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Joining a carbon policy coalition:

Flexible mechanisms, competitiveness and anti-leakage instruments in Europe

Abstract:
We analyse the impacts for a small, open country with carbon abatement ambitions of joining a coalition with allowance trading. Besides welfare impacts for both the coalition and the small, open economy joining the coalition, we scrutinise the carbon leakage and competitiveness effects of various flexibility designs. Our example is the EU 2030 policies and the Norwegian intention of linking its policies to EU's. The findings suggest that using flexible mechanisms also for emissions outside today's allowance trading system substantially reduces costs for the small, open economy and, also, benefits the coalition at large. If such flexibility is not facilitated, the small, ambitious country is better off by not joining the coalition and establishing an own allowance market. The analysis also identifies the impacts of anti-carbon-leakage policies. The anti-leakage policies scrutinised include the EU's free allowances and its financial compensation for indirect costs of electricity. Our results indicate that the anti-leakage policies of the EU perform fairly well in terms of effectiveness, but also illustrate that there is not necessarily a correlation between carbon leakage and competitiveness losses.

Keywords: Carbon policies, Energy efficiency policies, General Equilibrium analysis, Rebound effects

JEL classification: D58, Q43, Q48

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1 Introduction

The EU countries have among the worlds' most ambitious policies aimed at combatting greenhouse gas emissions. The EU 2030 climate and energy framework (EC, 2014) includes targets for greenhouse gas emissions for sources embraced by the Emission Trading System (ETS) as well as for those outside of the ETS (NETS). Emissions mitigation efforts can, however, be counteracted by carbon leakage. For this reason, the EU has introduced anti-leakage policy for the most trade-exposed ETS industries.

The 2030 climate and energy framework does, in practice, also allow for non-EU associates. Non-member Norway has decided to link its climate policy to the EU framework. This paper takes a look at costs and benefits of such a strategy for a small, open economy. Why does a small country without right to participate in EU decisions lay its fate in the hands of a larger coalition? Are the decisions of the coalition the best options for the small associate? In this context, we also include an analysis of the particular EU rules designed to limit carbon leakage. We ask whether the instruments chosen by the EU are the best for fighting carbon leakage cost-effectively – for the EU and for the fellow country, Norway. We also question whether anti-leakage instruments are beneficial for the competitiveness of the trade-exposed industries involved, and what are the repercussions for other industries.

ETS is the main European facilitator for emission cuts. The sector regulated by the ETS must limit its emissions by 2030 with 43% compared to its 2005 level. In addition, the non-ETS (NETS) emissions are to be cut by 30% during the same period. The framework in EC (2014) opens for interactions among non-ETS sources across borders and between the ETS and non-ETS sectors, so-called flexible mechanisms. The designs and the coverage of such mechanisms will be important for the costs of the 2030 goals.

Norway has committed to climate policy targets for 2030 in line with the EU (Norwegian Ministry of Climate and the Environment, 2015; UNFCCC, 2015). As Norway is part of EU ETS, approximately 40% of the Norwegian carbon emissions are already regulated joint with the EU. Recently, the government has also announced its interest to be part of the NETS Effort Sharing Decision.

Within the EU 2030 climate and energy framework, existing instruments that are designed to dampen carbon leakage are intended to be prolonged. Potential policy responses to carbon leakage include border carbon adjustments (carbon tariffs and export rebates), allocation of free allowances or other financial compensation schemes (e.g., Hoel,1996; Fischer and Fox, 2012). While border carbon adjustments have been frequently on the agenda, the main compensation arrangement in the EU ETS system has until now, and will probably still be, free allowances. The European Commission (EC) estimates that 43% of the total amount of allowances will not be auctioned, but freely allocated, during 2013-2020, and predicts a similar share for the period 2021-2030. Furthermore. the revised ETS Directive allows for national state aid schemes that compensate the most electro-intensive and trade-exposed industries for increases in electricity costs as an indirect result of the EU ETS. The aid intensity must not exceed 75 % of the eligible costs incurred in 2019 and 2020.

