



Accounting for CO₂ emissions: UK, US, China and International Trade

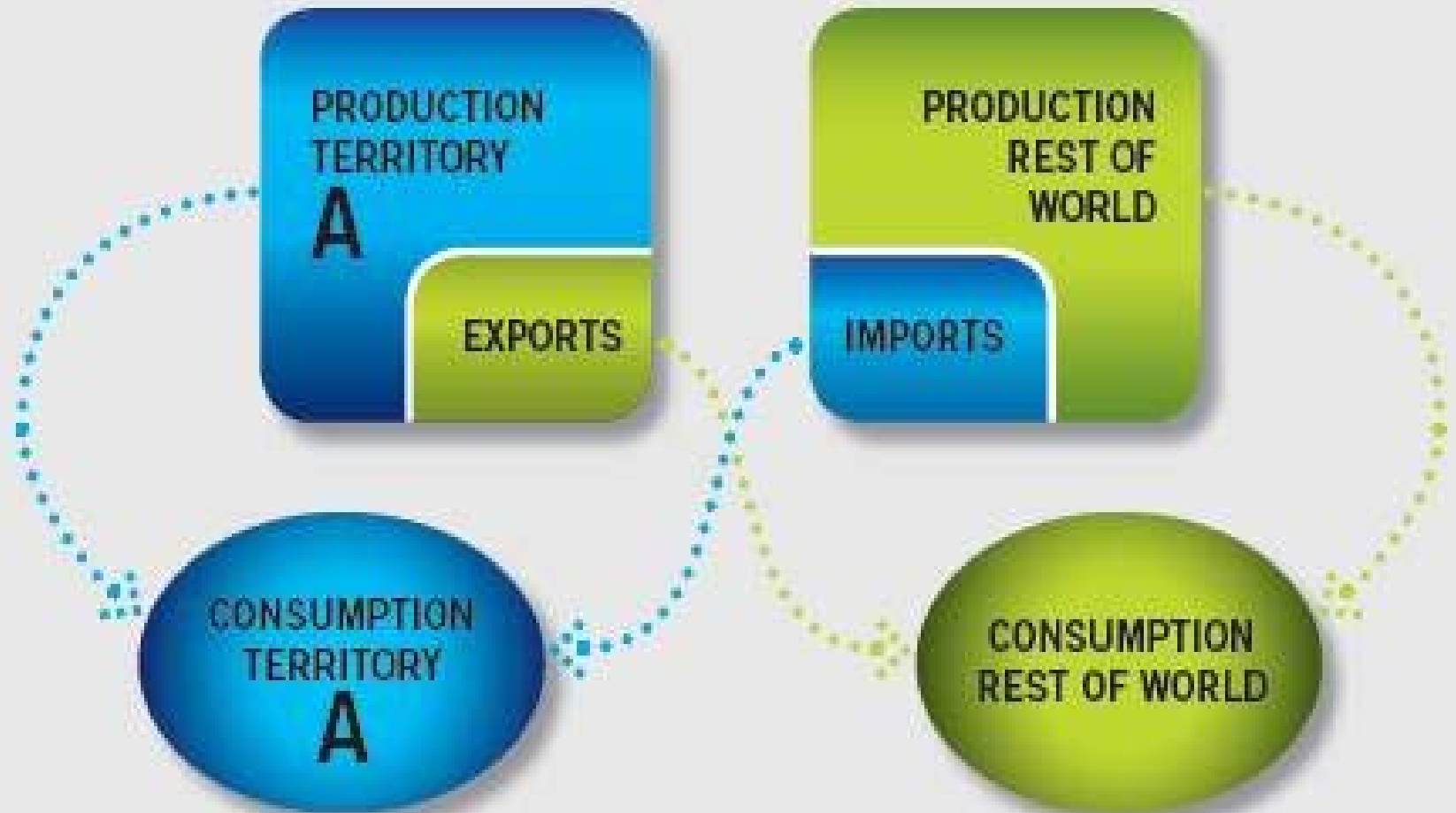
Klaus Hubacek

Today's production is based on global supply chains

