carbon price of $20 per tonne of carbon dioxide, but knows that an extra unit of production will likely lead to an emission allowance in five years, when the next allocations are set, it should discount the present value of this future emission allowance from its opportunity-cost calculation.

Consider the hypothetical example of a firm that faces a current carbon price of $20 per tonne of carbon dioxide, but knows that emitting now may lead to it receiving an allowance valid for its emissions in five years. If the firm discounts its costs at 10 per cent per year over the five years, assumes there is a 75 per cent chance of there still being an ETS in the future and assumes the price of an emission allowance in five years will be $30 per tonne of carbon dioxide, the expected present value of the future allowance would be $14 per tonne of carbon dioxide. The effective carbon cost faced by the firm in this case would thus be only $6 per tonne of carbon dioxide.

This example is clearly highly scheme specific, but illustrates a key point: when considering compensating firms for the impact of carbon costs, policy-makers should take into account whether the carbon cost of a firm has already been diluted by the scheme's allocation rules.

4.2.2 Output-based allocation (and rebates)

A major alternative to granting free allowances on an absolute basis is to grant free allowances as a function of a firm's output. At the fundamental level, this option is less economically efficient than using absolute caps: by removing the incentive to reduce production, the costs of meeting a given cap becomes more expensive than if the option were retained (Demailly and Quirion, 2006).

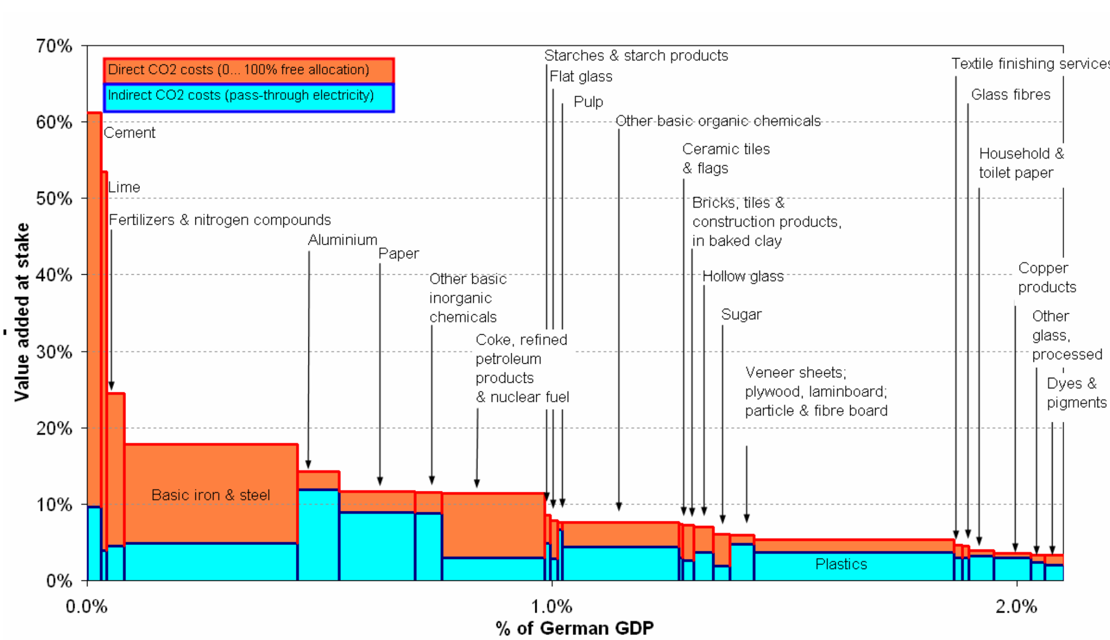
But there are also criteria against which output-based allocation performs well. A current example is the significant downturn of emissions which the EU ETS has seen following the financial crisis. Sandbag (2010) note that the EU ETS' rules, which include banking of allowances from Phase 2 into Phase 3, will guarantee that the emissions saved from the downturn are guaranteed to be emitted at a later date, whereas output-based allocation (OBA) would not have this downside. Clearly the opposite argument could be applied if there were a major boom in the EU's economy.

