

# Potential Effects of the EU's Carbon Border Adjustment Mechanism on the Turkish Economy

Sevil Acar, Ahmet Atıl Asıcı and A. Erinç Yeldan

# POTENTIAL EFFECTS OF THE EUROPEAN UNION'S CARBON BORDER ADJUSTMENT MECHANISM ON THE TURKISH ECONOMY<sup>1</sup>

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## Abstract

In December 2019, the European Union (EU) announced the European Green Deal (EGD) to create a climate-neutral continent by 2050. Accordingly, the EU Emission Trading System (ETS) will be revised to maintain economic growth against possible losses in competitiveness, leading to “carbon leakage.” The Carbon Border Adjustment (CBA) is one of the mechanisms proposed to tackle the carbon leakage problem; it is an import fee levied by the carbon-taxing region (in this case, the EU) on goods manufactured in non-carbon-taxing countries (in this case, Turkey). The purpose of this paper is to provide a first-order estimate of the potential sectoral impacts of the CBA on the Turkish economy by employing input-output methodology. Our results suggest that the CBA may bring a carbon bill of EUR 1.1-1.8 billion to Turkish exporters in the EU market. The revision of the Intended Nationally Determined Contributions (INDC) target and the ratification of the Paris Climate Agreement at the parliament are two steps that can be taken immediately. Speeding up the ongoing preparatory process of instituting an Emission Trading System (ETS) in Turkey (preferably linked to the ETS), will help minimize economic losses.

**Keywords:** European Green Deal, Carbon Border Adjustment, Turkey, input-output methodology.

**JEL Classifications:** C67, C68, Q56.

## ملخص

في ديسمبر 2019، أعلن الاتحاد الأوروبي عن الاتفاق الأخضر الأوروبي (EGD) لإنشاء قارة تتسم بالحياد المناخي بحلول عام 2050. وبناءً على ذلك، سيتم تنقيح نظام مقايضة حصص الانبعاثات (ETS) للحفاظ على النمو الاقتصادي ضد الخسائر المحتملة في القدرة التنافسية التي تؤدي إلى "تسرب الكربون". ويعد تعديل حدود الكربون (CBA) إحدى الآليات المقترحة لمعالجة مشكلة تسرب الكربون، فهي عبارة عن رسوم استيراد تفرضها منطقة فرض ضرائب الكربون (في هذه الحالة، الاتحاد الأوروبي) على السلع المصنعة في البلدان التي لا تفرض ضرائب على الكربون (في هذه الحالة، تركيا). فيعد الغرض من هذا البحث تقديم تقدير مبدئي للأثار القطاعية المحتملة لآلية تعديل حدود الكربون على الاقتصاد التركي، من خلال استخدام منهجية المدخلات والمخرجات. تشير نتائجنا إلى أن آلية تعديل حدود الكربون قد ينتج عنها فاتورة كربون بقيمة 1,1-1,8 مليار يورو للمصدرين الأتراك في سوق الاتحاد الأوروبي. وتعد مراجعة هدف المساهمة المعتمدة المحددة وطنياً (INDCs)، والتصديق على اتفاق باريس للمناخ في البرلمان خطوتين يمكن اتخاذهما على الفور. وإن تسريع وتيرة العملية التحضيرية الجارية لإنشاء نظام مقايضة حصص الانبعاثات في تركيا (ويفضل أن يكون مرتبطاً بنظام مقايضة حصص الانبعاثات التابع للاتحاد الأوروبي)، سيساعد على تقليل الخسائر الاقتصادية.

## **1. Introduction**

In December 2019, the European Union (EU) announced the European Green Deal (EGD), the ultimate target of which is to create a climate-neutral continent by the year 2050. With the EGD, reduction targets of greenhouse gases (GHGs) were declared with more ambition, and the EU industry was announced to be reorganized around circular economy principles.

Broadly set within the auspices of the European Commission, the EGD is presented “as a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient, and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use” (European Commission, 2019).

Combining ambitious climate mitigation targets of zero net greenhouse gas emissions by 2050, a viable industry working under the principles of energy efficiency and circularity, and a fair, healthy, and environmentally-friendly food system under farm-to-fork management, the EGD intends “to put sustainability and the wellbeing of citizens at the center of economic policy and the sustainable development goals at the heart of the EU’s policymaking and action” (European Commission, 2019). Therefore, the EGD is regarded, in the words of Gaventa (2019), as a “climate project, aimed at making Europe a climate-neutral continent; as a social project, to support a just transition; as an economic project, seeking to rejuvenate EU investment and competitiveness; as a European project, to give new purpose and unity to the EU; and as an international project which will take a more geopolitical approach to global climate security.”

The EGD focuses on three basic priorities regarding industrial strategy: a world-leading and globally competitive industry, an industry oriented towards becoming climate-neutral, and preparations for the transition to the digital future. Additionally, it intends to achieve this transition within the framework of the circular economy. The policy tools to enable such a transition include regulation, standardization, investment, innovation, reform, dialogue with stakeholders, and international cooperation. The European Climate Regulation is expected to provide a guidance and overseeing role with respect to energy and climate regulations in the context of the EGD. For this purpose, existing regulations surrounding the Emission Trading System (ETS) are stated to be revised by mid-2021 at the latest. Existing regulations are expected to be updated in light of these revisions.

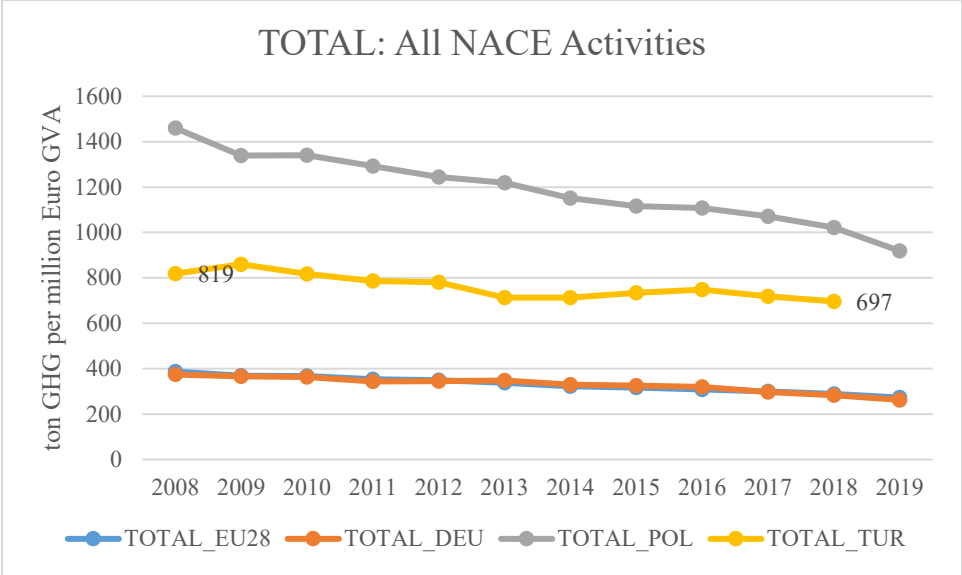
According to the European Commission, effective pricing of carbon throughout the economy is an essential precondition for achieving climate-related goals. For this purpose, the EU established the ETS and has been issuing ever-falling emission quotas for specific industries on an annual basis. Implemented through the market-determined “carbon pricing” mechanism, this system requires producers operating in relevant industries to obtain such quotas in trading

markets in case their emission levels exceed the limits assigned. Over the period 1990-2018, the EU was able to cut its greenhouse gas emissions by 23 percent, even though its economy grew by 61 percent. The EU plans to curb greenhouse gas emissions by the year 2030 by approximately 50 to 55 percent compared to 1990 levels, and to reach that target through a review of all its climate-related policies.

