IEooc_Methods5_Exercise2: Multi regional Input-Output modeling

Goal: *Application of the MRIO analysis, analysis of supply chains, carbon footprint calculations of final consumers in the EU, investigation of fine particulate matter and mercury emissions along the supply chain.*

Due to the international trade, the production of high emission and work intense goods is shifted from rich to poor countries (outsourcing). One side effect of this trend is that national emission values are no longer necessarily a representation of the actual emission intensity of the goods consumed by the final consumers within the individual countries. The MRIO analysis can reveal emissions along the supply chain. Calculation methods of the MRIO analysis are further the basis of calculations for life cycle assessments (LCA). In this exercise we analyze a simple MRIO model.

In the provided excel workbook 'IEooc_Methods5_Exercise2_MRIO_Data.xlsx' you can find an MRIO-A-matrix **A**, a matrix for total demand **Y**, along a stressor matrix **S**. The data was derived through aggregation of EXIOBASE2, a MRIO data base with 200 products and 48 regions. The dimensions of the matrices (3 regions, 11 product groups, 170 emissions) were chosen so any calculations with excel is possible as well as a measure to keep the model clean and clear. Following exercises need to be finished:

1) What are the dimensions of the MRIO-**A**-matrix and what do the dimensions mean? What are the units of **A** and what do they mean? Cell H10 value is 0.25787…, what does this number mean? Cell AE10 value is 0.012854…, what does this number mean?

2) What are the dimensions of the MRIO-**Y**-matrix and what do the dimensions mean? What are the units of **Y** and what do they mean? Cell AN7 value is 1,348,186. …, what does this number mean? Cell AO32 value is 14718…, what does this number mean?

3) What are the dimensions of the MRIO-**S**-matrix and what do the dimensions mean? What are the units of **S** and what do they mean? Cell I39 value is 2,544,378. …, what does this number mean? Cell T62 value is 0.1392…, what does this number mean?

4) Tom buys a desk, an air journey and two Snickers. Susi buys 10 kg of potatoes and a car. How do you calculate the combined carbon footprints of the bundles of goods for Ralf and Susi?

5) Determine the total global industrial production **x_EU28** needed to meet the total final demand of all consumers in EU28! What are the dimensions of vector **x_EU28** and what does it mean? Compute a series expansion for the Leontief inverse and specify the first six summands x_0 to x_5 along with the final result (limit value x_infinity). Examine the results for the sectors 'landfill' and 'mining'! How do the total outputs behave within the three regions compared to final demands of goods 'agricultural products' and 'mining products'? How do the single steps of the value chain develop with increasing order of x_i and how can the development be explained?

6) Determine the total emissions of 'CO2-combustion, air', CH4-combustion, air', 'CO2-non-combustion, air', 'CH4-non-combustion, air', and 'Hg-combustion, air' for the first six summands

for **x_EU28** and the total output **x_EU28**! How big is the share of a) emission of zeroth order and b) steps 1-5 of the supply chain compared to total CO2 emissions? What's the explanation for these results?

7) Determine the emissions of 'CO2-combustion, air' for each sector and region of x_EU28. Do your calculations in appropriate units (ex. Mt). What are the sector-region pairs that contribute the most emissions to total CO2 emissions? How do CO2 emissions split up among the three regions?

8) Determine the global CO2 and fine particulate matter (PM2.5 combustion air) emissions of one EU citizen generated through combustion processes using the average annual consumption of goods of 30,000 Euros (basic price w/o sales tax or other levy and taxes). How do the emissions split up among a) the three regions and b) the 11 sectors?