Preliminary methods and calculations for national statistics on the emissions effects of exports

Nils Brown, Andreas Poldahl, Mårten Berglund, Statistics Sweden

Abstract

Policy makers, companies and business associations in Sweden cite research studies in peer-reviewed scientific journals showing that the greenhouse gas emissions arising from Sweden's export products have lower greenhouse gas emissions than otherwise equivalent products produced according to global average technology. The same research studies find that this is also the case for the European Union's exports as a whole. In light of these considerations, Statistics Sweden is leading a study on behalf of the Swedish Ministry of Climate and Enterprise with the ultimate goal of producing statistics to measure the effect of Sweden's exports on global greenhouse gas emissions.

The aim of the work in this paper is to present relevant methodological considerations for this study and first estimates of the greenhouse gas emissions embodied in Sweden's export products compared with the emissions arising from otherwise equivalent foreign production.

The emissions arising from Sweden's export products are calculated and presented using the coupled input-output model that is already in use to produce official statistics on consumption-based greenhouse gas emissions. Two key input variables are required to determine the emissions arising from otherwise equivalent foreign products. The first is the productwise monetary value of Sweden's exports which can be obtained from Sweden's official statistics. The second is the productwise emissions intensity (in carbon dioxide equivalents per monetary unit of production) for said products. Data for these intensities can be obtained from the EXIOBASE global multi-regional input-output dataset. The paper will further discuss the methodological alternatives in establishing intensities relevant for comparison with Sweden's export. One option is to base the intensity on the global average intensity product group. Another option is to calculate intensities per product group based on a weighted average of production according to the geographical distribution of Sweden's exports. A further development is to establish a weighted average taking into account the geographical distribution of all products (including domestic production and imports) going to intermediate and final demand in the countries that Sweden exports to.

The paper will conclude with a discussion on the extent to which the methodologies presented are relevant for producing official statistics or some other kind of quantitative policy and scenario analysis.

Introduction

Peer-reviewed from recent years has proposed *technology-adjusted* consumption-based emissions as an alternative to consumption-based emissions and production-based emissions metrics for national greenhouse gas inventories[1]. If consumption-based emissions, CBE are calculated according to the following formula:

$$CBE = PROD + IMP - EXP_{DOM}$$

Equation 1

Where $PROD$ are emissions from domestic production, IMP are emissions embodied in products imported into the country and EXP_{DOM} are emissions embodied in products exported by the country, the technology-adjusted consumption-based emissions ($TCBE$) are calculated according to the formula:

$$TCBE = PROD + IMP - EXP_{GLO}$$

Equation 2

Where EXP_{GLO} are the emissions embodied in the country's export products calculated as if they had been produced according to a global average greenhouse gas intensity on a product-basis. The research proposes that TCBE complements both conventional consumption-based emissions and production-based emissions because it rewards countries that have greenhouse gas-efficient production systems for export products.

A recent consulting report has performed calculations in the same area[2]. This work has calculated the difference between the emissions arising from major Swedish export products and the emissions that would have arisen had these products been made with the greenhouse gas intensity of average global production. A difference so calculated in this work is termed the climate effect of exports. Readers should be aware that a common term for this difference in research is the "climate benefit" (Swedish: klimatnytta").

The Swedish cross-parliamentary committee on the environmental quality objectives presented an initial calculation of the climate effect of Sweden's exports based on previous research work[3]. The same report proposed that the climate effect of export so calculated could be used as a way to reach zero emissions in a proposed net-zero emissions goal for greenhouse gas emissions from Swedish consumption. This is conceptually equivalent to establishing a goal for zero emissions based on the technology-adjusted consumption-based emissions concept as proposed in research.

In light of these research developments and the noted policy interest, the Swedish Ministry of Climate and Enterprise has commissioned Statistics Sweden to carry out a study with the ultimate goal of producing statistics to measure the climate effect of Sweden's exports on global greenhouse gas emissions[4].

