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Analysis

The impact of carbon pricing and a CBAM on EU competitiveness

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1. Introduction

EU Member States have committed themselves to achieving an EU-wide 55% reduction in carbon emissions by 2030 with an ultimate goal of full climate neutrality by 2050. To reach these goals, the European Commission (EC) has presented various policy proposals in the 'Fit for 55' package under the EU Green Deal. These include proposals for better carbon pricing by strengthening the EU Emissions Trading System (ETS) with lower emission ceilings and by expanding the ETS to new sectors. The ETS price has increased significantly in recent years, from €6 in 2017 to €55 in July 2021. To meet the Paris Agreement targets cost-effectively, carbon prices should be between $50 (€44) and $100 (89€) per tonne of CO_2 by 2030 (World Bank, 2017). In theory, carbon pricing is the most efficient way of reducing carbon emissions by assigning a price to the external costs of emissions. Rising carbon prices in the EU could, however, lead to businesses transferring production to other countries with laxer climate policies, resulting in increased emissions in other regions (carbon leakage) and a loss of competitiveness among European producers. To mitigate carbon leakage and level the competitive playing field of European producers, the 'Fit for 55' package includes a proposal for a Carbon Border Adjustment Mechanism (CBAM). This study estimates the impact of a carbon tax and a CBAM on production costs and competitiveness of EU Member States.

The proposed CBAM aims to charge EU importers for the carbon content of the imported products from outside of the EU. This would be different from, and additional to, a normal tariff on imports, as importers in the EU could avoid the CBAM if they reduce their carbon intensity. The European Commission has proposed a CBAM that will initially target direct emissions of cement, electricity, fertilisers, iron, steel and aluminium production, with the goal of expanding the CBAM to new products/sectors and indirect emissions at a later date.

The idea of a CBAM is not new, and many studies have investigated the effectiveness of a CBAM in tackling carbon leakage and levelling the playing field across countries. However, the results of these studies are mixed and not conclusive. Kuik et al. (2009) studied the effectiveness of a European CBAM and concluded that the CBAM would not be very effective from an environmental point of view, but that implementation can nonetheless be justified on the basis of restoration of competitiveness in specific sectors. Böhringer et al. (2012) found that a CBAM was effective in decreasing the carbon leakage rate by almost one third relative to a benchmark scenario. In addition, numerous studies have examined the effects of a carbon tax on competitiveness and on the broader economy (Saddler et al., 2006; Vollebergh et al., 2019; McKitrick & Aliakbari, 2021). Hebbink et al. (2018) investigated the effects of imposing a €50 carbon tax on costs and competitiveness of the Dutch economy. They report a relatively small impact for the economy, emphasising at the same time heterogenous effects across sectors with high impacts for emission-intensive sectors. When the revenues from the carbon tax are used to lower income taxes, the net effect of a carbon tax on GDP is estimated to be positive.

We find that the impact of a €50 EU carbon tax on production costs and price competitiveness is relatively modest (between 0% and 2%) for most sectors and countries. There are, however, considerable differences between countries and sectors, with price effects generally larger in the Central and Eastern European (CEE) countries than in EU14 countries, especially in the energy sector. This is because most CEE countries' production is more carbon intensive than the average in the EU, and hence the carbon tax results in a higher price increase in these countries, providing a larger incentive to cut carbon emissions. Our estimates represent an upper bound of potential cost increases and in practice costs will probably increase by less (see chapter 2). Furthermore, the model we use does not allow for substitution between different production factors, neglecting the effects of price fluctuations on emissions. Despite these limitations, our estimates clearly suggest that a CBAM will fully mitigate the negative impact of a carbon tax on domestic market competitiveness for the majority of countries and sectors. In a few CEE countries (Bulgaria, Poland and Estonia), however, a deterioration of competitiveness still persists. The increase in EU production costs through the use of more expensive inputs from outside the EU as a result of the CBAM is shown to be minor. The CBAM does not prevent a deterioration in export competitiveness. Although the average effect of a €50 carbon tax on export competitiveness is relatively modest, more negative effects are found in specific (mostly CEE) countries and sectors, especially in their energy sectors.

This study is organised as follows: section 2 explains the methodology and chosen scenarios. In section 3 we analyse the effects of a carbon tax on EU production costs and export competitiveness. Section 4 discusses the effects of a CBAM on EU competitiveness in the domestic market. Section 5 concludes with a few policy recommendations.

2. Methodology and scenarios

To estimate the impact of a European carbon tax and a CBAM on production costs and competitiveness, we use an input-output (IO) model database that includes data for the year 2015 on carbon emissions covering all carbon emissions (but not other greenhouse gasses) that occur in a company's value chain.[1] The database also contains quantitative data on intermediate flows and final demand for 36 industries in 56 countries, including the EU27 and its main trading partners. Hence, the model provides a detailed picture of the national and international interconnectedness between sectors, both on an economic and environmental basis. Compared to Computable General Equilibrium (CGE) models, IO models do not allow for substitution between different production factors, neglecting the effects of price fluctuations on emissions and possible feedback loops and adjustment processes. This implies that the production structure is assumed to be fixed in this study, with no investment in emission reduction. The use of an IO analysis, however, permits us to investigate the first order policy impacts in the short run while accounting for the interdependencies between sectors and tracking effects on a sectoral and regional level. For a more detailed explanation of the methodology and a further discussion on the comparison between CGE and IO models, see Hebbink et al. (2018) and the technical appendix.[2]

We estimate how a European carbon tax and CBAM would impact European sectors' production costs, export price competitiveness (of exports to other EU Member States as well as non-EU countries) and competitiveness within the EU domestic market. The latter is relevant since the CBAM only targets imports from outside the EU, which compete with products produced in the EU domestic market. We assume a carbon tax of €50 per tonne of carbon emitted. In the IO-model estimated effects are assumed to be linear, where a €100 carbon tax will produce effects twice as large as reported here.[3] For export competitiveness, the production cost increase of a country is compared to the cost increases of all its competitors, weighted by trade intensity (see technical appendix). For domestic market competitiveness, domestic production cost increases are compared to cost increases of imports.

[1] The database used is 'OECD TECO2'. The most recent year available for these data is 2015.
[2] Hebbink et al. (2018) also use a scenario where they allow for production factor substitution between capital, labour and energy (but not between different types of energy) on a sectoral level. We do not allow for such substitution because its effect on the calculated cost increases resulting from carbon taxing is insignificant, due to the low substitution elasticity.
[3] The tax is imposed on top of the existing taxes on energy and the carbon tax levied as part of the ETS. The IO model is based on 2015 data, when the average ETS price was very low. This implies that the effect of existing carbon taxes in 2015 on production costs is also relatively small.

