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Border tax adjustments and the EU-ETS

A quantitative assessment

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Abstract in English

If the EU stands alone in adopting climate policy and imposes a strict emissions ceiling, competitiveness of EU energy-intensive sectors will be affected negatively. Relocation of EU energy-intensive firms to countries with a lax regime also leads to carbon leakage. However, when use is made of the opportunities of the Clean Development Mechanism these impacts are very modest. Border tax adjustments (BTAs) to 'level the playing field' between domestic and foreign producers may be considered to address the concerns about both competitiveness and carbon leakage. It is far from clear whether these measures are WTO-proof. Simulations show that both an import levy and an export refund restore competitiveness to a certain extent. BTAs may lower the costs for energy-intensive sectors, but induce higher costs for other sectors. This paper uses a general equilibrium model to quantify and assess the implications of a number of policy scenarios.

Key words: climate policy; border tax; revenue recycling; Clean Development Mechanism

JEL code: Q53

Abstract in Dutch

Als de EU alleen staat in het voeren van klimaatbeleid en een streng emissieplafond oplegt, wordt het concurrentievermogen van energie-intensieve sectoren aangetast. Ook leidt verplaatsing van energie-intensieve bedrijven naar landen met een lakser klimaatbeleid tot weglekken van de emissiereductie-inspanning. Als gebruik wordt gemaakt van de mogelijkheden van het Clean Development Mechanism, zijn deze effecten echter zeer bescheiden. Corrigerende grensmaatregelen (border tax adjustments, BTA's) kunnen worden overwogen om een gelijk speelveld te handhaven tussen binnenlandse en buitenlandse producenten en de koolstoflekkage te verminderen. Het is echter nog verre van duidelijk of dit soort maatregelen in WTO kader acceptabel zijn. Simulaties laten zien dat zowel een importheffing als een exportrestitutie het concurrentievermogen in zekere mate kunnen herstellen. BTA's beperken de kosten in energie-intensieve sectoren, maar leiden wel tot hogere kosten voor andere sectoren. Deze studie gebruikt een toegepast-algemeen-evenwichtsmodel om de gevolgen van een aantal beleidsscenario's te kwantificeren en te analyseren.

Steekwoorden: klimaatbeleid; grensheffing; opbrengsten terugsluizen; Clean Development Mechanism

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Preface

With the launching in January 2008 of its climate change action plan ’20 20 in 2020’ the European Commission has made a firm opening bid in the ongoing negotiations about the post-2012 architecture of world-wide measures against global warming. Though these may yield the ‘grand coalition’ that is needed to mobilise the emission reduction efforts that would offer a chance of meeting the EU temperature objective (limiting the rise of the mean global temperature to 2 degrees Celsius), it is also possible that the coalition will remain (much) more limited. In that case energy-intensive industries in the EU are at a competitive loss against the countries that are not conducting climate policy. Moreover carbon leakage is likely to occur, partly offsetting the reduction efforts made by the coalition. These concerns have led to the so-called border tax debate: would it be sensible to impose the domestic carbon tax on imports from countries that are not part of the coalition, while exempting exports to such countries from this tax?

This document that is a co-production of PBL Netherlands Environmental Assessment Agency and CPB Netherlands Bureau for Economic Policy Analysis addresses the border tax issue. The authors investigate the legitimacy of these measures within the WTO-framework. Making use of the global general equilibrium model WorldScan, they assess the impacts of adopting carbon import levies and export refunds for ETS-sectors in the EU when the EU would be virtually stand-alone in adopting strict emissions ceilings.

The conclusions of the study are that carbon border measures do indeed help to restore a level playing field for energy-intensive sectors in the EU and do reduce carbon leakage. Yet, adopting border measures may entail welfare losses, may be difficult to implement and compatibility with WTO-rules is far from guaranteed. Alternative measures, in particular recycling part of permit auction revenues to exposed ETS-sectors and greater reliance on the Clean Development Mechanism, should be considered as serious contenders.

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Summary

The stringent climate policy proposed by the European Commission raises concerns about competitiveness and effectiveness. European firms, faced with a price of carbon, would be at a competitive disadvantage compared to regions with a more lax climate policy. Particularly in energy-intensive sectors, this might lead to a loss of production and of jobs. Also, a shift in activity towards non-abating countries would induce higher emissions outside the EU. This carbon leakage would undermine the effectiveness of the policy to reduce overall emissions.

There may be an argument to impose carbon border taxes to restore competitive fairness and prevent carbon leakage. This paper focuses on import levies on energy-intensive imports and refunds on exports of European energy-intensive sectors. A number of stylized policy scenarios are considered to analyse the impact on competitiveness and to assess the potential for border tax measures. The focus is on sectors covered by the European Emission Trading Scheme (ETS). ETS-sectors are energy-intensive and can be expected to be most vulnerable to foreign competition. Our quantitative results are derived from simulations with CPB's global general equilibrium model WorldScan.

A stand alone European climate policy will lead to adjustments in energy-intensive sectors. If the opportunities of the Clean Development Mechanism (CDM) to reduce emissions in developing countries would *not* be used, production in these sectors arrives in 2020 on average 4.5% below the no-policy case and employment 3.2%. Foreign competitors increase their energy-intensive production and this increase amounts to 40% of the production loss of EU-firms. Carbon leakage is somewhat over 3%. This means that 3% of the intended emissions reduction is made undone by extra emissions elsewhere. By contrast, in a global climate policy setting, European energy-intensive firms could increase their market share. Their relatively better energy-efficiency would then lead to a competitive advantage.

We show the impacts of border tax measures against the background of a scenario where Europe is virtually alone in imposing stringent emissions ceilings *and* refrains from using CDM as a means to alleviate its burden. Border tax measures would restore competitiveness to a certain extent. The combination of import levies *and* export refunds may halve the loss in production and employment. Because Europe is a net exporter of energy-intensive products, a refund on exports is more effective to support employment in ETS-sectors than a levy on imports. However, refunds are welfare decreasing for Europe. Due to favourable terms-of-trade effects, EU welfare effects of import levies are slightly positive. The pain for non-EU regions is very small and by far not enough to enforce compliance with a global climate policy.

If the EU – in a stand-alone policy setting – would fully use the opportunities for CDM up to the limits proposed in '20 20 in 2020', the impacts on competitiveness and carbon leakage in 2020 would be smaller. ETS-production would fall by 1.7% and ETS-employment by 1.2%. Though foreign competitors would still increase their energy-intensive production, this increase is also in relative terms small, amounting to 25% of the production loss of EU-firms. Considering these modest impacts, one may conclude that the remedy of adopting border tax adjustments may not be worth the effort and worse than the disease.

Whether border tax measures will be compatible with the rules of the World Trade Organisation (WTO) is unclear. It is controversial whether WTO-rules leave room for border measures based on the carbon print of a good. The WTO-environmental window might come to the relief: countries may deviate from the rules if it is for the protection of animal, plant or human health or for the conservation of natural resources. Even if border tax measures would appear 'WTO-proof', feasibility to administer the measures and the possibility of retaliation deserve attention in the debate.

Concerns about loss in competitiveness can be met by alternative policy measures, *e.g.* by recycling part of the revenues from auctioning ETS-emission rights directly to the sectors that are most exposed.

1 Introduction

The European Union has set a climate change target to achieve by 2020 a 20% reduction in EU greenhouse gas emissions as compared to 1990 levels, or 30% if other developed nations agree to take similar steps. The EU Emission Trading Scheme (EU-ETS) is the backbone of the European policy. This cap-and-trade system will impose an implicit carbon tax on the combustion of fossil fuels in energy-intensive industries. There is some fear that European enterprises will find themselves at a competitive disadvantage with competitors based in countries that are not internalizing the climate costs. The competitiveness impact of EU climate policy can be particularly acute for energy-intensive manufacturers such as the iron and steel, aluminum, cement, glass, chemicals and pulp and paper industries. Carbon leakage may be another concern. Unilateral EU policy could induce emissions to increase elsewhere. Rather than reducing their emissions under a new EU climate policy, companies may consider to relocate to free-riding countries. Relocated firms may then actually emit more in, for example, China or India. While widely believed, this 'pollution haven effect' has proven difficult to demonstrate empirically. A few studies even find evidence for the Porter hypothesis; that regulation brings cost-reducing innovation. However, recent work by Levinson and Scott Taylor (2008) indicates that indeed industries, whose abatement costs increased most, experienced the largest increases in net imports.