A range of arguments for and against OBA have been mooted. While difficult to summarise them all, the use of OBA with rebates as envisaged under the United States' Waxman-Markey bill (2009) and other proposals can be defined as allowing a relatively soft start to be made regarding carbon commitments. OBA with rebates effectively reduces the risks of competitiveness and leakage, particularly from unforeseen changes in production levels. But it does so by also reducing the incentives to abate GHG emissions (see for example Fischer and Fox, 2009).

4.3 Sectors at risk of competitiveness and leakage impacts

Figure 4.3 is an excerpt from one of several studies which show how a certain carbon cost (in this case €20/tCO_2) would increase average carbon costs on industrial sectors (in this case in Germany). Graphs from different studies and covering different countries draw very similar conclusions, leading to the well-known series of sectors considered to be at risk. These are typically: cement and lime, iron and steel, pulp and paper, aluminium (if the indirect costs of increased electricity prices are included), basic inorganic chemicals and nitrogenous fertilisers. Together these sectors typically make up 1% of a country's GDP and of the order of 10% of its GHG emissions.

Figure 4.3: Possible impacts of EU-ETS on German manufacturing sector (20EUR/tCO_2). Direct and indirect cost impacts on manufacturing sub-sectors in Germany - assuming 20EUR/tCO2 carbon price and corresponding 19EUR/MWh electricity price increase: 2004 data. ***Source: Sato and Mohr, 2008 adapted from Öko-Institut 2008.***



The conclusion that sectors with more than a specific level of “value added at stake” (i.e. whose production costs would increase significantly at a certain carbon cost) are at risk of competitiveness and leakage impacts is clearly a simplification. Perhaps its major assumption is that exposure to international trade, and hence the ability of sectors to pass-through cost increases, can also be included in this indicator.

An interesting way of taking the analysis further is included in the Grattan Institute (Daley and Edis, 2010) analysis of Australia’s proposed CPRS scheme. Starting from a list of sectors which are carbon-intensive, it develops sector-specific analyses that indicate whether carbon costs might alter the ability of specific Australian plants to compete internationally. It does so by analysing where Australian plants sit on international supply curves and then assessing how these plants’ positions might alter if the proposed CPRS scheme led to the carbon costs being implemented. If the position is not fundamentally altered, there is no impact and the plant is considered able to absorb the carbon cost without competitiveness and leakage impacts. This is the case for industries including coal mining and LNG (liquefied natural gas). It is only in the aluminium refining, iron and steel and cement sectors that carbon costs appear significant enough to alter the competitiveness of industry. In the case of aluminium refining, this could put some plants immediately out of business, although the Grattan Institute conclude that replacing Australia’s refining, which uses electricity generated from coal, would reduce world GHG emissions. For cement and iron and steel, the increased costs would not put plants out of business immediately but may affect the decisions regarding future investment. But the study notes that there has not been any significant investment in the two sectors for a significant period of time; if this trend provides the baseline, then we cannot conclude that the implementation of a carbon cost would reduce future investment.

The Grattan Institute study provides a number of useful lessons:

- getting into plant level detail is illuminating;
- there are practical methodologies which policy-makers can use, even when faced with significant uncertainty;
- the methodology readily identifies where there may be concerns, and where they are not. If we accept that there may be significant economic and/or political costs from implementing responses to competitiveness and leakage concerns, then it must make sense for such response measures only to be contemplated for those sub-sectors where there is really the potential for impacts.

4.4 Economic impacts of options to reduce competitiveness and leakage impacts

Section 3.1 reviewed the empirical evidence of the impacts of carbon prices in the EU ETS and CDM. The principal conclusions were that: it appeared too early to draw definitive conclusions as to the impacts of the EU ETS, particularly because of the inclusion of free allowances; the impacts of the CDM hinge on an assessment of additionality, and this additionality cannot be measured purely in economic terms. To these conclusions can be added the growing view that carbon prices may not, on their own, be sufficient to drive significant abatement of GHG emissions.