We use three different scenarios to quantify the effects of a carbon tax and a CBAM. In *scenario 1,* a carbon tax of €50 per tonne is introduced in the EU (excluding the UK) on carbon emissions in the current ETS sectors of manufacturing and energy, as well as on the transportation sector. This is broadly in line with the 'Fit for 55' proposals to expand the ETS to the building and transportation sectors and to abolish free emission rights for air transport and for industries where a CBAM is proposed.[4] For the electricity sector, this is roughly equivalent to the increase in ETS prices in recent years, from 6€ in 2017 to €55 in July 2021. In *scenario 2*, the emissions of the entire European economy are taxed; the carbon tax is thus levied on all European sectors. Next, we add a CBAM of €50 per tonne of carbon emitted to the carbon tax. This means that in *scenario 3,* all carbon emissions (direct and indirect emissions) embodied in imported products from outside the EU are taxed at €50 per tonne of carbon emitted for the expanded ETS sectors. The current proposal for a CBAM applies only to six products and only to direct emissions (see p. 3), although the EC has indicated that the CBAM could be extended later to other products and sectors and to indirect emissions as well. The database used in this study is not granular enough to allow for taxing only the six products in the current CBAM proposal, so we only calculate the effect of a CBAM for the expanded ETS sectors as a potential future expansion of the CBAM.

Estimated effects in this study represent an upper bound of the potential impact of the carbon tax and the CBAM on cost increases and competitiveness. In practice, the effects of the carbon tax will probably be smaller for several reasons. Firstly, certain companies will find reducing emissions to be cheaper than paying the carbon price, but in the IO model the production structure is assumed to be fixed. Furthermore, while these estimates are based on data of production structures in 2015, the carbon intensity of production has decreased significantly in the last couple of years, further reducing the impact of a carbon tax. Additionally, the CBAM as currently envisaged by the EC applies to average 'default emissions' where import-related emissions cannot be accurately quantified on a company-product level. This means that not all import emissions will be fully taxed in practice, even though this is the case in our estimates. Finally, the revenues from the carbon tax can be used to lower other taxes or increase subsidies for emission reduction, further mitigating the negative economic impact of a carbon tax (see Hebbink et al., 2018).

3. Effects of carbon tax on EU production costs and competitiveness

This section estimates the effect of a €50 EU carbon tax[5] on production costs and competitiveness. In all scenarios, effects on production costs and export competitiveness of a €50 carbon tax are found to be rather small for most countries and most sectors. However, effects vary considerably between countries and between sectors. In particular, specific carbon-intensive sectors (such as the energy sector, predominantly in CEE countries) face relatively strong increases in production costs, although in practice this will be mitigated by investments in emission

[4] The entire manufacturing sector is taxed, with exception of the sectors 'Machinery and equipment', 'Motor vehicles, trailers and semi-trailers', 'Other transport equipment' and 'repair and installation of machinery and equipment'

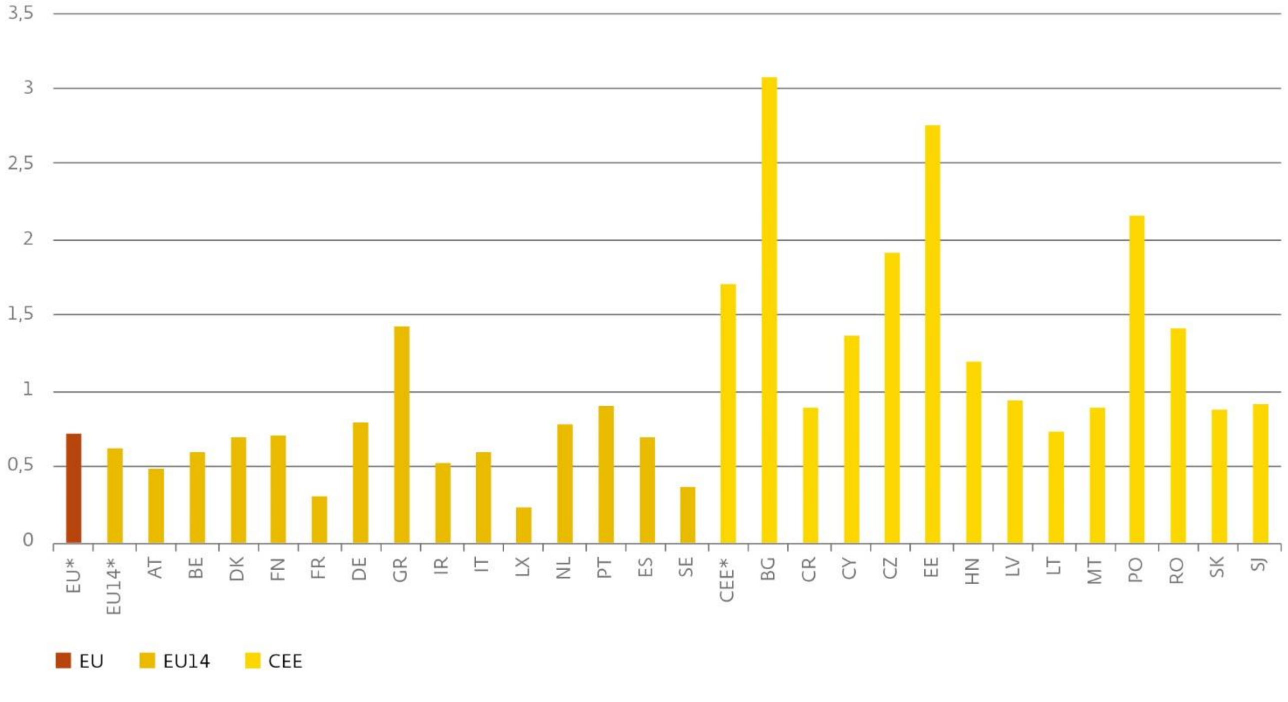
[5] In this study, the carbon tax is additional to the fiscal and regulatory framework of 2015, the latest year for which all relevant data are available. In 2015, the EU ETS price was €7 per tonne. For the electricity sector, the effects of this tax roughly equal the effects of the rise in ETS-prices since 2015.

reduction. Nonetheless, the effects on export competitiveness are less pronounced than would be expected based on the production cost increase because a large share of these countries' exports are destined for other EU Member States which are also subjected to the carbon tax. In the majority of countries in which a large part of exports is destined for non-EU countries, the deterioration of competitiveness remains modest as well, as these EU Member States face a relatively limited increase in production costs as a result of the carbon tax.

3.1 Effects on production costs on EU and individual countries

Figure 1 shows the impact on production costs of an €50 carbon tax levied on the expanded ETS sectors (*scenario 1*). The carbon tax increases production costs directly as well as indirectly. The latter effect arises due to higher costs of intermediate inputs used in the production process. In the EU, a carbon tax of €50 per tonne increases production costs by 0.7% on average.[6]

Figure 1 Effects (%) on production costs of a €50 carbon tax, total economy (scenario 1)



* Weighted average. Source: OECD TECO2 and DNB calculations.

