Developing and evaluating methods for policy-relevant production- and consumption-based greenhouse gas emissions accounts with improved timeliness

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Introduction

There is a growing interest and expertise in statistics and indicators produced using environmentally-extended input-output (EEIO) analysis. Many countries around the world are using the method to produce statistics on consumption-based environmental impacts[1] (in particular greenhouse gas emissions). In 2021, Eurostat published the FIGARO tables for the first time. The tables provide multi-regional input-output (MRIO) tables with global coverage, comprising all EU members on country-level, 18 major EU trading partners and a "rest of world" category ensuring global coverage. The tables are updated yearly[2]. The IMF have also proposed the inclusion of consumption-based greenhouse gas emissions as part of their ongoing work with the data gaps initiative (DGI). In Sweden, thanks partly to the official statistics already being produced, a government enquiry has recently proposed the adoption of official targets for consumption-based greenhouse gas emissions, greenhouse gas emissions from public procurement and the tracking of Swedish export's effect on global greenhouse gas emissions. The enquiry also proposes that Statistics Sweden further develop their existing model so as to monitor progress in the aforementioned areas. In particular the enquiry has proposed that Statistics Sweden improve the timeliness of the current production of the official statistics on greenhouse gas and other air emissions from approximately 21 months after the end of the final reference year to approximately six months.

Meanwhile, there is growing international interest in producing timely quarterly statistics on greenhouse gas emissions with a production perspective. These data were included in the recently completed round of the IMF's data gaps initiative and Eurostat have started producing estimates for member states. The Netherlands, New Zealand and Sweden are already producing time series for quarterly greenhouse gas emissions. In Sweden the sum of four quarters in a year are published as

[1] Brown et al., 2021 - https://ec.europa.eu/eurostat/web/products-statistical-working-papers/-/ks-tc-21-001

[2] https://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/figaro

preliminary yearly statistics. This is done 4.5 months after the final reference period included in the statistics (i.e. the fourth quarter of a given year). Final yearly statistics on greenhouse gas emissions (production perspective) are produced 13 months after the end of the final reference period included in the time series. Therefore the preliminary yearly statistics make data available over 10 months before the final statistics.

In light of these ongoing processes, Statistics Sweden is investigating the possibility of producing preliminary yearly statistics on greenhouse gas emissions with a consumption perspective.

Broadly the work presented in this paper has been carried out with the following aims:

- To evaluate the accuracy of Statistics Sweden's preliminary year statistics on greenhouse gas emissions with a production perspective as well as preliminary economic statistics that can be used as input data in Statistics Sweden's input-output model compared to the final statistics
- To propose and evaluate a simple model to produce preliminary year statistics on greenhouse gas emissions with a consumption perspective

The work has been limited to looking at sources that are useful for calculation the consumption-based emissions arising from Swedish production. Emissions embodied in Swedish consumption arising due to products imported to Sweden are discussed at the end of the paper.

Method

Comparison of potential sources for input data

In a study presented at the London Group meeting in 2021, a number of potential sources for preliminary economic data were identified and that were studied in this work.

The following data sources were evaluated for their accuracy in relation to the national accounts final statistics on production values:

- Production value index (sum of published quarterly values)
- Production value index (national accounts confidential dataset)
- National accounts preliminary data (sum of quarters) on valued added

The national accounts preliminary data (sum of quarters) on final demand was also compared with the national accounts final data on final demand.

The accuracy of environmental accounts preliminary data on greenhouse gas emissions (sum of quarters) as compared with environmental accounts final data was also evaluated.

The general approach applied included:

- Calculating the product-wise or industry-wise change in greenhouse gas emissions from the initial year to the final year in the preliminary data
- Calculating the product-wise or industry-wise change in greenhouse gas emissions from the initial year to the final year in the final data

- Comparing the correlation of the changes by evaluating the Pearson correlation coefficient. For environmental data, the development of the totals was also evaluated

Proposed method for calculating preliminary year statistics for greenhouse gas emissions

Statistics Sweden's preliminary year greenhouse gas emissions (the sum of four quarters) were taken as a starting point. These are classified according to 32 industries. These data were reclassified according to 91 industry groups based on the distribution of emissions amongst these groups for the previous year. The so reclassified industry-wise data on greenhouse gas emissions in vector form were pre-multiplied with a transposed branch-normalised make table from the previous year to produce an emissions vector classified by products as opposed to industries. The resulting emissions vector for the preliminary year was used as an input for the single-regional input-output calculation, where the input-output table used in the calculation was imputed from the latest available final yearly data.