Border trade measures might be considered to alleviate the EU competitiveness concern. Such competitiveness provisions would essentially aim at leveling the playing field by imposing the same or similar costs, as EU climate policy imposes on domestic EU production. At the same time, border measures might also address the leakage concern. Within Europe, especially France has been quite active in promoting corrective measures. This study focuses on border tax adjustments (BTAs); the application of a domestic tax on imported goods while exempting exported goods from the tax in an effort to make the goods' price competitive both nationally and internationally. It should be noted, there are many ways to address competitiveness concerns, international agreement on collective action probably being the most desirable. In the current state of the debate, the EU allows for limited use of the Clean Development Mechanism (CDM). CDM allows EU-countries to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries.

It is open for discussion whether the use of economic measures, including trade measures against other industrialized countries, would be effective, appropriate and legitimate for countries, or groups of them. There is an ample literature discussing the legitimacy of BTAs and climate policy (e.g., Cosbey and Tarasofsky, 2007; Pauwelyn, 2007). In contrast there are few empirical studies that have considered trade measures to ameliorate these negative competitive effects of unilateral climate policy. One example is Babiker and Rutherford (2005)

discussing trade measures in the light of the Kyoto agreements. From this study it turns out that countervailing carbon levies can substantially reduce the welfare losses for the coalition members by shifting a great part of the carbon policy burden to the non-coalition members. In this paper we want to answer the following questions.

- Does unilateral climate policy by the EU lead to changes in competitiveness and relocation of energy-intensive industries to non-abating countries?
- Is there a case for trade measures to restore the level playing field?
- How would trade measures, in particular carbon import levies and export refunds mitigate the impacts of the climate policy?

We use WorldScan, a multi-sector, multi-region, global general equilibrium model, to quantify the competitive effects and the scope for leakage under different climate scenarios and the impact of BTAs. We build upon earlier work (Boeters *et al.* , 2007; Wobst, 2007).

The stage is set by two scenarios: GRAND COALITION and IMPASSE. These scenarios are stylized versions of current EU proposals. In GRAND COALITION a broad group of important countries joins a common climate regime. The EU sets its emission target for 2020 at 30% below 1990 levels. Global emission trading allows for full flexibility. In the IMPASSE scenario Europe is virtually alone in climate change abatement. The EU target in 2020 lies 20% below 1990 levels. The EU-ETS allows for flexibility among energy-intensive sectors within the EU. CDM meets the worries about competitiveness in IMPASSE. To reflect the limited use of CDM in the current EU proposals, we analyze a variant on IMPASSE that includes CDM up to the limits proposed. To assess the impact of BTAs, we build upon the scenario with the largest impacts on EU-competitiveness and carbon leakage: IMPASSE without CDM. We analyze variants on IMPASSE with levies on energy-intensive EU imports and refunds on energy-intensive EU exports. An alternative scenario is added in which part of the revenues from auctioning emission permits are recycled to vulnerable energy-intensive sectors.

Before discussing empirical results, first, we examine some pros and cons of border tax measures and discuss its legitimacy (section 2). Next, we briefly explain the policy simulations and the methodology used (section 3). Simulation results are discussed in section 4. Section 5 concludes.

2 A case for trade measures?

In the climate context, trade measures are likely to be justified by the need to offset any competitive advantage held by producers in countries that have not implemented costly mitigation measures (Stokke, 2004). To level the playing field on world markets, the EU might consider border tax adjustments (BTAs). BTAs are taxes imposed on imports or tax-relief granted to exports, used to level the playing field between taxed domestic industries and untaxed competitors abroad. The focus in this study is on BTAs. However, competitiveness concerns may be addressed by alternatives like: the Clean Development Mechanism (CDM), grandfathering emission rights or exemptions for energy-intensive sectors. Revenues raised by auctioning emission permits could also be used to lower other costs such as taxes on labor or capital, or technology development and application costs (cross-subsidization). Although the immediate demand for trade measures is economic in nature, there may be other, environmental reasons. A BTA would raise the prices of at least all those goods that enter the EU market to levels reflecting the social cost of carbon. Thus, carbon leakage may be reduced.

As noted by the 2006 Stern Review (Stern, 2006), unilateral trade barriers "are clearly second best to implementing a similar carbon price across the global economy" through international agreements. One must, therefore, remain aware of the costs and risks of trade measures. Barriers to trade are inefficient. Trade restrictions skew the optimal allocation of the world's resources and the principle of comparative advantage. They are also costly especially for EU consumers and EU industries that depend on imported inputs. The competitiveness impact can be exaggerated and abused. Even where trade barriers may be needed as second or third best solutions, competitiveness provisions risk being abused by import-competing EU industries for purely protectionist purposes unrelated to global warming. BTAs may undermine the trust necessary for future international cooperation and agreement on emission reductions. Furthermore, the administration of competitiveness provisions is likely to be complex and costly.

Politicians, economists and environmentalists have periodically promoted BTAs. The Stern review emphasized that the cost of inaction will be considerably greater than the cost of taking action to mitigate climate change. For this reason, it is important to forcefully pursue all possible courses of action, including BTAs. Also Stiglitz has called for a carbon tax or trade measures against countries not cutting carbon emissions (Stiglitz, 2006). The subject hit the EU agenda when its High Level Group on Competitiveness, Energy & Environment advised the European Commission on the long-term energy future (EU, 2007). Some were concerned over repercussions on free trade; others felt the issue needed serious study. There is evidence of differences in opinion within the EU Commission. On the one hand, enterprise Commissioner Verheugen (Enterprise and Industry) asked Commission President Barroso to explore

possibilities including border tax adjustments. On the other hand, Trade Commissioner Mandelson considers them as problematic under current WTO rules, and almost impossible to implement in practice. He said "It would also be bad politics. A punitive approach to pursuing international cooperation on climate change would be politically and strategically clumsy, igniting a carbon war" (Mandelson, 2006). The French government has also demanded the introduction of a BTA. France will produce its own proposal for a BTA – a so-called 'Eco-Duty', which it intends to circulate at EU level for EU approval. Concerns about competitiveness are widespread. In the USA senators Lieberman and Warner introduced America's Climate Security Act. This bill exemplifies the intention of U.S. Congress to start fighting climate change while at the same time protecting U.S. industry from any competitive disadvantage through border tax adjustments.

Risk of a WTO challenge

Import tariffs are regarded by some as a form of protectionism, and thus may not be compatible with international trade regulations. Any measure with a serious trade impact is likely to trigger a WTO complaint. The WTO consistency of such provisions is, therefore, crucial.

It can be argued that WTO rules on border tax adjustment permit the imposition of a tax on imports as long as such a tax is equivalent to the tax or other charge imposed on domestic EU products. The flip-side of the right to impose a domestic tax on imports is the right to deduct the same tax on domestic products that get exported. Under WTO rules, such rebates are not considered to be prohibited export subsidies. BTAs of this kind are permitted under the WTO rules, but the extent to which they can apply to energy or carbon inputs is unclear. Is border adjustment limited to "product" measures or does it extend also to "process" measures? This raises fundamental debates, still not completely resolved, as to whether the WTO permits distinctions based on the method by which a good is produced, rather than just on the product as such. Unlike product taxes, process taxes 'by and large cannot' be adjusted at the border. Most controversial by far would be the imposition of trade restrictions on imports based on the carbon or other greenhouse gases that were emitted in their production abroad.