We analyse the economic costs of the 2030 emissions caps under different flexibility regimes to identify the impacts of joining a coalition with allowance trading (full or restricted). Besides welfare impacts for both the EU and the small, open economy joining the coalition, we scrutinise the carbon leakage and competitiveness effects of various flexibility designs. Our findings suggest that using flexible mechanisms also for emissions outside today's allowance trading system substantially reduces costs for the small, open economy and, also, benefits the coalition at large. If such flexibility is not facilitated, the small, ambitious country is better off by not joining the coalition and establish an own allowance market.

Moreover, we identify the impacts of anti-leakage policies, including the intended compensation policies for the years to come. These include the mechanisms already in use in the EU ETS: free allowances and financial compensation for indirect costs of CO_2-emissions in the electricity market (higher electricity prices) for energy intensive industries. Two aspects are analysed. First, they are compared to other instruments recommended in the literature (carbon tariffs and export rebates; see, e.g., Fischer and Fox, 2012). Second, we scrutinise whether, as common sense seems to suggest, competitiveness and carbon leakage solutions go hand in hand, which need not be true (Böhringer et al., 2015). The industries vary substantially with respect to the associated carbon leakage and competitiveness impacts of the anti-leakage policy instruments.

2 The model and the analytical approach

2.1 The numerical model

We use a regional, multi-sector CGE model, **SNOW**[1] of global trade and energy established for analysing carbon emission control strategies. Table 1 presents the modelled regions. CGE models build on general equilibrium theory that combines behavioural assumptions about rational economic agents with analysis of equilibrium conditions. They provide counterfactual ex-ante comparisons, comparing the outcomes of different policy regimes. The main virtue of the CGE approach is its comprehensive micro-consistent representation of price-dependent market interactions in a setting with various, existing public interventions. The simultaneous explanation of the origin and spending of the agents' income makes it possible to address both economy-wide efficiency and distributional impacts of policy reforms.

[1] **SNOW** is **S**TATISTICS **NO**RWAY's **W**orld model

Table 1: Regions in the SNOW model

CHN	China
NOR	Norway
RUS	Russia
NAM	North America
REU	Rest of Europe
OOE	Other OECD
EEX	Energy exporting countries
ROW	Rest of the World

The model includes sectors for all major primary and secondary energy carriers: coal, crude oil, natural gas, refined oil products, and electricity. In addition, we separate the main emission-intensive and trade-exposed industries: chemical products, non-metallic minerals, iron and steel products, and non-ferrous metals, as they will be the most affected by emission control policies and the prime candidates for anti-carbon-leakage measures. See Table 2 for a list of the sectors.