The resulting preliminary year was then evaluated for accuracy against the relevant final data by apply the revision analysis procedures applied above for the input data.

Results

Table 1: Summary of results of revision analyses performed. All datasets cover Sweden according to the economic residence principle.

Row number	Source – preliminary data	Source – final data	Classification	Year comparison	Pearson's correlation coefficient
1	Preliminary greenhouse gas emissions from production	Final greenhouse gas emissions from production	34 industries	2020 vs 2019	0.98
2	Preliminary greenhouse gas emissions from production	Preliminary greenhouse gas emissions from production	91 product groups	2019 vs 2018	0.87
3	Preliminary greenhouse gas emissions from consumption (domestic prod. only)	Final greenhouse gas emissions from consumption	93 product groups	2019 vs 2018	0.84
4	Total final demand, preliminary national accounts	Total final demand, final national accounts	91 industries	2019 vs 2018	0.69
5	Production value index, fixed prices, published	Production values, final national accounts, current prices	91 industries	2019 vs 2018	0.65
6	Production value index, fixed prices, national accounts confidential dataset	Production values, final national accounts, current prices	91 industries	2019 vs 2018	0.73
7	National accounts preliminary value added in current prices	Production values, final national accounts, current prices	91 industries	2019 vs 2018	0.82
8	National accounts preliminary value added in fixed prices	Production values, final national accounts, current prices	91 industries	2019 vs 2018	0.76

Table 1 summarizes results of the data comparisons performed. The positive values for the Pearson coefficients shown in the table arise because changes calculated using preliminary data are to a great extent good predictors of changes arising in the final data. The variation in the Pearson coefficients

suggest that there is considerable variation in the extent to which the preliminary data is a good predictor. This highest value of the Pearson coefficient arising in the table is 0.97, for the comparison made between preliminary and final greenhouse gas emissions with a production perspective and 34 industry groups. That this value is higher than the others may be due to the relatively small number of industry groups for this dataset. It may also be due to the comparison being done between 2019 and 2020, where because of the onset of the Covid-19 pandemic in 2020 the absolute change in emissions between the years is larger than for other years in the dataset.

Table also shows that the Pearson coefficients for environmental data are all higher than for the economic data. This may arise because the preliminary environmental data can make use of more of the same data that are used for the respective final data than the economic. The measure does not however say anything about the overall accuracy of each respective final statistic.

It is also interesting to note that the Pearson coefficient comparing preliminary with final differences for greenhouse gas emissions from production (row 2), at 0.87 is only slightly greater than that for greenhouse gas emissions from consumption (row 3) at 0.84. This suggests that economic data for the years that are compared in this case (2018 and 2019) resemble each other. As a corollary this suggests that the application of final economic data to calculate consumption-based emissions would yield only a marginal improvement in accuracy.