There are significant differences between countries. Production cost increases are considerably higher in CEE countries compared to EU14 countries (EU15 minus UK). Whereas production cost increases on average by 1.7% in CEE countries, the average cost increase is only 0.6% in EU14 countries. The more pronounced price increase in CEE countries is primarily caused by a higher carbon intensity *within* sectors, and to a lesser degree by the sectoral composition of their economies. Energy sectors in CEE countries generally have a relatively high carbon intensity compared to the EU14 due to a larger share of fossil fuels in their energy mix. Furthermore, the carbon-intensive

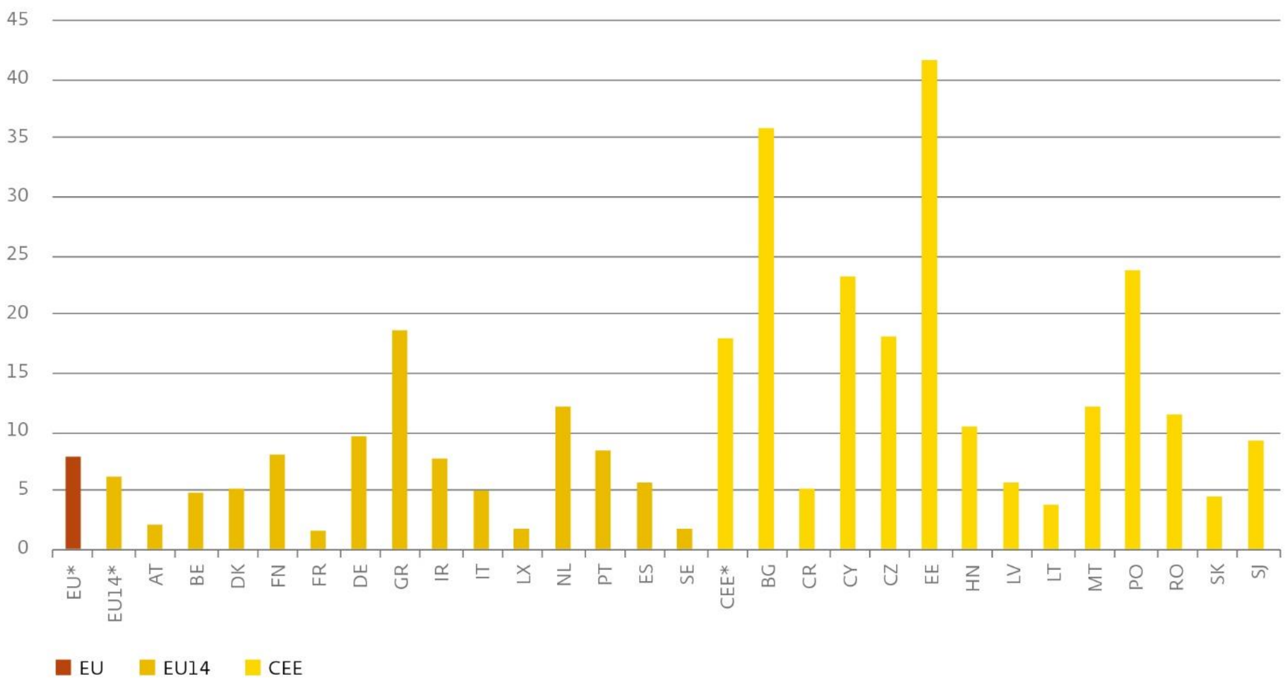
[6] This section focuses on scenario 1, where a €50 carbon tax is levied on the expanded ETS-sectors. The effects on production costs and competitiveness of a carbon tax on emissions in all sectors (scenario 2) are very similar to the results in scenario 1 and will only be discussed briefly at the end of this chapter.

energy and transport sectors constitute a relatively large part of CEE countries' economies. The energy sector includes the generation and distribution of electricity as well as the production and distribution of (non-crude) gaseous fuels, in line with the OECD TECO2 database.[7] The mining of oil, coal, and crude gas is classified as a 'mining and quarrying' activity, and the *processing* of oil and coal is categorised as a 'manufacturing' activity.

3.2 Sectoral differences

This paragraph discusses sectoral differences in production cost increases as a result of a €50 carbon tax (*scenario 1*). Figure 2 depicts the increase in production costs in EU Member States' energy sectors, which comprises electricity and gas as mentioned above. Because of the extensive use of fossil fuels in energy production, the average cost increase in the EU is 7.9%, which is significantly higher than the average of 0.7% for all sectors. However, there are considerable disparities in the increase of production costs between countries, with cost increases of more than 20% or more in about one third of CEE countries, due to the relative importance of coal and oil in power generation. In Estonia, for instance, the substantial cost increase of 42% is due to the country's heavy reliance on carbon-intensive power plants. The energy sector also accounts for a larger share of GDP in CEE-countries (on average 3,7% of GDP) compared to EU-14 countries (on average 2,7% of GDP). In contrast, the majority of the EU14 countries' costs in the energy sector rise by less than 10%. Cost increases are significantly lower than 5% in certain EU14 member states due to a high share of renewable energy (e.g., in Sweden and Austria) or nuclear energy (France). In the Netherlands, the share of fossil fuels in the energy mix is rather high, resulting in a 12% increase in energy costs.

Figure 2 Effects (%) on production costs of a €50 carbon tax, energy sector (scenario 1)



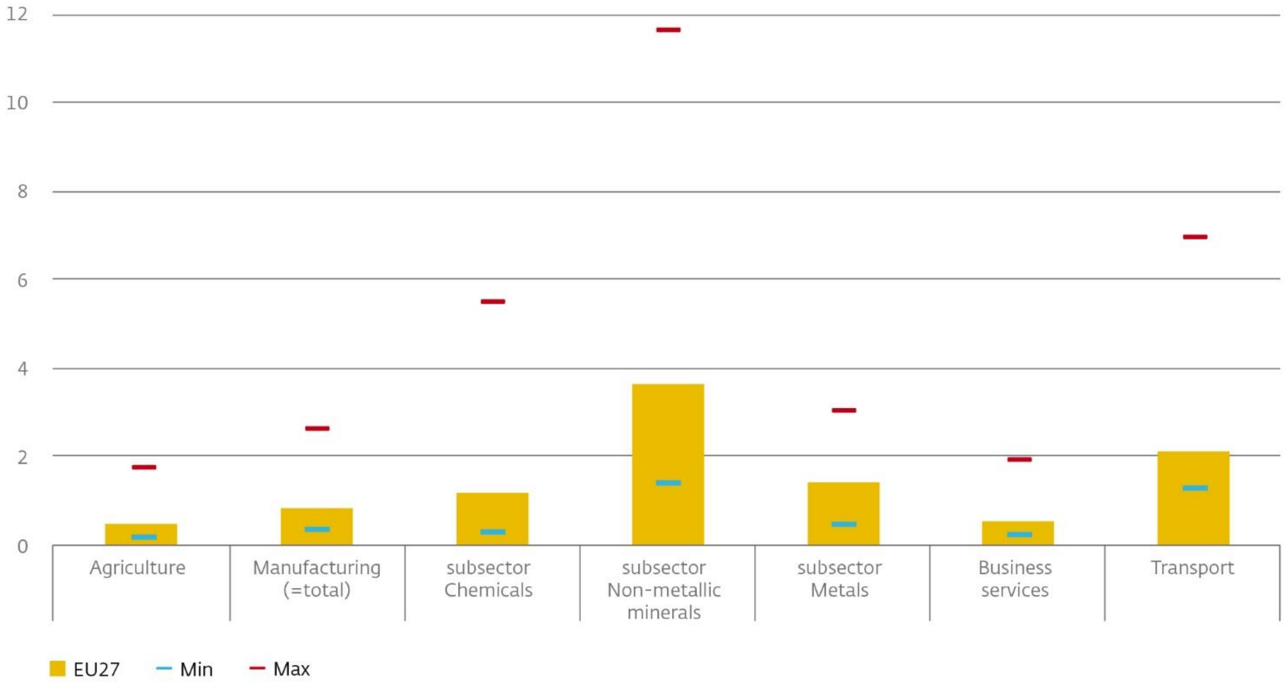
* Weighted average.