Accordingly, the EU’s ETS will be revised to keep economic growth and employment strong against possible losses of competitiveness due to an increase in carbon price under ETS, a problem called “carbon leakage.” The Carbon Border Adjustment (CBA) is one of the alternative mechanisms proposed to tackle the carbon leakage problem. The CBA, in essence, is expected to serve as an import fee levied by the carbon-taxing region (in this case, the EU) on goods manufactured in non-carbon-taxing countries (in this case, Turkey). The CBA is expected to have a considerable effect on emission-intensive Turkish exports (Yeldan et al., 2020) as the EU continues to be the top destination of Turkish exports (accounting for 47 percent of the total in 2018).

Minimizing the costs incurred by the CBA requires the decoupling of emissions from economic growth. Figure 1 below shows the evolution of the GHG intensity of the Turkish economy as measured by the tons of GHGs per EUR million gross value-added (chain-linked volumes 2005) in comparison to those of EU28, Germany, and Poland.

**Figure 1. GHG per gross value-added (ton CO2e/million EUR)**



Source: Eurostat and authors’ calculations

While the decrease in the overall GHG intensity of the Turkish economy (all NACE activities) from 819 tons in 2008 to 697 tons of GHG per EUR million gross value-added in 2018 indicates

a relative decoupling of the economic growth from the GHG emissions, it is still more than double that of EU28 and Germany, and the decline is not as fast as that of Poland.

To the best of our knowledge, the quantitative impacts of a possible CBA on the Turkish economy have not been analyzed so far. The current study is a first attempt to model and estimate the immediate upon-impact effects of a CBA Mechanism (CBAM) on the Turkish industry, agriculture, mining, and services sectors. The purpose of this paper is to provide a first-order estimate of the potential sectoral impacts of a possible CBA on the Turkish economy by employing input-output methodology.

The plan of the paper is as follows. After summarizing the main elements of the EGD and undertaking a comprehensive literature review on the implementation experiences of CBAMs in section 2, we calculate the carbon bill that Turkish exporters are expected to pay for the embedded carbon in products exported to the EU market by employing an input-output analysis in section 3. Section 4 concludes with due policy proposals.

## **2. Literature review**

The ETS, as a carbon pricing mechanism, certainly affects the costs incurred by manufacturers in the EU, and, thus, their competitiveness in the EU and international markets. It can be foreseen that EU manufacturers would react to such an arrangement in various ways, based on the characteristics of the product (in terms of carbon-intensiveness and trade volumes). While certain industries (e.g. road transportation) that are unable to avoid regulation will have to incur extra costs for their greenhouse gas emissions, others (such as iron and steel or cement production), which are characterized by significant levels of foreign trade, will likely be inclined to move their operations to countries where carbon regulations are laxer. For the EU, this poses two distinct problems. First of all, a not so insignificant volume of production and employment would be lost to overseas as a direct consequence of the carbon emission regulation. Secondly, any manufacturer who would have to incur the obligation of cutting back on emissions would be free to move outside the EU and continue operations elsewhere while maintaining original emission levels. Thus, the impact of any system designed to lower greenhouse gas emissions within the EU would only have limited success on a global scale, a problem referred to as carbon leakage.

Clearly, the threat of carbon leakage is an issue that arises due to the contrast between regions/countries that *do* or *do not* implement effective carbon regulations. Hence, one of the most strategic decisions of the EGD, in the context of reducing carbon leakage, is the mechanism of carbon adjustment at the border. The purpose of this mechanism is to eliminate any discrepancies of carbon costs across traded goods through an adjustment procedure to be applied at the border (Neuhoff, 2011). Even though the specifics of the mechanism and the industries it will target have yet to be clarified, the carbon contents of the goods awaiting entry through the

borders of the EU will be subjected to a surcharge if they were not taxed or priced earlier at their country of origin, or to a discount if the tax or pricing applied at the country of origin was higher than the figure required by the EU.

The relocation of polluting sectors from high-income regions to low-income regions has an international counterpart. As countries get richer, they shift their polluting industrial production such as cement, iron and steel, and textiles to poorer countries, thereby exporting pollution. For example, high-income countries often relocate their fossil fuel-intensive pollutant sectors towards low-income regions through an increased volume of foreign direct investments (Poelhekke and van der Ploeg, 2015). High-income countries, which change their production composition and focus on cleaner industries, experience better environmental quality as they export their polluted industries abroad; however, there is no reduction in total pollution on a global scale. Instead, increased production in such countries where environmental standards are lower puts more pressure on the environment. In the economics literature, this phenomenon is discussed within the framework of the “Pollution Haven” and “Race to the Bottom” hypotheses (Daly, 1993; Ayres, 1996; Eskeland and Harrison, 2002; Frankel and Rose, 2005). According to the Pollution Haven hypothesis, low-income countries may have to liberalize trade and finance to accelerate economic growth and lower their labor and environmental standards to attract more foreign investment. Such concessions, made in an effort to gain competitive power in underdeveloped or developing countries, trigger a race to the bottom in environmental (and labor) standards. As a result, low-income countries are turned into shelters for dirty industries. On the other hand, high-income countries can reduce their domestic greenhouse gas emissions and relatively improve environmental quality indicators by importing (rather than producing) goods with high GHG content without the need to change their consumption patterns.

Consequently, this causes an increase in global emissions. For example, the United Kingdom (UK) is cited as a successful example of lowering greenhouse gas emissions. However, this is only valid for area-based emissions from production. In fact, considering the UK’s import and consumption, it appears that it caused more greenhouse gas emissions than it mitigated in recent years (Baiocchi and Minx, 2010). Since the EU ETS system does not cover all sectors in particular, and because there may be a loss of competitiveness in the sectors it does cover due to trade, the possibility of carbon leakage shows itself even more. With the announcement of the EGD, foreign trade policies need to be revised to prevent this leakage. It has turned into a problem that greatly contributes to the increase in global emissions as a result of the increase in consumption along with the increased volume of global trade. In order to cope with this problem, solutions such as the international ETS, international carbon tax, and the CBAM have been proposed. The legal basis for international ETSS under the WTO rules has been partially discussed by Jegou and Rubini (2011) and it has been concluded that emission permits can be distributed under Article XX exceptions of the GATT 1994 provisions (mainly on the health impacts of trade, including climate change-related impacts when adapted to the environment).

The CBA is a tool that has been discussed for many years and has been implemented in some countries and states. It is used to eliminate the competitiveness disadvantages faced by producers in countries/regions implementing a unilateral climate policy. For the first time in the 80s and 90s, the mechanism was used to balance the taxes on domestic goods related to the imports of certain chemicals and to tax the entry of ozone-depleting substances. The first and only CBA still in effect started to be implemented in California with the inclusion of electricity imports in the cap-and-trade program of California in 2013 (Pauer, 2018). The system requires electricity importers to purchase carbon permits for the carbon content of imported electricity if the state (or Mexico) from which the electricity was purchased does not have a carbon pricing system linked to California's ETS. According to the data of the California Air Resources Board (2020), the GHG content of electricity imports decreased from 0.5 tons of CO<sub>2</sub>e/MWh in 2011 to 0.25 tons of CO<sub>2</sub>e/MWh in 2018. Besides, the emission intensity of electricity generated within the state has also fallen below 0.2 tons of CO<sub>2</sub>e/MWh.

Böhringer et al. (2012) find that the CBA can effectively cope with carbon leakage and smooth out the negative impacts on energy-intensive and trade-exposed sectors in countries that have unilateral carbon pricing mechanisms. The channel behind this consequence, according to the study, is the change in international prices and the transfer of the climate mitigation cost to the non-abating countries. As such, the cost of climate change can be internalized into domestic prices.