This section expands on this analysis by assessing what can be learned from simulation models and other theoretical analysis. It does not look only at whether responses to competitiveness and leakage concerns would be effective at reducing these concerns within certain sectors – it is also necessary to ask what the impacts on the wider economy would be, nationally and internationally. This section briefly reviews five issues:

a. Free allowances;
b. Sectoral approaches;
c. BCAs;
d. Sector-specific solutions;
e. Economic impact assessments made for the EU and US schemes.

4.4.1 Free allowances

There has been little direct modeling of the impacts of free allowances. What has been conducted has largely been within partial equilibrium models. PEMS typically aim to analyse a single industrial sector. Their advantage is that they can do so in detail, simulating the many specificities of the sector in question, for example its GHG abatement opportunities, transport costs or use of recycled materials. They tend to simulate at best only a partial linkage to the rest of the economy and do not generally include the positive and negative feedbacks from changes to market equilibrium prices for other products.

Partial equilibrium models have tended to focus on the EU ETS, typically estimating carbon leakage impacts for sectors considered at significant risk. Steel and cement have been the most studied sectors, with aluminium and electricity following. The leakage rates projected are highly variable and should be seen as providing useful indications of relative, rather than absolute, results. The differences between models mean that it is difficult to compare their results on an absolute basis (Wooders, Cosbey and Stephenson, 2009). Reinaud (2008) summarises studies showing that leakage rates could range from 0.5% to 70% in the iron and steel sector. Again looking at steel, a study by Gielen and Moriguchi (2002) on the steel sector in Japan and the EU-15 shows a doubling of the leakage rate from 35% to 70% when the carbon cost applied is increased from \$11/tCO_2 to \$42/tCO_2.

The models tend to conclude that some production tends to relocate to countries without carbon prices. They are of course driven by assumptions, the most important probably being how decisions on where to invest in new plant investment are modeled. In the short term, the potential for the movement of production between the existing set of plants can be reasonably well understood, noting that there remain the whole set of reasons driving Armington elasticity effects (the need for exporters to offer prices below domestic producers in order to gain market share). Industry also has the ability to defend itself, at least in the short term, by moving away from profit-maximising strategy and other measures (Hufbauer and Goodrich, 2002 is one of many papers highlighting the number of cases of litigation that the US has taken against steel importers). For the longer term, assumptions must be made on the drivers of where new plants will be built. This is far more complex than the consideration of short-term production movements. Although investors will consider current and potential carbon policies and measures, they will also consider factors such as how fast local markets are set to grow, labour costs, availability of raw materials, environmental regulations and likely transport costs of getting goods to the most valuable markets.

As concluded in Section 4.2.1, we still have only an incomplete understanding of how such decisions are made in practice, including on how free allowances might impact these decisions in the long-term. Given how sensitive model results are to the assumptions made, considerable uncertainty must be associated with all models – PEMs and others - ability to predict how long-term competitiveness and leakage impacts are impacted by carbon costs and response measures.

4.4.2 Sectoral approaches

Sectoral approaches have often been presented as a solution to competitiveness and leakage concerns. They could be – but only if they reduce carbon cost differentials between economies. In order to do so to any significant extent, they would need to see transnational trading of carbon allowances. Other proposed sectoral approaches – for example sectoral no-lose targets in developing countries or agreements between countries to progressively standardize technologies – would have only a very limited impact on reducing cost differentials. Those sectoral approaches which do not allow for transnational trading of carbon allowances would not alter the essential difference in conditions faced by countries – one has to pay a carbon cost on its emissions and the other does not.

