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Multi-Regional IO Tables: Applications and Construction Challenges

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Presentation Elements

- Multi-regional EE SUT and IOT
  - What is it?
  - What is the policy relevance ?
  - What are the main characteristics of ongoing projects?
  - How can research help NSIs and UNCEEA and in reverse?
- My own background
  - Manager at TNO, a large not for profit research institute in NL
  - Professor of Sustainable Innovation, Industrial Ecology Program, NTNU, Trondheim, Norway
  - Leader of EU funded MR EE IO projects of EXIOPOL and CREEA (total 6 Mio Euro, 10-15 partners)

Backgrounds on SUT/IOT

	Products	Industries			
Products		Use	Final use	Exports	*Use of products*
Industries	Make / Supply				*Output of industries*
	Imports cif	Value added			
	Supply of products	*Input of industries*			
		Extensions: - Primary Natural Resource input - Emissions output - etc.			

- EE SUT for a single country
  - Economic Supply and Use
  - By industry: emissions and primary resource use
- Can provide you
  - Per final use category: value added by industry
  - With impact per Euro per industry known: life cycle impacts per final use category
- Advantages
  - Inherently complete
  - Inherently consistent

Relations between SUT and IOT

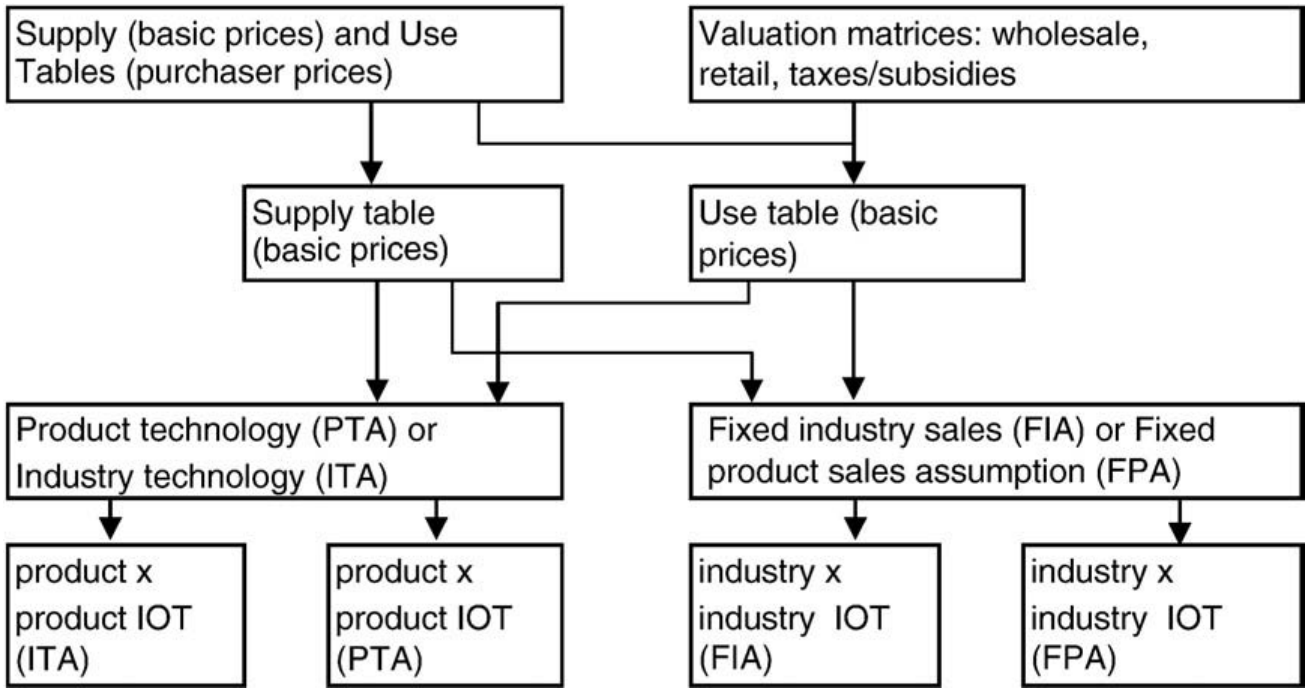


Figure courtesy of Jose Rueda Cantuche, EU DG JRC IPTS, Sevilla, Spain

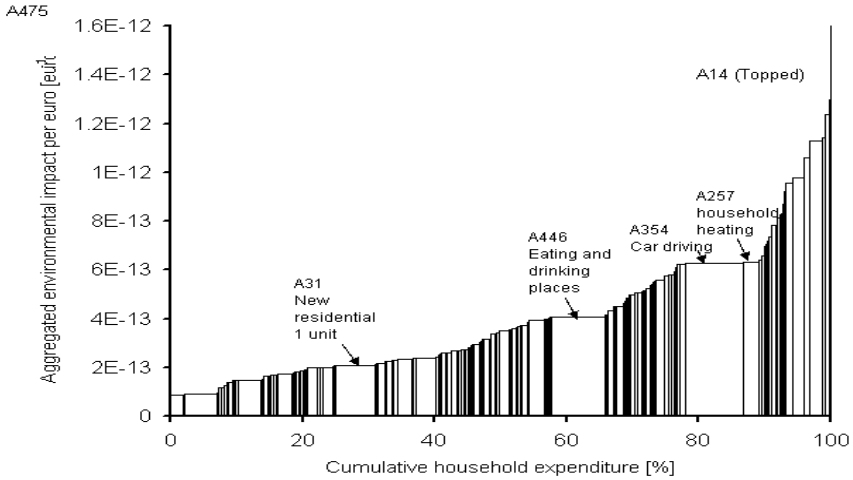

