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Carbon footprint: Consumption-based approach to emissions accounting

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Capabilities and limitations of the economic modelling of european environmental tax as an EU own resource

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Territorial emissions vs. Carbon footprint

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- Territorial emissions
  - Production principle: Captures the emissions produced in the country´s territory, either by the business or the households
  - Directly “measurable“
  - Long history of data recording
- Carbon footprint
  - Consumption approach: Captures the emissions consumed by domestic final demand (households, government, investments) plus the emissions generated by the households (own heating facilities, individual transport)
  - Has to be modelled
  - A new concept (ecological footprint was first introduced in the 90´s (Rees, 1992; Wackernagel and Rees, 1996))

Carbon footprint

- Two possible approaces
  - Single-region input-output (SRIO) analysis
    - Employs national coeficients of emission intensity for both – domestic production as well as imports
    - Underestimates the carbon footprint in low-emission countries and overestimates it in emission-intensive economies
  - Multi-region input-output (MRIO) analysis
    - Employs regional (country-specific) coefficients of emission intensity for imports
    - Applicable since the recent development of MRIO tables

What can we compute?

- $\hat{\mathbf{e}}_\mathbf{i}$ denotes the emission intensity of the respective sectors in country *i* ,
- matrices $\mathbf{L}_\mathbf{ij}$ map the intra-industry, inter-industry and inter-country linkages (direct and indirect),
- $\mathbf{y}_\mathbf{i1}$ holds for final domestic demand in country 1 for goods from country *i* ,
- $\mathbf{g}_\mathbf{i}$ represents the emissions generated in the sectors of the country *i* .

$$\tilde{\mathbf{g}} = \begin{pmatrix} \hat{\mathbf{e}}_1 & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \hat{\mathbf{e}}_2 & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \hat{\mathbf{e}}_3 \end{pmatrix} \begin{pmatrix} \mathbf{L}_{11} & \mathbf{L}_{12} & \mathbf{L}_{13} \\ \mathbf{L}_{21} & \mathbf{L}_{22} & \mathbf{L}_{23} \\ \mathbf{L}_{31} & \mathbf{L}_{32} & \mathbf{L}_{33} \end{pmatrix} \begin{pmatrix} \mathbf{y}_{11} \\ \mathbf{y}_{21} \\ \mathbf{y}_{31} \end{pmatrix}$$

$$\tilde{\mathbf{g}} = \begin{pmatrix} \mathbf{g}_1 \\ \mathbf{g}_2 \\ \mathbf{g}_3 \end{pmatrix} = \begin{pmatrix} \hat{\mathbf{e}}_1\mathbf{L}_{11}\mathbf{y}_{11} + \hat{\mathbf{e}}_1\mathbf{L}_{12}\mathbf{y}_{21} + \hat{\mathbf{e}}_1\mathbf{L}_{13}\mathbf{y}_{31} \\ \hat{\mathbf{e}}_2\mathbf{L}_{21}\mathbf{y}_{11} + \hat{\mathbf{e}}_2\mathbf{L}_{22}\mathbf{y}_{21} + \hat{\mathbf{e}}_2\mathbf{L}_{23}\mathbf{y}_{31} \\ \hat{\mathbf{e}}_3\mathbf{L}_{31}\mathbf{y}_{11} + \hat{\mathbf{e}}_3\mathbf{L}_{32}\mathbf{y}_{21} + \hat{\mathbf{e}}_3\mathbf{L}_{33}\mathbf{y}_{31} \end{pmatrix}$$

What can we compute?

Emissions generated in the domestic economy by the demand for domestic goods

Emissions generated in the domestic economy by the demand for goods from countries 2 and 3

$$\tilde{\mathbf{g}} = \begin{pmatrix} \mathbf{g_1} \\ \mathbf{g_2} \\ \mathbf{g_3} \end{pmatrix} = \begin{pmatrix} \hat{\mathbf{e}}_1\mathbf{L}_{11}\mathbf{y}_{11} + \hat{\mathbf{e}}_1\mathbf{L}_{12}\mathbf{y}_{21} + \hat{\mathbf{e}}_1\mathbf{L}_{13}\mathbf{y}_{31} \\ \hat{\mathbf{e}}_2\mathbf{L}_{21}\mathbf{y}_{11} + \hat{\mathbf{e}}_2\mathbf{L}_{22}\mathbf{y}_{21} + \hat{\mathbf{e}}_2\mathbf{L}_{23}\mathbf{y}_{31} \\ \hat{\mathbf{e}}_3\mathbf{L}_{31}\mathbf{y}_{11} + \hat{\mathbf{e}}_3\mathbf{L}_{32}\mathbf{y}_{21} + \hat{\mathbf{e}}_3\mathbf{L}_{33}\mathbf{y}_{31} \end{pmatrix}$$