---

[1] https://www.nature.com/articles/nclimate2555, https://www.mdpi.com/1996-1073/13/2/339

[2] https://www.svensktnaringsliv.se/sakomraden/hallbarhet-miljo-och-energi/klimatnyttan-av-svensk-export_1167102.html

[3] https://www.regeringen.se/rattsliga-dokument/statens-offentliga-utredningar/2022/04/sou-202215/

[4] https://www.esv.se/Statsliggaren/Regleringsbrev?rbid=23214

The aim of the work in this paper is to present relevant methodological considerations for this study and first estimates of the greenhouse gas emissions embodied in Sweden's export products compared with the emissions arising from otherwise equivalent foreign production.

Method

A starting point for the study is the greenhouse gas emissions embodied in Swedish export products from Statistics Sweden's official statistics on greenhouse gas emissions from consumption.

These actual embodied emissions are compared with three scenarios where different intensities in the supply chain for the production of Swedish export products are assumed. The purpose of these comparisons is to demonstrate emissions that would arise in the counterfactual case where Sweden did not produce export products, and they are produced elsewhere in the globe instead.

In the first scenario, the greenhouse gas emissions E_i (in tonnes of greenhouse gas equivalents) that would have arisen had Sweden's export products M_i (in MSEK) been produced outside of Sweden, was calculated based on the formula:

$$E_i = e_i \otimes M_i$$

Equation 3

Where e_i is the global average greenhouse gas intensity of production (in tonnes of greenhouse gas equivalents per MSEK production). All variables in Equation 3 are vectors with i rows, where each row represents a certain product group (91 product groups are used for the calculations). The operator $\otimes$ represents an elementwise multiplication. e_i has been calculated using the EXIOBASE global multiregional input-output dataset. The monetary value of Sweden's export products M_i is from Statistics Sweden's official statistics.

In a second scenario, the greenhouse gas emissions E_{ij} (in tonnes of greenhouse gas equivalents) that would have arisen had Sweden's export products M_{ij} (in MSEK) been produced outside of Sweden, was calculated based on the formula:

$$E_{ij} = e_{ij} \otimes M_{ij}$$

Equation 4

Where e_{ij} is the greenhouse gas intensity of production of product type i in country j (in tonnes of greenhouse gas equivalents per MSEK production). All variables in Equation 4 are matrices, with i rows (for product types) and j columns (geographical classification of 49 countries or regions). The operator $\otimes$ represents an elementwise multiplication. e_{ij} has been calculated using the EXIOBASE global multiregional input-output dataset. The monetary value of Sweden's export products M_{ij} is from Statistics Sweden's official statistics.

In a scenario 3, it is assumed that Sweden's export products are replaced according to the geographical distribution of all products (including domestic production and imports) going to intermediate and final demand in each country that Sweden exports to. The basic equation for calculating this scenario is as for the previous scenario (see Equation 4). However in this case the

intensity factors e_{ij} have been calculated as weighted averages based on the geographical distribution of all products (including domestic production and imports) going to intermediate and final demand in each country that Sweden exports to.

All of the above calculations have been performed using 91 separate product groups, and were performed for a time series from 2008 through 2020.