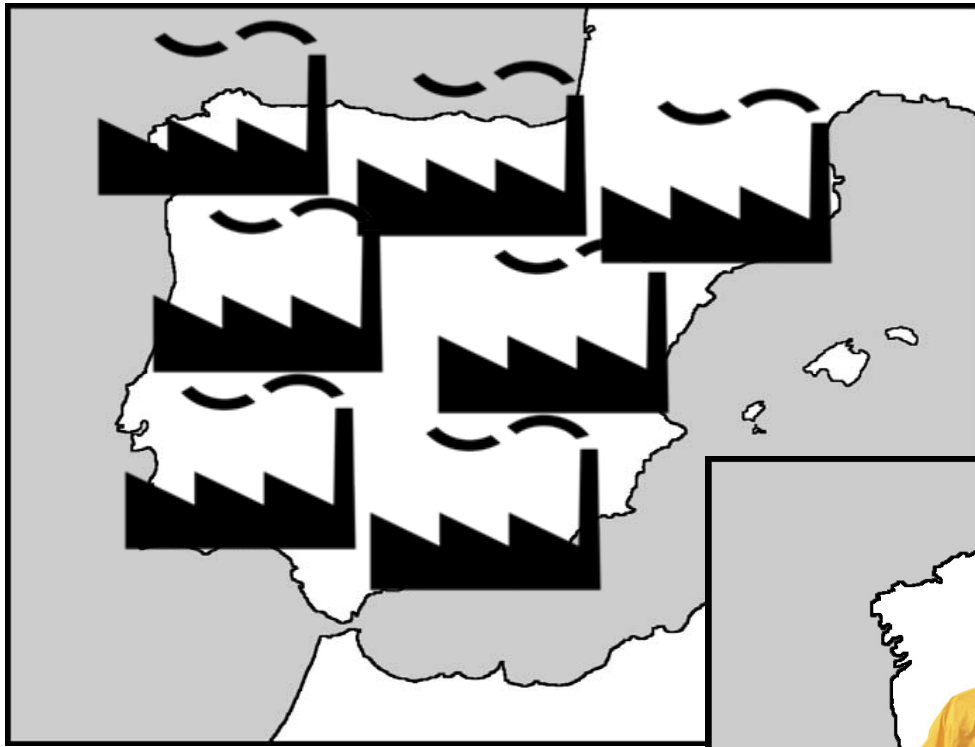
Division of labor "Sonicare Elite 7000" production and supply locations



What are consumption-based emissions?



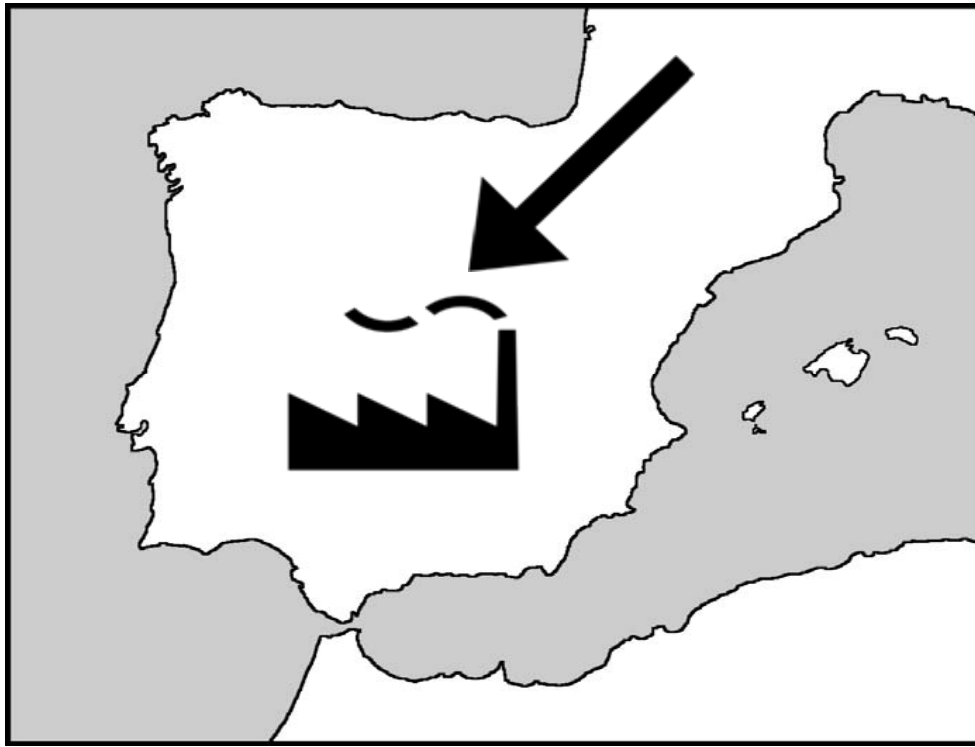
(Carbon Trust, 2006)