Emissions generated in the domestic economy by the demand for goods from countries 2 and 3

Emissions generated in the the countries 2 and 3 by the demand for their goods

Territorial emissions and Carbon footprint, Slovakia, Mt CO_2-eq.

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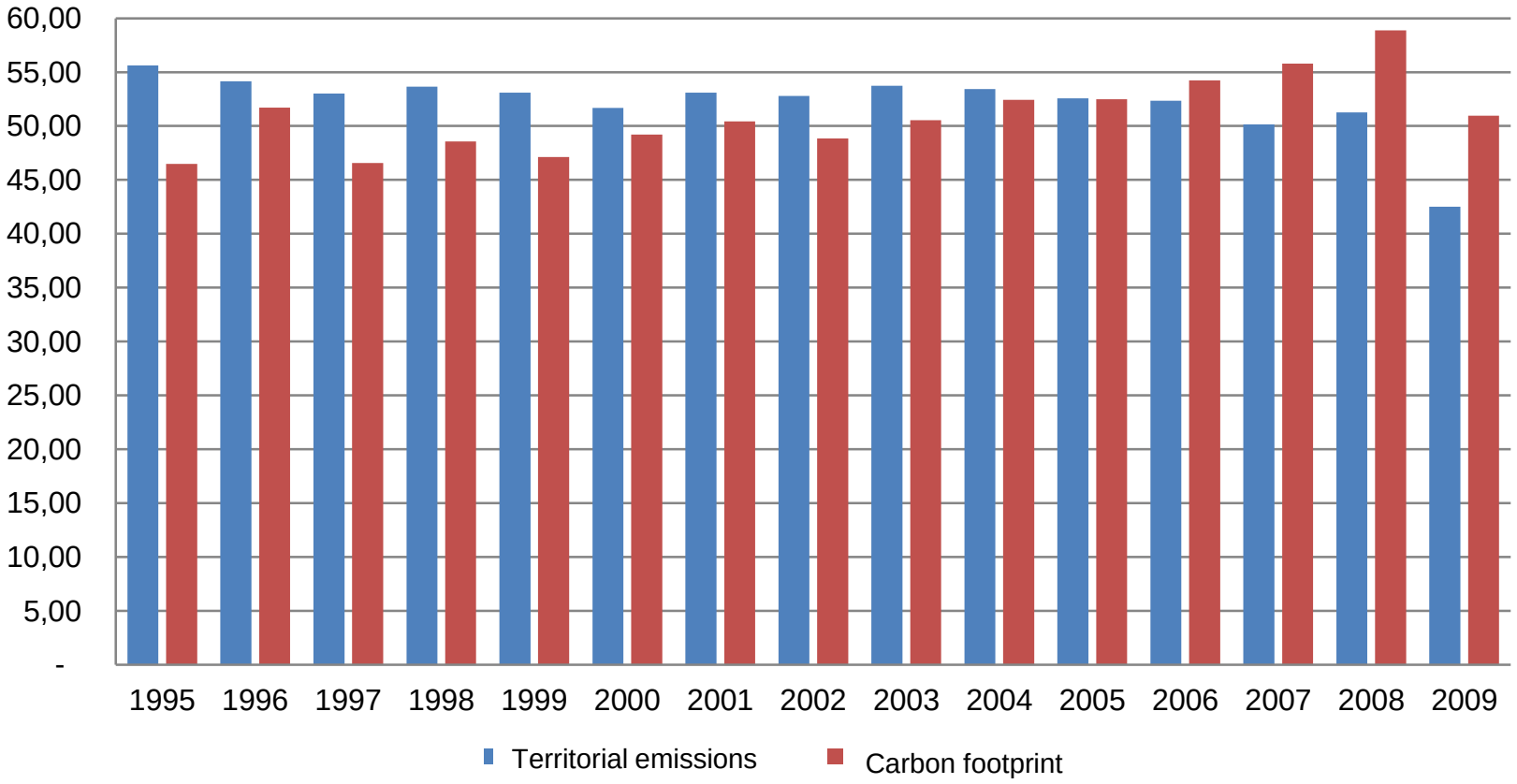

