Multi-regional Comparison of Carbon Footprint Taxation schemes

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Agenda

- Motivation
- Method
  - Model
  - Data
  - Step 1 – Calculate Footprint
  - Step 2 – Implement Taxation scheme
- Outlook

Motivation

- The European consumer contributes directly (domestically) and indirectly (globally) to **GHG emission**s
- GHG emissions/capita are beyond a globally sustainable limit in Europe
- Security of supply is an increasing concern of European resource policy
- Indirect Emissions or Consumption based Carbon Footprints (CF) are „**hot topic**“ amongst climate researcher
- Goals of this study
  - Estimate the **scope** of the induced emissions
  - Evaluate the **effects** of two taxation schemes
  - Inculde indirect effects and **rebounds** in the Economies

Method

- Econometric IO Analysis
- Combination of two Single-Region approaches
  1. Calculation Carbon Footprints (CF) [1] of priv. consumption
     - Indirect and induced
     - Commodity specific CF
  2. Implementation GHG-taxation schemes [2]
     - Production based – „Green Tax Reform“
     - Consumption based – „Environmental Fiscal Devaluation“
- Tax with equal Price for CO2e
- Integration in Multiregional Model (ADAGIO)

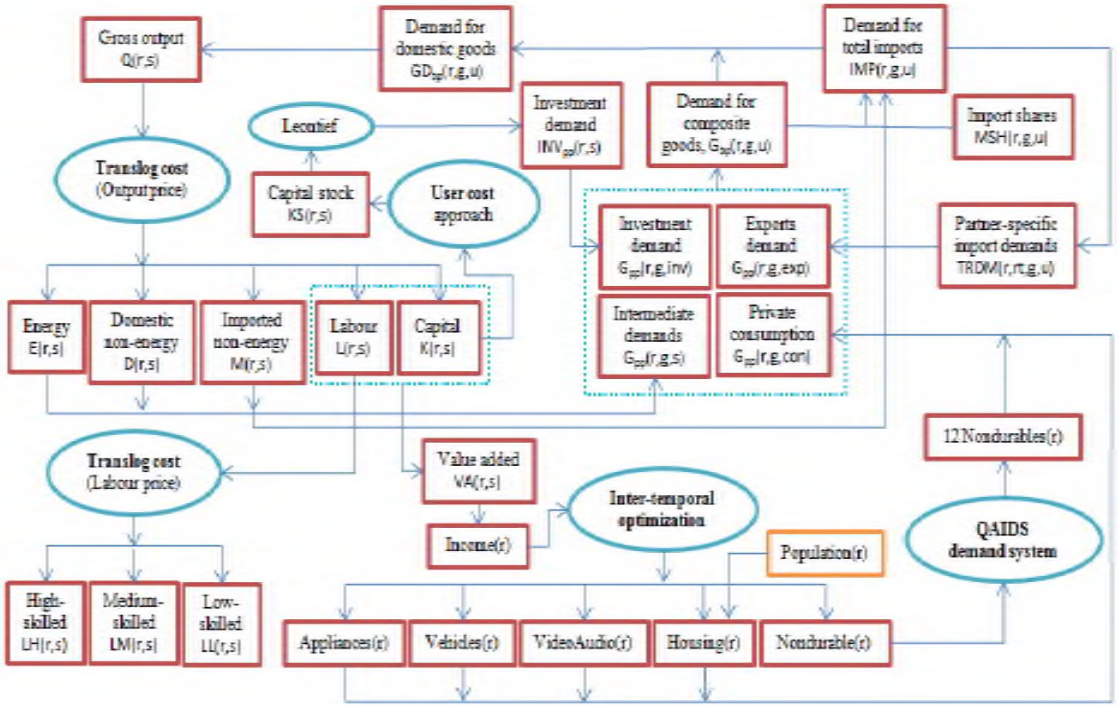
1) Sommer, Kratena (2016) - The Carbon Footprint of European Households and Income Distribution
http://www.sciencedirect.com/science/article/pii/S0921800916303627
2) Kratena, Sommer (2015) - Consumption vs. Production Based CO2 Pricing Policies: Macroeconomic Trade-Offs and Carbon Leakage
http://www.foreurope.eu/fileadmin/documents/pdf/Workingpapers/WWWforEurope_WPS_no113_MS231.pdf

Model

- Model ADAGIO "**A** **D**yn**A**mic **G**lobal **I**nput-**O**utput"
  - 59 Sectors & Commodities (NACE rev.1.1)
  - 67 Regions/Countries (WIOD+27)
  - Econometrically estimated behavioural equations
    - Producer (KLEMD-Translog specification)
    - Private Consumer - commodity nests
      - Durable (buffer stock model)
      - Non-Durabele (AIDS Specification)
      - Energy (estimated demand functions)
  - Endogenous Prices
  - Endogenous Investment and Public Spending