Sectoral approaches featuring transnational trading of carbon allowances enjoy very little support at present in the UNFCCC, from either developed or developing countries. Their implementation in at least the medium-term must be considered highly unlikely. If sectoral approaches are to be implemented, we are much more likely to see national schemes (in developing countries, probably in the form of NAMAs – nationally appropriate mitigation actions) or the slow introduction of technology-oriented agreements (see for example the Asia-Pacific Partnership on Clean Development and Climate, www.app.gov). We can conclude that sectoral approaches, in the forms which have the highest chance of implementation, would not have a significant impact on competitiveness and leakage in the medium-term.

4.4.3 Border carbon adjustment

Applying a BCA within a PEM yields interesting, if tentative, results. Monjon and Quirion (2009), modeling the EU and its ETS, have assessed different forms of BTA (border tax adjustment). As an example, they find that applying a full border adjustment to steel (export rebates and import tariffs) can see a 40% leakage rate outside the EU reversed to a negative 25% leakage rate of carbon into the EU: the combination of export rebates and import tariffs allows EU producers to gain market share.

PEMs tend to conclude that BTAs would be effective in reducing competitiveness and leakage impacts. But they are unable to simulate impacts across the whole economy, which models of the whole economy tend to conclude are extremely important. Whilst results are again tentative, and based on a series of assumptions, (computable) general equilibrium models "cast doubt over the effectiveness of border adjustment for offsetting competitiveness and leakage" (Wooders et al, 2009a). Reviewing studies from the literature, the paper concludes that, "BTA may be useful for reducing costs facing carbon-intensive domestic industry, while the effect on reducing leakage is less clear and might only be modest. BTA is likely to be less useful for minimizing the overall costs of climate policy." The reasons critically include the fossil fuel price leakage channel, where reductions in fossil fuel demand because of carbon policy in one part of the world lower prices (and hence increase demand) in the rest of the world, and changes to demand in general and demand for products from regulated sectors in particular.

Whilst highly divergent impacts are noted, the models all project that domestic welfare will be reduced. In general, they also show welfare decreases in the rest of the world. McKibbin and Wilcoxen (2009), in a simulation of the effects of BTA in the United States, find that BTA reduces demand for US exports by lowering welfare in trading partners, more than offsetting the protective effects of BTA. Finally, BTAs are shown to increase the cost of carbon reductions; this comes about because abatement costs tend to be lower in sectors being considered for protection using BCAs than for other sectors of the economy.

A consensus viewpoint does emerge from the models as to the likely sign and magnitude of impacts. In part this is because they tend to use the same database (GTAP). But we should also bear in mind how the models decide where to place, for example, new plant. Algorithms within the models are generally based on the econometric analysis of past relationships between variables – the ability of the models to offer good projections depends on these holding into the future.

4.4.4 Sector-specific solutions

Analysis is now being released arguing that it may be preferable to use sector-specific solutions to competitiveness and leakage concerns, rather than a "one-size-fits-all" approach. Dröge (2009, for Climate Strategies; and 2010, for the Carbon Trust) has developed a decision-making framework for designing sector-specific options, and has included within this the option of investment subsidies. For three key sectors, she concludes (see Figure 4.4 for details):

- *Aluminium*: give investment subsidies, consistent with EU State Aid rules;
- *Steel*: free allocation, with a new entrant reserve;
- *Clinker and cement*: benchmarked border leveling.

The main conclusion from this work is probably that deeper analysis, on a sector-specific basis, is needed to identify the most appropriate solutions.

Figure 4.4: Sector-specific responses to competitiveness and leakage concerns (Dröge, 2009, 2010)

Aluminium – Investment subsidy: Consider on a case-by-case basis consistent with EU State Aid restrictions and intensify efforts to decarbonise EU power generation, including review of options to facilitate long-term contracts for low carbon based power. Pursue full carbon-added accounting procedures around aluminium and other electricity-intensive processes globally. Use product labelling both to facilitate consumer pressures for 'low carbon' aluminium and to provide the basis for possible border levelling that reflects actual embedded carbon and rewards low carbon intensive manufacturers wherever located.