Source: Habrman (2014)

Countries of origin of the slovak carbon footprint

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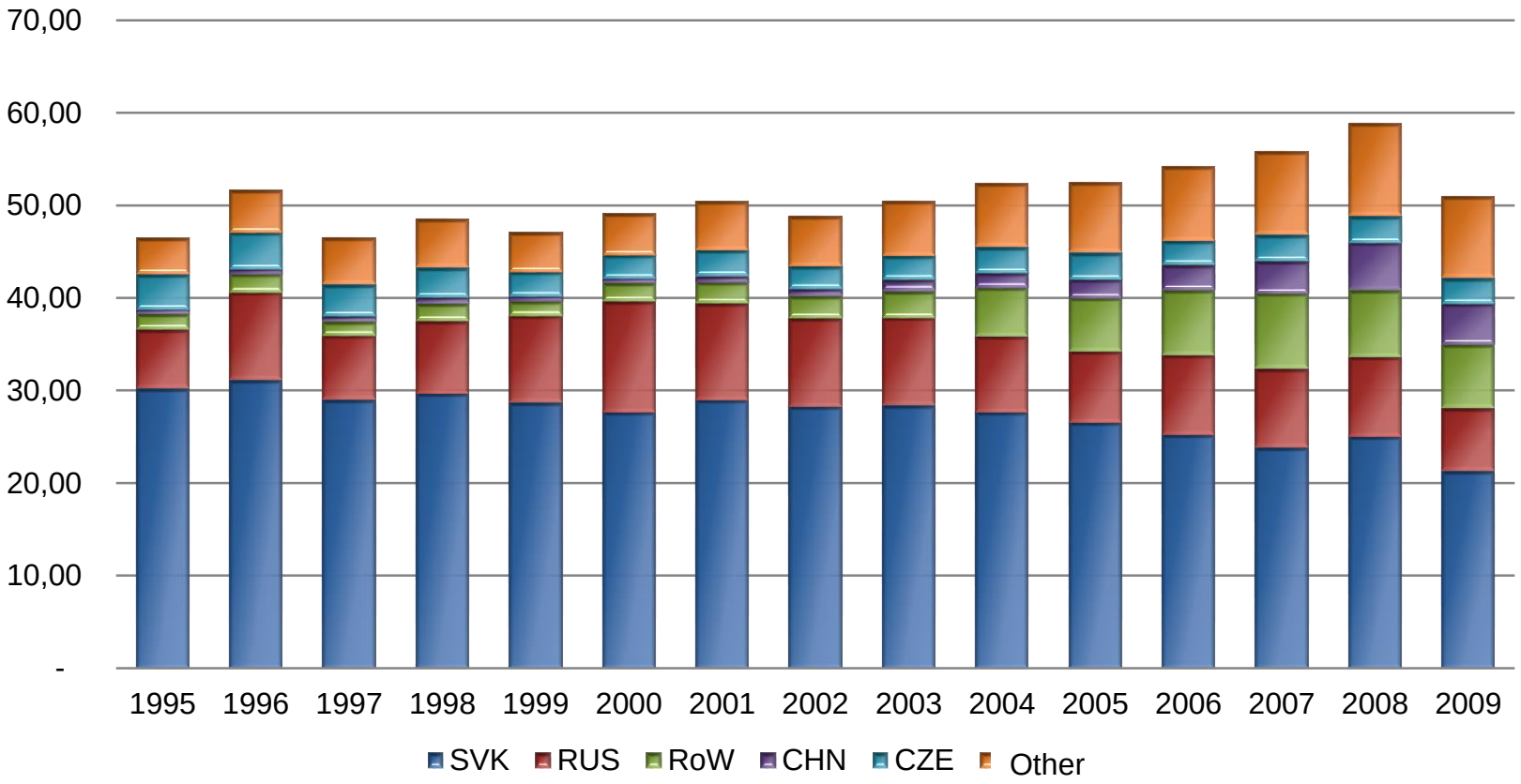

Source: Habrman (2014)

Structural decomposition of the slovak carbon footprint (contributions in Mt CO_2-eq.)