Backgrounds on MR SUT/IOT

- Country SUT/IOT do not provide insight in ‘pollution embodied in trade’
- Ideal solution: MR EE SUT/IOT
  - Country SUT/IOT including value added and final demand (red)
  - Import and export trade matrices for intermediate and final demand (green)
  - Exensions: emissions, energy, materials (grey)

		Industries				$Y_{*,A}$	$Y_{*,B}$	$Y_{*,C}$	$Y_{*,D}$	q
Products		$Z_{A,A}$	$Z_{A,B}$	$Z_{A,C}$	$Z_{A,D}$	$Y_{A,A}$	$Y_{A,B}$	$Y_{A,C}$	$Y_{A,D}$	q_A
		$Z_{B,A}$	$Z_{B,B}$	$Z_{B,C}$	$Z_{B,D}$	$Y_{B,A}$	$Y_{B,B}$	$Y_{B,C}$	$Y_{B,D}$	q_D
		$Z_{C,A}$	$Z_{C,B}$	$Z_{C,C}$	$Z_{C,D}$	$Y_{C,A}$	$Y_{C,B}$	$Y_{C,C}$	$Y_{C,D}$	q_C
		$Z_{D,A}$	$Z_{D,B}$	$Z_{D,C}$	$Z_{D,D}$	$Y_{D,A}$	$Y_{D,B}$	$Y_{D,C}$	$Y_{D,D}$	q_D
W		W_A	W_B	W_C	W_D					
g		g_A	g_B	g_C	g_D					
C & L		$Capital_A$	C_B	C_C	C_D					
		$Labor_A$	L_B	L_C	L_D					
Environ Ext		$NAMEA_A$	$NAMEA_B$	$NAMEA_C$	$NAMEA_D$					
		$Agric_A$	$Agric_B$	$Agric_C$	$Agric_D$					
		$Energy_A$	$Energy_B$	$Energy_C$	$Energy_D$					
		$Metal_A$	$Metal_B$	$Metal_C$	$Metal_D$					
		$Mineral_A$	$Mineral_B$	$Mineral_C$	$Mineral_D$					
		$Land_A$	$Land_B$	$Land_C$	$Land_D$					

Relevance of EE SUT and IOT

- EE SUT are very versatile and powerful analytical tools
- EU EIPRO (480 sector EE IOT)
  - Priority setting of products
  - Proved that food, mobility and housing were prio's
- EU Diet change
  - Change to healthy diets by changing demand vector
  - Showed rebounds by linking EE IOT to the CAPRI model