Bao et al. (2013) investigate the impact of a possible CBA that can be applied by the EU and the United States (US) on the carbon emissions of Chinese sectors via a dynamic multi-sector general equilibrium model. Accordingly, the CBA will reduce the export prices of China, and hence will affect the output of the sectors, the effects of which will spread to the whole economy. On the supply side, sectors may tend to sell goods in the domestic market instead of exporting. On the demand side, the decrease in revenues due to cheaper export prices may manifest itself in the form of a decrease in the demand for goods in the respective sectors. Such a shrinkage in demand may also reduce energy prices and call for new energy substitution possibilities. If the trend shifts towards fossil fuels, this may even have an increasing effect on the country's emissions. At the sectoral level, a CBA applied at a level of USD 50 per ton in 2020 is found to reduce the total emissions from the use of primary and secondary energy resources, especially from non-metallic mineral products, glass manufacturing, casting, and pressing of ferrous metals. On the other hand, a CBA at the same level is expected to increase emissions from sectors such as electrical and electronic equipment manufacturing, non-ferrous metal mining and processing, and textile manufacturing in China. The different energy demands of the sectors lie behind these results that differ from each other in terms of emissions. Following the implementation of the CBA, energy demand is found to decline in sectors with decreasing emissions. The greatest decrease in export prices will be observed in export-oriented and energy- and carbon-intensive

sectors. Sectors with the highest export price decline will have more total output decline than sectors with lower export prices. For example, in sectors such as non-metallic mineral products and glass manufacturing, the output reduction will be greater than in sectors such as electrical and electronic equipment manufacturing, cultural activity, and office machinery. As a result, a CBA to be applied to China by the EU and the US may lead to a further increase in carbon leakage, apart from not achieving its original purpose. According to the analysis of Bao et al. (2013), such a CBA would serve to negligibly reduce the total emissions in China. On the other hand, according to the authors, measures such as cooperation agreements, technology sharing, energy-saving, and transitions to low carbon technologies can further contribute to the reduction of global emissions.

Several studies propose that mechanisms like the CBA should only be activated when it is not possible to reduce global emissions and prevent carbon leakage by other means (e.g. see Winchester et al., 2011). In their analysis of possible border adjustment measures in the US and the EU, Van Asselt and Brewer (2010) argue that there should be a thorough risk analysis for the sectors that might be prone to carbon leakage before adopting any CBA. Second, they propose that alternative measures to address leakage and competitiveness loss issues should be investigated. Third, it is recommended that the timing of border adjustment measures – if used – should give policymakers in the EU and US sufficient time to conclude international climate change negotiations that could reinstate their use (Van Asselt and Brewer, 2010: 50).

Another concern regarding the success of CBAs relates to the use of a state carbon tax and CBA revenues from imports. How these income strands are utilized determines the effects of a CBAM on social welfare (McKibbin et al., 2018).<sup>6</sup>

The novelty of the current study originates from the fact that the quantitative impacts of a possible CBAM on the Turkish economy have not been analyzed so far. This is the first attempt to model and estimate the static impacts of a CBAM on the sectors.

### **3. Materials and methods**

Turkey's exports of goods and services were valued at a total of EUR 192.5 billion in 2018. The EU continues to be the top destination of Turkish exports, having the highest share in aggregate Turkish exports with EUR 91 billion in 2018, reaching 47 percent of its export revenues (see Table A3 in the appendix). The automotive (AU), textiles (TE), machinery (MW), iron and steel (IS), and chemicals (CH) sectors have emerged as the most exported sectors to the world. The share of the EU28 market in the total exports of these sectors is 78 percent for automotive, 60

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<sup>6</sup> For an evaluation of the studies investigating the effects of the CBA on international trade, see Condon and Ignaciuk (2013). For an assessment of the CBA and alternative mechanisms within the EU, see Ismer et al. (2020).

percent for textiles, 57 percent for machinery, 44 percent for iron and steel, and 43 percent for chemicals in 2018.

The Customs Union agreement that was initiated in 1996 had been particularly conducive to expanding bilateral trade relations with the EU. Over the years, the two economic bodies have dwelled in wide-reaching partnerships in trade and joint ventures. Following the European Commission's declaration of the EGD at the end of 2019, it is predicted that countries' attitudes towards climate issues will affect their bargaining power in the negotiations to be held with the EU on issues such as the ongoing Custom Union Modernization negotiations (PMR, 2018, p.50). Besides, the effects of the contraction experienced during the COVID-19 pandemic in the global economy are expected to be extremely severe for developing countries like Turkey, the economies of which are highly reliant on external markets. Turkey's steps to be taken in the private sector, as well as public awareness on the climate facade, will support a sustained trade market share in the international arena as well as a greater share of the globally expanding green finance.

Given this historical background, it is clear that the EU's call for the EGD will generate very strong repercussions on Turkish industry as well as its trade relations at large. Now, we turn to a quantitative analysis of these likely impacts on the Turkish economy.

### **3.1. The input-output model and data sources**

Our "base year" is 2018, given the most recent available greenhouse emissions inventory. The heart of our data set is the 2012 input-output (I-O) data released by the TurkStat. We first aggregate the 65 sectors of the original 2012 I-O table to 24 model sectors. Making use of the final demand components of national income accounting, we have updated the 2012 intermediate flows to 2018 using the RAS technique. This consistent dataset is then utilized to "calibrate" the micro/sectoral and macroeconomic balances of the analytical model to the existing data. The 2018 I/O Table is in the Appendix.

In 2018, Turkey emitted a total of 520.9 Mt CO<sub>2e</sub> of GHG emissions to the atmosphere. This sum is grouped by the GHG Inventory under energy combustion (321.2 Mt), industrial and agricultural processes (130.0 Mt), and household waste (69.6 Mt). After putting aside the household waste, we allocate the remaining 451.3 Mt of GHGs emissions to the 24 sectors by making use of the TurkStat data as reported to the UNFCCC inventory system. The original data on greenhouse gas source and sink categories are used whenever it is possible to make a direct connection between the sectors recognized in the official data and our aggregation, which is

distinguished in the model.<sup>7</sup> Following Acar and Yeldan (2016), we allocate the remaining unaccounted CO<sub>2e</sub> emissions using the share of sectoral intermediate input demand to the aggregate volume of sectoral output as weights. Sectoral GHGs allocation is shown in Table A1 in the Appendix.

### 3.2. Emissions embodied in Turkey's exports to the EU28 market

In the second step, we conduct an input-output analysis to calculate the sectoral emissions embodied in the exports to the EU28 market to analyze the potential effects of the CBA on Turkish sectors exporting to the EU market (see Table A3 for sectoral exports to the EU market in 2018). The GHGs emissions embodied in the EU28 exports are calculated using Equation 1 given below:

$$GHG = K_{GHG}(I - A)^{-1}EX_{EU28} \quad (1)$$

where  $EX_{EU28}$  is the diagonalized vector of exports to the EU28 market,  $(I - A)^{-1}$  is the Leontief inverse,  $K_{GHG}$  is the diagonalized GHG-intensity vector,<sup>8</sup> and  $GHG$  is the 24\*24 matrix of GHGs embodied in EU28 exports. The row sums of the GHG matrix give the total GHGs embodied in the exports of the corresponding sector column. The I-O analysis makes it possible to decompose emissions over different scopes. The diagonal elements of the GHG matrix show Scope 1, the electricity row elements show Scope 2, and the sum of the rest of the column elements shows Scope 3 emissions embodied in exports to the EU28 market.

It is still not clear how the CBA will be implemented in regards to the scope of emissions<sup>9</sup> and sectoral coverage. Currently, under the ETS mechanism, the EU prices the Scope 1 emissions of intra-EU plants/power stations under the seven energy- and carbon-intensive sectors listed in Table A1 in the Appendix. However, covering only the Scope 1 emissions of a limited number of sectors does not necessarily mean leaving the majority of emissions outside the ETS. Note that pricing Scope 1 emissions in the ETS-covered sectors increase the production costs directly as well as the costs of other sectors using them as inputs in their production processes. For example, the textiles sector (C13-C15) does not pay for its emissions since it is not currently covered under the EU ETS. Yet, it faces higher costs for its inputs, such as electricity and chemical

<sup>7</sup> Direct sectoral emissions data were available for agriculture, mining, food processing, paper products, refined petroleum, chemicals, cement, iron and steel, transportation, and electricity.

<sup>8</sup> The GHG-intensity vector shows the amount of sectoral tons of GHGs per million TL sectoral total output (taken from the 2018 I-O table of Turkey) and is reported in the Appendix. It is similar to the employment/value-added ratios that have been traditionally used in the I-O analysis. Note that sectoral imports are a part of the total sectoral output and are treated as complimentary to the domestic inputs, or as a substitute.