Authors of the New Economics Foundation report (New Economics Foundation, 2003) have examined the question "whether implementing trading barriers to climate-change policy is possible?" They have convincingly shown that the European Union does have a good chance to win any possible dispute over such a border tax. Climate related trade restrictive measures are countervailing duties. The WTO allows states to impose these countervailing duties to offset the competitive trade advantage that foreign companies gain when they receive subsidies from their government. In the case of climate change, the US government and other governments of non-complying nations are not giving direct subsidies but indirectly favor their industries by not

imposing climate policy constraints on them. The use of remedial trade restrictions is allowed in particular where there has been 'a good faith effort to reach an international agreement'.

Even if border adjustments were permitted for EU climate policy, that is not the end of the story. A carbon tax must meet the substantive test. This test essentially requires that imported products are not treated less favorably than similar domestic products. The issue is primarily whether, for example, steel from China made with coal (subject to a high carbon tax or regulation) is "similar to" domestically produced EU steel using natural gas (subject to a lower carbon tax or regulation). A BTA must also avoid discrimination between imports from different countries. This follows from the so-called "most-favored-nation" (MFN) obligation.

The use of tariff or other trade restrictions to induce compliance with the EU climate regime would be difficult to justify under present WTO regulation. One can only assume that a complete ban on imports from countries that do not have carbon restrictions in place is not on the table, unless such violation could be justified under the environmental exceptions, any punitive "carbon tariff" would violate WTO rules.

Whether a BTA would be permitted under GATT/WTO regulations is uncertain. There are no clear regulations in the WTO. Above all, whether elements not physically present in the final product can be taxed is hotly debated. Given the vague nature of WTO law, the WTO may either uphold or strike down the provision. WTO-bodies have so far been restrictive regarding the exceptions in WTO agreements to the general ban on embargoes and discrimination. Although there are certain options to be avoided as they would violate WTO law (e.g. anti-dumping and anti-subsidy duties), the broader WTO consistency of such process-based restrictions is unclear and remains to be tested.

Notwithstanding these uncertainties, the following guidelines should be kept in mind for a carbon border tax to qualify as a "border tax adjustment". To limit the impact on trade, only a limited list of imports of energy intensive products should be covered; studies indicate that only for these products competitiveness concerns may arise; the administration of a carbon tax on imports, and the problem of determining the carbon footprint of goods produced abroad, would also be much easier if it applies only to some basic products (such as iron and steel, aluminum, cement, bulk glass, paper and a number of chemicals) and not to finished goods (such as cars, consumer goods and durables or drugs). The carbon tax on imports must be "equivalent" to the internal cost imposed by EU climate policy.

Environmental window

The 'environmental window' of the global trade regime might provide an escape if (i) the WTO would not permit BTAs for a process-based tax or charge or (ii) the WTO does permit BTAs but the adjustment is found to discriminate imports. Any violation may still be justified under the environmental exceptions of GATT Article XX as a measure: "relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption" (the environmental window). The relevance of uncoordinated, i.e. unilateral, trade measures, for environmental purposes has been debated extensively for decades. Especially the United States has been active in implementing unilateral trade measures justified by environmental goals. (Tarasofsky, 2005). Whereas pre-1995 GATT panels never found that a measure met the exceptions in this article, Post-1995 WTO jurisprudence has proven to be much more flexible and "greener". The WTO accepted a French ban on imports of asbestos for health protection. The most famous case of a trade measure is that taken by the US in the 'shrimp-turtle' case. The WTO found that a US ban on shrimp based on how these shrimp were caught abroad was justified as a conservation measure for endangered turtles.

The most crucial requirement is likely to be the introductory phrase of the 'environmental window'. It requires essentially that the carbon tax on imports is flexible and varies in a way that takes account of local conditions in foreign countries exporting to the European Union. In case a carbon tax would need justification under the environmental window, two adjustments in particular would need to be made (Pauwelyn, 2007);

- A sliding scale based on efforts to fight climate change in the exporting country: taking account of carbon taxes or export taxes in the exporting country;
- A sliding scale based on the stage of economic development of the exporting country: given that many international agreements recognize that developing countries ought to carry a lighter burden in the fight against global warming.

3 Methodology

WorldScan

The macroeconomic consequences of climate policy scenarios are assessed using the applied general equilibrium model WorldScan. This model has global coverage and in particular details regions within Europe (see Lejour *et al*., 2006, and Bollen, Manders and Mulder, 2004). With respect to climate policies, two general categories of regions are distinguished: developed countries, referred to as Annex I countries and developing countries, referred to as Non-Annex I countries.

WorldScan data for the base year 2001 are to a large extent taken from the GTAP-6 database (Dimanaran and McDougall, 2006) that contains integrated data on bilateral trade flows and input-output accounts for 57 sectors and 87 countries and regions. A more disaggregated sector

Table 3.1 Overview of regions, sectors and production inputs in WorldScan

Regions[a)]	*Sectors*[b)]	*Inputs*[b)]
Netherlands	Cereals	*Factors*
EU-15 (old member states)	Oilseeds	Low-skilled labour
EU-12 (new member states)	Sugar crops	High-skilled labour
Other Europe	Other agriculture	Capital
Former Soviet Union	Minerals	Land
United States	Oil	Natural resources
Other OECD (ex Mexico)	Coal	
Brazil	Petroleum and coal products	*Primary energy carriers*
Mexico, Central and other Latin Am.	Natural gas	Coal
Middle East and North Africa	**Electricity**	Petroleum, coal products
China and Hong Kong	**Ferrous metals**	Natural gas
India	**Chemical, rubber, plastic products**	Modern biomass
Other South and South -East Asia	**Mineral products**	Renewables
Rest of World	**Paper products, publishing**	
	Non-ferrous metals	*Other intermediates*
	Vegetable oils and fats	Cereals
	Other consumer goods	Oilseeds
	Capital goods and durables	Sugar crops
	Road and rail transport	Other agriculture
	Other transport	Minerals
	Other services	Oil
	Biodiesel	**Electricity**
	Ethanol	**Ferrous metals**
	Modern biomass	**Chemical, rubber, plastic products**
	Renewables	**Mineral products**
		Paper products, publishing
		Non-ferrous metals
		Vegetable oils and fats
		Other consumer goods
		Capital goods and durables
		Road and rail transport
		Other transport
		Other services
		Biodiesel
		Ethanol

[a)] non-Annex I regions are denoted in italics

[b)] ETS-sectors and inputs denoted in bold

classification is used in WorldScan that permits the assessments to come as close as possible to the sectors that are currently subject to the EU Emissions Trading Scheme (ETS). The version of WorldScan used for this study distinguishes 25 markets for goods and services and factor markets for labour, capital, land and natural resources in each of the selected 14 countries and regions (see Table 3.1).

Five primary energy carries are distinguished: coal, petroleum and coal products, natural gas, modern biomass and renewables. Only the first three of these contribute to the CO_2-emissions simulated by the model. The following six sectors are assumed to be covered by the EU Emission Trading Scheme (EU-ETS): Electricity, Ferrous metals, Chemical, rubber, plastic products, Mineral products, Paper products, publishing and Non-ferrous metals. There is no perfect match, though. Emissions issued by the combustion of fossil fuels in the sectors Electricity and Ferrous metals can be considered to be fully subject to the EU-ETS emission ceiling, but this assumption may not hold for the remaining sectors that comprise also activities that are not covered by EU-ETS (such as publishing as opposed to paper production).

Policy cases

In this study we assess seven stylized policy variants. We consider a reference case (IMPASSE), in which we implement no border adjustment. IMPASSE describes a stand-alone EU climate policy with very minor mitigation efforts in other industrialized countries. It should be noted that in IMPASSE no CDM is allowed for. This reference case will be compared with an alternative policy environment in 2020: GRAND COALITION. GRAND COALITION shows the impacts of an ambitious global mitigation effort, including large fast-growing countries as China, India and Brazil. Both IMPASSE and GRAND COALITION are associated with the two most extreme scenario's that were developed for the Interdepartmental Policy Research 'Future climate policy' (Boeters *et al.*, 2007). For this study both scenario's have been brought in line with the '20 20 in 2020' proposals of the European Commission. According to these the EU will impose in 2020 a ceiling on greenhouse gas emissions of 20% below the 1990 level (or 30% if a broad coalition of countries embarks on abating global warming), a targeted 20% share of renewable energy in total energy use and a 10% biofuel share in road fuel use

To assess the implications of border adjustments we assess three policy cases in which specific adjustment measures are combined with the climate regime to protect the energy intensive industry in the EU member states. These measures are carbon levies, refunds or a combination of both.