Steel – free allocation with new entrant reserve: Complement transitional allocation of free allowances to steel producers (which provides a temporary but incomplete solution) by close monitoring to establish the potential extent of operational leakage from facilities receiving free allowances. Work with US and others on mutual recognition of climate change action and the options for designing border levelling for specific steel products. The core objective should be to move from free allocation to one of three options that reflect full carbon costs by 2020: import levelling, export adjustments by producer countries, or a carbon-cost-reflective global sectoral agreement.

Clinker and cement – benchmarked border levelling: Pursue multilateral negotiations prioritised to ensure that all cement consumed in the EU pays a carbon cost irrespective of origin, by requiring importers of clinker and cement to purchase EU ETS allowances or surrender matching credits. The starting point, analogous to excise taxes already applied to petroleum, should be to establish a fixed 'benchmarked' requirement to purchase per tonne of product, based on emission levels from best available technology.

4.4.5 Economic impact assessments made for the EU and US schemes

The US has only recently (May 2010) commissioned official bodies to assess the impacts of their proposed policies, now the Kerry-Lieberman bill. They have charged the Congressional Budget Office, Environmental Protection Agency and the Energy Information Administration to assess the economic impacts. "If the CBO analysis concludes the cost of reducing US emissions and reliance on fossil fuels will come at a modest cost, it could improve the bill's chances of passing, experts say. But if the CBO finds the bill will impose a high financial burden on consumers, especially middle class families, it will give ammunition to the bill's opponents."[32] Elmendorf of the CBO further noted that "carbon-capping legislation usually results in a reduction of national gross domestic product (GDP) and employment, but said by how much depends on how the policy is written" and that modeling the negative impacts of climate change on the US economy represented a major challenge.

The European Commission conducts impact assessments for all its major policies. Within the proposed energy and climate change package released on 23 January 2008 (covering Phase 3 of the EU ETS; Commission of the European Communities, 2008b), the impacts on GDP of granting free allowances were compared to auctioning. The results were that a 0.5% decrease in GDP in the period to 2020 would be expected if free allocation were used, reducing to 0.35% if auctioning were used. The impact assessment stated that the results are dependent in how auction revenue is recycled, which affects GDP, employment and the distribution of income. In general, CGE models tend to assume that revenues received go back into general household income. CE Delft (2010) point out that the possible downside from hypothecating revenue, for example to clean energy infrastructure, which may increase the welfare loss from policies if the options chosen are not part of the optimum expenditure mix.

The European Commission (2010) has also recently released its assessment of the costs of moving from a 20% reduction in EU emissions by 2020 to the 30% value which would result if there were a global climate change agreement where other countries take on their "fair share". It says "since 2008 the absolute costs of meeting the 20% target have decreased from €70 billion to €48 billion (0.32% of GDP) per year by 2020. This is due to several factors: lower economic growth has reduced emissions; higher energy prices have spurred energy efficiency and reduced energy demand; and the carbon price has fell

[32] See http://www.pointcarbon.com/news/1.1444760

below the level projected in 2008 as EU ETS allowances not used in the recession are carried forward. However, at the same time, this reduction in absolute costs comes in the context of a crisis which has left businesses with much less capacity to find the investment needed to modernise in the short run. Since 2007 the EU is committed to move to a 30% emissions cut by 2020 if other major economies take on their fair share of the effort under a global climate change agreement. The cost of reaching the 30% target is now estimated at €81 billion per year by 2020, €11 billion higher that the price tag for the 20% target two years ago. The 30% target would cost €33 billion (0.2% of GDP) more than the 20% target is estimated to cost today."

4.5 Economic impacts in non-regulated countries

Section 4.4.3 briefly reviewed the results of global models assessing the economic impacts of carbon pricing with BCAs, concluding that these tended to result in welfare losses in all countries (i.e. both those implementing policy and those outside). But another policy aim commonly stated by proponents of BCAs is that they will leverage actions to reduce GHG emissions in other economies. The intuitive view that a BCA would result in significant leverage appears to be widely held.