Model description:
https://www.econstor.eu/bitstream/10419/129046/1/wp_497.pdf
https://www.klimafonds.gv.at/assets/Uploads/Projektberichte/ACRP-2012/20160810CC2BBEACRP5EBB286285KR12AC5K01355.pdf

Model



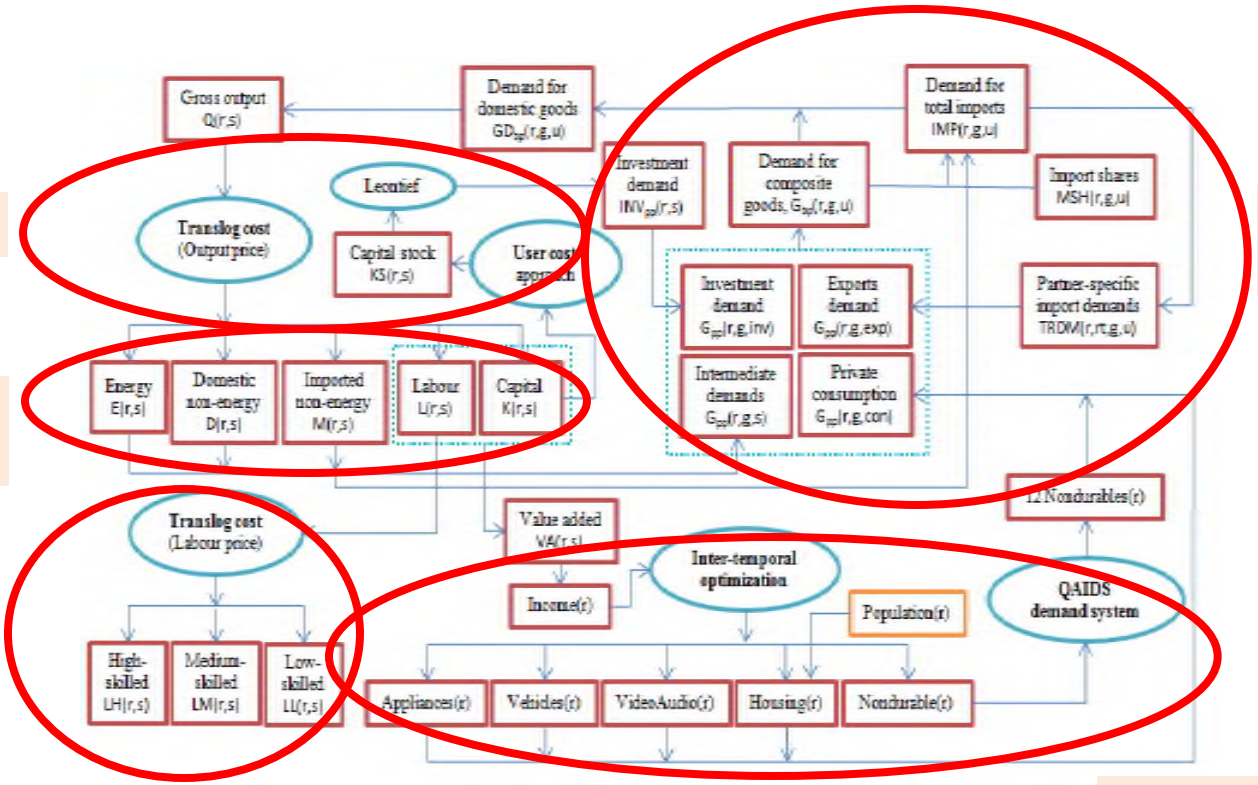
Scheme of ADAGIO Model (Version 2007)

Model

PRICE SYSTEM

PRODUCTION (TRANSLOG-SYS)

LABOUR MARKET



SUPPLY/USE & TRADE TABLES

Scheme of ADAGIO Model (Version 2007)

PRIVATE CONSUMPTION
- Buffer Stock Model
- Intertemporal Optimization

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Data

- Supply & Use Tables of 67 Countries

  (WIOD, GTAP, UNO, Comtrade, World Bank, OECD, UNSTATS)

- Energy & Emission balances

  (Eurostat, WIOD)

- Econometric Estimations

  (Eurostat, WIOD)

Data

Data Update 2017 (**in Progress**)

- Base year 2011
- Upcoming data relase (WIOD, GTAP)
- Structure (NACE 2)
- Integration of Energy Balances

  (derive GHG Emissions as alternative to WIOD)