Similar to calculating emissions by all factories in a given territory

we could also calculate emissions by all products and services consumed in that territory

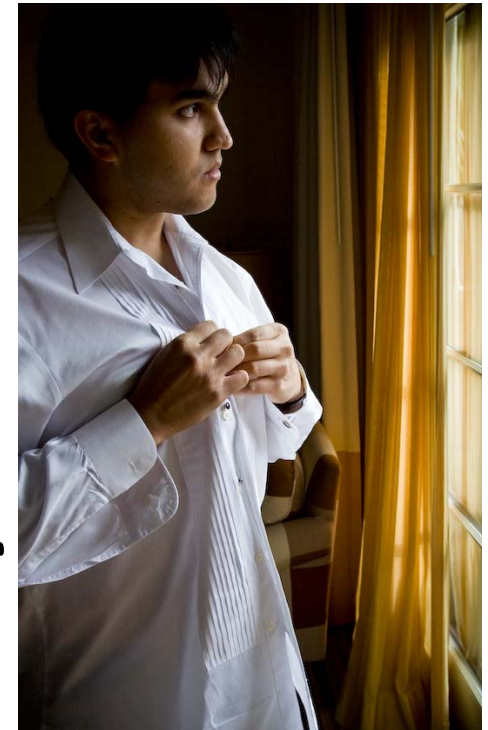




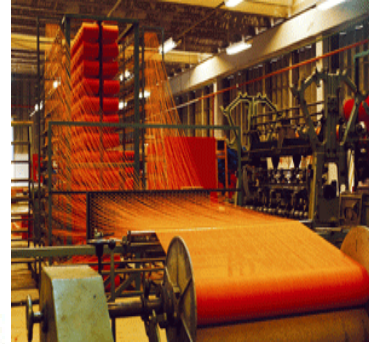
in the first case, we will know **WHERE** emissions occur



in the second case, we will know **WHY** emissions occur



From cradle to the grave using Life-Cycle Analysis (LCA)





There are millions of products, each one is different from the other!

If we want to calculate emissions from **all consumption** of a given territory, we will obviously not be able to do that with LCA



"TOP DOWN" AND "BOTTOM-UP" APPROACH CONSUMPTION EMISSIONS (CARBON FOOTPRINT)



Carbon footprint of countries



Regional carbon footprint
Local carbon footprint



Carbon footprint of companies and organizations

Citizen carbon footprint



Carbon footprint of products and activities

"TOP DOWN"

Input-Output Analysis



"BOTTOM-UP"

LCA

CALCULATING CONSUMPTION EMISSIONS

SPANISH INPUT-OUTPUT TABLES (2000)

M €

		Products of agriculture, hunting and related services	Products of forestry, logging and related services	Fish and other related services
		TSIO-01	TSIO-02	TSIO-03
Products of agriculture, hunting and related services	TSIO-01	2751,1	2,1	9,4
Products of forestry, logging and related services	TSIO-02	**	0,5	0
Fish and other related services	TSIO-03	0	0	0
Anthracite, coal, lignite and peat	TSIO-04	0,5	0	0,2
Crude petroleum and natural gas.; services incidental to oil and gas extraction	TSIO-05	0	0	0

Input-Output Tables
show how

- the sectors of an economy are interrelated (in \$)
- an economic activity *demands*, in its production process, *inputs* from other economic activities
- an increase in final demand of a good or service produces an *indirect demand* of other goods and services that serve as intermediate inputs to producing that specific good