Whilst there are significant political issues around the implementation of BCAs, this paper examines the economic impacts only. The economics question we are asking is whether a carbon price in one economy will lead to an effective carbon price in (non-regulated) economies, and how this would be modified by the imposition of a BCA.

Section 3.1 concluded that carbon prices alone may not be sufficient to incentivize abatement; clearly the lower these carbon prices are, the lower any incentive is. Abatement impacts may be low even if there are significant economic costs. But it is far from clear that there would be significant economic costs. A simple modeling assessment of the world steel industry (Wooders, 2010) concluded that only a very low effective carbon price in developing countries would be created by carbon prices in the NAFTA and EU regions of \$50/tCO_2 – which must be considered at the high end of estimates. If we accept that there must be compliance with WTO rules, then countries or regions which levy BCAs can only do so up to the level at which they levy costs on domestic producers. Thus a BCA of \$50/tCO_2 could only be levied if there were a carbon price of \$50/tCO_2 in the market in question *and* there were no compensation given to domestic producers (or there were a higher price and partial compensation). The highest EU ETS price has been of about this value, but industrial sectors have received, and will continue to receive post-2012, significant quantities of allowances for free. These should be subtracted before any BCA is calculated.

What an eventual US scheme may look like is still uncertain. The Waxman-Markey bill included output-based rebates, which again should be subtracted from the carbon price before any BCA were calculated. Kerry-Lieberman may see a carbon price collar, with a starting point in the range \$12-28/tCO_2. Industry would be exempted from any cap-and-trade scheme until at least 2016 under the latest plans. Whether there were will be eventual compensation payments to industry, or whether revenues from auctions are recycled back to the population under a 'cap-and-dividend' scheme, or some other methodology is used, remains uncertain.

The conclusion is that applicable BCAs would be low, at least for the medium-term. Even if they were significantly higher, initial analysis suggests that their impacts on non-regulated economies would be low.

4.6 Implementation issues

This paper does not directly consider issues outside economic effectiveness. Yet a general point arising from the literature is worth making: implementation issues will tend to reduce the level of BCA which can be charged.

On the data side, the level of carbon content on which a BCA could be levied will tend to be reduced from its actual level. Even for sectors with relatively simple, homogenous products – e.g. steel and cement – there are sufficient differences in products, production methods, inputs, gaming options, etc. to give rise to uncertainty (see for example Wooders, Reinaud and Cosbey, 2009). On the legal side, the need to devise workable schemes would have a similar impact in reducing the effective level of carbon level against which a BCA could be charged. Clearly the lower the level of tax which could be levied, the less effective the BCA would be in reducing competitiveness and leakage impacts. Papers 4 and 5 discuss these issues in detail, although further work is required to pin down precisely how much implementation issues would reduce the level of carbon content on which a BCA could be levied.

Drawing some general conclusions from the discussion of economics presented during Section 4 we can conclude:

- many sub-sectors to which the EU plan to grant free allowances do not appear to need protection. Granting protection when it is not needed involves an opportunity cost;
- similarly, there is a lost opportunity cost when sectors are over-compensated by being granted too many free allowances;
- under BCAs, all other sectors of the economy, and all countries, will generally lose welfare. In certain cases, this loss of welfare outside the protected sector can cause it to lose welfare too.

5 Key messages for policy-makers

1. Would tariffs and subsidies designed to mitigate the impacts of unilateral climate change policies be cost-effective? In common with many policy questions, we have: some empirical evidence to answer the question; a range of modeling and other theoretical analysis; differing opinions; and uncertainty.
2. This paper discusses the two major options being discussed as responses to competitiveness and leakage concerns:
   a. *Border carbon adjustment (BCA)*. BCA would apply a tax, or require the equivalent purchase of carbon emission allowances, on the import of products into a market with a carbon cost. Rebates could also be applied to exports from this market. When applied as a tax, the mechanism is typically referred to as a 'border tax adjustment' (BTA);
   b. *Free allowances*. Allowances to emit carbon dioxide and other greenhouse gases can either be granted for free to companies (i.e. are "free allowances") or must be purchased (at auction or on the carbon market).