→ Shown interim results base on „old“ model & data

Method

- Step 1: Calculate Carbon Footprint (CF) in total and per consumption commodity

- Step 2: Calculate Tax rates (w.r.t. CF) & implement in ADAGIO

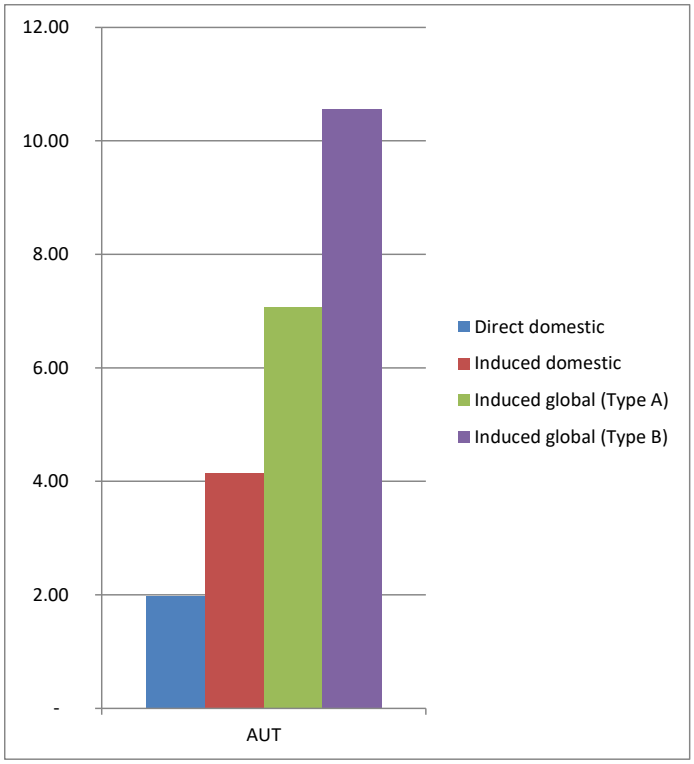
Method Step 1 - Calculate Footprint

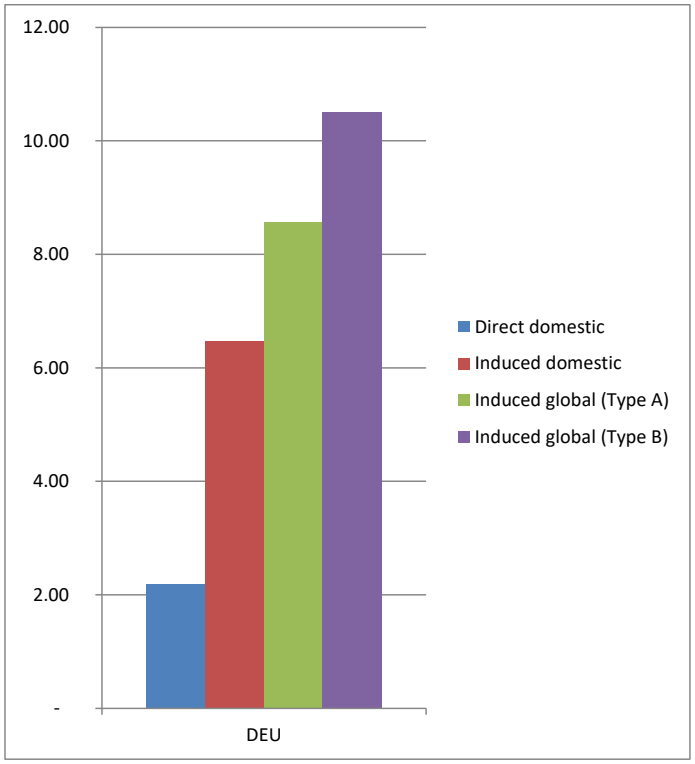
- **Direct**
  - Direct consumption (fuel, heating oil)
- **Indirect**
  - Emissions caused through the triggered production chain
- **Induced**
  - **„Type A“ (short run)**
    - higher production acitvity
    - -> higher income of private Households
    - -> additional induced consumption
    - -> additional indirect effects
  - **„Type B“ (long run)**
    - -> Investments and Public spending reacts to value added
    - -> additional indirect effects

→Goal is to calculate „implicit“ footpring per unit of consumption as basis for a tax

Method Step 1 - Calculate Footprint

Interim results for Austria & Germany





GHG emissions per capita and country for the year 2007 by scope of footprint

Source: WIFO calculations based on Model ADAGIO (Version 2007, WIOD)