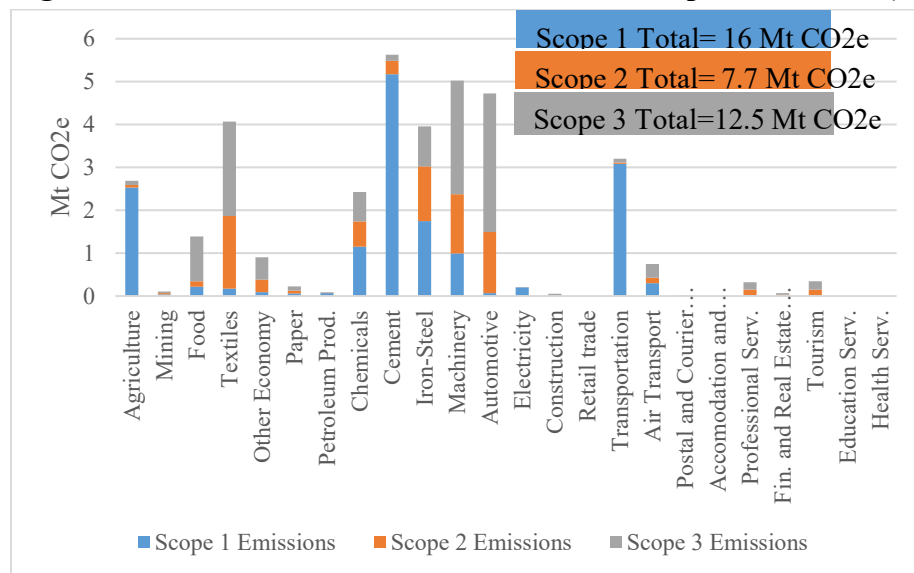
<sup>9</sup> The emissions of the plants are grouped under three sections. Scope 1 emissions are direct emissions generated by owned or controlled sources; Scope 2 emissions are indirect emissions from the generation of purchased energy; and Scope 3 emissions are indirect emissions from the production of other purchased inputs (WRI and WBCSD, 2004).

inputs, as these are covered under the ETS. Once electricity or chemical input providers reflect the carbon price in their prices, the unit costs of a textile plant will also increase. This is similar to when a textile plant is required to pay for its Scope 2 and (part of) Scope 3 emissions. Taking into account the fact that one of the main aims of the CBAM is to level the cost disadvantages of intra-EU producers caused by carbon taxation vis-a-vis producers outside the EU (with no or weaker carbon regulation), this will necessarily require the CBA to consider not only Scope 1 emissions, but also Scope 2 and Scope 3 emissions (see Marcu et al., 2020 for a detailed discussion).

Therefore, we proceed with two scenarios reflecting the implementation of the CBAM in the short and long run. The CBAM is expected to cover the Scope 1 and Scope 2 emissions of a handful of sectors in the transitional 2023-2026 period, i.e. cement, iron and steel, aluminum, basic chemicals, and electricity. Hence, the short-run analysis only covers these sectors' Scope 1 and Scope 2 emissions. Following the transitional period, the CBAM's product and emission coverage are expected to expand gradually. Therefore, the long-term analysis covers the entirety of the 24 model sectors' Scope 1, Scope 2, and Scope 3 emissions.

The I-O analysis makes it possible to decompose GHGs over different emission scopes. The diagonal elements of *GHG* represent the sectors' Scope 1 emissions embodied in exports, and the elements of the electricity row represent the sectors' Scope 2 emissions related to the use of electricity input. The rest of the elements show the Scope 3 emissions of the sector column related to the use of corresponding inputs purchased from the sector row. The decomposition of the sectoral emissions is given in Figure 2.

**Figure 2. GHG emissions embodied in Turkish exports to EU28 (2018, Mt CO<sub>2</sub>e)**



Turkish exports to the EU28 market in 2018 contained 36.2 Mt of CO<sub>2</sub>e emissions (Scopes 1, 2, and 3), and the majority of them were concentrated in the cement, machinery, automotive, iron and steel, and textiles sectors.

The high carbon intensity of electricity production in Turkey is one of the vulnerabilities of the Turkish exporting sectors. Figure 2 shows that the Scope 2 emissions (7.7 Mt) embedded in EU28 exports account for 21.3 percent of the total emissions (36.2 Mt CO<sub>2</sub>e). Irrespective of their Scope 1 emissions, heavy reliance on electricity inputs in the textiles, chemicals, iron and steel, machinery, and automotive sectors would pose serious competitiveness risks in the EU export market.

### 3.3. Calculating the CBA-induced carbon cost

The CBA-induced carbon cost is calculated simply by multiplying the carbon embodied in exports with a unit carbon price of EUR 30 and EUR 50 per ton of CO<sub>2</sub>e. At the time this study was initiated (at the beginning of 2021), carbon prices in the EU ETS market were fluctuating around EUR 30 per ton. At the beginning of May 2021, the unit carbon cost (i.e. EU Allowance (EUA)) hit EUR 50 per ton, the highest since the carbon market was launched in 2005. Alberici et al. (2014) estimate that EUR 50 per ton is a central value of the climate cost of CO<sub>2</sub> emissions. OECD (2021) also uses very close unit cost values to the ones chosen in this study as carbon price benchmarks. EUR 30 per ton is taken as a historic low-end price benchmark of carbon costs in the early and mid-2010s and EUR 60 per ton is chosen as a low-end 2030 and mid-range 2020 benchmark by the OECD (2021).

#### 3.3.1. CBAM in the short run

During the transitional 2023-2026 period, CBAM will apply to a handful of products grouped under the cement, iron and steel, chemicals, and electricity sectors.