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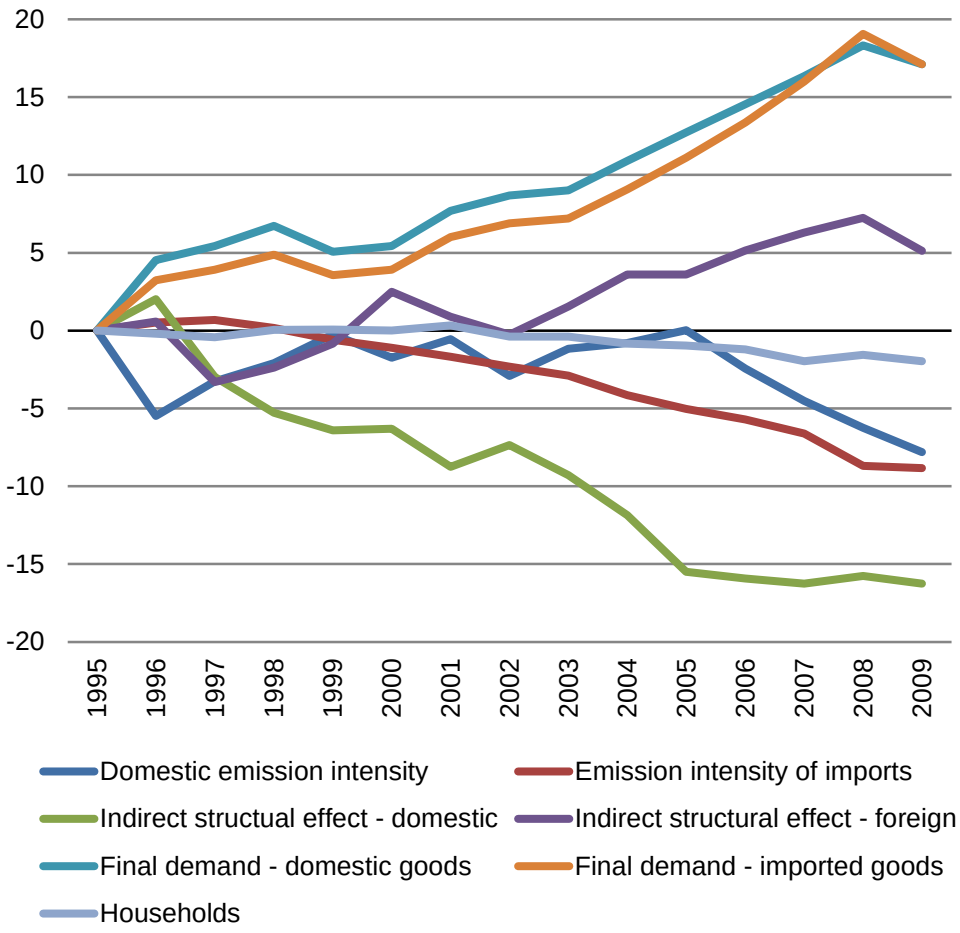

- Direct emission intensity of domestic production was not falling untill 2005
  - Emission intensity of imports was decreasing during the whole time period
- Changes in the structure of production and consumption lead to a decrease in domestic emissions, but an increase in foreign emissions (pollution haven hypothesis)

Source: Habrman (2014)

Advantages and drawbacks of consumption-based approach to emissions accounting

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- Advantages:
  - Takes into account international transportation (which is not allocated to individual countries in territorial emissions)
  - Prevents carbon leakage – naturally encourages cleaner global production

- Drawbacks:
  - Requires more complex calculations and hence assumptions and increased uncertainty
  - It shifts the calculation from one extreme (production principle) to another (consumption principle)
  - Extends outside the standard geo-political region (country, EU)

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Thank you for attention....