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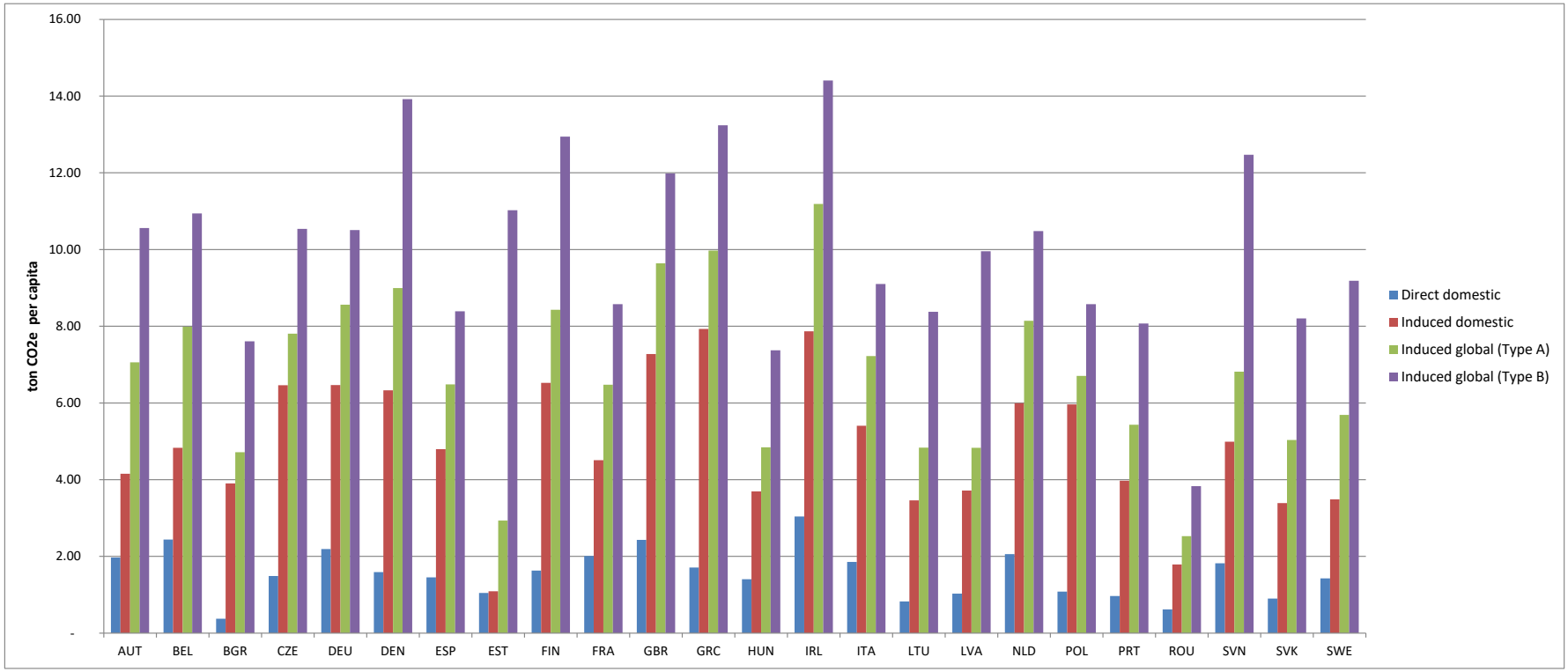
Method Step 1- Calculate Footprint

Interim results EU27 (excl. MTL,LUX,CYP)



GHG emissions per capita and country for the year 2007 by scope of footprint

Source: WIFO calculations based on Model ADAGIO (Version 2007, WIOD)

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Method

- Step 1: Calculate Carbon Footprint (CF) in total and per consumption commodity

- Step 2: Calculate Tax rates (w.r.t. CF) & implement tax schemes in ADAGIO

Method Step 2 - Tax scheme

- Scheme 1 „Green Tax reform“
  - Tax **on fuel** inputs in production (acc. to GHG content)
  - Tax **revenue neutral** recycling via reduced tax on labour