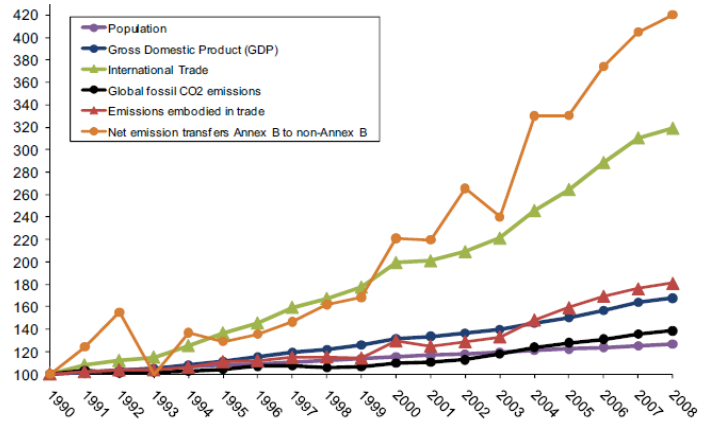
Tukker (ed., 2006), Journal Industrial Ecology 10: 3

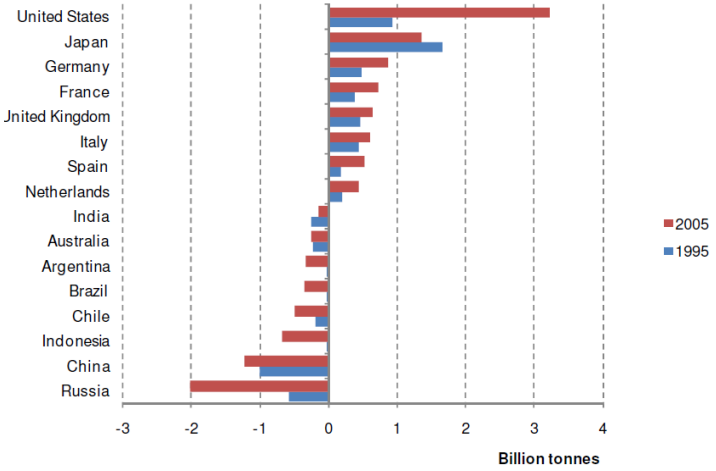
	Aggregated environmental impacts (%)			
	Scenario 0: Status quo	Scenario 1: Recommendations	Scenario 2: Recommendations including red meat reduction	Scenario 3: Mediterranean
Sub-scenario 'All'				
Food	27	27	25	25
Non-food	73	73	73	73
Total	100	100	98	98
Sub-scenario 'All + first order'				
Food	27	27	25	25
Non-food	73	73	74	73
Total	100	100	99	98
Sub-scenario 'All + first and second orders'	100	100	99	99

Tukker et al., 2011, Ecological Economics (in press)

Relevance of imports - MR EE SUT and IOT

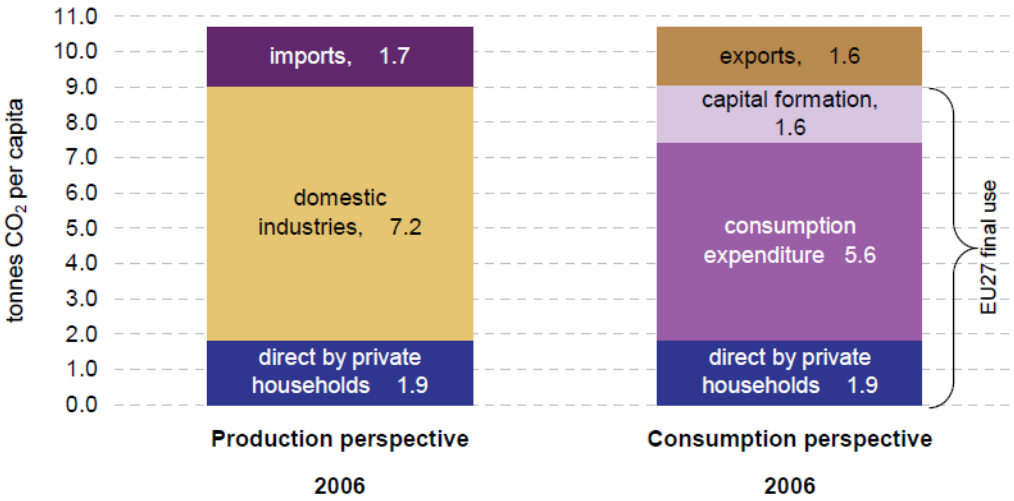
- Peters et al., PNAS 2010:
  - Global CO2 emissions (black)
  - Transfer from Annex B to non Annex B (yellow)
  - Similar work of Ahmad and Wyckoff, 2003, Davis and Caldeira, 2010
- Giljum et al. (in press)
  - Focuses on materials
  - Gives net materials imports and exports in trade