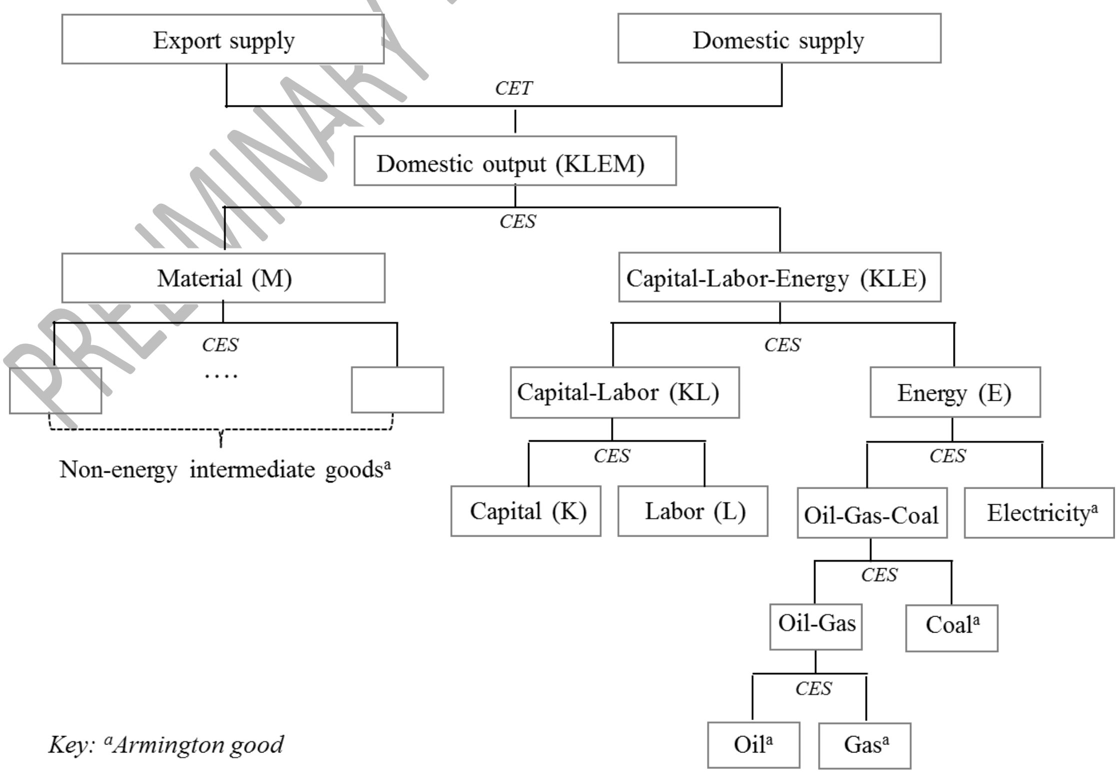
Table 2: Sectors in the SNOW model

COL	Coal
CRU	Crude oil extraction
AGR	Agriculture and forestry and fishery
OIL	Petroleum and coal products (refined)
GAS	Natural gas extraction
PPP	Paper and pulp and print
CRP	Chemical products
NMM	Non-metalic minerals
I_S	Iron and steel
NFM	Non-ferrous metals
ELE	Electricity
OTP	Other transport
WTP	Water transport
ATP	Air transport
AOG	All other goods

C	Household
G	Government consumption
I	Investment

The production of commodities is captured by three-level, constant elasticity of substitution (CES) cost functions describing the price-dependent use of capital, labor, energy, and materials (KLEM); illustrated in Figure 1. At the top level, a CES composite of intermediate material demands trades off with an aggregate of energy, capital and labor subject to a constant elasticity of substitution. At the second level, a CES function describes the substitution possibilities between intermediate demand for the energy aggregate and a value-added composite of labor and capital. At the third level, capital and labor substitution possibilities within the value-added composite are captured by a CES function, whereas different energy inputs (coal, gas, oil and electricity) enter the energy composite subject to a constant elasticity of substitution.

Figure 1: The production technologies



The production of fossil fuels (extraction of coal, oil and gas) are modelled differently in two main ways. First, the sectors use fossil fuel resources, provided in fixed amounts, in addition to the other inputs. Second, all inputs other than the natural resources are used in fixed proportions, i.e., the substitution elasticities among them are assumed to be 0.

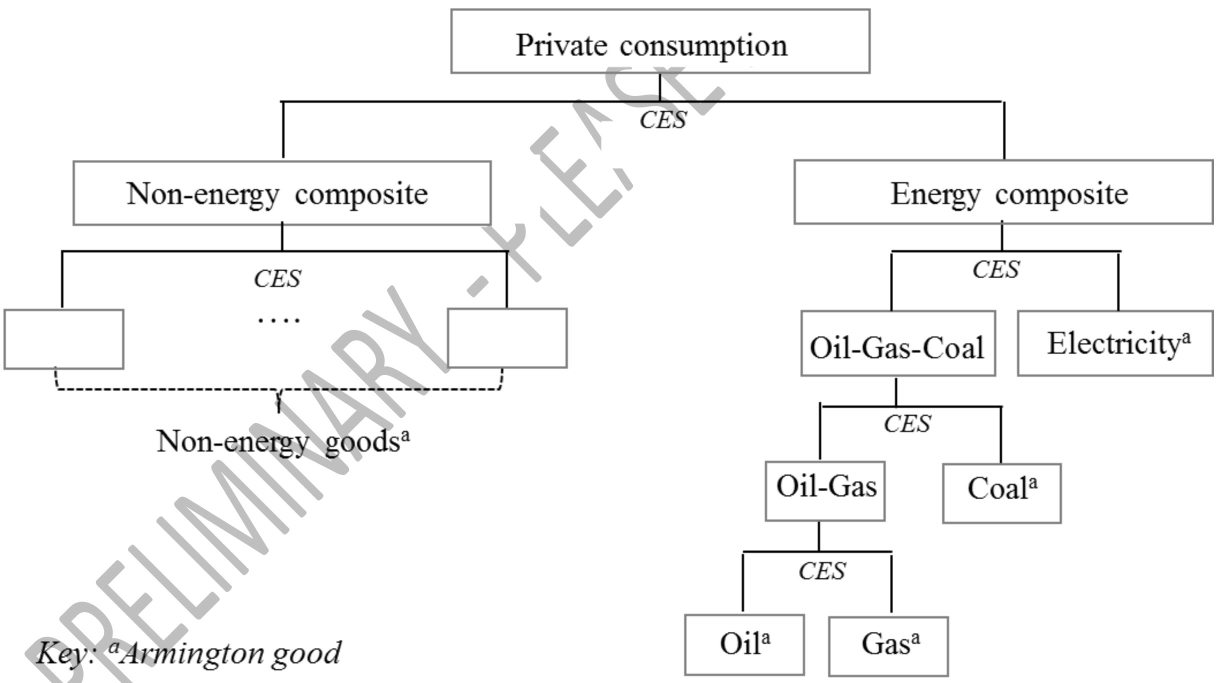
Labour and capital are mobile across all industries *within* a region, but immobile *across* regions. Fossil fuel resources are sector and country/region-specific.