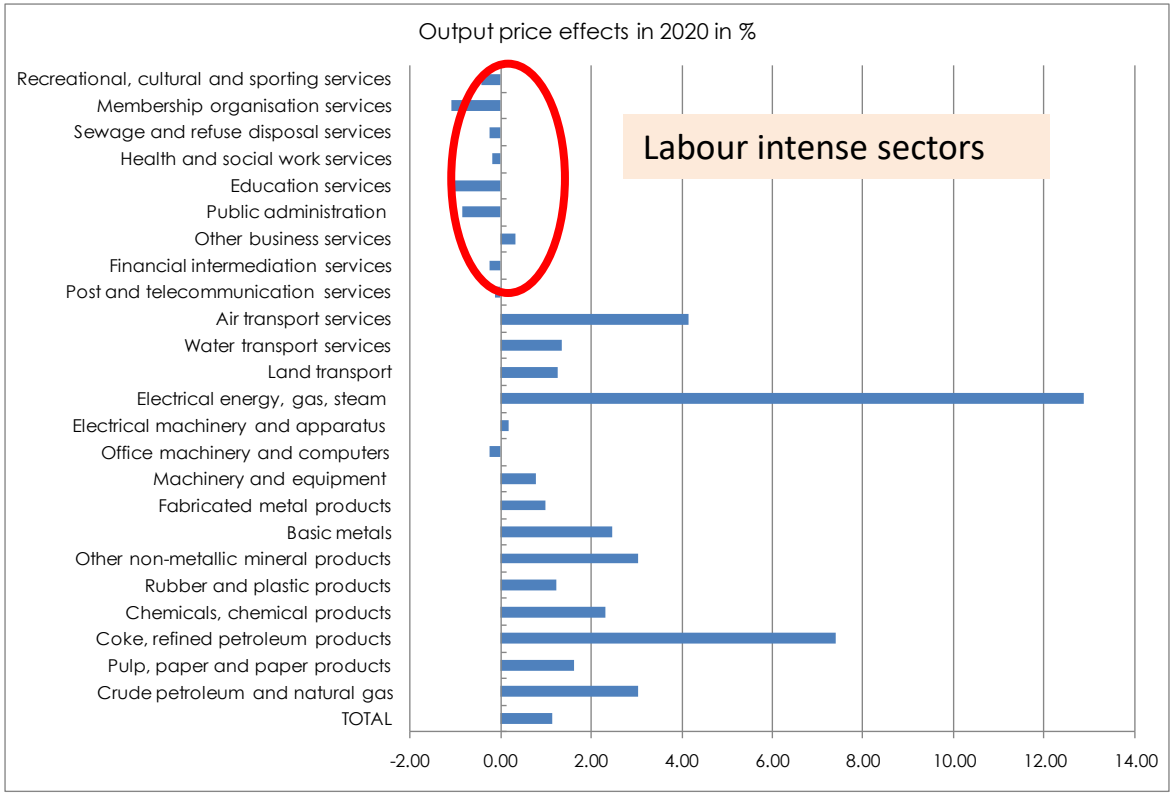
  → Taxation of Production

- Scheme 2 „Environmental Fiscal Devaluation“
  - Goal: improvement of competetiveness by altering taxes
  - Tax on private **consumption commodities** (acc. to Carbon-Footprint content of commodity)
  - Tax revenue neutrality (equal as above)

  → Taxation of Consumption

Method Step 2 - Tax scheme 1

Effect on Production prices



Sectoral Effects on EU27 production prices due to taxation scheme

Source: Calculations in Kratena, Sommer (2015) - Consumption vs. Production Based CO2 Pricing Policies: Macroeconomic Trade-Offs and Carbon Leakage