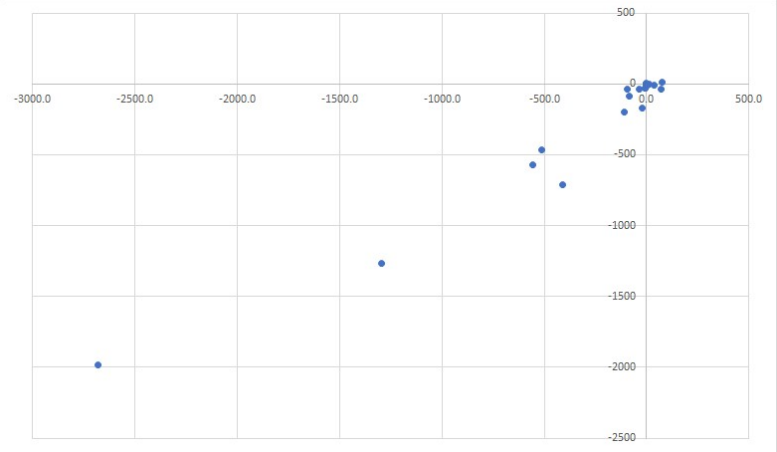

Figure 1: Change in emissions between 2020 and 2019 according to preliminary statistics (x-axis) and final statistics (y-axis). Pearson correlation coefficient=0.98. This figure represents data that are summarized in row 1 of Table 1.

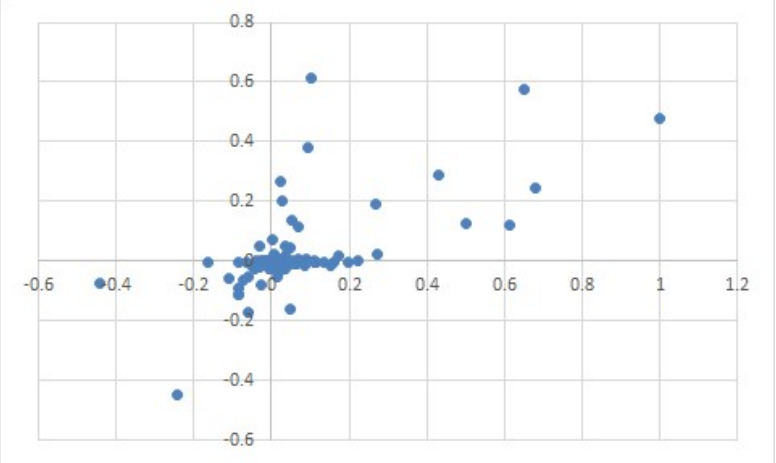

Figure 2: Change in production values between 2019 and 2018 according to preliminary statistics (y-axis – production value index, a quick statistic) and final statistics (x-axis – national accounts production value, final statistics). Data have been normalized with respect to the highest noted change in both datasets. Pearson correlation coefficient=0.65. This figure represents data that are summarized in row 5 of Table 1.

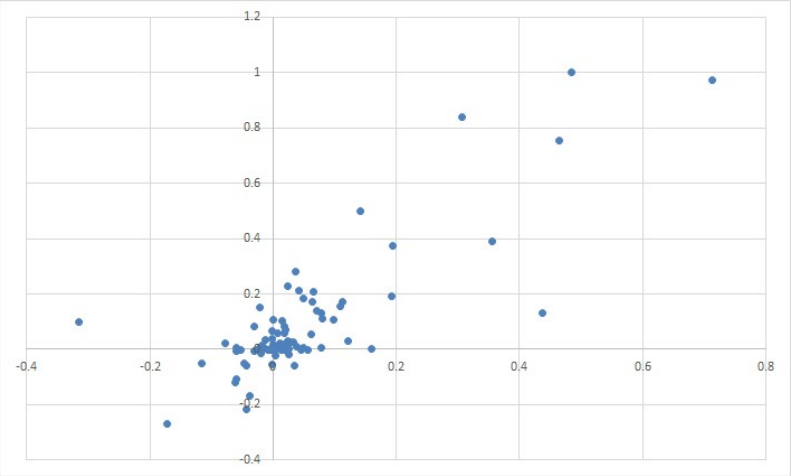

Figure 3: Change in production values between 2018 and 2019 according to preliminary statistics (y-axis – national accounts preliminary yearly statistics, value added) and final statistics (x-axis – national accounts production value, final statistics). Data have been normalized with respect to the highest noted change in both datasets. Pearson correlation coefficient – 0.82. This figure represents data that are summarized in row 7 of Table 1.

Figures 1 through 3 each compare preliminary data with final data based by plotting the changes calculated between two reference years from the preliminary and final data respectively on different axes. Figure 1 shows the preliminary data with the highest calculated Pearson coefficient and from the dataset comparisons shown in Table 1, and Figure 2 the lowest calculated Pearson coefficient. The low value noted for the datasets compared in Figure 2 can arise partially due to the fact that the preliminary dataset used in one part of the comparison does not present data for all industry groups.