Production and consumption categories

Calculation of consumption emissions by production activities

Category of goods and services	SIOT code
Products of agriculture, hunting and related services	SIOT-01
Products of forestry, logging and related services	SIOT-02
Fish and other fishing products and related services	SIOT-03
Anthracite, coal, lignite and peat	SIOT-04
Crude petroleum and natural gas; services incidental to oil and gas extraction. Uranium and thorium ores	SIOT-05
Iron ores; non-ferrous metal ores, except uranium and thorium ores	SIOT-06
Non-metallic and non-energy ores	SIOT-07
(...)	
Non-market education services	SIOT-65
Non-market healthcare and veterinary services; social services	SIOT-66
Non-market public sanitation services	SIOT-67
Services provided by trade unions; services provided by other types of associations	SIOT-68
Non-market recreational, cultural and sporting services	SIOT-69
Private households with employed persons	SIOT-70
Financial mediation services indirectly measured (FISIM)	SIOT-71



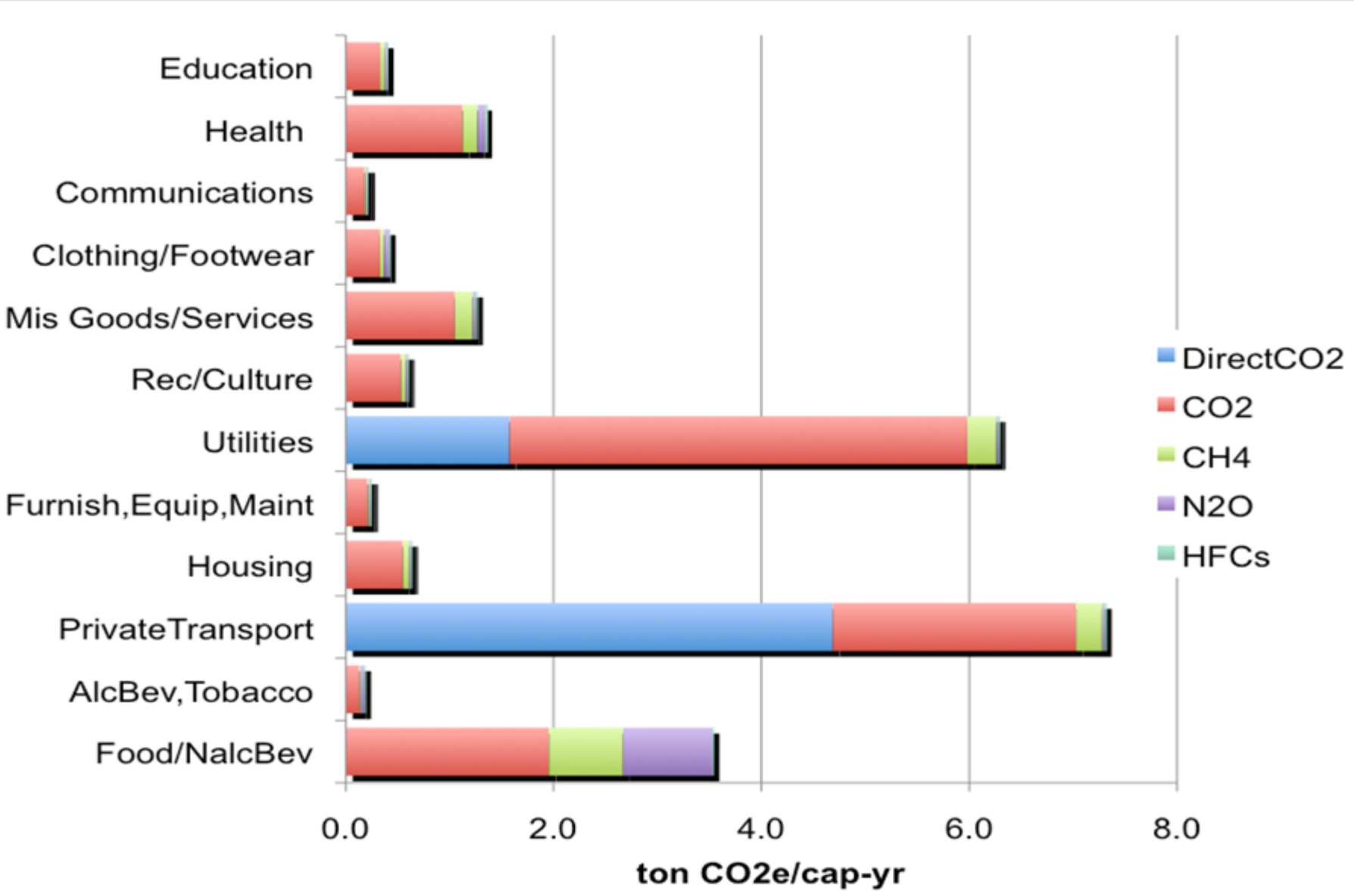
Consumption categories (COICOP group)