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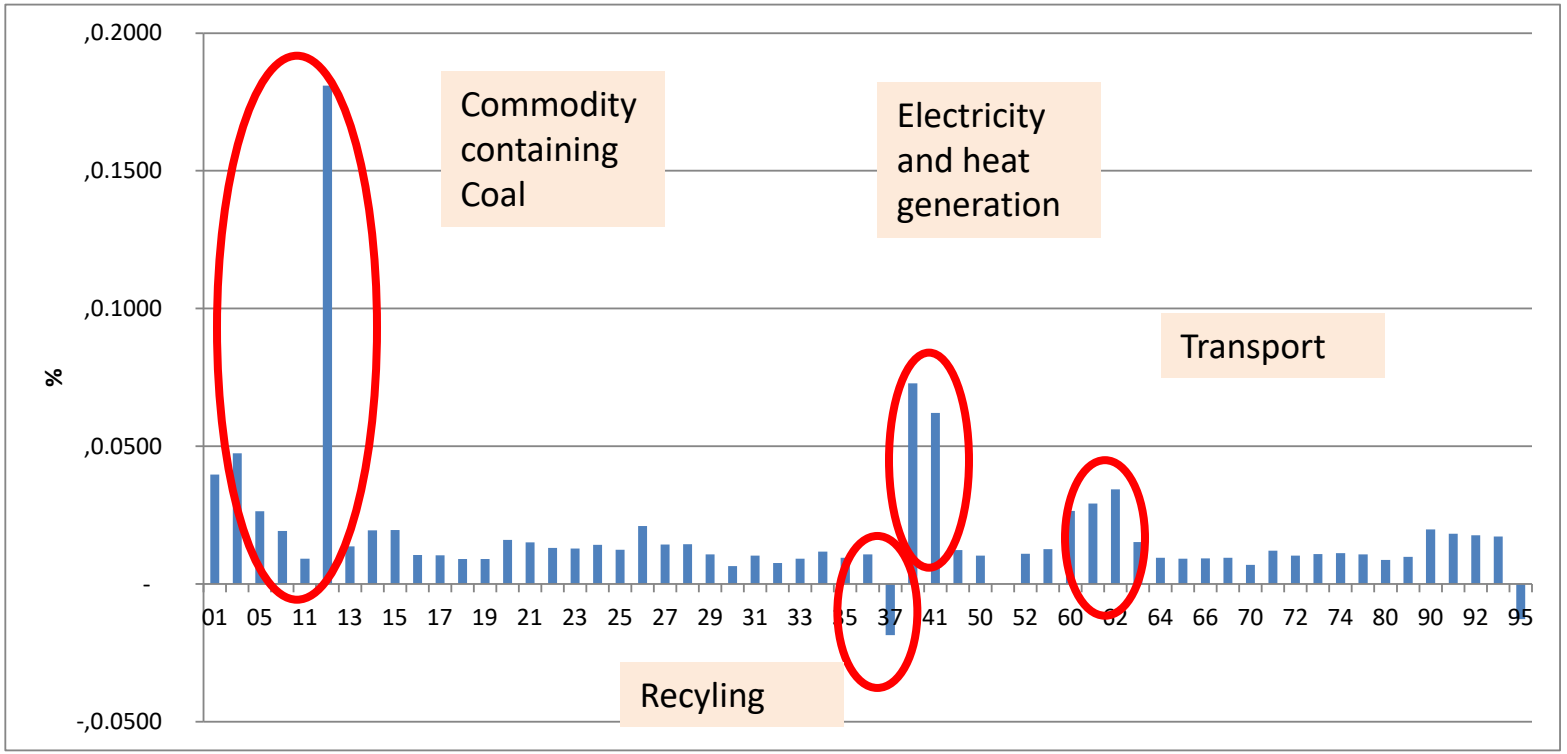
Method Step 2 - Tax scheme 2

Derived tax rate for consumption commodities



CO2e-Taxrate at €50/t CO2 – over 59 commodities (NACE1.1). Scale in accordance to CO2-Content of commodity

Source: Calculations in Kratena, Sommer (2015) „Consumption vs. Production Based CO2 Pricing Policies: Macroeconomic Trade-Offs and Carbon Leakage"

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Expected Effects

- Scheme 1 („Green Tax Reform“)
  - Price effect
    - Higher Production prices
  - Production effect
    - Technical change (towards less GHG intense inputs)
    - Leakage (increase of imports)
    - Less competitiveness (loss in real Exports)

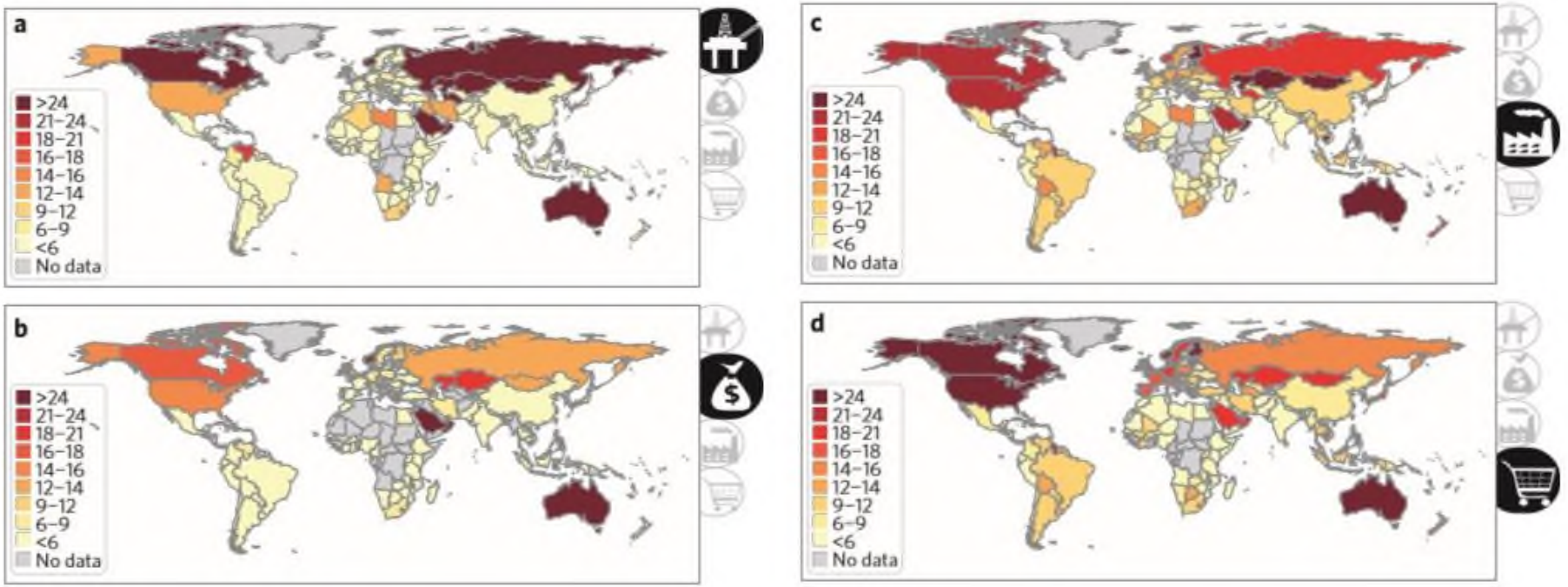
- Scheme 2 („Environmental Fiscal Devaluation“)
  - Price effect
    - Lower Price for Labour
    - Higher Price for Private Consumption
  - Consumption effect
    - Shift towards Commodities with lower CF
    - Higher income due higher employment (short term)