**Figure 3. GHGs emissions embodied in Turkish exports to EU28 (2018, Mt CO<sub>2</sub>e)**

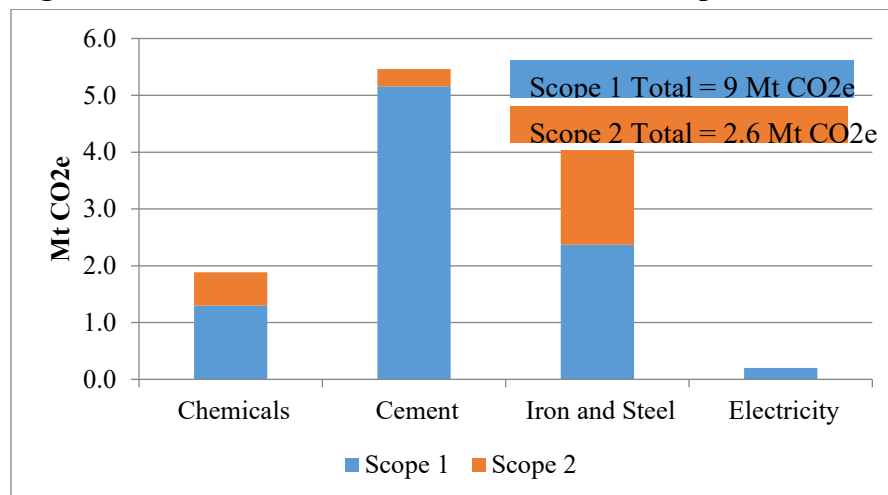
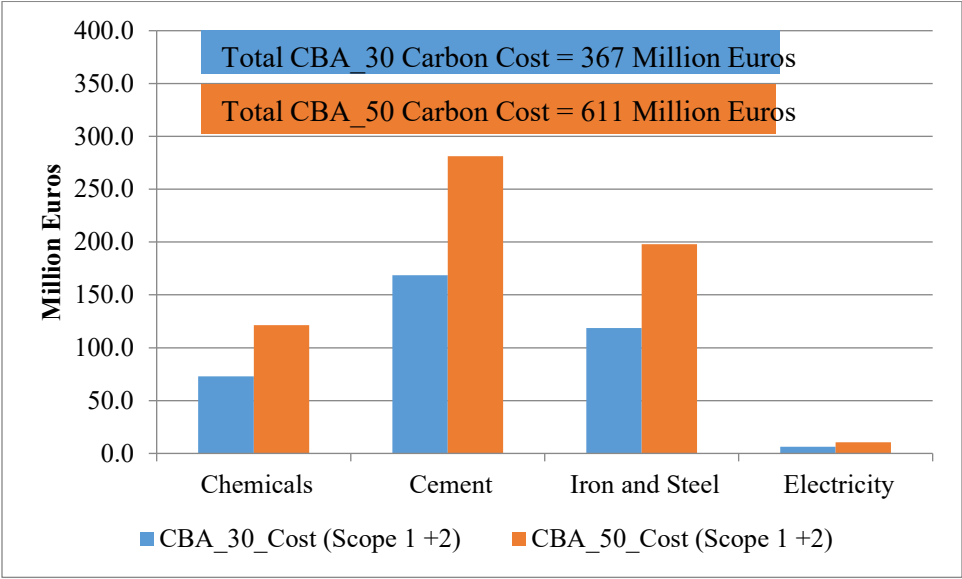
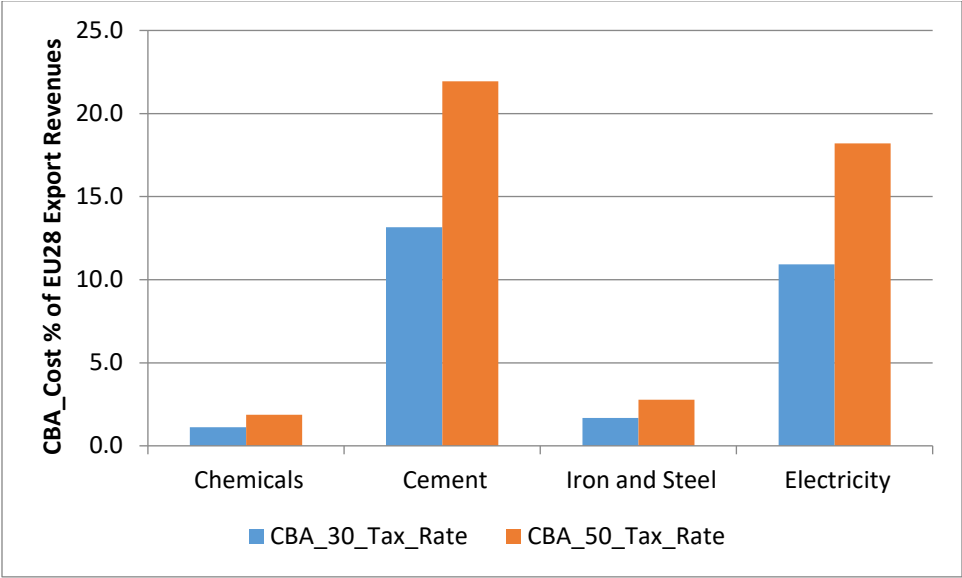


Figure 3 shows that the Turkish exports to the EU28 market in these four sectors contained 11.6 Mt CO<sub>2</sub>e, with the cement sector having the highest emissions. Multiplying these figures by EUR 30 and EUR 50 gives the carbon costs that would be faced by these sectors. Figure 4 shows that the short-run cost of CBAM ranges between EUR 367-611 million.

**Figure 4. Carbon costs (million Euros)**



**Figure 5. CBA tax rates (Scope 1 and Scope 2 only)**



### 3.3.2. CBAM in the long run

The calculations based on the I-O analysis are static and reflect the sectoral GHG risks of “all” sectors as of 2018. Meanwhile, the CBAM will affect iron and steel, aluminum, cement, fertilizers, and electricity at the beginning (between 2023 and 2026) and its coverage is expected to increase to other sectors such as paper products and ceramics. It would be sound to assume that the paper or ceramics industries will be as GHG-intensive as they were in 2018 when they will eventually be taken under the CBAM in the future. Such a dynamic analysis is possible with the CGE methodology, but it is beyond the scope of this paper.

This subsection repeats the analysis conducted above, except that the working assumption is that the CBAM will cover “all” emission scopes of “all” model sectors.

Multiplying the sum of Scope 1-2-3 emissions (shown in Figure 2) by EUR 30 and EUR 50 yields the carbon costs of the sectors.

**Figure 6. Carbon costs in the long run (all scopes)**

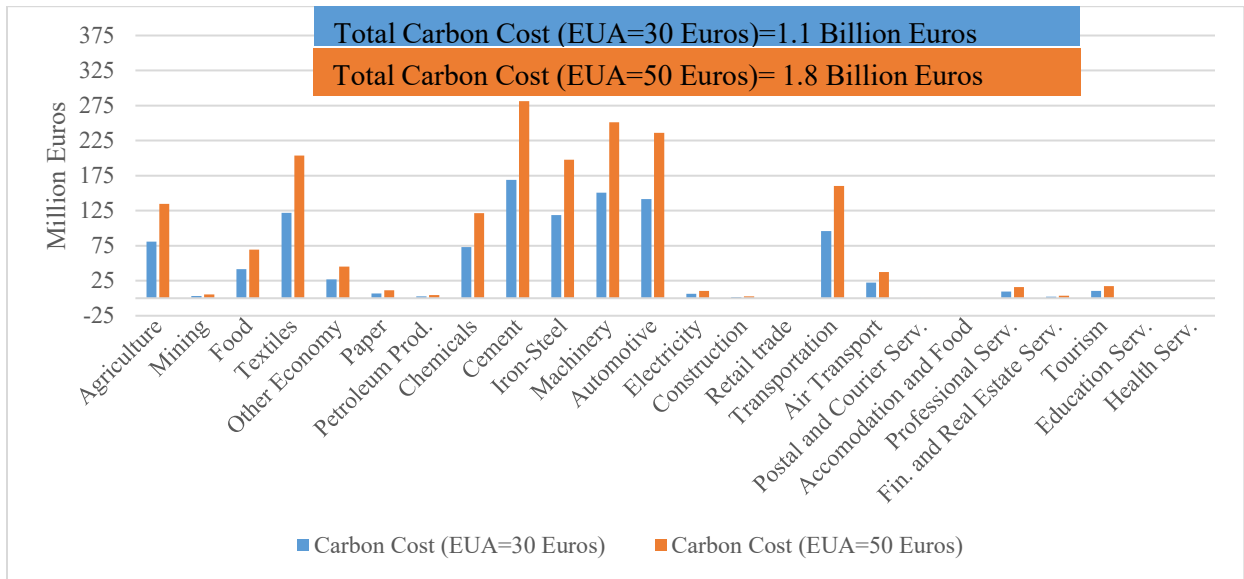


Figure 6 shows that if Turkish exporters were required to pay EUR 30 per ton of GHGs (all scopes), they would have faced a carbon cost of EUR 1.1 billion (EUR 1.8 billion if the price of EUA were to be EUR 50). Yet, carbon costs may not fully quantify the level of vulnerability (which can be defined as the export revenue fall risk) to the CBA. Dividing sectoral carbon costs to export revenues earned from the EU28 market would give a much clearer picture. In terms of the sectoral “shadow” tax rates (CBA\_30/CBA\_50 when the EUA price is EUR 30/50), one can see that the CBA would have the worst impact on the cement and electricity sectors in Turkey. Figure 7 shows that GHG-intensive cement and electricity exporters to the EU28 market should

pay back, respectively, EUR 22 and EUR 18 per EUR 100 of the earned revenues to the EU ETS (see Table A3 in the Appendix).

**Figure 7. CBA tax rates in the long run**



### 3.4. Instituting a Turkish ETS

Turkey became a partner of a technical support program titled Partnership of Market Readiness (PMR) of the World Bank in 2013. Since 2013, PMR-Turkey has been researching the possible effects of different carbon pricing schemes on the Turkish economy and the implementation of the monitoring, reporting, and verification guidelines. Turkey took this step in 2014 by issuing the Monitoring-Reporting-Verification (MRV) Guideline. The communique titled “The Verification of the Greenhouse Gas Emissions and the accreditation of the Verification Bodies” was issued in Turkey’s Resmi Gazete (no: 30258) in December 2017. According to the regulation, plants operating under the sectors listed in Appendix 1 of the communique are required to undertake annual monitoring, reporting, and verifying processes (Aşıcı, 2021).