Food (COICOP 1, 2)
Clothing and footwear (COICOP 3)
Household energy (COICOP 45)
Housing, furnishings and household goods (COICOP 4, 5)
Health (COICOP 6)
Transport (COICOP 7)
Communication (COICOP 8)
Recreation and culture (COICOP 9)
Education (COICOP 10)
Restaurants and hotels (COICOP 11)
Miscellaneous goods and services (COICOP 12)

Households

(Santacana, 2008)

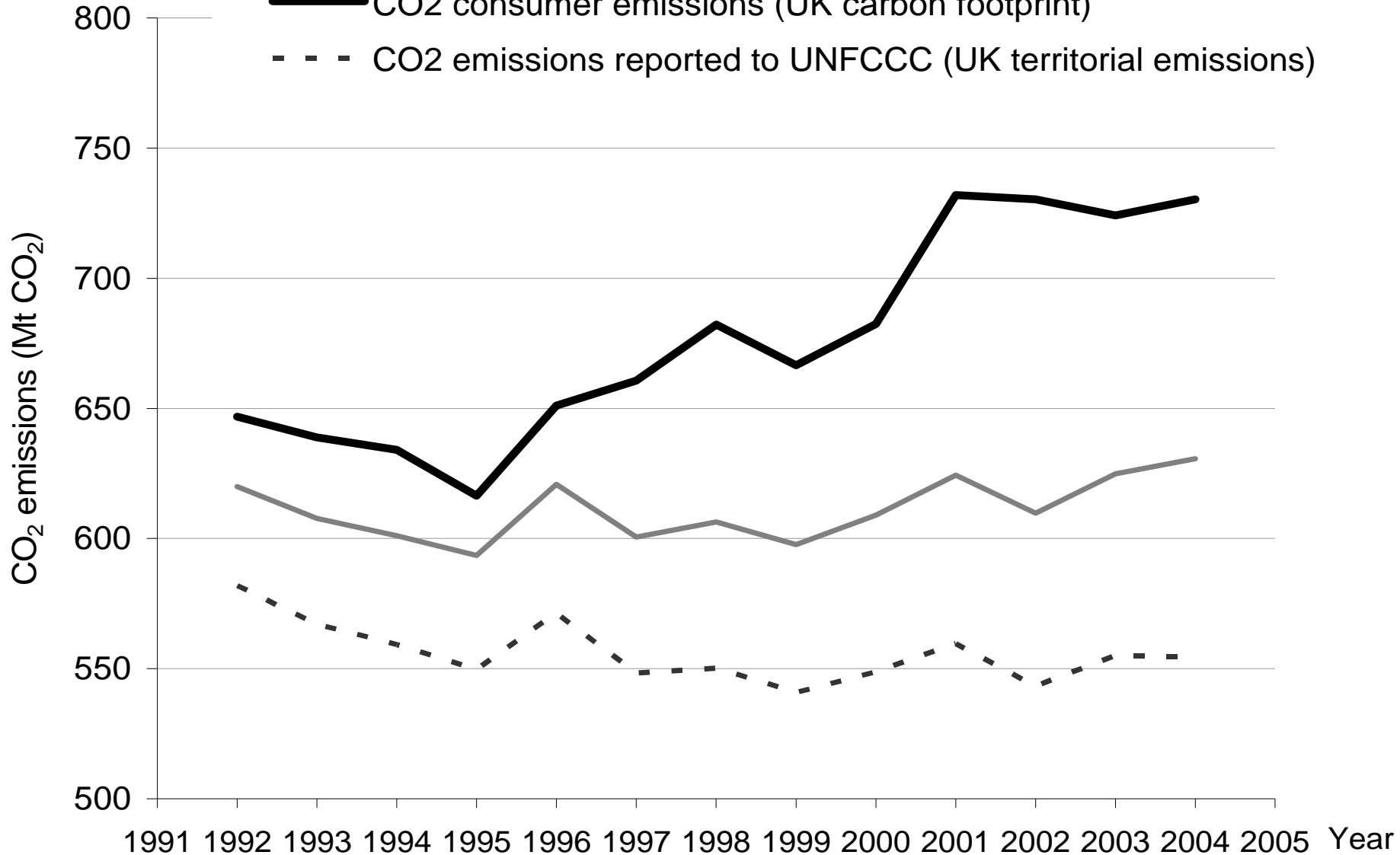
What are **direct** and **indirect** emissions of a household?