Relevance of MR EE SUT/IOT instead of DTA

- Results of Eurostat EU 27 EE SUT/IOT with 'Domestic technology assumption'
- EU is seemingly carbon neutral in trade….
- …where other studies show carbon in imports is a factor 2-3 higher as in exports…..



http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/documents/eeSUIOT%20TechDoc%20final%20060411.pdf

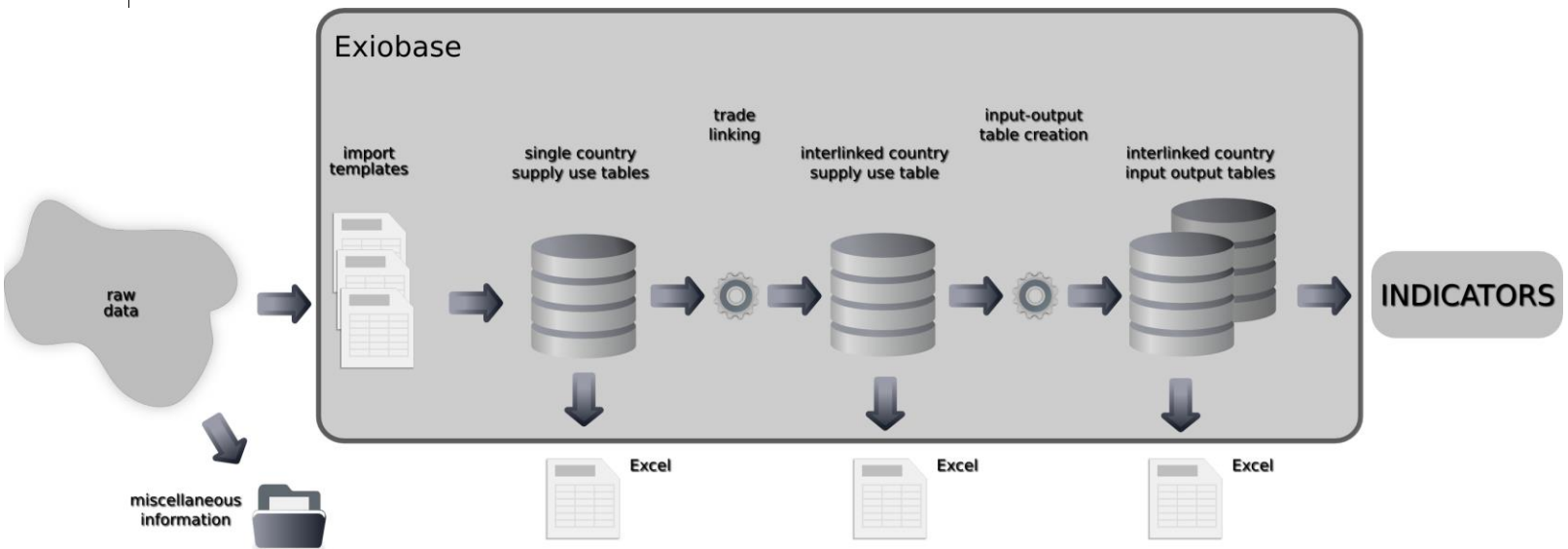

Major attempts in creating (Global) MR EE SUT/IOT

Project name	Funding	Countries	Type	Detail (ixp)	Time	Extensions	Approach
IDE JETRO (Inomata)	Japan	Asia Pacific (10)	MR IOT		2000, 2004	-	Harmonize IOT; Link via trade; move discrepancies to RoW
GTAP (Hertel)	Subscrip-tion	World (113)	MR IOT	58x58	2000, 2004	10 (GWP)	Harmonize trade; use IOT to link trade sets; relative crude IOT estimates
WIOD (Dietzenbacher, RUG)	EU FP7	World (40)	MR SUT	30x60	1995?-2000-2006	20+	Harmonize SUT; Link via trade; problems with discrepancies
EXIOPOL/ CREEA (Tukker, TNO & NTNU))	EU FP6/7	World (43)	MR SUT	129x129	2000, 2007	30 emissions, 60 IEA energy carriers; water, land, 80 resources	Create SUT bp; Split Use_dom and Use_imp; Detail and Harmonize SUT; Use trade shares to estimate implicit exports; confront with exports in SUT, RAS out differences, add extensions
AISHA/ EORA (Lenzen, Un. Syndney)	Austral-ian NSF	World, t.b.d. (200?)	MR SUT	t.b.d (>150?)	1990-2006?	t.b.d.	Create initial estimate; Gather all data available; apply in original format; Formulate constraints; Detect & judge inconsistencies; Let routine calculate Global MR SUT/IOT
Eurostat (Remond-Tiedrez, Moll)	Eurostat	EU 27 aggregate	SUT	59x59	1995-2007	10 (GWP)	Create SUT bp, Split intra and extra EU trade, aggregate to EU27 totals, remove intra EU imports / export differences to RoW, add extensions

Note: WIOD seems only project that develops current and constant price tables

What did EXIOPOL produce

- WP III.4.b: Database with five ‘big blocks’; flexible set up with regard to sectors, products, countries, etc., import/export and aggregation routines
  - Block 0: ‘Fuzzy front end’ with transformations in WS III.2 and III.3