Results

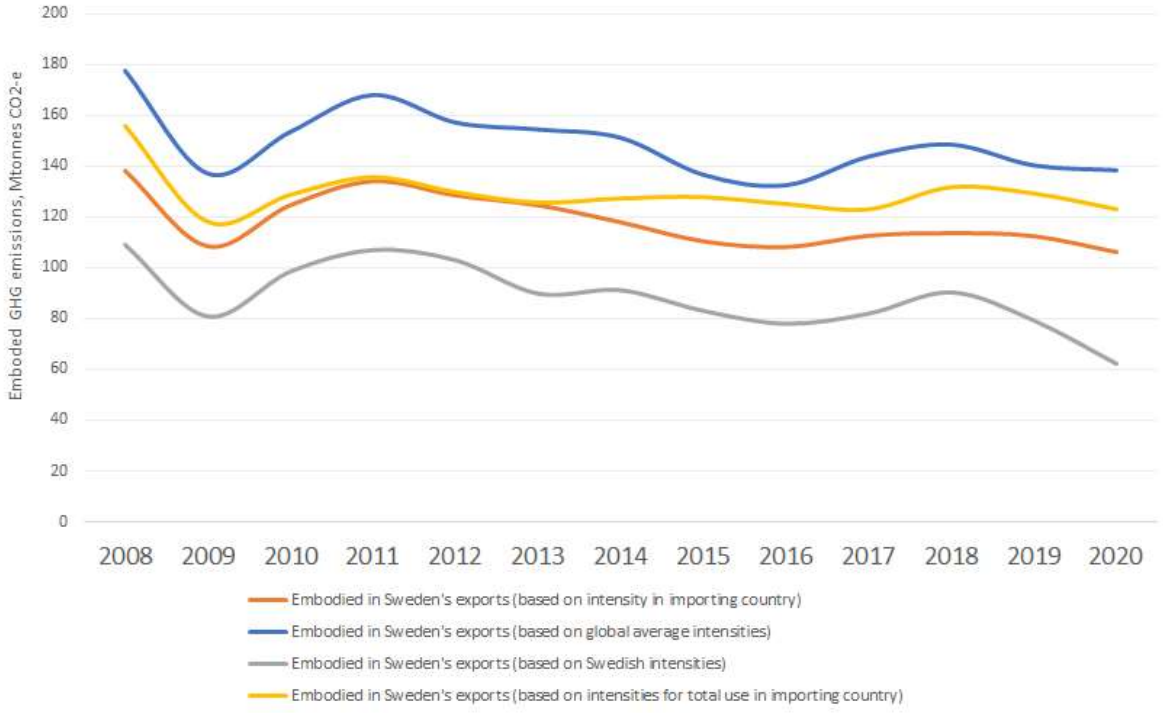

Figure 1: Comparison of emissions embodied in Sweden's exports, calculated according to the actual greenhouse gas intensity ("Swedish intensities") from official statitistics, scenario 1 using global average intensities, scenario 2 using the intensity for the production chain in the importing country and scenario 3 using the intensity for the total use of each given product in an importing country.

Figure 1 shows emissions embodied in Sweden's export products based on the official statistics with counterfactual emissions based on the scenarios considered. The figure shows that the actual emissions from Sweden's export products are significantly lower than all the scenarios considered. It has not been possible in this work to further investigate the reasons for this. Swedish electricity and space-heating technologies give rise to very low fossil carbon dioxide emissions, though this is most likely only one of many factors. Material differences between Sweden's export products and global average products in each product group may also be a significant factor. These differences may be manifested as Sweden achieving a higher value added from inputs than production elsewhere, e.g. manufacturing vehicles with a higher value added than other equivalent vehicles. Since the product groups used (91 are used for the calculations) do also incorporate a range of different products themselves, e.g. iron and steel versus aluminium in product group C24, this may also be a reason for the varying emissions levels shown.

The figure also shows that the emissions arising from the scenarios considered do vary significantly between each other. That the emissions are higher when assuming global average intensities than for other scenarios does suggest that Sweden's trading partners on the average produce with a lower intensity than the countries that Sweden does not trade with.

A further outstanding question to be addressed in the project is the extent to which Sweden's export products do actually displace similar production elsewhere. This question has not yet been addressed in existing research in the area. Neither is it a question that is addressed in relevant statistical standards and related documents, in particular the System of National Accounts (SNA) and the SEEA. This is in spite of the fact that between themselves these standards do address the input data required for the calculations, namely input-output tables (in the SNA) and environmentally-extended input-output analysis (which is described as in the Applications and Extensions of the SEEA). The question is being investigated further as a part of the project. The question of comparative emissions is one of interest for companies environmental reporting, and has been taken up for example by the GHG protocol and the World Resources Institute and the World Business Council on Sustainable Development. The company-oriented guidelines do differ somewhat in terminology and methods, though they are all quite consistent in pointing out that assessments of comparative emissions can only be done after companies have assessed (and set targets for) their own scope 1, 2 and 3 emissions.

Final reflections

The work has shown that there are significant differences between the emissions embodied in Swedish export products and the emissions that would have arisen had these products been produced elsewhere on the globe. The work has also shown that the emissions that would have arisen had these products been produced elsewhere on the globe varies significantly depending on the intensity assumed for this production elsewhere.

There is currently a lack of knowledge on the extent to which Swedish export products actually displace production elsewhere, and it is not a question that is addressed in relevant statistical standards. These issues need to be taken into account when assessing the possibility to produce statistics on comparative emissions.