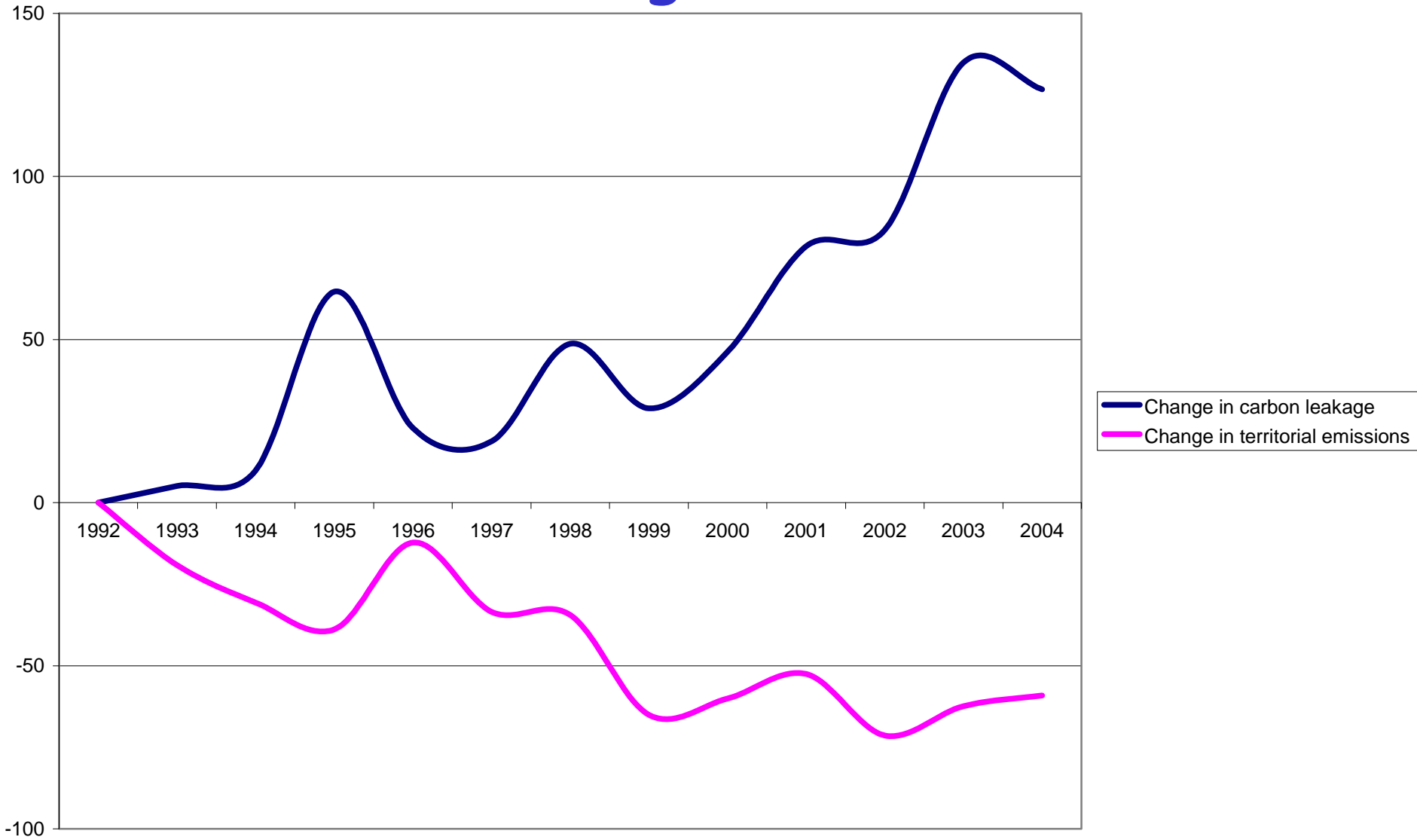
(Weber & Matthews 2008 with newer data)