The Turkish ETS is assumed to cover the direct emissions of the energy-intensive petroleum products, paper, cement, iron and steel, chemicals, and electricity sectors (same sectors covered under the EU ETS). Also, the GHG price is assumed to be EUR 50, reflecting the current price under the EU ETS.

Table 1 below shows the revenues that can be generated by the Turkish ETS and compares them with the carbon cost that sectors will face at the EU border.

**Table 1. Costs and benefits of having a national ETS**

<b>Sectors</b>	<b>CBA 50 Cost (Scope 1 +2) Million Euros</b>	<b>TR ETS Revenues (Direct Emissions) Million Euros</b>
<b>Chemicals</b>	121.3	580.8
<b>Cement</b>	281.2	3752.5
<b>Iron and Steel</b>	197.9	904.8
<b>Electricity</b>	10.5	7676.9
<b>Paper</b>		77.4
<b>Petroleum Products</b>		347.1
<b>Total</b>	<b>610.9</b>	<b>12915.1</b>

In the short run, the annual cost of the CBAM to the four sectors can go up to EUR 611 million. The CBAM Authority is expected to transfer these revenues collected at the EU border to the EU budget, unlike the implementation at the EU ETS. Note that the EU ETS has been returning the revenues to the countries under the condition that they would be spent on green transformation.

How can Turkey minimize the costs associated with the CBAM? One can argue that it would be wiser to institute a national ETS and retain these funds in Turkey. Table 1 shows that the Turkish ETS can generate up to EUR 13 billion annually from the six Turkish ETS sectors also covered in the EU. With the assumption that these revenues are earmarked for the green transformation of sectors, sectors may find it in their best interest to accept a national ETS.<sup>10</sup>

#### **4. Conclusion and policy implications**

The CBAM forces non-EU exporters belonging to a list of energy-intensive sectors to pay more attention to the GHG intensity of their production process. Moreover, the source of the electricity consumed (fossil or renewable) would also matter since the CBAM includes Scope 2 emissions embedded in exports as well. The CBAM is expected to increase the production costs both in the domestic economy and at the EU28 market and has the potential to alter the competitiveness of the exporting firms in the EU market. Acknowledging the extent of the CBA-related risks that exporters will face before the CBAM takes effect is quite important to retain their competitiveness. The present study sheds light on these risks in sectoral detail and helps policymakers identify and prioritize actions on a sectoral level.

The inclusion of Scope 2 emissions in the CBAM calls for a transformation of the electricity sector that exceeds the sector's financial capabilities. To avoid market failure, the government must step in by designing a general decarbonization program for electricity production in

<sup>10</sup> The CBAM is expected to grant free allocations to non-EU exporters up to benchmark values determined by the EU ETS for EU-producers. This would reduce the actual carbon costs faced by exporters. Moreover, a similar policy can also be followed in the future national ETS. To be able to calculate the free sectoral allocations, however, one needs to have plant-level data, which are not made public by the Turkish state.

Turkey. In designing such a program, it is quite important to know the Scope 2 intensity of sectors as a measure of their transformation appetite. This study will help policymakers identify the sectoral positions of the Turkish economy.

Our results suggest that the CBAM may bring a carbon bill of EUR 1.1-1.8 billion annually to the Turkish exporters in the EU market depending on the price of EUR 30 and EUR 50 per ton of GHGs. The cement and electricity sectors are expected to be the worst affected. For every EUR 100 of export revenues, the cement and electricity sector should return EUR 13-22 and EUR 11-18, respectively. Note that this figure reflects only the effects of the CBAM and not the costs associated with the circular economy regulations that will require Turkish exporters to redesign their product specifications.

Speeding up the ongoing preparatory process of instituting an ETS in Turkey (preferably linked to the EU ETS) will help minimize economic losses. Rather than transferring to the CBAM Authority, under such a system, Turkey would keep the EUR 1.1 to 1.8 billion carbon bill that can be used to decarbonize the sectors. Overall, a shift to an active climate-policy will help Turkey access climate finance opportunities which will ease the climate-friendly transformation of Turkish sectors. The revision of the INDC target and the ratification of the Paris Climate Agreement at the parliament are two steps that can be taken immediately.

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## Appendix

**Table A1. Model sectors and sectoral GHG allocations**

<b>2018</b>	<b>Million tons</b>	<b>Share</b>
<b>Total CO<sub>2</sub>e Emissions (Energy, Industrial Processes and Agriculture)</b>	<b>451.3</b>	<b>86.63</b>
AG: Agriculture (NACE Rev 2 Code: A01-A03)	74.6	14.33
MI: Mining (NACE Rev 2 Code: B05, B06 - B09)	2.4	0.46
FO: Food Processing (NACE Rev 2 Code: C10 - C12)	5.2	1.01
TE: Textiles, Clothing (NACE Rev 2 Code: C13 - C15)	0.6	0.11
OE: Other Economy (NACE Rev 2 Code: C16, C30 -C33, E36 - E39, G45, G46, N80 - N82, O84)	4.4	0.84
PA: Paper Products (NACE Rev 2 Code: C17, C18)	1.0	0.20
PE: Petroleum Products (NACE Rev 2 Code: C19)	6.7	1.28
CH: Chemicals (NACE Rev 2 Code: C20-C22)	10.1	1.95
CE: Cement (NACE Rev 2 Code: C23)	75.1	14.42
IS: Iron and Steel (NACE Rev 2 Code: C24)	17.6	3.38
MW: Machinery, White Goods (NACE Rev 2 Code: C25-C28)	5.8	1.12
AU: Automotive (NACE Rev 2 Code: C29)	0.2	0.03
EL: Electricity (NACE Rev 2 Code: D35)	154.9	29.75
CN: Construction (NACE Rev 2 Code: F41-F43)	3.0	0.58
RT: Retail trade (NACE Rev 2 Code: G47)	1.0	0.20
TR: Transportation (NACE Rev 2 Code: H49, H50)	81.7	15.68
AT: Air Transport (NACE Rev 2 Code: H51, H52)	3.8	0.72
PS: Postal and Courier Services (NACE Rev 2 Code: H53)	0.2	0.03
AF: Accommodation and Food (NACE Rev 2 Code: I55, I56)	0.3	0.05
PR: Professional Services (NACE Rev 2 Code: J58 - J63, M71 - M75, N77 - N78, S94 - S96)	0.7	0.14
FS: Financial and Real Estate Services (NACE Rev 2 Code: K64 - K66, L68, M69-M70)	1.2	0.23
TS: Tourism (NACE Rev 2 Code: N79, R90 - R93)	0.2	0.03
ES: Education Services (NACE Rev 2 Code: P85)	0.3	0.05
HE: Health Services (NACE Rev 2 Code: Q86 - Q88)	0.3	0.06
<b>Total CO<sub>2</sub>e Emissions from Households &amp; Waste</b>	<b>69.6</b>	<b>13.37</b>
<b>Total (CO<sub>2</sub>e)</b>	<b>520.9</b>	<b>100</b>