In addition, two alternatives are considered. We consider an IMPASSE scenario, including use of CDM. CDM allows EU-countries to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries. CDM

meets the worries about competitiveness in IMPASSE. Actually this scenario reflects the limited use allowed in the current EU proposals. RECYCLING answers the current debate about distribution of revenues from auctioning emission permits in ETS.

IMPASSE	IMPASSE describes a stand-alone EU climate policy with half-hearted mitigation efforts elsewhere; in this scenario meeting the EU temperature objective (to limit global warming during this century to 2 degrees Celsius above pre-industrial levels) is extremely improbable. The EU 20% renewables target is imposed by subsidizing the use of renewables and allowing for green certificate trade among member states. Adoption of a 10% share of biofuels in road fuel use contributes to the overall renewables target.
GRAND COALITION	GRAND COALITION, on the other hand, shows the impacts of a global mitigation effort that has a reasonable chance to meet the EU temperature objective; in GRAND COALITION the overall targets for renewables from IMPASSE are imposed in volume terms
IMPASSE + LEVY	The third policy variant (LEVY) combines IMPASSE with a tax levied on the embodied carbon of the energy-intensive imports (ETS-sectors) into the EU-27 assessed at the prevailing carbon tax rates and the carbon content of domestic production.
IMPASSE + REFUND	The refund case is a variant where in IMPASSE the EU-27 energy intensive exports (ETS-sectors) get a full refund of the carbon tax at the point of shipment.
IMPASSE + LEVY + REFUND	This variant combines an import tariff (LEVY) and an export subsidy (REFUND) in IMPASSE.
IMPASSE + CDM	This variant allows for CDM up to the limits proposed by the European Commission in '20 20 in 2020'
IMPASSE+RECYCLING	This variant assumes that 80% of the auctioning receipts from exposed ETS-sectors (ferrous metals, chemical products, paper products, non-ferrous metals) is recycled directly to these industries.

We observe here, that if post-2012 climate change negotiations would fail to bring a coalition that is both determined to abate global warming and broad enough to be effective in reaching this goal, IMPASSE + CDM would come closest to the current '20 20 in 2020' policy proposal. Instead we use IMPASSE without CDM as the reference scenario for an assessment of the impacts of BTAs, simply because the analysis of these impacts would become quite amorphous if we would choose the more relevant reference of IMPASSE + CDM. In the latter scenario the policy impacts on EU competitiveness and carbon leakage are too small to enable a clear-cut analysis of BTAs.

Baseline

The effects of climate policy depend strongly on the underlying baseline. All counterfactual analyses depart from a so-called middle-course scenario without climate policy that has also been used in Boeters *et al.*, 2007 and was developed by PBL Netherlands Environmental Assessment Agency (Van Vuuren *et al.,* 2006). This scenario is based on estimates of trends, and is comparable to the reference scenario used by the International Energy Agency (IEA) and the so-called B2 scenario used by the IPCC. According to this baseline scenario, global population will continue to expand. Combined with a worldwide economic growth of around 3% per year, the global demand for energy will increase significantly: a 50% increase in 2020 relative to 2001. This expansion will primarily take place in the nations currently known as developing countries, which will thus partially reduce the gap in energy consumption per capita with the industrialized countries. Table 3.2 gives some key characteristics on the baseline for the 2001-2020 period.

Energy prices in the baseline differ significantly from current prices. Baseline values depart from the relatively low energy prices in 2001 baseyear. The baseline shows a gradual rise in energy prices over time due to depletion of resources. In 2020 the oil price amounts to about 25 US$/barrel. It remains to be seen whether current three digit oil prices are permanent, but taking account of a higher oil price seems inevitable. In the near future, we will update the baseline in this respect.

Table 3.2 Characteristics of baseline scenario, average annual growth, 2001-2020

	Population	GDP volume	Energy consumption a)	CO_2 emissions	Energy intensity	CO_2 intensity
	%	%	%	%	%	%
Annex I	0.3	2.7	1.1	1.1	-1.5	0.0
EU-27	0.0	2.3	1.0	1.1	-1.3	0.1
USA	0.9	2.9	0.7	0.7	-2.2	0.1
Former Soviet Union	-0.2	6.1	1.7	1.3	-4.2	-0.3
Other	0.6	2.6	1.6	1.6	-0.9	-0.1
Non-Annex I	1.3	5.4	3.5	3.2	-1.8	-0.3
China	0.6	7.8	2.6	2.6	-4.8	0.0
India	1.5	5.7	4.1	3.9	-1.5	-0.1
Brazil	1.2	3.5	2.2	1.9	-1.3	-0.3
Other	1.6	4.5	4.0	3.5	-0.5	-0.5
World	1.1	3.3	2.1	2.0	-1.2	-0.1

a) Total of coal, refinery products, natural gas, biofuels, commercial biomass and renewable energy

Source: WorldScan

4 Results

4.1 Impasse

Against the background of the baseline, the IMPASSE policy scenario has been developed as a reference policy. IMPASSE describes a strong EU climate policy, only modest efforts by other Annex I parties and no action by non-Annex I countries. There is emission trading between energy intensive sectors (ETS) within the EU-27. Hence, ETS allows for some flexibility. In this stylized scenario there is no CDM.

Table 4.1 IMPASSE without CDM, 2020

	Percentage CO_2 reduction			Emission price[a]	National income
	Target (*or 2020 emissions*) compared to 2005 emissions	Target compared to baseline emissions 2020	Emissions 2020 compared to baseline emissions 2020		
	(%)	(%)	(%)	€ / tCO_2	% change compared to baseline
Annex I	6	-9	-9	9	-0.3
EU-27	-14	-28	-28	52	-0.7
EU-15	-18	-32	-27	29	-0.7
EU-12	5	-8	-30	2	-1.3
USA	13	-2	-2	2	-0.1
Former Soviet Union	7	-2	-2	2	-0.6
Other	20	-2	-2	1	0.0
Non-Annex I	*55*	-	0	-	-0.1
China	*42*	-	1	-	-0.1
India	*62*	-	-1	-	-0.3
Brazil	*41*	-	0	-	-0.4
Other	*65*	-	1	-	-0.1
World	*25*	-	-5	5	-0.3

a) For EU-27 ETS-price, for member states non-ETS national carbon tax, for other Annex-I countries national carbon tax
Source: WorldScan

The outcomes for IMPASSE show an emission reduction of 5% compared to the baseline in 2020 at the global level at a cost of 0.3% of world national income (see Table 4.1). It is hardly surprising that for EU-27 the costs are – at 0.7% of national income – considerably larger. Driven by the strong EU efforts, emissions reduction for Annex I amounts to almost 9% below the baseline level. Emissions elsewhere increase with almost 0.5%, reflecting carbon leakage. International permit trade is only operational for the ETS-sectors within the EU, at an emission price of 52 €/tCO_2. Within the ETS, the old member states (EU-15) are a net permit importer from the new member states (EU-12). For EU-15 actual emissions in 2020 are 27% below baseline, while the target for EU-15 lies 32% below baseline. National carbon taxes that are needed to curb emissions in non-ETS vary a lot over member states (29 €/tCO_2in EU-15 versus a mere 2 €/tCO_2in EU-12).

As a result of the tight EU emissions ceiling in ETS-sectors both domestic (-2.8%) and export demand (-9.1%) decline in EU-27 (see Table 4.2). Moreover, as domestic production becomes less competitive imports from other regions increase (8.1% in EU-27). Hence, EU production falls more than domestic demand (-4.5% in EU-27). Most non-EU regions increase their production. Yet, at the global level, aggregate ETS-production remains below baseline (-0.6%).