  - = Import routine SUT, EE, trade shares, consistency checks, error reporting
  - Block 1: Harmonized EE SUT by country, trade shares, rRoW initial structure
  - = Trade link routine (20 minutes)
  - Block 2: Trade linked MR EE SUT,
  - = SUT to IOT transformation routine, pxp and ixi, one technology assumpion)
  - Block 3: MR EE IOT (pxp, ixi) Inverse, aggregation routines, links to models etc.
  - = output to CMLCLA indicator program (EF, TMR, LCIA, Externalities)
  - …a very flexible engine capable of dealing very quick with updates, or even fully new data sets and formats




What EXIOPOL did produce (2)

- 43 harmonized country SUT plus a small RoW
  - 130 sectors (detail in agri, energy, minerals, mining, etc.)
  - detailed Value added blocks
- Harmonized data on trade shares by country by sector (products, services)
- Large set of environmental extensions including physical SUT
  - Physical energy SUT (transformed IEA database, 60 carriers by 130 sectors) plus energy related emissions by carrier (30-40 substances)
  - Non-energy emissions (30 substances)
  - Primary resource extraction by 130 sectors (80 resources)
  - Land use, water use,
- External cost values per emission per sector and country (including some spatial differentation, e.g. using default stack hights per sector)
- Data set on factor constraints (mainly: 3 classes of labor, land, water) and estimates of resource rents and royalties.


How EXIOPOL did produce its data set - SUT

- Working with SUT as core *(// GTAP, IDE)*
  - Trade and FD is in products
  - Emissions and resource extractions are by Industry
- Production routine
  - Gather and create balanced SUT in bp in original sector format
    - EU: Eurostat SUT with S in bp, U in pp, few give valuation layers - > reverse engineer Ubp from IOT and Sbp
    - Non EU: often IOT, heroic assumption of diagonal S
  - Detail
    - Map SUT bp on EXIOPOL classification
    - Úse auxiliary information and optimisation routine to create detail
      - AgriSAMS for food and agriculture
      - IEA database, information on material extraction, LCA co-efficients, SUT/IOT othe countries for estimated co-efficients