   Whilst these options have characteristics that can define them as "tariffs" and "subsidies" respectively, it is not an exact overlay and it is more precise to refer to them simply as BCAs and free allowances.

3. "Competitiveness" concerns are generally understood to occur at the sectoral level, for example relating to how production or other costs differ relatively between two jurisdictions in response to a certain policy or measure. "Leakage" is defined as any increase in greenhouse gas (GHG) emissions in foreign jurisdictions that results from climate policies taken in an implementing jurisdiction. It is an issue for environmental policy-makers who fear that it might undermine the environmental effectiveness of their regulations. Competitiveness and leakage are intimately connected and largely follow the same mechanisms, for instance the movement out of a regulated jurisdiction of production in the short term would be a result of a loss in competitiveness and would be likely to result in leakage. The impacts of this production movement could importantly include the loss and relocation of jobs, and there is at least circumstantial evidence that BCAs could be, and free allowances are, implemented in order to support domestic employment.
4. There is very little direct empirical evidence of the impacts of climate change policies. Evidence from the EU ETS Phase 1 (2005-7) tends to conclude there has been little impact, although data quality issues, the ability to separate out the effects of the EU ETS alone and the granting of free allowances confuse the picture. There is the possibility that these issues will continue to make conclusions drawn from empirical analysis uncertain, even if we have better, longer time period data available in the future. Analysis of the impacts of the CDM depend on what is considered additional to a business as usual baseline. This is not only an economic question – behavioural effects, e.g. the time higher management spend engaging in energy efficiency discussions, is also important.

5. In the absence of empirical information, we must rely heavily on theory and simulation models applying this theory.
6. Outside climate change, there are competitiveness impacts associated with environmental regulation, that in most cases they are moderate, but not in all cases. Several of the surveys cited above found that unobserved heterogeneity was a problem, as was over-aggregation of sectors. The key here is that firm and sectoral characteristics matter a great deal when we consider the competitiveness impacts of environmental regulations. These results seem to be generally in line with the analysis and literature to date on the impacts of climate-related regulations.
7. Again outside climate change, most studies seemed to find that violating core labour standards had little or no impacts on trade or investment flows, but the results are still not entirely satisfactory – the problems of unobserved heterogeneity and endogeneity are problems here, as they are for the studies looking for pollution haven effects. While some analysts found tariffs and bans potentially effective, others (e.g., Maskus (1997), Busse (2000)) caution that the problems of implementation may be too serious in relation to the minimal gains to be had.
8. The Montreal Protocol and the US CERCLA (Superfund) legislation constitute perhaps the only experience we have of border measures implemented to address leakage concerns, and thus bear some analysis.[33] Likewise, the GATT Working Party on Border Adjustment process is valuable as the only multilateral attempt to come to grips with some of the underlying principles that should guide the use of such border measures.
9. One of the stark messages of the analysis was the difference in magnitude of the past measures and what might transpire under a regime of border carbon adjustment. Generous estimates of the potentially vulnerable economic activity under the Superfund, and under a US carbon scheme, varied by a factor of almost 100. Clearly the stakes are higher in the case of carbon.
10. Nonetheless, trade measures used in both the Superfund and the Montreal Protocol seem to have been successful in achieving their objectives, though there are key differences between both of those instruments and any conceivable BCA. It is remarkable, however, that there seems to have been little or no cost-benefit analysis to assess the use of the measures in either the case of the Superfund or the Montreal Protocol. In that sense, history has little guidance to offer us as we contemplate the use of border measures for climate change.
11. Methodology stands out as a considerable concern, as highlighted in the discussions of the Working Party, and in the Montreal Protocol's rejection of coverage for goods produced with, but not containing ODS. The Working Party stands out as a commendable multilateral attempt to agree on methodology, albeit in a limited way. Clearly some agreement on best practice would be helpful in the practice of both border carbon adjustment and free allocation of allowances, given the significant potential for poor design, and the significant impacts on traded goods.
12. Economic constructs can be used to project changes to prices, profit, pass-through of costs, etc. resulting from the implementation of a carbon cost to a given market. But the assumptions required, and the quality of the available data, mean that such calculations are subject to major