The modelled behaviour abstracts from heterogeneity within regions by featuring one representative agent in each region that receives income from the three modelled primary factors: labour, capital, and fossil-fuel resources. Final consumption demand in each region is determined by the representative agent who maximises welfare subject to a budget constraint with fixed investment (i.e., a given demand for savings) and exogenous government provision of public goods and services. Total income of the representative agent consists of net factor income and tax revenues net of subsidies. Consumption demand of the representative agent is given as a CES (Constant Elasticity of Substitution) composite that combines consumption of composite energy and an aggregate of other (non-energy) consumption goods; see Figure 2.

Bilateral trade is specified following the Armington's differentiated goods approach, where domestic and foreign goods are distinguished by origin (Armington, 1969). Prices on traded goods may then develop differently among regions. All goods used on the domestic market in intermediate and final demand correspond to a CES composite that combines the domestically produced good and the imported good from other regions. Quite analogously, export production and domestic deliveries are allocated by a CET (Constant Elasticity of Transformation) function; see Figure 1. A balance of payment constraint incorporates the base-year trade deficit or surplus for each region.

CO_2 emissions stem from both energy use and production processes. The emissions from energy use are linked in fixed proportions to the use of fossil fuels in the sectors (industries and consumption), with CO_2-coefficients differentiated by the specific carbon content of fuels. CO_2 emissions abatement takes place by fuel switching (interfuel substitution) or energy savings (either by fuel-non-fuel substitution or by a scale reduction of production and final consumption activities). Process emissions are linked to the output of the production process and can only be abated by reducing output from the sector. Restrictions to the use of CO_2 emissions in production and consumption are implemented as emissions constraints, which are exogenously set and imply carbon pricing – see below.

Figure 2: The nested CES consumption model



2.2 Data

The CGE model is based on the *Global Trade, Assistance and Production* (GTAP 9.0) dataset, which includes detailed national accounts on production and consumption (input-output tables) together with bilateral trade flows and CO_2 emissions for up to 112 regions, including Norway, and 57 industries (Narayanan et al., 2015). GTAP can be flexibly aggregated to form a composite dataset that accounts for the specific requirements of the policy issue under investigation. The data for CO_2 emissions from GTAP are supplemented with detailed information on process emissions that formed the basis for Bednar-Friedl et al. (2012) and with national emission inventories, primarily the Norwegian (http://www.ssb.no/en/statistikkbanken).

For model parameterisation, we follow the standard calibration procedure for applied general equilibrium analysis: the base-year input-output data determine the free parameters of the functional forms (cost and expenditure functions), so that the economic flows represented in the data are consistent with the optimizing behaviour of the model agents.

The responses of agents to price changes are determined by a set of exogenous elasticities taken from pertinent econometric literature. Elasticities in international trade (Armington elasticities) are taken from the GTAP database. The GTAP database also provides substitution possibilities in production (between primary factor inputs). The elasticities of substitution in fossil fuel sectors are calibrated to match exogenous estimates of fossil fuel supply elasticities (Graham,Thorpe and Hogan 1999, Krichene 2002).