Outlook

The study will give an evaluation of both tax schemes

- Economic effects (GDP, employment)
- Carbon footprints
- Extend of Carbon Leakage
- Rebounds on Labour market
  - Consumption rebound due to higher income/employment

Further Possibilities



Carbon Footprints based on

a) Extraction
b) Income
c) Production
d) Consumption

Source: Steininger et al. (2015) Multiple carbon accounting to support just and effective climate policies

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Thank you for your attention!

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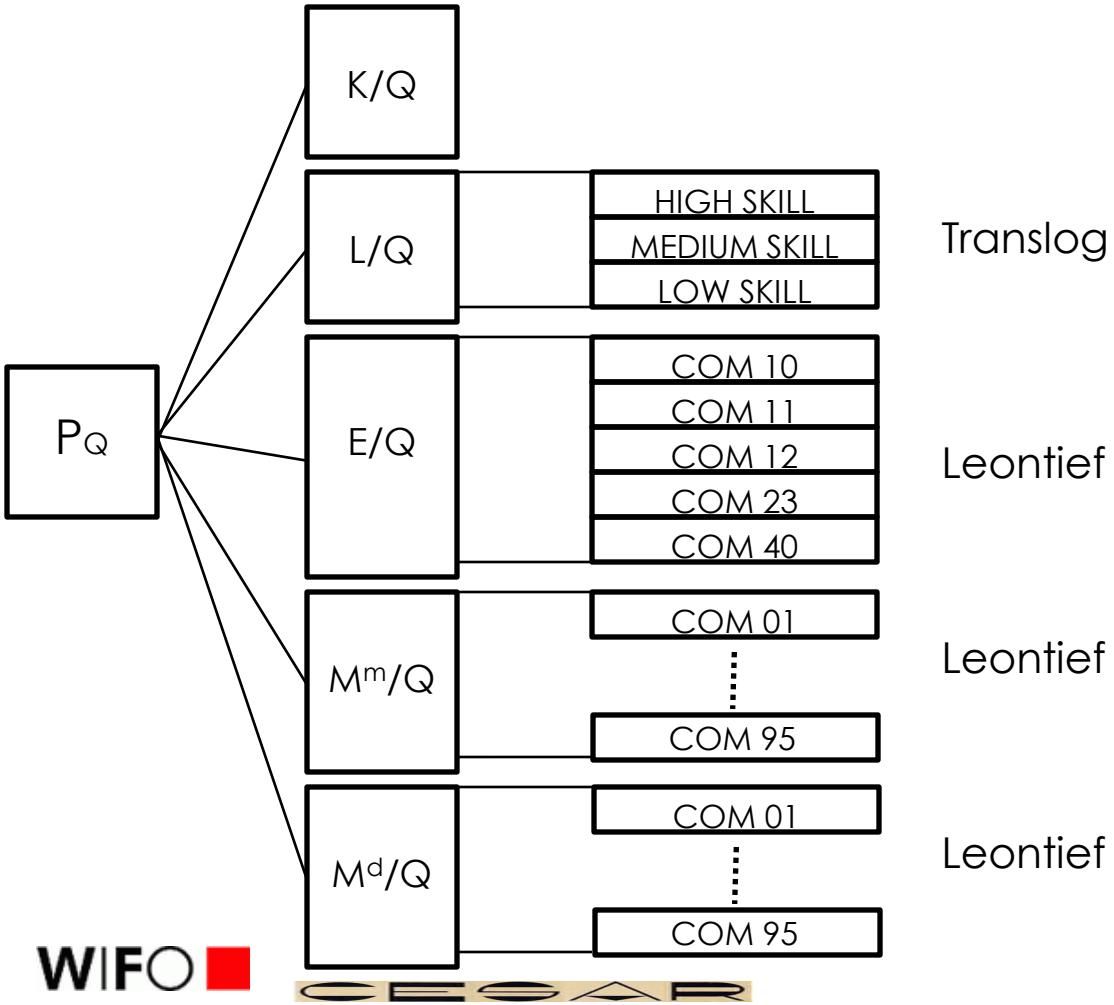
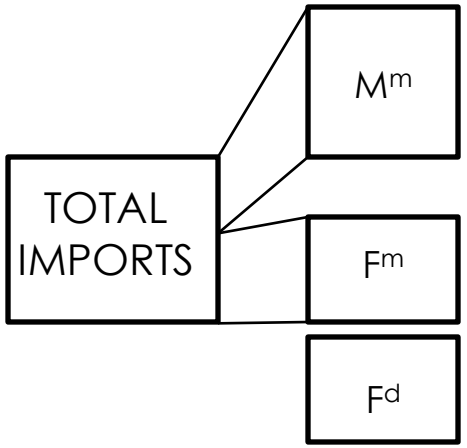
Appendix