Finally, Figure 4 shows the change in greenhouse gas emissions in the Swedish economy between the reference years shown and the previous year based on the preliminary statistics (blue bars) and the final statistics (orange bars). The average absolute difference between the changes noted in the preliminary compared with the final statistics is 1.00 percent. This is judged in general to be significant in light of the targets that have been set for reduction of greenhouse gas emissions. The average difference between the changes noted is less at - 0.3 percent because over- and underestimates cancel each other out.

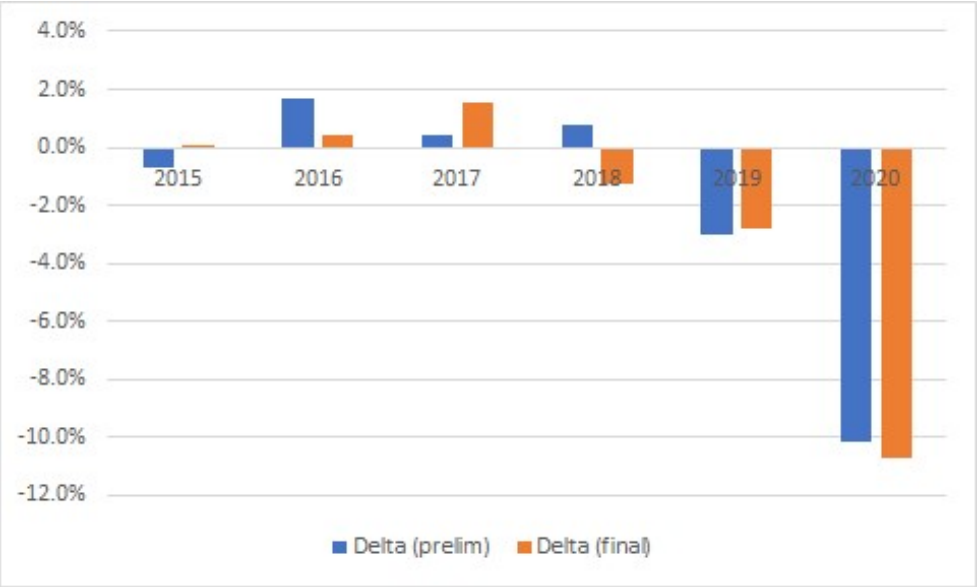

Figure 4: Changes in total greenhouse gas emissions from the Swedish economy (production perspective) between the reference year shown and the year before, calculated according to preliminary data (in blue) and final data (in orange).

Discussion and future work

The method proposed and evaluated for producing preliminary statistics on greenhouse gas emissions from a consumption perspective is quite simple because it relies on simple imputation of economic data in the input-output tables. Nevertheless, the results shown above suggest that with preliminary data for greenhouse gas emissions, the method can provide preliminary year statistics with an acceptable accuracy compared with the final statistics.

Further improvements to the method can be discussed. The inclusion of preliminary economic data such as those considered above could contribute to increasing the accuracy of the preliminary statistics on consumption-based emissions. However, the results suggest that it may be difficult to improve significantly in light of the fact that the input environmental data (i.e. greenhouse gas emissions from a production perspective) seem to have greater impact on the accuracy of the preliminary consumption-based emissions.

In any case, in the scope of the current project, a method for producing preliminary statistics for greenhouse gas emissions from Swedish consumption due to imported products needs to be evaluated. This is highly relevant since emissions from this source amount to about two thirds of Sweden's total consumption-based emissions. It is currently proposed to produce preliminary statistics in this area by using the official statistics on foreign trade in goods in previous year's prices in conjunction with the trade multipliers already produced in Statistics Sweden's input-output model. Statistics in previous year's prices are currently not available for foreign trade in services. However, Sweden's foreign trade in services amounts to only 15 percent of the total embodied greenhouse gas emissions from Sweden's imports. Therefore at this stage and in light of a lack of data it is proposed to apply a simple imputation here.

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