Source: OECD TECO2 and DNB calculations.

[7] In the OECD TECO2 database, the energy sector also includes the supply of water as well as sewerage, waste and remediation services. The bulk of value added in this sector is, however, generated by the generation and distribution of electricity and gaseous fuels.

Figure 3 shows the EU average as well as the lowest and highest country values for the increase in production costs in various sectors under scenario 1. The average production cost increase amounts to 1% in the manufacturing sector across the EU, although some countries face cost increases of about 2%. Cost increases are, however, more substantial in subsectors of manufacturing (chemicals, non-metallic minerals and metals). In the 'metals' sector, costs increase by 1.4% percent on average in the EU, with increases of approximately 2-3% in half of the Member States. Other manufacturing subsectors experiencing somewhat larger cost increases include 'chemicals', where costs increase by 3-4% in half of the EU Member States, and 'non-metallic minerals' (which includes cement production), where production costs increase by 4% in the majority of countries. The 'non-metallic minerals' sector is, however, one of the smallest manufacturing subsectors in terms of GDP (<1% for nearly all countries), while the subsectors 'chemicals' (2,4%) and 'metals' (2,1%) are one of the largest subsectors.

Figure 3 Effects (%) on production costs of a €50 carbon tax, sectoral level EU average (scenario 1)



In the transport sector, average cost increases are rather significant (2.1% in the EU). Although agricultural emissions are not directly taxed in *scenario 1*, agricultural production costs increase indirectly by 0.5% due to price increases in energy and chemical inputs such as fertilisers. In a few CEE countries such as Bulgaria, Estonia and Poland, agriculture prices increase by 1.4-1.7%, mostly due to the significant increase in energy prices in these countries. In the business services sector, which is also not subject to direct taxation under *scenario 1*, prices increase as a result of rising energy costs for electricity, building heating and transportation. While prices in this sector increase by 0.5% on average in the EU, CEE countries see a greater increase (1,1%) since their energy prices rise more strongly.

The findings presented in figures 1-3 are largely in line with the literature to date. Econometric analyses of the impacts of the ETS have found very limited effects on production costs and competitiveness, with the exception of the energy sector in specific countries (see for a literature review Verde, 2020). This is partly due to the low ETS-price in the years for which historical data are available, and partly to the limited share of emission-costs in total costs. The size of the effects reported above are also in line with several country-specific studies that model the effects of higher prices (e.g. Bollen et al., 2020). Reporting limited average effects, however, hides substantial variation, both at the country-level and at the sector-level (see for example Ellis & Venmans, 2019).

Comparison with scenario 2

In *scenario 2*, where an EU carbon tax is implemented for the entire economy, production costs rise by 0.9% on average in the EU. In *scenario 1*, where only ETS sectors are taxed, the average rise was 0.7%. Hence, the results of *scenarios 1* and *2* are very similar. This is because the bulk of carbon emissions are already taxed under the expanded ETS, which accounts for 74% of total EU emissions (EC, 2021). The most significant difference between *scenarios 1* and *2* is found in the agricultural sector, where production costs increase by 1.5% versus 0.5% in *scenario 1*. Poland is an outlier, with a cost increase of 2.8%. This can in part be explained by the Polish agriculture sector's heavy reliance on fertilisers and fossil fuels (mostly coal and oil). In all four scenarios, other greenhouse gases (such as nitrous oxide and methane) are not taxed. Because these non-CO_2 greenhouse gases account for a sizable share of agricultural emissions (81.5% of agricultural emissions in the EU), cost increases would be significantly higher for the agricultural sector if all emissions were taxed.

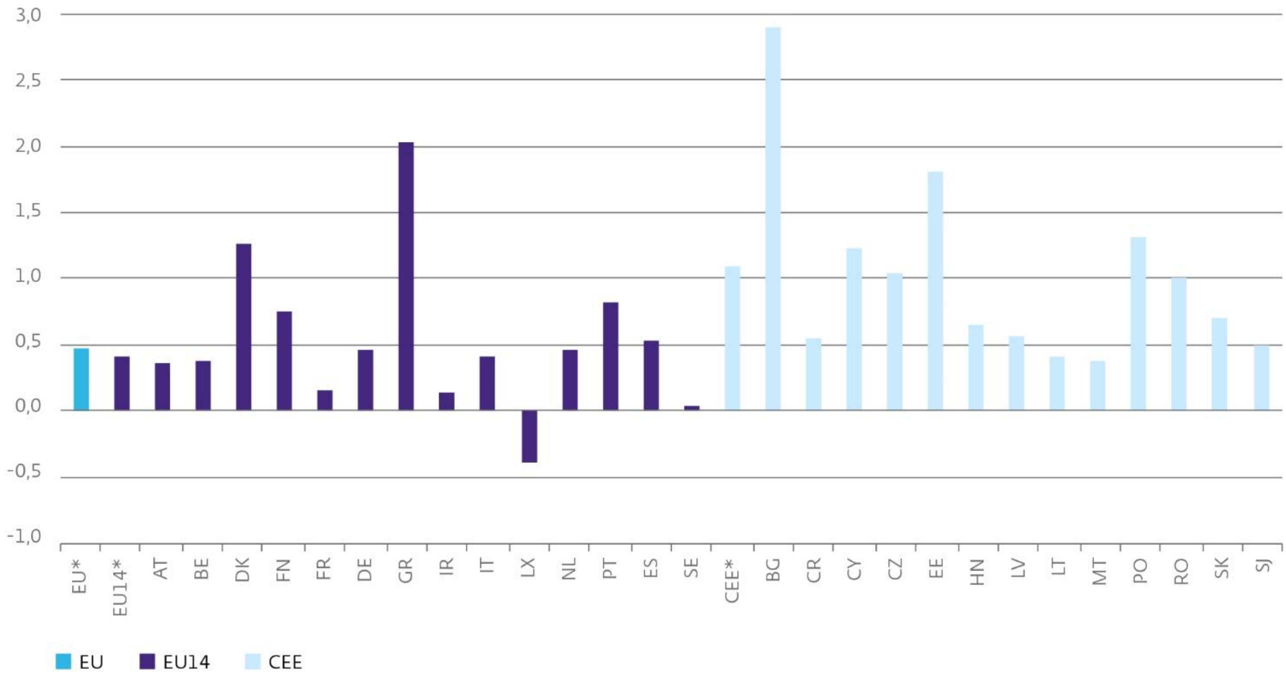
3.3 Effects of carbon tax on EU competitiveness of exports

A higher carbon tax for the European corporate sector will impact the international competitiveness of exporting companies. Exporting companies compete on various aspects, including sales prices, predominantly reflecting production costs. This section considers the production costs of exports relative to those of competing countries inside and outside the EU (weighted by trade flows of all exports of a country, including exports to other EU-countries and non-EU countries, see technical appendix) as a proxy of export competitiveness in international markets.