Table 4.2 **IMPASSE without CDM; employment, production, import, export and domestic us of ETS-sectors, % difference with baseline, 2020**

	Employment	Production	Imports a)	Exports a)	Domestic use
Annex I	-0.7	-1.3	3.4	-2.9	-1.0
EU-27	-3.2	-4.5	8.1	-9.1	-2.8
EU-15	-2.4	-3.9	5.4	-7.0	-2.5
EU-12	-5.5	-8.3	5.2	-12.9	-5.1
USA	0.4	0.3	-2.2	1.5	0.0
Former Soviet Union	1.4	0.9	-7.9	4.9	-0.2
Other	0.6	0.2	-1.9	1.1	-0.3
Non-Annex I	0.6	0.6	-2.9	3.4	0.1
China	0.2	0.3	-1.4	2.0	0.0
India	0.4	0.5	-2.2	2.1	0.2
Brazil	0.6	0.4	-2.4	0.3	0.0
Other	1.1	1.1	-2.5	2.7	0.3
World	0.4	-0.6	-	-	-0.6

a) Excluding intraregional trade

Source: WorldScan

Employment in ETS-sectors decreases in the EU with 3.2% (see Table 4.2) and rises in all other countries, especially in the Former Soviet Union (+1.4%). In absolute terms the shift in employment is modest, given the small share of ETS in total employment. The baseline employment share of ETS is 8.9% in 2020. It should be noted that in the version of WorldScan used here, labour supply and unemployment are exogenous. Thus, the decline of employment in ETS (-3.2%) is compensated by an increase in employment in non-ETS (+0.3%).

Behind the production decrease at aggregate ETS-level in EU-27 of 4.5% there is considerable variation at the individual sector level in EU-27 (see Table 4.3). The simulation outcomes show largest reductions in production and employment for electricity, non-ferrous and ferrous metals while the decrease is most modest for the sector ‘Paper products, publishing’. Obviously, individual plants within these sectors may be affected differently than the average impacts indicate. In addition the average impacts may underestimate the negative consequences for some sectors where the classification exceeds the boundaries of ETS. For example, within ‘Paper products, publishing’ paper mills do belong to the ETS but publishing does not. Hence, the decline of production in paper mills may be larger than the 0.8% that is recorded for ‘Paper products, publishing’.

Table 4.3 IMPASSE without CDM; impacts by ETS-sector, % differences with baseline, EU-27, 2020

	Employment	Production	Imports[a)]	Exports[a)]	Domestic use
Electricity	-8.8	-8.1	91.9	-51.0	-5.6
Ferrous metals	-3.6	-6.1	10.7	-12.5	-4.2
Chemical, rubber, plastic products	-3.2	-4.7	5.7	-8.2	-2.8
Mineral products	-1.1	-3.2	7.1	-8.3	-2.2
Paper products, publishing	-0.2	-0.8	1.4	-2.5	-0.6
Non-ferrous metals	-3.6	-6.0	6.2	-10.5	-2.8
All ETS-sectors	-3.2	-4.5	8.1	-9.1	-2.8
Non-ETS sectors	0.3	0.3	-2.5	0.9	0.0

a) Excluding intraregional trade

Source: WorldScan

The increase of imports and the decline of exports are larger than average in electricity and ferrous metals. The sweeping changes in electricity trade do not imply large trading volumes, as electricity is hardly traded. In the baseline both exports and imports amount to a mere 1.5% of total demand.

Leakage

Carbon leakage may occur via three channels: induced exports of energy-intensive products from countries with more modest carbon policies, relocation of polluting activities to countries where taxation is lower and increased fossil energy use in non-coalition members because of a decrease in primary fossil energy prices. We define the carbon leakage rate as the increase of emissions in non-coalition members (with respect to the baseline) as a percentage of the emission reduction by the coalition members (with respect to the baseline). In IMPASSE carbon leakage is 3.3% in 2020 and occurring in China and Other Non-Annex I (see Table 4.4). Given the (mild) cap, there is no carbon leakage to the other countries of Annex I. In a variant of IMPASSE, with USA and other non-EU regions not complying to any emission targets, carbon leakage more than doubles.

Table 4.4 IMPASSE without CDM, carbon leakage and production leakage by sector[a)], 2020

Carbon leakage [a)]	3.3
Production leakage [b)]*:*	
Electricity	17
Ferrous metals	30
Chemical, rubber, plastic products	52
Mineral products	40
Paper products, publishing	26
Non-ferrous metals	45
All ETS-sectors	38

a) Non-Annex I emissions increase over the baseline as a % of Annex I emissions decrease below baseline

b) Non-EU-27 production increase over the baseline as a % of EU-27 production decline below baseline

Source: WorldScan

In table 4.4 we also show so-called *production leakage* rates for ETS-sectors and for aggregate non-ETS in EU-27. Production leakages may occur via the very same channels that cause carbon leakage: import penetration by lower cost producers, production relocation from higher cost producers and production expansion by non-members due to decreased primary energy costs. Similar to the carbon leakage rate we indicate the production leakage rate by the increase of production outside the EU as a percentage of the reduction of production within the EU. On average, ETS leakage amounts to almost 40%. This means that almost two fifths of the production decline in EU-ETS is compensated by a production increase elsewhere. This amounts to 1.8% of EU baseline ETS production. At the level of individual sectors leakage is smallest for electricity (17%) because the opportunities for electricity trade are minor. EU electricity trade is almost completely confined to trade with Other Europe and the Former Soviet Union.

There are several reasons why the ETS production leakage rate (38%) is much higher than the carbon leakage rate (3.3%). First, carbon leakage can only occur in non-Annex I as all Annex I parties impose some emissions ceiling in IMPASSE. Carbon leakage would double to 6.7% in IMPASSE if the emission ceilings in all other Annex-I countries would be lifted. Second, the output of ETS-sectors is – with the exception of electricity and cement – easily traded internationally. The output of some other sectors (such as road and rail transport) must take place within the EU and the trade substitute does not apply. Finally, import substitution cannot compensate for emissions reduction in residential consumption (heat, power, and road fuels) either.

4.2 Grand Coalition

GRAND COALITION shows the impacts of a global mitigation effort that has a reasonable chance to limit global warming during this century to 2 degrees Celsius above pre-industrial levels (the EU objective). The costs of significant emissions reductions remain limited because emissions trading is used on a large scale. Not just the countries with absolute targets (Annex I), but also the nations with relative targets (China, India and Brazil) use emissions trading, at least for the energy-intensive sectors. The outcomes for GRAND COALITION at the global level show an emission reduction of 22% in 2020 compared to the baseline at a cost of 0.4% of world national income (see Table 4.5). The costs to EU-27 amount to 0.7% of national income. Within the global coalition Annex I countries in general reduce emissions to a smaller extent than targeted (EU-12 and the Former Soviet Union being the exceptions), buying permits from non-Annex I countries, especially from China and India against an international permit price of 18 €/tCO_2. Though the reduction target of EU member states are more stringent in GRAND COALITION (-30% with respect to 1990) than in IMPASSE (-20% with respect to 1990) the income loss for EU-27 is slightly less in GRAND COALITION. The income loss for EU-15 (-0.6%) is less than in

IMPASSE (-0.7%) while the loss to EU-12 (-2.2%) is considerably larger than in IMPASSE (-1.3%). The cause of this divergence in income developments between the old and new member states is permit trade. EU-15 is an importer of permits and quadruples its volume of permit imports in GRAND COALITION at a price that is 65% lower than in IMPASSE. Conversely, in GRAND COALITION EU-12 is unable to compete with other exporters of emissions permits and has to reduce its export volume by 80%.

It should be noted that these outcomes depend on the assumption that the overall renewables targets of GRAND COALITION are kept at the levels of IMPASSE. If instead a target of a 20% share of renewable energy in total energy would have been imposed the income loss to EU-27 would rise above IMPASSE to 0.9% of national income. Compared to IMPASSE total energy use is higher in GRAND COALITION *and thus also* renewable energy use. The progressive marginal costs of renewable energy are the cause of the additional income loss if the target for renewables would have been applied in percentage terms.