ADAGIO – Production Block





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Translog model: K,L,E,M^m,M^d

- Constant returns to scale → unit cost function
- Technological change: TFP, factor bias with spillovers
- p_K is endogenous (index of user costs):

  p_{INV} is the price of investment by industry:
- $p_{INV} = p_{USE,INV} * \mathbf{B}_{INV}$, where $\mathbf{B}_{INV}$ …investment matrix
- p_E , p_{Mm} , and p_{Md} are endogenous and directly linked to the use prices
- p_L is endogenous and determined in wage curves by skill and industry
- SUT database offers consistent accounts for estimating a comprehensive production system with *K*, *L*, *E*, M^m, M^d inputs:

  (i) value data from SUts,

  (ii) price data constructed (partly other sources)
- Imported non-energy intermediates (M^m) can be directly and flexibly substituted against *K*, *L*, *E*, and domestic intermediates M^d → **'beyond' Armington**

Translog model: K,L,E,M^m,M^d

$$\log p_Q = \alpha_0 + \alpha_K \log(p_K / p_D) + \alpha_L \log(p_L / p_D) + \alpha_E \log(p_E / p_D) + \alpha_M \log(p_M / p_D) + \log p_D +$$
$$+ \alpha_t t + \frac{1}{2}\alpha_{tt} t^2 + \frac{1}{2}\gamma_{KK}(\log(p_K / p_D))^2 + \frac{1}{2}\gamma_{LL}(\log(p_L / p_D))^2 + \frac{1}{2}\gamma_{EE}(\log(p_E / p_D))^2 +$$
$$+ \frac{1}{2}\gamma_{MM}(\log(p_M / p_D))^2 + \gamma_{KL}\log(p_K / p_D)\log(p_L / p_D) + \gamma_{KE}\log(p_K / p_D)\log(p_E / p_D) +$$
$$+ \gamma_{KM}\log(p_K / p_D)\log(p_M / p_D) + \gamma_{LE}\log(p_L / p_D)\log(p_E / p_D) + \gamma_{LM}\log(p_L / p_D)\log(p_M / p_D) +$$
$$+ \gamma_{EM}\log(p_E / p_D)\log(p_M / p_D) + \rho_{tK} t \log(p_K / p_D) + \rho_{tL} t \log(p_L / p_D) + \rho_{tE} t \log(p_E / p_D) +$$
$$+ \rho_{tM} t \log(p_M / p_D)$$

$$v_K = [\alpha_K + \gamma_{KK}\log(p_K / p_D) + \gamma_{KL}\log(p_L / p_D) + \gamma_{KE}\log(p_E / p_D) + \gamma_{KM}\log(p_M / p_D) + \rho_{tK}]$$

$$v_L = [\alpha_L + \gamma_{LL}\log(p_L / p_D) + \gamma_{KL}\log(p_K / p_D) + \gamma_{LE}\log(p_E / p_D) + \gamma_{LM}\log(p_M / p_D) + \rho_{tL}]$$

$$v_E = [\alpha_E + \gamma_{EE}\log(p_E / p_D) + \gamma_{KE}\log(p_K / p_D) + \gamma_{LE}\log(p_L / p_D) + \gamma_{EM}\log(p_M / p_D) + \rho_{tE}]$$

$$v_M = [\alpha_M + \gamma_{EM}\log(p_E / p_D) + \gamma_{KM}\log(p_K / p_D) + \gamma_{LM}\log(p_L / p_D) + \gamma_{MM}\log(p_M / p_D) + \rho_{tM}]$$