How EXIOPOL created its data set - EE

- Resources: allocation SERI (FAO, USGS, etc.) database to extracting sectors
- Emissions
  - Allocation of EIA database to sectors + emission factors (IPCC, CLRTAP, etc.)
  - Other activity variables + emission factors
- Land, Water: mainly FAOSTAT plus allocation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How EXIOPOL created its data set – Trade links

- Use bp is separated in Use dom and Use imp
- Use imp is further allocated to country of origin with trade shares (harmonized UN COMTRADE by Feenstra et al.)
- When we do so for all countries, we get an ‘implicit export’ by country that in theory should match export vector in Use table
- It does not due to
  - Valuation differences (cif versus fob)
  - Statistical differences / error
- We match this by
  - Using Exports in SUT as constraint;
  - Rescaling so that total imports = total exports at global level
  - GRAS is applied to the bilateral Import Use tables to get a balanced system


Plans in CREEA (2011-2014)

- FP7 CREEA (Compiling and Refining Economic Environmental Accounts
  - EXIOPOL team with notable additions – CBS (NL) and SCB (Sweden)
  - Does practical data refining tests and compilation related to SEEA 2012
    - Water*
    - Materials and waste*
    - Kyoto issues – land use change, carbon trading, taxes*
    - Forests
  - Will also use outcomes of * to update EXIOBASE,
    - Additional physical SUT and waste accounts
    - Improved water, land use change and carbon trading accounts
    - Next to creating a more recent base year
- We have funds reserved for intensive collaboration with formal circles (e.g. OECD, UNCEEA, UNEP ????)


Longer term roadmap ideas for EE SUT/IOT

- Further harmonization of SUT/IOT in more detail
- Expanding number of countries covered
- Integration with physical data to P-SUT (e.g. with FAO and IEA data)
- Harmonizing trade data sets/shares (both economic as physical)
- Integration of Life cycle inventory data (is SUT/IOT by single process)
- Integration of spatially explicit information for land and water use
- Inclusion of monetary and physical capital stocks


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Potential for improvements and collaboration

- Research groups in fact make MR SUT/IOT rather than NSIs or UN
- My main suggestions to official data gatherers like NSIs, UN, FAO, IEA:
  - SUT & IOT
    - Publish valuation layers – particularly EU must have them….
    - Please use harmonized sector classifications – really!
  - Trade
    - Solve ‘mirror statistics puzzle’ in UN COMTRADE
    - Start work on service trade sets…..
  - Physical data (energy – IEA; agro-food: FAO)
    - Please use CPC for classifying products
    - IEA: ideally, try to move to an industry classification based on ISIC
    - …and move from territorial to resident principle


Potential for improvements and collaboration

- Improved collaboration between research projects and official institutes can help
  - Eurostat experience
  - Used EXIOPOL and WIOD staff and methods to create their official EU27 EE SUT
- Quite some countries create their own EE SUT/IOT
- Why not form a (in)formal collaborative working group on this
  - With NSI and research representatives
  - Akin the OECD WG on Material Flow Analysis
  - Various ‘hosts’ thinkeable (UNCEEA & London Group, UNEP, OECD, or a combination of these)
  - CREEA can offer some funds to support this.


THANKS FOR YOUR ATTENTION!


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Some issues about data availability

- Eurostat works with
  - IPTS and Konstantz on gap filling ESA95 SUT
  - TNO, RUG, NTNU, CML on creating an EE SUT
- For 16 out of 27 EU countries (75% GDP) an ‘Excellent data set’
  - 3-4 countries with valuation layers transmitted to Eurostat
  - 12 other countries that give voluntary information, but many do not want to have this published!!!!!
- Even in our Eurostat project we could not work with these tables
- We will publish
  - Aggregated EU27 table constructed by separating Uimp, non EU and Uimp, EU, rebalancing intra EU trade
  - With extensions, and several analyses
- In a way weird – WIOD, EXIOPOL are forced to redo this work with less information…..hope with time this will improve