Table 4.5 **GRAND COALITION, 2020**

	Percentage CO_2 reduction			Emission price	National income
	Target (*or 2020 emissions*) compared to 2005 emissions	Target compared to baseline emissions 2020	Emissions 2020 compared to baseline emissions 2020		
	(%)	(%)	(%)	€ / tCO_2	% change compared to baseline
Annex I	-25	-36	-18	18	-0.5
EU-27	-25	-37	-17	18	-0.7
EU-15	-29	-41	-16	18	-0.6
EU-12	-10	-21	-26	18	-2.2
USA	-33	-43	-19	18	-0.4
Former Soviet Union	15	5	-21	18	-0.3
Other	-46	-54	-15	18	-0.4
Non-Annex I	*12*	-	-28	13	-0.1
China	27	-10	-51	18	0.1
India	56	-5	-36	18	-0.1
Brazil	28	-10	-15	18	-0.5
Other	*47*	-	-11	10	-0.1
World	*2*	-	-22	16	-0.4

Source: WorldScan

EU employment in ETS-sectors exceeds the baseline (+0.4%) whereas employment decreases everywhere else (see also Table 4.6). In contrast with IMPASSE supply and demand are especially reduced in non-Annex I countries and in the Former Soviet Union, where major reductions take place in return for permit payment transfers from Annex I. Supply and demand are exceeding baseline levels in the countries of EU-15. This outcome indicates that ETS-industries in EU-15 are able to meet their (most stringent) emissions reduction target by purchasing emissions reductions elsewhere. Moreover, as production costs increase almost everywhere they do not face increased import competition.

4.3 Border tax adjustments

Both levies and refunds restore loss in competitiveness to a certain extent. We report the effects of border tax adjustments (BTAs) in ETS-sectors on employment, welfare and carbon leakage.

Table 4.6 Employment in ETS-sectors, differences (in % of baseline) with IMPASSE, 2020

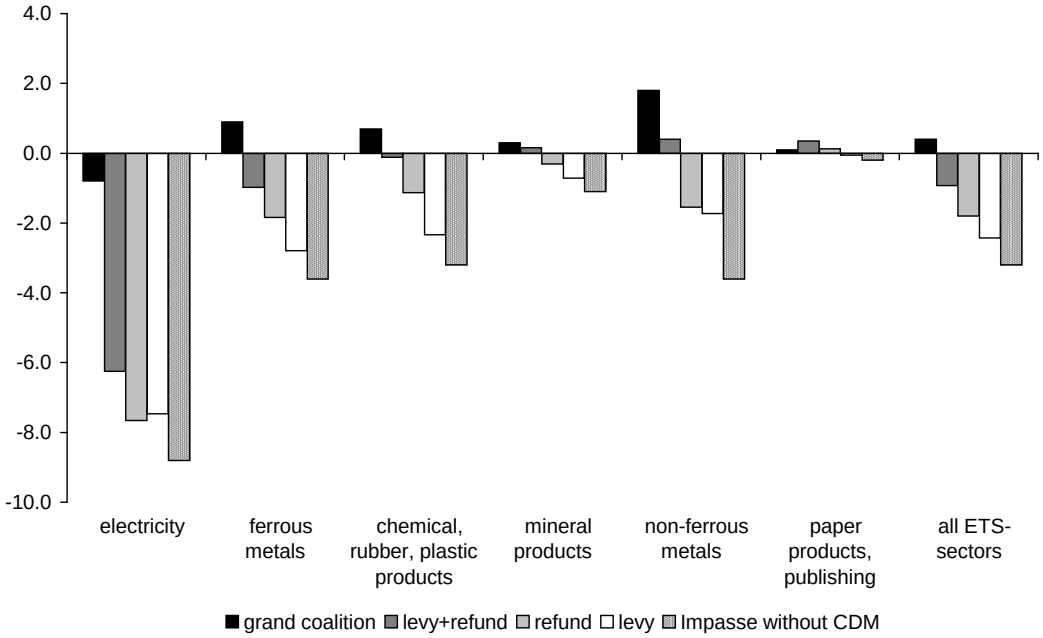
	GRAND COALITION	IMPASSE	LEVY	REFUNDS	LEVY + REFUNDS
	% differences with baseline		differences (in % of baseline) with IMPASSE		
Annex I	-0.4	-0.7	0.1	0.3	0.4
EU-27	0.4	-3.2	0.8	1.4	2.3
EU-15	0.7	-2.4	0.8	1.6	2.6
EU-12	-0.6	-5.5	0.7	0.8	1.6
USA	-0.3	0.4	-0.2	-0.3	-0.6
Former Soviet Union	-2.4	1.4	-0.3	-0.4	-0.8
Other	-0.1	0.6	-0.6	-0.4	-1.0
Non-Annex I	-1.1	0.6	-0.2	-0.4	-0.6
China	-0.5	0.2	-0.1	-0.1	-0.2
India	-5.1	0.4	-0.1	-0.2	-0.4
Brazil	-1.8	0.6	-0.2	-0.9	-1.1
Other	-0.3	1.1	-0.4	-0.5	-1.0
World	-1.0	0.4	-0.2	-0.2	-0.4

Source: WorldScan

Compared to the reference case of IMPASSE, levies improve employment in ETS sectors in EU-27 by 0.8%; refunds improve employment by 1.4% (see Table 4.6). The combined effect of levies and refunds is 2.3%. Given the initial employment loss in IMPASSE of 3.2% in ETS-sectors, an employment loss remains that reflects reduced demands in the EU. The employment gain in the LEVY and REFUND case is paid for by foreign producers. Compared to IMPASSE, energy intensive employment in all non-EU regions declines with both EU import levies and export refunds. Producers in regions that benefited most in IMPASSE suffer the largest losses from BTAs. Given the fact that the EU is a net exporter of energy intense goods, creating a level-playing-field for exports (REFUND) has larger employment effects than an import tariff (LEVY).

Focusing on specific sectors within the ETS-aggregate, it appears that under BTA's employment rises in all energy-intensive sectors. The changes are most pronounced outside the electricity sector (see Figure 4.1). The rise of employment within ETS is at the expense of employment in non-ETS however, as total employment is exogenous in the model.

Figure 4.1 Employment in % difference of baseline, EU-27, 2020



From an overall perspective of the EU, the LEVY case is welfare improving compared to the reference case (IMPASSE). The REFUND case is welfare worsening. However the effects are small (see Table 4.7). For EU-27 in LEVY welfare improves by 0.03% relative to IMPASSE. Revenues from import tariffs and the positive terms-of-trade effect (foreign producers have to lower their prices), more than compensates the producer's and consumer's loss due to the tariff. In REFUND welfare decreases by 0.05% relative to IMPASSE. The public spending on refunds causes the welfare loss.

Table 4.7 Welfare, ETS-price and carbon leakage in EU-27, 2020

	GRAND COALITION	IMPASSE	LEVY	REFUND	LEVIES + REFUND
	% differences with baseline		differences (in % of baseline) with IMPASSE		
Welfare	-0.69	-0.72	0.03	-0.05	-0.02
	€ / tCO_2		% differences with IMPASSE		
ETS-price	18	52	6	7	14
	%		differences with IMPASSE		
Carbon leakage	1.0	3.3	-1.4	-1.3	-2.8

Source: WorldScan

Import levies are welfare worsening for non-Annex I. The effect is small, however. Trade measures are unlikely to persuade non-abating countries to join a climate coalition: they are not a credible threat to non-abating countries. On average, income losses for non-Annex I in GRAND COALITION are larger than in IMPASSE (-0.4% versus -0.3%). Import levies impose extra costs on non-complying countries, but not enough to tip the balance. Theoretically speaking, it

is possible to raise import duties to a level where they may be more harmful to outsiders. It seems unlikely that WTO-agreements allow for these extreme measures.

In the LEVY case the ETS-price rises by 6% compared to IMPASSE. In the REFUND case there is a 7% increase in the emission price. Restoring imports and exports gives a boost to production in ETS-sectors. Emission prices have to rise to keep emissions at the ETS-target.