[33] Other such measures currently exist in the form of standards. California and British Columbia (Canada) have laid down standards that dictate the acceptable carbon footprint of electricity and fuel imports – an attempt to preserve the integrity of their respective internal standards.

uncertainties. Without empirical evidence, and interpretation of the independent impacts of carbon costs, policy-makers are condemned to make their decisions in an atmosphere of major uncertainty, and are thus more likely to adopt a risk-averse strategy.

13. In the short-term, and under an absolute emissions cap such as applies under the EU ETS, firms will pass through the value of carbon allowances (the 'opportunity cost') whether they were granted these for free or bought them at auction or from the carbon market.
14. This raises the possibility of over-compensation and windfall taxes. Setting the 'correct' level of free allowances to be used as compensation is very challenging, but that does not mean that the level should default to one which is too high (as current and planned levels of the EU ETS – including the Phase 3 benchmark at a nominal best available technology level – appear to be for many sub-sectors.
15. What firms do with their free allowances in the longer-term remains a key area in need of research. The income from these free allowances may be directed to new investment in the EU, but may alternatively be used for a range of other purposes, some outside the EU.
16. Complicated allocation rules complicate incentives. Thus Phase 1 (2005-7) and Phase 2 (2008-12) EU ETS rules on closure include an incentive to emit now, as this would result in higher allowances in the future. Policy-makers must ensure they are not compensating twice in this case.
17. Output based allocation tends to reduce economic effectiveness. In the form most discussed with respect to practical schemes (e.g. the US' Waxman-Markey bill of 2009), output based allocation is often associated with rebates. These tend to both reduce competitiveness and leakage impacts but also the incentive of domestic firms to abate GHG emissions.
18. Typically around 1% of a country's GDP, representing around 10% of carbon emissions, would see a significant enough increase in its production costs from carbon prices to be deemed at potential risk of competitiveness and leakage effects.
19. There has been little direct modeling of the economic impacts of granting free allowances. Partial equilibrium models – those modeling typically only a single industrial sector, without links to the rest of the economy – project very varied rates of leakage. Characterisations of what drives long-term industrial decision-making, particularly with regard to new investment location decisions, is an essential assumption in these models and remains highly uncertain.
20. Sectoral approaches would only significantly impact competitiveness and leakage if they involved transnational trading of carbon allowances. Such schemes are very unlikely to be implemented, even if sectoral approaches were.
21. BCA analysis shows that sectors are protected, but at the economic costs of everyone else – other sectors and other countries. But it should be noted that free allowances and output based allocation schemes would also be likely to see welfare losses world-wide.
22. Sector-specific solutions are indicated. Further detailed analysis is required to establish what drives decision-making and costs in industrial sectors, and thus how any potential competitiveness and leakage could most cost-effectively be dealt with.
23. BCAs are likely to cause only very small impacts in countries outside those protected by the BCAs. It is unlikely that carbon prices in countries where BCAs will be high in the short- to medium-term, and compensation through free allowances must be subtracted from this carbon price. Thus the level of

BCAs applicable in the near future is likely to be low, and the effective carbon price in unprotected countries thus also low.

24. Practical constraints around data and legal issues are likely to reduce the carbon content on which a BCA could be levied, thus reducing its impact.
25. Drawing some general conclusions from the discussion of economics presented we can conclude:
    a. many sub-sectors to which the EU plan to grant free allowances do not appear to need protection. Granting protection when it is not needed involves an opportunity cost;
    b. similarly, there is a lost opportunity cost when sectors are over-compensated by being granted too many free allowances;
    c. under BCAs, all other sectors of the economy, and all countries, will generally lose welfare. In certain cases, this loss of welfare outside the protected sector can cause it to lose welfare too.

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