Figure 4 depicts the effects on relative export prices for the different EU Member States resulting from a €50 carbon tax on the expanded ETS sectors (*scenario 1*). An increase in the relative export costs indicates a deterioration of competitiveness. The increase in the relative export costs of EU countries is 0.5% on average. Again, there are significant differences between countries, mostly due to the varying effects on production costs discussed above. The countries that suffer the largest adverse effects on export competitiveness are primarily located in Central and Eastern Europe, including Estonia, Bulgaria, and Poland, but also Greece. While CEE countries' competitiveness deteriorates almost twice as much as that of the EU14, the absolute increase in CEE countries' relative export prices of 1.1% on average remains modest.

Export competitiveness is also affected by the share of a country's exports to non-EU countries. In countries such as Greece and Cyprus, the impact on export competitiveness is relatively sizeable because a relatively large share of exports goes to non-EU countries where the carbon tax is not implemented. Competitiveness effects are more moderate in countries that trade extensively with other EU Member States. For example, Poland and the Czech Republic face cost increases that are comparable to other CEE countries, but their deterioration in competitiveness is far more muted because of their relatively high share of EU exports. Luxembourg is the only country that experiences improved competitiveness. This is because it is one of the countries with the highest share of exports destined for the European market, while its production costs increase the least of any EU country, partly due to a high share of financial services (Figure 1). Despite high non-EU trade in several EU14 countries such as Germany, Italy and France, competitiveness effects are relatively small (less than 0.5%) since these countries face a relatively limited increase in production costs.

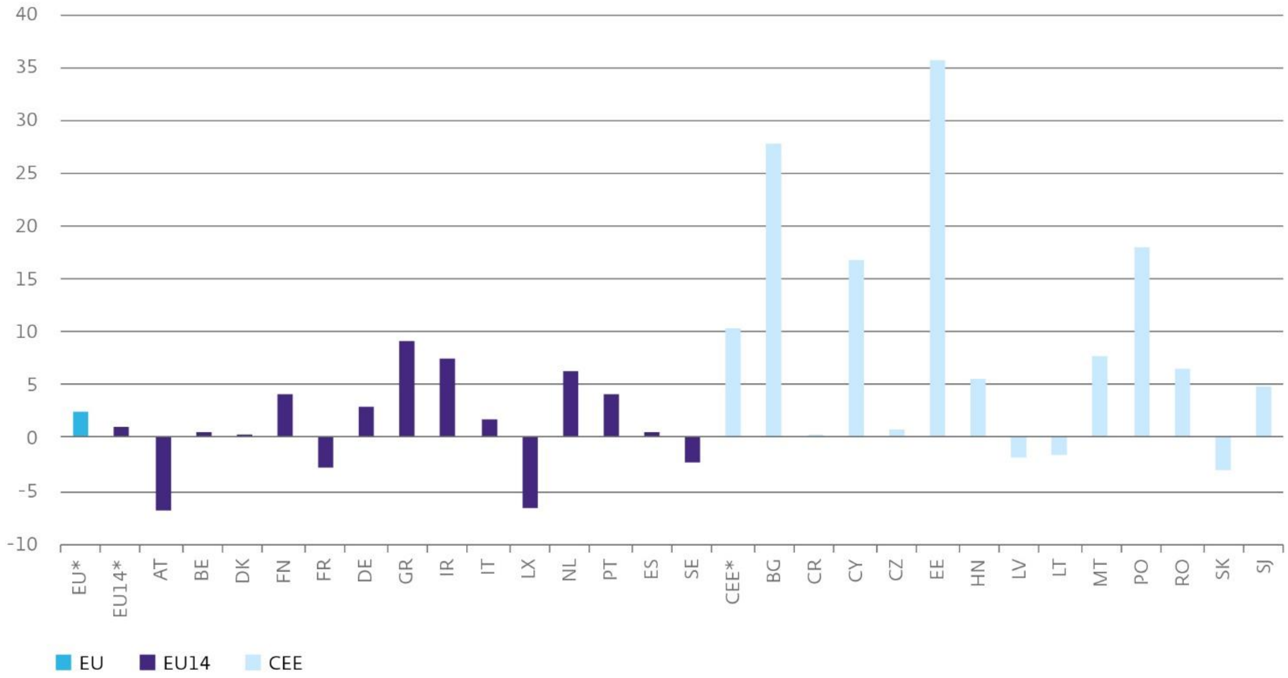
Figure 4 Effects (%) on export competitiveness of a €50 carbon tax, total economy (scenario 1)



* Weighted average. Source: OECD TECO2 and DNB calculations.

Although the effects on export competitiveness are rather limited in most EU Member States, the effects are much stronger in certain carbon-intensive sectors. This is especially the case in the energy sector, where the difference between EU14 countries (average effect 0.9%) and CEE countries (10.4%) is the most pronounced (Figure 5). Relative export costs of energy increase by 28% in Bulgaria and 36% in Estonia due to the relatively large rise in production costs (see Paragraph 3.1). Export competitiveness in the energy sector improves significantly in Austria, Sweden and Luxembourg, partly due to the high share in renewables (except in the latter). For the EU as a whole, the energy sector has the lowest export intensity of all sectors; only 5.4% of total value added generated in this sector stems from exports (1.5% to non-EU countries). The effects of the deteriorating export competitiveness in this sector on GDP may therefore be less pronounced than indicated by the strong increase in relative export costs in some countries.

Figure 5 Effects (%) on export competitiveness of a €50 carbon tax, energy sector (scenario 1)