BTAs not only restore the level-playing-field for ETS-sectors. These measures also help to limit carbon leakage. Both tariffs and refunds decrease leakage by more than 1%-point. Jointly applying import tariffs and refunds decreases leakage from 3.3% to 0.5%.

4.4 Recycling and CDM

An alternative to BTAs is to meet the worries of ETS-sectors by recycling part of the revenues from auctioning emissions permits. In IMPASSE + RECYCLING we assume that 80% of the permit auction receipts from the most exposed ETS-industries (ferrous metals, chemical products, paper products, non-ferrous metals) are recycled to these industries in the form of an output subsidy. It is to be noted that this form of recycling can also be seen as an alternative to grandfathering part of the permits to exposed industries. When recycling rules would be the same in all member states one could circumvent certain disadvantages of grandfathering, such as: international and intersectoral disparities in the allocation of free permits, recurring cumbersome allocation processes and internationally divergent rules for firm entry and exit in the industries concerned. Compared to lump-sum redistribution of auction revenues in IMPASSE, ETS-targeted recycling is slightly welfare decreasing. Recycling partly makes up for the carbon tax. ETS-price has to go up to keep emissions below the ETS-ceiling. Carbon leakage decreases by 0.7%-points and employment is 1.6%-points higher than in IMPASSE.

CDM takes the sharp edge of a unilateral climate regime like IMPASSE. CDM allows EU-countries to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries. In the '20 20 in 2020' proposal of the European Commission the use that can be made of carbon credits from CDM is limited, however. We have adopted these constraints and assumed that for ETS-sectors at most one third of the yearly reduction efforts (baseline minus target) may be covered by CDM-credits, while the yearly CDM-ceiling for non-ETS is 3% of 2005 emissions.

IMPASSE + CDM lowers the emission price considerably and thereby the mitigation costs (see table 4.8). The average emission price in ETS-sectors amounts to 27 €/tCO_2 (-58%). If CDM would not have been allowed, the ETS price would rise to 52 €/tCO_2. If the economy can rely on inexpensive abatement options, the welfare loss from the climate policy declines. In IMPASSE

+ CDM welfare loss is 0.02%-points less than in IMPASSE. The limited use of CDM reduces carbon leakage by 3%-points. For the EU as a whole employment impacts in ETS-sectors are lower as well. CDM mitigates the employment loss in IMPASSE with 2%-points, compared to IMPASSE (compared to the baseline an employment loss of 1.2% remains). It should be noted that new EU member states suffer from CDM projects. The old member states will partly buy credits from CDM-projects in non-Annex I, instead of emissions permits from the new member states. With CDM welfare loss for new member countries (EU-12) rises to 1.6%, compared to 1.2% in IMPASSE without CDM.

Table 4.8 Welfare, ETS-price, carbon leakage and employment in ETS-sectors, EU-27, 2020

	GRAND COALITION	IMPASSE	IMPASSE + CDM	IMPASSE + RECYCLING
	% differences with baseline		differences with IMPASSE	
Welfare	-0.69	-0.72	0.02	-0.01
	€ / tCO_2		% differences with IMPASSE	
ETS-price	18	52	-48	5
	%		differences with IMPASSE	
Carbon leakage	1.0	3.3	-3.0	-0,7
	% differences with baseline		differences with IMPASSE	
Employment ETS-sectors	0.4	-3.2	2.0	1.6

Source: WorldScan

Figure 4.2 illustrates the impact of allowing CDM up to the limits proposed in ‘ 20 20 in 2020’ in IMPASSE by comparing costs of the ETS in the different ETS-sectors with GRAND COALITION and IMPASSE. The figure shows the unit cost shares of ETS-permits for different industries at the level of EU-27, taking account of both the direct and the indirect costs (such as the permit value in the electricity input bought by the aluminium industry). The figure shows that the ETS-unit cost-shares in IMPASSE+CDM come quite close to the unit cost-shares in GRAND COALITION and are considerably smaller than in IMPASSE. The impacts on employment in ETS-sectors in IMPASSE+CDM are substantially smaller than in IMPASSE as well (see figure 4.3). In 2020 IMPASSE+CDM entails an employment loss for ETS-sectors of 1.2% compared to the baseline. The loss in production is 1.7% and the production leakage rate 25% (implying a production increase outside EU-27 to an extent of 0.4% of EU-27 production). Thus, in a stand-alone climate policy environment the provisions of ‘ 20 20 in 2020’ regarding CDM-usage seem to rule out large impacts on competitiveness as well as carbon leakage. Hence, one may conclude that even if the post-2012 negotiations would lead to the unfavourable outcome of an IMPASSE the remedy of adopting BTAs may not be worth the effort and worse than the disease.

Figure 4.2 Percentage share of ETS-permits in unit production costs, EU-27, 2020

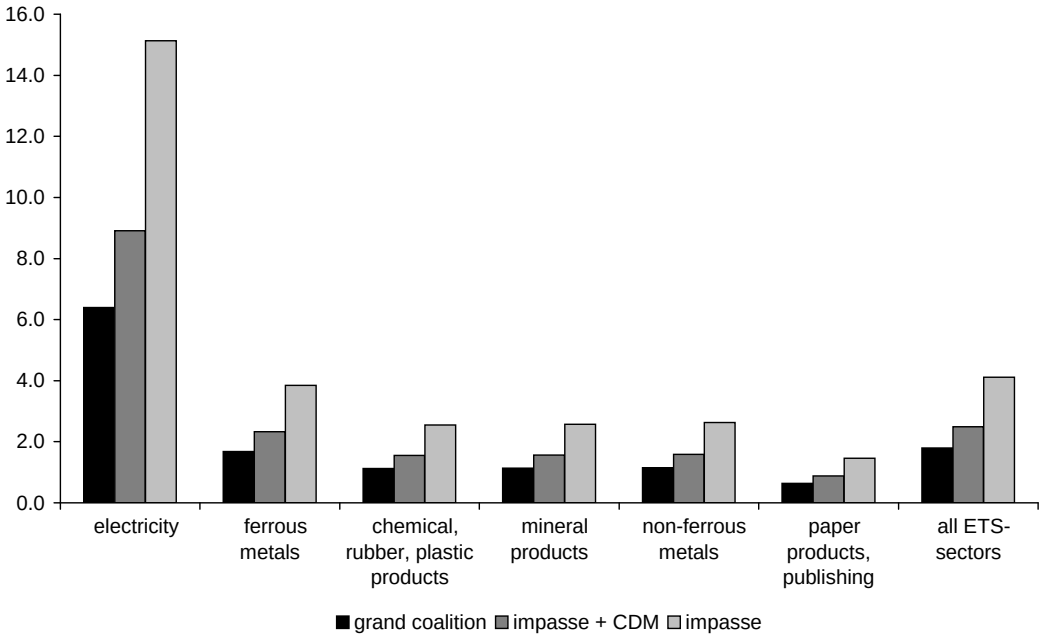
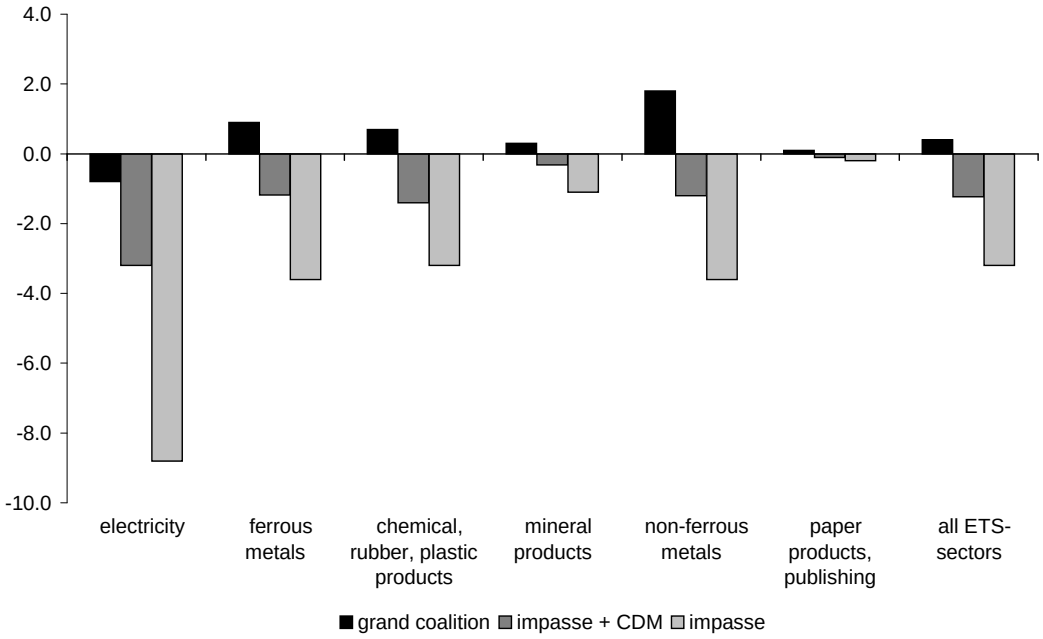