**Table A2. Input-output table, 2018 (at basic prices, Millions TL)**

	AG	MI	FO	TE	OE	PA	PE	CH	CE	IS	MW	AU	EL	CN	RT	TR	AT	PS	AF	FR	FS	ES	HE	Total (Column)		
<b>AG: Agriculture</b>	54,341	44.3	92,812	13,883	8,722	876.9	1.2	2,198.9	749	6.4	49.3	0.2	1.4	21.7	403.9	141	4.4	0.0	8,158.7	346.4	198.0	314.3	388.0	314.3	<b>30,242.3</b>	
<b>MI: Mining</b>	134.4	6,661.1	1,362.9	2,547.1	3,713.1	713.6	109,949.9	8,317.2	20,902.0	38,420.7	1,133.5	397.0	174,812.2	0.1	116.1	517.5	400.3	6.7	1.2	283.5	386.4	4,433.1	39.3	34.5	873.9	<b>30,516.9</b>
<b>FO: Food Processing</b>	11,793.5	1,167.5	38,798.0	1,240.5	7,721.1	521.4	20.0	561.4	49.0	61.1	120.0	61.0	120.0	20.0	2,609.0	151.0	103.0	603.0	40,253.0	1,075.0	317.4	586.0	839.1	1,034.1	<b>30,586.4</b>	
<b>TE: Textile, Clothing</b>	30.6	520.3	80.3	12,766.3	13,874.4	1,376.0	12.4	2,275.1	480.9	272.1	1,033.3	1,551.1	28.2	28.2	6,019.0	155.0	170.7	387.1	703.0	1,407.4	176.5	627.0	201.0	804.1	<b>30,540.1</b>	
<b>OE: Other Economy</b>	9,912.1	5,425.1	15,962.1	20,122.0	116,430.0	5,525.7	2,475.5	8,812.4	8,751.0	112,011.0	30,712.0	22,886.0	6,391.0	36,000.0	12,610.0	10,811.0	14,371.0	1,401.0	10,146.0	8,102.4	20,863.0	4,474.0	4,542.0	34,251.0	<b>30,611.1</b>	
<b>PA: Paper Products</b>	207.1	2.4	4,641.0	2,659.0	11,800.0	20,388.0	114.5	1,448.5	1,366.0	929.1	2,611.0	426.1	471.9	28.5	1,811.0	365.0	1,118.0	311.0	1,374.0	8,194.1	2,517.0	1,063.0	1,663.0	1,063.0	<b>31,561.1</b>	
<b>PE: Petroleum Products</b>	8,340.0	5,894.7	1,064.0	9,971.0	25,226.0	274.2	1,066.0	1,038.0	4,979.0	1,588.0	2,813.5	499.0	2,491.0	6,291.5	5,831.0	21,207.0	29,141.0	1,009.0	1,331.0	3,717.7	2,876.0	895.0	1,581.0	1,038.0	<b>31,511.1</b>	
<b>CH: Chemicals</b>	16,513.0	2,825.0	9,800.0	27,880.0	21,292.0	3,000.0	181.0	10,548.0	3,440.0	6,656.0	20,401.0	10,791.0	4,010.0	8,796.0	2,283.0	2,284.0	4,011.0	170.0	1,544.0	1,742.0	9,492.0	891.0	529.0	11,014.0	<b>32,343.0</b>	
<b>CE: Cement</b>	262.0	464.4	819.0	311.1	4,834.0	114.0	3.0	3,798.0	17,969.0	1,927.0	3,002.0	2,041.0	8,000.0	40,138.0	229.0	1,037.0	0.0	0.0	30.2	89.0	830.0	30.0	1.0	1,926.0	<b>31,511.0</b>	
<b>IS: Iron and Steel</b>	11.4	1,182.2	179.0	82.0	16,873.0	340.0	53.2	2,164.5	1,024.0	86,762.0	110,200.0	31,601.0	444.0	46,810.0	30.0	265.0	210.0	6.3	236.1	639.2	194.3	20.4	4.1	2.0	<b>30,975.0</b>	
<b>MW: Machinery, White Goods</b>	486.2	1,436.4	1,343.0	1,518.4	24,170.0	301.4	124.0	1,034.5	861.0	1,264.0	72,240.5	28,990.0	3,338.2	8,000.0	4,339.0	1,198.0	626.1	64.5	879.3	7,061.2	6,688.0	813.1	382.7	1,371.1	<b>30,878.0</b>	
<b>AU: Automobile</b>	492.2	32.4	0.0	0.0	10,514.0	3.0	0.1	3.5	44.5	8.1	3,291.0	58,429.0	0.0	0.0	1.5	1,161.0	90.1	0.4	1.0	628.3	17.7	12.0	0.1	5.0	<b>30,810.5</b>	
<b>EL: Electricity</b>	1,666.2	1,646.2	2,379.0	7,225.0	15,310.0	1,485.2	926.0	7,088.4	6,201.0	17,231.2	5,276.0	175,351.0	796.3	7,101.0	849.0	1,540.0	1,071.0	4,706.0	3,746.0	7,622.0	1,114.1	4,800.0	3,301.1	4,000.0	<b>30,979.0</b>	
<b>CN: Construction</b>	472.1	280.1	908.0	446.4	23,702.0	119.0	7.1	79.4	2,162.0	1,080.0	1,100.0	347.0	2,542.7	81,802.0	4,471.0	772.1	129.4	96.1	1,093.0	3,257.0	3,481.0	2,178.2	1,123.2	1,068.0	<b>30,821.0</b>	
<b>RT: Retail Trade</b>	2,017.0	790.0	4,315.0	4,679.0	7,944.0	722.2	792.0	1,191.2	1,531.0	1,271.0	6,636.0	2,400.0	1,044.0	6,050.0	1,024.0	1,142.0	2,191.0	1,101.0	2,174.0	1,491.1	1,560.7	129.1	262.0	1,542.1	<b>30,846.0</b>	
<b>TR: Transportation</b>	4,793.0	1,546.7	11,243.0	6,703.0	43,147.0	2,758.2	2,969.0	0.798.4	4,701.0	17,653.0	16,511.0	1,342.0	1,071.1	0.1	6,623.0	35,337.0	9,833.0	1,943.0	6,397.2	2,460.9	1,071.3	6,360.0	1,217.3	6,360.0	<b>32,596.0</b>	
<b>AT: Air Transport</b>	179.0	747.0	1,228.0	799.7	15,254.0	372.4	324.4	1,287.7	30.5	497.0	1,391.0	444.5	136.0	485.0	1,173.0	10,093.0	3,272.1	1,292.5	61.1	1,039.0	1,360.0	4,578.1	34.0	340.1	<b>30,791.0</b>	
<b>PS: Postal and Courier Services</b>	7.0	4.0	10.0	38.2	4,473.0	96.0	0.0	29.1	96.3	397.0	39.0	184.0	18.1	246.0	21.0	877.0	44.0	1,024.0	90.0	46.0	210.0	74.0	14.0	74.0	<b>30,841.0</b>	
<b>AF: Accommodation and Food</b>	41.1	29.1	32.0	330.0	8,803.0	183.0	42.0	76.9	231.0	1,413.0	344.0	22.4	78.4	1,660.0	124.0	931.0	114.2	1,924.0	3,147.1	1,927.0	11,291.4	1,129.2	1,326.0	1,326.0	<b>30,710.0</b>	
<b>FR: Professional Services</b>	1,501.0	2,404.0	3,275.0	2,267.0	40,902.0	1,598.4	860.0	3,928.4	1,581.0	2,081.0	7,082.0	1,505.0	4,170.0	8,158.0	11,180.0	3,149.0	5,232.0	1,117.0	2,752.0	46,837.4	42,588.0	6,292.0	2,780.0	10,647.0	<b>31,511.0</b>	
<b>FS: Financial and Real Estate Services</b>	304.2	2,140.4	4,417.0	10,162.0	53,325.0	1,072.5	1,487.0	8,344.0	1,044.0	3,190.0	12,274.0	1,764.2	17,475.0	9,122.2	38,308.0	4,747.0	12,161.0	1,941.0	12,478.0	19,780.7	34,430.0	4,417.0	4,303.0	11,143.0	<b>31,541.0</b>	
<b>ES: Education Services</b>	0.0	0.0	1,096.0	2.0	1,132.0	36.0	21.2	206.2	25.0	30.0	140.0	34.1	29.0	40.0	679.0	414.0	1,500.0	12.0	689.0	2,005.0	84.0	8,102.0	33.1	221.1	<b>31,541.0</b>	
<b>HE: Health Services</b>	1.1	8.0	16.0	791.0	4,481.0	78.2	21.2	18.3	11.0	31.0	1,864.0	229.0	63.0	8.0	118.0	29.1	472.0	1.1	319.0	378.0	892.0	184.1	2,782.0	184.1	<b>31,541.0</b>	
<b>HT: Health Services</b>	0.0	0.0	14.0	54.0	341.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.0	58.7	44.0	10.0	16,992.0	<b>31,511.0</b>		
<b>TOTALS (Column Sum)</b>																									<b>4,380,898.4</b>	
<b>Compensation of Employees</b>	19,186.2	18,190.0	56,498.0	31,203.0	280,467.2	7,366.6	1,068.6	10,077.7	10,521.6	7,551.4	36,599.0	26,612.0	8,761.5	76,438.0	38,340.0	84,232.2	22,366.9	6,087.0	51,801.0	70,105.2	48,914.3	18,021.0	13,268.3	52,599.1	1,233,832.0	
<b>Gross Fixed Capital Formation</b>	224,708.1	20,448.4	140,115.0	43,261.1	199,798.0	16,969.0	11,117.0	8,212.2	20,409.0	21,472.0	33,303.0	32,807.7	22,481.0	30,449.0	98,110.0	218,877.0	116,620.0	2,446.1	82,034.1	141,946.0	101,925.1	20,212.0	8,607.3	14,605.0	2,401,020.0	
<b>Exports of Products</b>	295.4	3.76	3,411.0	5,072.0	42,103.0	3,244.1	2,210.0	8.78	4,520.0	6,950.0	10,036.0	4,029.5	3,908.0	30.0	6,271.0	31,772.0	6,999.0	92.1	6,634.0	9,775.0	11,962.0	1,286.0	1,061.0	1,926.0	168,871.0	
<b>Total Value Added (GDP)</b>	243,989.8	38,408.4	200,102.4	140,543.3	522,654.1	26,296.7	15,223.1	8,129.6	36,054.4	39,123.1	81,142.5	65,491.2	33,830.2	28,746.1	142,617.7	354,382.7	93,308.5	9,688.5	140,216.6	227,897.4	442,361.2	39,992.4	142,021.0	69,106.1	<b>3,710,351.0</b>	
<b>Total Production Exp</b>	357,867.1	10,444.1	397,897.1	172,141.2	1,006,002.1	74,977.3	17,049.9	25,008.4	153,813.0	141,344.1	311,462.0	243,648.0	827,544.6	151,228.1	243,519.1	448,771.9	184,191.3	19,902.5	213,825.1	381,586.4	96,912.0	91,555.0	178,044.0	101,493.1	<b>5,063,193.0</b>	