2.3 Analytical design

Our *Baseline* scenario for 2030 is based on continuing the energy and climate policy as before the 2030 framework was launched. We base the inputs on (EC, 2016), which projects that about 80% of EU's committed CO_2 abatement from 2005 for 2030 is realised under the continued, old, policy regime. We then look at three *Framework* scenarios, F1, F2 and F3. In all the *Framework* scenarios, the EU needs to cut its 2030 emissions from the *Baseline* with 10% to meet its commitments. This is true for both the ETS and the NETS sector. F1 assumes full cross-border and cross-industry flexibility within the two sectors, but no flexibility across EU ETS and NETS. This results in different CO_2-prices in the markets for ETS and NETS.

F2 simulates the extreme flexibility regime with full allowance trading among countries and across ETS and NETS sectors, which will result in a common carbon price for all EU emissions sources. F3 still allows for full trading in the ETS, but no trading across countries in NETS, nor across the two sectors. The last alternative gives a common price in ETS, but country specific prices in NETS as we assume cost-effective NETS policy within countries. In all scenarios, Norway is modelled as part of the EU. F3 implies a 40% reduction target in NETS for Norway, in accordance with the current proposal of EC.

We then look at the impacts of the various components of the carbon policies and how they interact. This is done by introducing into the *Framework* scenarios EU's anti-leakage and competitiveness policies successively; first the free allowances in ETS, then the electricity CO_2-compensation schemes. We also simulate a regime with the compensation scheme, only. We wish to identify both their isolated effects and their interaction effects. The anti-leakage scenarios enable us to examine whether the flexibility matters for the effects of the anti-leakage policies. We also examine border carbon adjustments as an alternative instrument for reducing leakage.

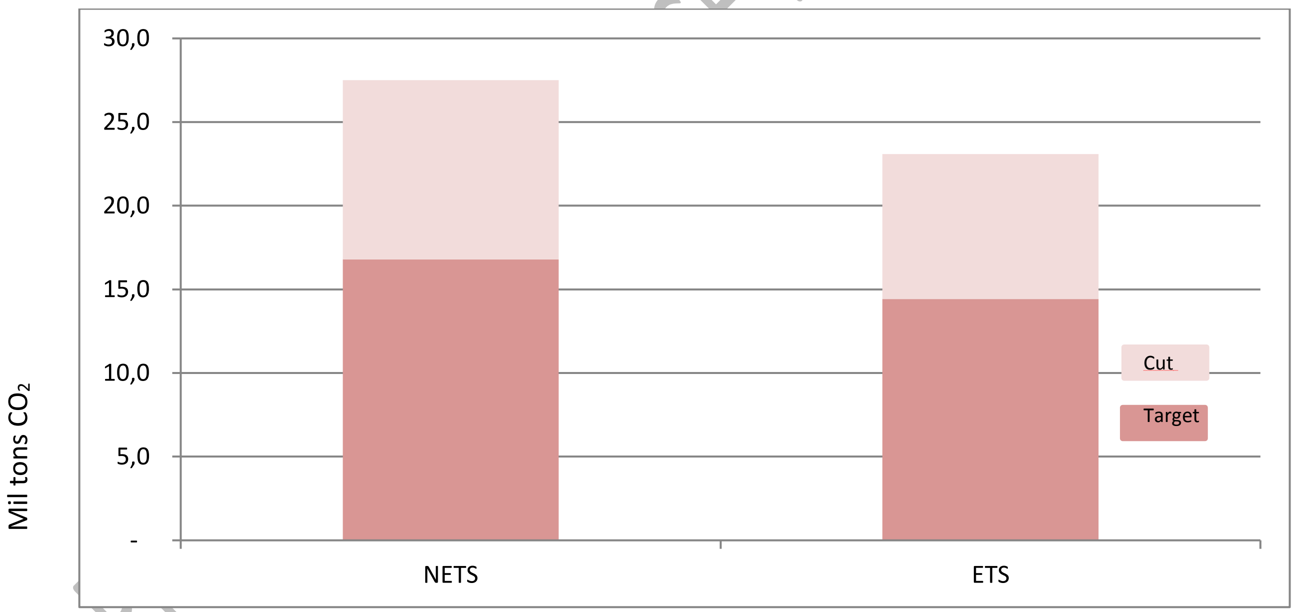
In addition, in order to benchmark the linking up of Norway's policies to that of the EU, we also simulate a Norwegian act-alone scenario where the 2030 targets are met without linking the national policies to the EU policy. Finally, we do sensitivity analyses of the remaining cap from the *Baseline* (increased from 10% to 20%), impacts of changing the Armington elasticities and how a global regime with abatement policies in the rest of the world affect the results.