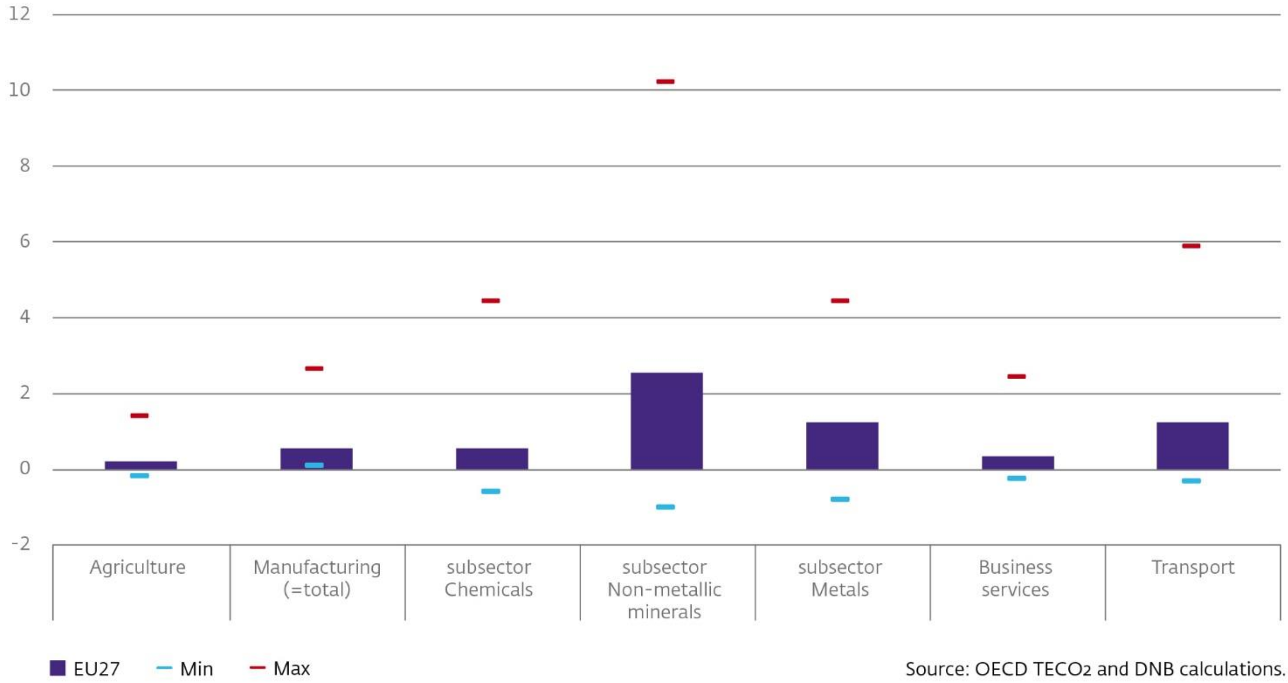


* Weighted average.

Source: OECD TECO2 and DNB calculations.

In most other sectors, the deterioration in competitiveness resulting from a carbon tax is relatively modest (Figure 6). Relative export cost increases are strongest in the manufacturing subsector 'non-metallic minerals' (which mostly consists of cement), with an average deterioration in export competitiveness of 2.5% in the EU. The sizeable increase of 10% in Cyprus can be considered an outlier, as in all other countries relative export costs for non-metallic mineral rise by less than 4.5%. In the manufacturing subsector 'metals', the average relative cost increase is limited (1.2%), although in four CEE countries (Bulgaria, Poland, Romania and Slovak Republic) the relative export costs increase by more than 2,5%. The average relative costs increase in the manufacturing subsector 'chemicals' is also significantly smaller in EU14 countries (0.4%) than in CEE countries (1.6%), with cost increases as high as 4,4% in Bulgaria and 3.5% in Romania. The chemicals and metals sectors face relatively strong international competition due to high trade intensity and limited product variation.

Figure 6 Effects (%) on export competitiveness of a €50 carbon tax, sectoral level EU average (scenario 1)



Source: OECD TECO2 and DNB calculations.

Export competitiveness in the transport sector deteriorates more strongly than in most other sectors. However, outsourcing to non-EU countries is less of a risk in this sector, as passenger transport, for example, often cannot be moved to third countries. The impacts are quite minor in agriculture with virtually all countries experiencing effects of less than 1%. This is because production costs do not rise considerably in this scenario. Furthermore, most agricultural products are traded within the EU, so the deterioration in export competitiveness is limited as well. For business services, effects on competitiveness are also relatively small due to the relatively low carbon intensity in this sector.

Comparison scenario 2

When all carbon emissions are taxed, rather than only those covered by the extended ETS (*scenario 1*), the deterioration in competitiveness is very similar to *scenario 1* (0.54% compared to 0.48%). Country and sectoral differences are also fairly similar to *scenario 1*. The most pronounced changes occur in the agricultural sector, where relative export prices rise by 0.6% when all CO2 emissions in the economy are taxed, compared to 0.2% when only expanded ETS sectors (non-agriculture) are taxed. However, at 0.6% the deterioration is also rather limited in this sector.[8]

[88] Although methane emissions and other non-CO_2 greenhouse gases are not taxed in this scenario, see p.9.

4. Effects of carbon tax with a CBAM on EU domestic market competitiveness

In this section we present a scenario in which a CBAM is added to the carbon tax. We find that a CBAM does not significantly increase domestic production costs and that it prevents deterioration in domestic market competitiveness. Often, a CBAM even results in a minor gain in domestic market competitiveness as imported goods are typically more carbon-intensive than domestic production.[9] In a few countries, a CBAM significantly mitigates, but does not fully prevent, a deterioration in domestic market competitiveness, particularly in CEE countries' carbon-intensive sectors such as energy and metals.

The effectiveness of a CBAM in creating a level playing field is measured by comparing the increase in import prices (of all imports, from other EU countries as well as non-EU countries) to the rise in domestic production costs on a sectoral level.[10] This measure is referred to as 'domestic market competitiveness'. This indicator is used because the proposed CBAM design mostly affects price competitiveness in the EU domestic market, and to a lesser extent in international markets, because only imports to the EU are taxed. The CBAM is levied on the total carbon content of imports.

The addition of a CBAM to the carbon tax increases domestic production costs further because intermediate inputs from outside of the EU now become more expensive. Figure 7 shows the effect of a carbon tax (*scenario 1*) and the combined effect of a carbon tax and a CBAM (*scenario 3*) on domestic production costs. Average EU production costs increase by 0.7% if only a carbon tax (*scenario 1*) is applied and by 1,0% if the CBAM is added to the carbon tax (*scenario 3*). Hence, the CBAM increases domestic production costs on average by 0.2 percentage points.[11] This modest effect is quite similar across countries.