	PCE: Private Consumption Exp	GCE: Government Consumption Exp.	GFCF: Gross Fixed Capital Formation	EXP: Exports	IMP: Imports (-)	Total Exp on Value Added	Total Expenditures
<b>AG: Agriculture</b>	154,302.6	0.0	38,500.6	28,337.8	-46,036.0	175,105.0	357,867.3
<b>MI: Mining</b>	13,406.2	0.0	7,603.8	16,449.0	-29,406.6	8,052.3	393,464.3
<b>FO: Food Processing</b>	254,147.6	0.0	1,657.2	66,454.2	-33,758.2	288,500.7	397,087.1
<b>TE: Textiles, Clothing</b>	113,631.6	0.0	902.4	141,790.9	-38,726.1	217,598.7	372,143.2
<b>OE: Other Economy</b>	155,583.1	232,161.0	99,782.0	71,701.0	-97,266.7	461,960.5	1,006,092.2
<b>PA: Paper Products</b>	9,573.2	0.0	0.0	11,916.2	-18,815.2	2,674.3	74,577.3
<b>PE: Petroleum Products</b>	53,661.5	0.0	299.9	26,353.7	-78,327.0	1,988.1	137,694.9
<b>CH: Chemicals</b>	34,237.3	22,767.7	670.0	86,906.2	-191,757.3	-47,176.2	275,085.8
<b>CE: Cement</b>	6,203.9	0.0	1,940.6	20,352.1	-8,851.9	19,644.7	115,515.8
<b>IS: Iron and Steel</b>	0.0	0.0	106,098.0	93,482.9	-158,112.1	41,468.8	341,344.5
<b>MW: Machinery, White Goods</b>	47,211.8	0.0	196,452.8	158,434.5	-224,447.1	177,651.9	381,490.2
<b>AU: Automobile</b>	39,210.6	0.0	76,285.7	144,610.5	-91,316.1	168,790.8	243,648.3
<b>EL: Electricity</b>	144,298.5	0.0	0.0	483.1	-27.6	144,505.2	627,564.6
<b>CN: Construction</b>	4,478.4	13.5	484,118.9	2,740.7	-959.1	490,392.4	633,220.7
<b>RT: Retail Trade</b>	171,003.4	7,616.3	17,430.2	0.0	0.0	196,049.9	254,518.3
<b>TR: Transportation</b>	184,509.6	1,419.2	16,029.9	49,153.9	-26,930.2	224,182.4	448,771.9
<b>AT: Air Transport</b>	32,810.2	0.1	203.5	69,384.8	-16,804.2	85,594.4	164,193.3
<b>PS: Postal and Courier Services</b>	4,655.8	0.0	0.0	1,004.5	-162.8	5,497.5	19,902.5
<b>AF: Accommodation and Food</b>	160,921.2	0.0	0.0	44,751.3	-10,922.2	194,750.3	233,825.3

**Table A3. Exports, emissions, carbon costs, and tax rates (2018)**

	Emissions (Mt CO2e)				Carbon Costs (million euros)		Revenues (million euros)	Tax Rates (Carbon Cost as a % of Revenues)	
	Scop e 1	Scop e 2	Scop e 3	Total	EUA=30 Euros	EUA=50 Euros	Exports to EU28	CBA_30	CBA_50
AG: Agriculture	2.53	0.06	0.10	2.69	81	135	2057	4	7
MI: Mining	0.04	0.03	0.04	0.11	3	5	1093	0	0
FO: Food	0.22	0.13	1.04	1.39	42	69	2842	1	2
TE: Textiles	0.17	1.70	2.20	4.07	122	203	14853	1	1
OE: Other Economy	0.09	0.29	0.52	0.90	27	45	3585	1	1
PA: Paper	0.06	0.07	0.09	0.22	7	11	754	1	1
PE: Petroleum Prod.	0.07	0.01	0.02	0.09	3	5	369	1	1
CH: Chemicals	1.15	0.59	0.68	2.43	73	121	6468	1	2
CE: Cement	5.17	0.31	0.14	5.62	169	281	1280	13	22
IS: Iron-Steel	1.75	1.27	0.93	3.96	119	198	7121	2	3
MW: Machinery	0.99	1.38	2.65	5.02	151	251	15752	1	2
AU: Automotive	0.07	1.42	3.23	4.72	142	236	19669	1	1
EL: Electricity	0.20	0.00	0.01	0.21	6	10	58	11	18
CN: Construction	0.00	0.01	0.04	0.05	2	3	91	2	3
RT: Retail trade	0.00	0.00	0.00	0.00	0	0	0	.	.
TR: Transportation	3.08	0.03	0.09	3.20	96	160	2894	3	6
AT: Air Transport	0.30	0.13	0.32	0.75	22	37	2040	1	2
PS: Postal and Courier Serv.	0.00	0.00	0.00	0.01	0	0	24	1	1
AF: Accommodation and Food	0.00	0.00	0.00	0.00	0	0	0	.	.
PR: Professional Serv.	0.03	0.12	0.17	0.32	10	16	2321	0	1
FS: Financial and Real Estate Serv.	0.01	0.03	0.04	0.07	2	4	405	1	1
TS: Tourism	0.02	0.13	0.20	0.35	10	17	7339	0	0
ES: Education Serv.	0.00	0.00	0.00	0.00	0	0	0	.	.
HE: Health Serv.	0.00	0.00	0.00	0.00	0	0	0	.	.
<b>Total</b>	<b>16</b>	<b>7.7</b>	<b>12.5</b>	<b>36.2</b>	<b>1085</b>	<b>1809</b>	<b>91016</b>		