Figure 4.3 Employment in % difference of baseline, EU-27, 2020



4.5 Robustness of results

The impact on competitiveness depends crucially on how import flows from different origins respond to price differentials. The so-called Armington elasticities determine this responsiveness. These elasticities are key parameters in the model. Central values in WorldScan are based on Hertel, et al, 2004). To test the robustness of the results a sensitivity analysis was carried out with alternative values of the Armington elasticities (Table 4.9).

Table 4.9 Leakage rates and production change in ETS-sectors at alternative levels of Armingron elasticities, 2020

	Central values	50% of central values	150% of central values
		Armington elasticities	
Electricity	4.6	2.3	6.9
Ferrous metals	4.9	2.5	7.4
Chemical, rubber, plastic products	5.6	2.8	8.4
Mineral products	4.8	2.4	7.2
Paper products, publishing	4.9	2.5	7.4
Non-ferrous metals	7.4	3.7	11.1
		Carbon leakage rates in %	
GRAND COALITION	0.9	0.7	1.2
IMPASSE without CDM	3.3	1.9	4.4
		ETS production in % difference from baseline	
IMPASSE without CDM	-4.5	-1.6	-6.7
		ETS production leakage rate in %	
IMPASSE without CDM	38	-	58

Source: WorldScan

With Armington elasticities at 50% of the central values, there is a more sluggish response of trade flows to price differentials between domestic and foreign producers. Carbon leakage is about 80% of the level at central values in GRAND COALITION and 60% in IMPASSE; the production decline of ETS-sectors is 60% less than in IMPASSE; production leakage is only present in the ferrous and non-ferrous metal sectors and not occurring in other ETS-sectors. With higher Armingtons, 150% of the central values, trade flows respond stronger to price changes. Carbon leakage rates increase with about one third; the production decline of ETS-sectors is 50% more than in IMPASSE and production leakage rates increase on average with 50% too.

It should be kept in mind that the outcomes need some qualification. First, labour supply and unemployment are exogenous in the WorldScan version that is used here. Hence, there are no impacts from reduced real wages on labour supplies, nor do climate change policies induce a (short-term) rise in unemployment. Second, only average impacts on ETS-sectors are shown and individual plants may obviously be affected differently. Moreover, though we did come as close to the ETS sector classification as our database allowed, some of these extend to a broader

group of industries that are not covered by the ETS. Hence, the negative impacts for some industries (such as basic chemicals and paper production) in IMPASSE may understate the actual consequences because the costs increase due to the ETS has been applied to a wider sector (such as chemical, rubber and plastic products and paper and publishing).

5 Conclusions

We use WorldScan, a multi-region multi-sector global general equilibrium model to assess the implications of border tax adjustments to protect the competitiveness of energy intensive industries in the EU. This study shows simulation outcomes for a number of stylized policy environments for 2020. In IMPASSE the EU is virtually alone in adopting a strict CO_2 emissions ceiling of 20% below the 1990 level. Though emission trading allows for some flexibility among energy-intensive sectors (the ETS-sectors). In GRAND COALITION a global coalition aims at meeting the EU two-degree temperature target. EU targets in 2020 are 30% below the 1990 level, full emissions trading is allowed for.

The stand-alone European climate policy IMPASSE brings only modest global reductions of greenhouse gas emissions. Reduction comes at relatively high costs; the global climate regime GRAND COALITION quadruples reductions at the same costs

Does unilateral climate policy by the EU lead to changes in competitiveness and relocation of energy-intensive industries to non-abating countries?

- In general we find only modest effects on competitiveness. Even in energy-intensive sectors, energy expenditure is only a fraction of total production costs. Trade flows are hardly affected, because intra-European trade is much more important than inter European trade. Also, the energy-intensive sector is small compared to other sectors.
- IMPASSE with CDM comes closest to the current EU-proposals. CDM allows ETS-sectors to benefit from inexpensive abatement options in developing countries. Impacts on competitiveness of energy-intensive sectors are limited. In 2020 employment loss amounts to about 1.2%.
- In IMPASSE without CDM the competitiveness of energy-intensive sectors is affected more negatively. On average, emission prices are higher and shifts in production and employment are stronger. Both production and employment for the aggregate ETS-sector fall by 3-4%. In non-ETS sectors there is a production gain of 0.4%. Moreover, production leakage is considerable: almost 40% of the decline in ETS-production pops up as a rise in production outside the EU. Carbon leakage is small – with a leakage rate of over 3%.
- The climate policy environment predominantly determines the impacts on both global CO_2 emissions and the competitiveness of ETS-sectors in the EU. In a global climate regime the relatively energy efficient EU ETS-sectors can benefit from a competitive advantage, as can be seen from GRAND COALITION.

How would border trade measures, more specific import duties and export subsidies, mitigate the impacts of the climate policy?

- Both import levies on ETS-imports and export refunds for ETS-exports partly restore competitiveness. If energy-intensive non-EU-imports face a levy that reflects the additional costs for EU producers due to the ETS, EU sectors loose less market share to foreign competitors on domestic markets. With a refund on exports, reflecting the costs of the ETS, EU energy-intensive sectors can restore their market share on foreign markets. With import levies *and* export refunds employment losses in ETS sectors are less than two thirds of what they would have been in IMPASSE without CDM.
- Export refunds are more effective in restoring production and employment losses in ETS-sectors. The EU is a net exporter of energy intensive products.
- Border tax measures reduce carbon leakage. Compared to a 3.3% carbon leakage in IMPASSE without CDM, with import levies *and* export refunds leakage drops to 0.5%.
- Border tax measures may entail a welfare loss for the outside world. Due to favourable terms-of-trade effects, the EU benefits from an import levy. An export refund is welfare decreasing, due to government spending on export refunds.
- Trade measures are not a credible threat to non-abating countries. Trade measures do not seem to be effective in persuading non-abating countries to join a climate change regime. However, these measures mitigate the negative structural effects for affected sectors. Theoretically speaking, it is possible to raise import duties to a level where they may be harmful for outsiders. It seems unlikely that WTO-agreements allow for these extreme measures.
- There are alternatives to border tax measure to take the sharp edge of a unilateral climate regime like IMPASSE.
- Recycling the auction revenues to ETS-sectors helps energy-intensive sectors to cope with higher energy costs. In IMPASSE WITH RECYCLING, where 80% of the auction receipts are redistributed to exposed ETS-industries, employment loss in EU ETS-sectors is only half of what it would have been without recycling.

Is there a case for trade measures to restore the level playing field?

- Whether border tax measures will be implemented, however, is disputable. There is no definitive answer to the question whether such measures would be WTO-legal. Border trade measures might well be found to contravene WTO's Article I on most-favoured nation (MFN) treatment. The question hinges on whether it is permissible to consider the carbon content of a good when deciding whether two goods are due similar treatment. On the other hand, based on article XX of the WTO (the environmental window), the EU may argue for a countervailing tariff on the ground that the absence of a carbon policy in non-coalition countries represents an implicit production and export subsidy. To a large extent the answer will depend on the design of the measure in question, of course.

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