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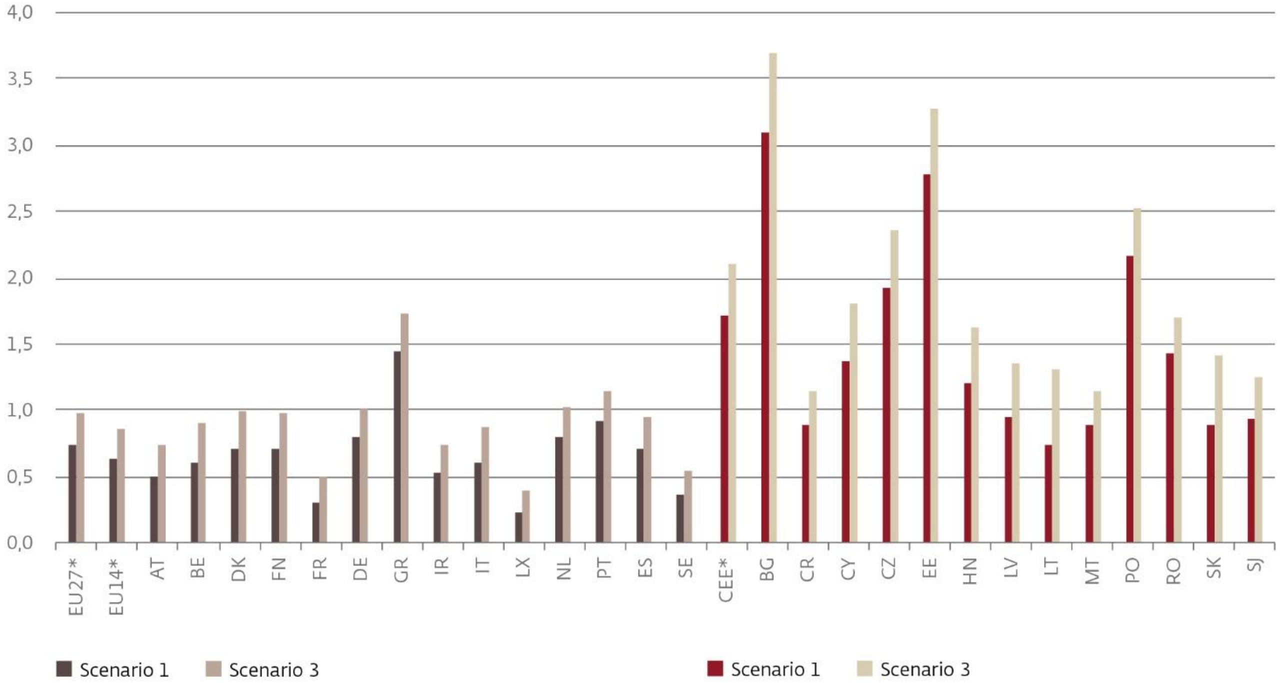
[9] In practice, it could be difficult to measure the carbon content of imports, in which case an average EU carbon intensity is assumed for the CBAM. This implies that an improvement in domestic market competitiveness will only materialize when an EU country is less carbon intensive than the EU average.
[10] To compare a similar composition of goods and services, sectors are weighed by the share of domestic production for the EU domestic market for the calculation of import prices (total economy).
[11] Differences are due to rounding. Calculated in two decimals, average EU production costs increase by 0.73% if only a carbon tax is applied and by 0,97% if the CBAM is added to the carbon tax. This results in a difference of 0,24 percentage points.

Figure 7 Effects (%) of carbon tax (scenario 1) and carbon tax with CBAM (scenario 3) on production costs, total economy



* Weighted average.

Source: OECD TECO2 and DNB calculations.

While the CBAM raises domestic production costs only modestly, the rise in import prices is more pronounced. Import prices increase by 1.3% on average in the EU, of which 59% is a result of the CBAM and the rest is due to the EU carbon tax. Figure 8 shows how a CBAM and a carbon tax levied on expanded ETS sectors (*scenario 3*) affect EU import prices and domestic production costs. The difference between these two values represents the net impact of a carbon tax and CBAM on domestic market competitiveness of EU Member States, where a positive value indicates a deterioration in competitiveness. Differences in price increases result solely from differences in carbon intensity between imports and domestic production because both are taxed at the same rate. For most countries, the CBAM fully compensates the deterioration in competitiveness resulting from the carbon tax and even leads to a slight improvement in domestic market competitiveness (on average by less than 0.5%). In CEE countries, production cost increases are generally higher due to more carbon-intensive production, but import price increases are also more pronounced due to relatively high carbon intensity of imports. In about a quarter of EU Member States, however, domestic market competitiveness still deteriorates in the presence of a carbon tax and a CBAM. This is because domestic production in these countries is generally more carbon-intensive than imports. Still, the deterioration of competitiveness in these countries is much less pronounced (less than 1% in all countries except Bulgaria) compared to a scenario with a carbon tax and no CBAM. Latvia and Lithuania, in particular, experience a large improvement in their domestic market competitiveness. This is due to the large share of imports from Asia-Pacific Economic Cooperation (APEC) countries, Russia in particular, which are relatively carbon-intensive.

Figure 8 Effects (%) of carbon tax with CBAM on EU domestic market competitiveness, total economy (scenario 3)

* Weighted average. Source: OECD TECO2 and DNB calculations.

On a sectoral level, differences between countries are more significant. In the energy sector, the CBAM eliminates the consequences of a carbon tax on domestic market competitiveness for the EU as a whole (Figure 9). About half of EU Member States see an improvement in the domestic market competitiveness of their energy sectors, generally around 5% and in a few cases even more. Some European countries close to the EU's external border are relatively dependent on energy imports, mainly from Russia, whose energy production is significantly more carbon-intensive. Latvia and Lithuania, for instance, face an improvement in competitiveness of around 30% because a substantial share of their energy imports is from Russia. In approximately a third of the EU countries, the domestic market competitiveness of energy still deteriorates despite the CBAM because their domestic energy production is more carbon-intensive than their energy imports. Although the CBAM is effective at mitigating the negative effects of a carbon tax in these countries, a significant deterioration in the energy sector’s domestic market competitiveness persists.

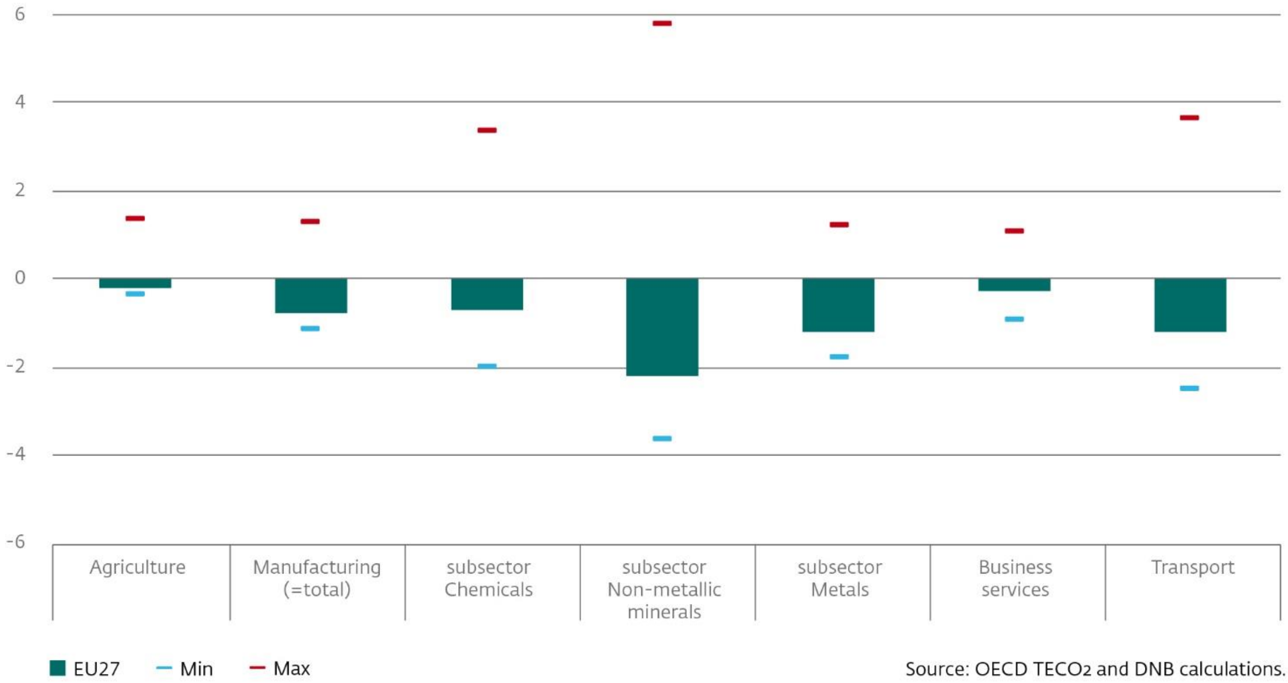
Figure 9 Effects (%) of carbon tax with CBAM on EU domestic market competitiveness, energy sector (scenario 3)

* Weighted average.