3 Analysis and results

The Framework scenarios

Figure 3 shows the targets in the *Framework* scenarios F1 to F3 and the necessary emission cuts from the *Baseline*. In all the *Framework* scenarios, the Norwegian targets for NETS and ETS stay unchanged; the scenarios only differ in the available abatement options. The options are most flexible in F2, where cuts can be implemented across NETS and ETS and across Norway and the rest of the EU (REU), while F3 is the least flexible with no flexibility in the NETS sector. F1 is in between. Here, the Norwegian NETS cuts can be implemented by paying for abatement measures in the NETS sector in REU. This is modelled analogously to the emission trading system already in place for the ETS sector.

Figure 3: The Norwegian Baseline emissions and targets in the Framework scenarios



Our preliminary results indicate that using flexibility mechanisms in NETS will significantly reduce the abatement costs for the coalition, as a whole, and for Norway, in particular. For the Norwegian NETS emissions, marginal abatement costs more than halve from the non-flexible scenario F3 to F1 and they are cut to a tenth in the fully flexible F2; see Table 3. Even if flexibility is encouraged and some mechanisms will be provided for the period 2021-2030, each country is free to use them or not. Political signals both in Norway and other European countries indicate that several countries intend to heavily rely on unilateral abatement within NETS. The proposed reduction target for Norway is at the coalitions's maximum (40% from 2005) and virtually no mitigation is expected in the *Baseline* scenario (Aune and Fæhn, 2016). Therefore, a 40% commitment from the *Baseline* remains in our *Framework* scenarios. Moreover, as abatement options are relatively expensive in Norway, the country is much better off within a coalition that practices flexibility. The expensive options are due to already very small gas consumption in households and a scattered population, which rises the costs of transforming to low-emission transportation.

Table 3: Marginal abatement costs for Norway, €/t CO_2

	F1	F2	F3
ETS	40	60	40
NETS	250	60	600

Even though Norway acting totally alone, i.e., dropping out of the ETS, is currently unrealistic, the comparison between the unilateral and collaborating regimes is interesting both as a benchmarking for the linking strategy, and as lessons for other countries not yet determined to collaborate in a coalition or not. The comparison shows that joining the coalition is costly for Norway, if that implies a separate ETS and NETS target. The reason is a large abatement cost wedge between the two sectors. It is, therefore, cost-effective for Norway to abate the lion's share within industries that are ETS-regulated today.

Table 4: Welfare, carbon leakage and ETS output (FI, F2 and F3, percentage changes from *Baseline*)

The anti-leakage policy scenarios

The EU has two main policy instruments directed towards the most carbon-leakage exposed businesses in the ETS system, free allowances and a compensation scheme for electricity costs. We simulate the effects of both. In addition, we simulate the alternative of imposing border carbon adjustments (BCAs). These include tariffs designed to tax the carbon content embodied in imports combined with rebated of emissions payments for exports. Such border adjustments are not at present topical in the European system, but are the recommended instrument to combat carbon leakage from an efficiency point of view; see Markusen (1975) and Hoel (1996). We therefore study their effect as a benchmarking for the adopted EU policies.