Source: OECD TECO2 and DNB calculations.

In the manufacturing sector, domestic market competitiveness improves slightly (-0.75%) for the EU as a whole. Domestic market competitiveness deteriorates in a few (mainly CEE) countries, although never by more than 1% (Figure 10). Again, there are considerable differences between sectors. In the manufacturing subsector 'chemicals', domestic market competitiveness still deteriorates by 1-3% in five CEE countries, with the strongest deterioration in Bulgaria (3.2%), as indicated by the red bar in figure 10. In the manufacturing subsector 'metals', the domestic market competitiveness improves in all EU14 countries, but deteriorates slightly (between 0.5%-1.1%) in four CEE countries. While domestic market competitiveness in the transport sector improves on average and in most European countries, a significant deterioration persists in three EU14 countries (Denmark: 2.3%, Ireland: 3.6%, Portugal: 0.6%) and three CEE countries (Bulgaria: 1%, Hungary: 2.9%, Malta: 3.2%). In agriculture, domestic market competitiveness generally remains stable or improves slightly for the majority of EU Member States, except for Bulgaria and Estonia, which face a deterioration of 1.3%.

Figure 10 Effects (%) of carbon tax with CBAM on EU domestic market competitiveness, sectoral level EU averages (scenario 3)



Source: OECD TECO2 and DNB calculations.

5. Policy implications

The most efficient way of reducing harmful carbon emissions is to assign a price to the external effects of emissions: a carbon tax or an emission trading system. However, partly due to concerns about negative impacts on competitiveness, support for the introduction of better carbon pricing often tends to be lacking in practice. This analysis illustrates the disparities across EU countries in the effects of a carbon tax on production costs and competitiveness, as well as the extent to which a CBAM can prevent a deterioration in competitiveness in the EU domestic market.

This analysis shows that the impact of a carbon tax of €50 per tonne on production costs and export competitiveness is relatively modest (between 0% and 2%) for the majority of sectors and countries. Nonetheless, significant differences between countries and sectors exist. In approximately a third of EU Member States, mostly CEE countries, the impact of an EU carbon tax is more negative. The countries most affected by the carbon tax also have the lowest per capita GDP, which suggests that climate policies might hamper economic convergence in the EU. A carbon tax of €50 has the biggest impact on production costs and export price competitiveness in the energy sector. However, trade in this sector with non-EU countries is relatively limited, especially in member states that do not share land borders with third countries. Production costs also increase significantly in certain manufacturing subsectors and the transport sector. Therefore, additional policies should be considered in these sectors, such as a

CBAM and partly using the carbon tax revenues to help these sectors reduce emissions. The estimated effects are relatively modest in other sectors.

The results also suggest that a CBAM is effective in mitigating the negative impact of a carbon tax on domestic market competitiveness for the majority of countries and sectors. We estimate that many countries in the EU14 may even encounter a slight improvement in domestic market competitiveness due to a higher carbon intensity of imports compared to domestic production. For a quarter of EU Member States, especially in Central and Eastern Europe, the CBAM mitigates the deterioration in domestic market competitiveness on a macro level, although it does not fully eliminate it. On a sectoral level, moreover, a more pronounced decline in competitiveness persists in the carbon-intensive sectors of a few CEE countries. The increase in EU production costs due to the CBAM through the use of more expensive inputs from outside the EU is shown to be minor (0.2% increase). This suggests that the CBAM itself does not deteriorate the EU's export competitiveness significantly, although it does not by design mitigate the impact of a carbon tax on EU export competitiveness either. The average effect of a €50 carbon tax on export competitiveness is relatively modest, but more negative effects are found in specific (mostly CEE) countries and sectors, especially in the energy sector.

Although further research is needed to determine the broader effects of these estimated price increases on employment and aggregate demand (see below), a few tentative conclusions can be drawn from this study:

- **The results suggest that more effective carbon pricing can be implemented without significantly impairing competitiveness in the majority of sectors and countries.** The ETS can probably be strengthened by lowering emission ceilings, cancelling free rights and by expanding to buildings and transportation (as envisaged in the 'Fit for 55' proposals) without a significant deterioration of competitiveness in most countries and sectors. Further research is necessary to shed light on the longer-term economic effects of a carbon tax and CBAM, for example by using a CGE model that allows for technological change and possible feedback loops and adjustment processes.
- **For the few carbon intensive sectors where production costs do increase significantly, a CBAM should be considered, in line with EC proposals.** Our analysis suggest that a CBAM is an effective instrument in levelling the playing field for the European domestic market. With an increasing ETS price, the need to level the playing field in the EU domestic market becomes even more important. Several reforms to the ETS in the past few years have boosted the ETS price past €50 in recent months, with a projected increase up to €85 by 2030 (European Commission, 2021). However, given the modest impact of a carbon price on most sectors and countries, the benefits of a CBAM must be carefully weighed against the administrative costs and risks of retaliation through import tariff increases from third countries affected by the CBAM.
- **To reduce the threat of retaliation, it is critical to align the CBAM with WTO agreements.** This means that companies that export to the EU are not taxed more intensively than those that operate within the EU, in line with the European Commission's current proposal. This probably implies that the current system of partially free rights for carbon-intensive businesses must be abolished, which is also necessary because currently the effective carbon price in many carbon intensive industries does not sufficiently tax negative externalities. Further research could elaborate on the effects of a potential retaliation by non-EU trading partners in response to a CBAM.
- **Temporary compensation measures, such as subsidies for emission reduction, can be considered to limit the negative effect of a carbon tax on certain carbon intensive exporters to non-EU countries.** A CBAM will, by design, not prevent a deterioration in export competitiveness of exports destined for non-EU countries. While the deterioration of export competitiveness is generally modest, it can be significant for specific

carbon- and trade-intensive products. Temporary compensation measures may therefore be needed, although these should not hamper the incentive to reduce emissions. The deterioration in competitiveness will also be smaller if foreign countries implemented a carbon tax. The CBAM may incentivise non-EU countries to strengthen their climate policies and exporting non-EU companies to reduce their emissions. Part of the CBAM revenues can be used to compensate the hardest hit sectors through subsidies. These subsidies should cover the unprofitable parts of investments in emission reduction in sectors that experience a strong deterioration in competitiveness. In addition, projects that are profitable but experience financing constraints because of uncertainty about future climate policies (Polzin & Sanders, 2020) should be given priority by the European financing mechanisms and institutions, such as the European Investment Bank. Furthermore, the significant discrepancies between the EU14 and CEE countries may warrant EU assistance to help CEE countries reduce their emissions. This can be done, for instance, by providing grants from the EU Modernisation Fund and the Social Climate Fund, as envisaged in the 'Fit for 55' proposals. Compensation may be necessary to provide public support for climate measures in CEE countries.

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