Free allowances are received by businesses in the ETS system deemed to be exposed to carbon leakage, even if auctioning of allowances is the default in the system. Carbon leakage applies primarily to firms in manufacturing industries, as well as to the aviation sector. For data on actual allocations, see https://www.eea.europa.eu/data-and-maps/ data/data-viewers/emissions-trading-viewer-1. In total, the Commission estimates that 57% of the total amount of allowances will be auctioned during 2013-2020, while the remaining allowances are available for free allocation. In the context of the 2030 climate and energy framework (EC, 2014), EU leaders decided in October 2014 that free allocation shall not expire, but that the share of allowances to be auctioned will not reduce during the next decade. The Commission's proposal for revision of the EU ETS Directive foresees that the share of allowances to be auctioned will remain the same after 2020. In the aviation sector, 15% of allowances in circulation will be auctioned. The allocation of free allowances is subject to strict rules on emission intensities, to ensure that in practice, output not emissions is the basis for allocations.

Table The compensation scheme for costs of electricity is regulated by Article 10a(6) of the revised ETS Directive. It gives Member States the possibility to compensate the most electricity-intensive sectors for increases in electricity costs as a result of the EU ETS, through national state aid schemes. The Commission must approve the national schemes to ensure that they are in line with the EU state aid rules. The guidelines state that aid intensity must not exceed 80 % of the eligible costs incurred in 2016, 2017 and 2018 and 75 % of the eligible costs incurred in 2019 and 2020. Electricity efficiency and emission coefficient benchmarks apply to ensure that compensation does not increase with low productivity.

We simulate four different anti-leakage policy scenarios:

P1: Free quotas in ETS for REU and Norway, else like F1 (<u>without</u> CO_2-compensation scheme for electricity-related, indirect emissions)

P2: Free quotas in ETS for REU and Norway (as POL1), but also <u>with</u> CO_2-compensation scheme for indirect emissions (electricity)

P3: No free quotas in ETS for REU and Norway (as in REF 1), but <u>with</u> CO_2-compensation scheme

P4: Border carbon adjustments

Our findings are preliminary and will be reported in Table 5. The simulations indicate that EU's anti-leakage policies seem to be relatively costly for the economy as a whole, but mostly, but not always, benefit the individual industries involved. Thus, a welcome auxiliary benefit of reducing carbon leakage is that the policies favour certain industries.

Nevertheless, there is not necessarily a correlation between carbon leakage and competitiveness losses. For Norway acting alone, anti-leakage policies do not necessarily improve competitiveness of domestic trade-exposed industries. We find quite heterogeneous effects from industry to industry, depending on their electricity intensity, embodied emissions in imports and export shares. Least profitable for the exporting industries are border carbon adjustments, though they more effectively alleviate carbon leakage than the options used in the EU today and suggested for the forthcoming period.

An interesting effect of accounting for process emissions is also identified. Anti-leakage policies tend to shift abatement from reducing the output in emission-intensive industries to reducing their energy input. However, when process emissions are accounted for, the emissions from process industries will respond less and abatement costs amplified. Even if carbon leakage is smaller for the coalition than for Norway acting alone, the leakage effects of joining the EU coalition also vary a lot among industries. Not only the total cap, but also the allocation of emissions matters for leakage effects. Norwegian industries with high abatement costs will not abate to the same extent in a coalition. Some of these industries have relatively low leakage effects to the rest of the world, and the reallocation of abatement contribute to increasing leakage.

A sensitivity section will be included, where we vary the caps, the Armington elasticities and the climate policy in the rest of the world.

4 Conclusions

In this paper, we analyse different ways to operationalise EU's and Norway's greenhouse gas mitigation commitments for 2030. We analyse the economic costs of the caps under different flexibility regimes, and the interplay between the flexibility of carbon policies and anti-leakage policies, which include the two main instruments of the EU: free allowances and financial compensation for indirect costs of regulated CO_2-emissions in electricity generation. Our preliminary results show that flexibility is even more crucial for keeping down Norwegian than for EU's abatement costs.

The preliminary results also indicate that EU's anti-leakage policies seem to be relatively costly for the economy as a whole, but mostly, but not always, benefit the individual industries involved. Thus, a welcome auxiliary benefit of reducing carbon leakage is that the policies favour certain industries. In the wake of the Paris agreement, carbon leakage will be far less topical, as a much larger share of global emissions will be subject to some sorts of caps. Expectedly, motivating policy measures by their anti-leakage effect will be less legitimate, yet still tempting, as different (shadow) prices of the caps in different regions will mean loss of competitiveness for ambitious countries like the European.

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