UK's CO₂ emissions

- CO₂ producer emissions (UK Environmental Accounts)
- CO₂ consumer emissions (UK carbon footprint)
- - - CO₂ emissions reported to UNFCCC (UK territorial emissions)



Carbon Leakage



International trade



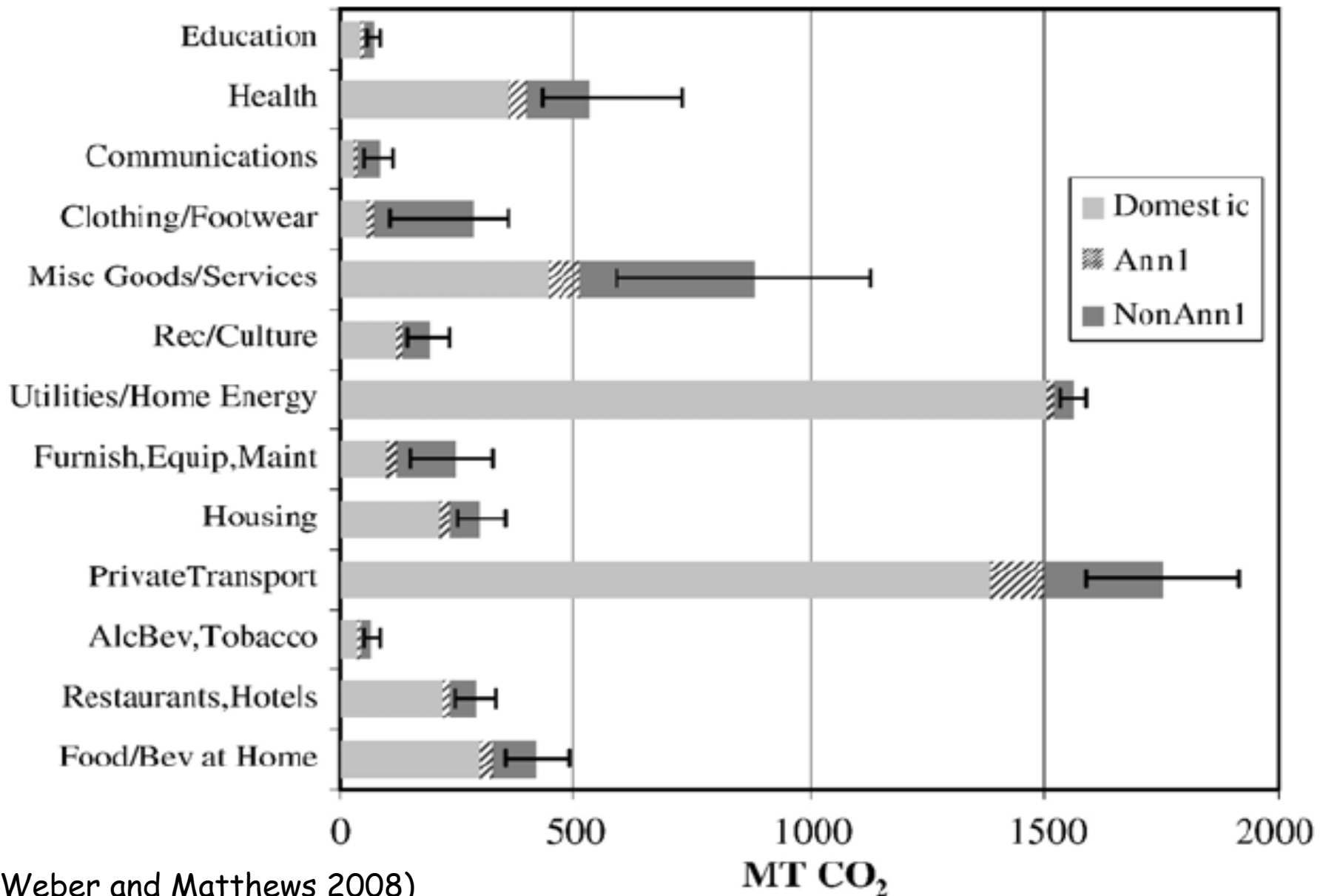
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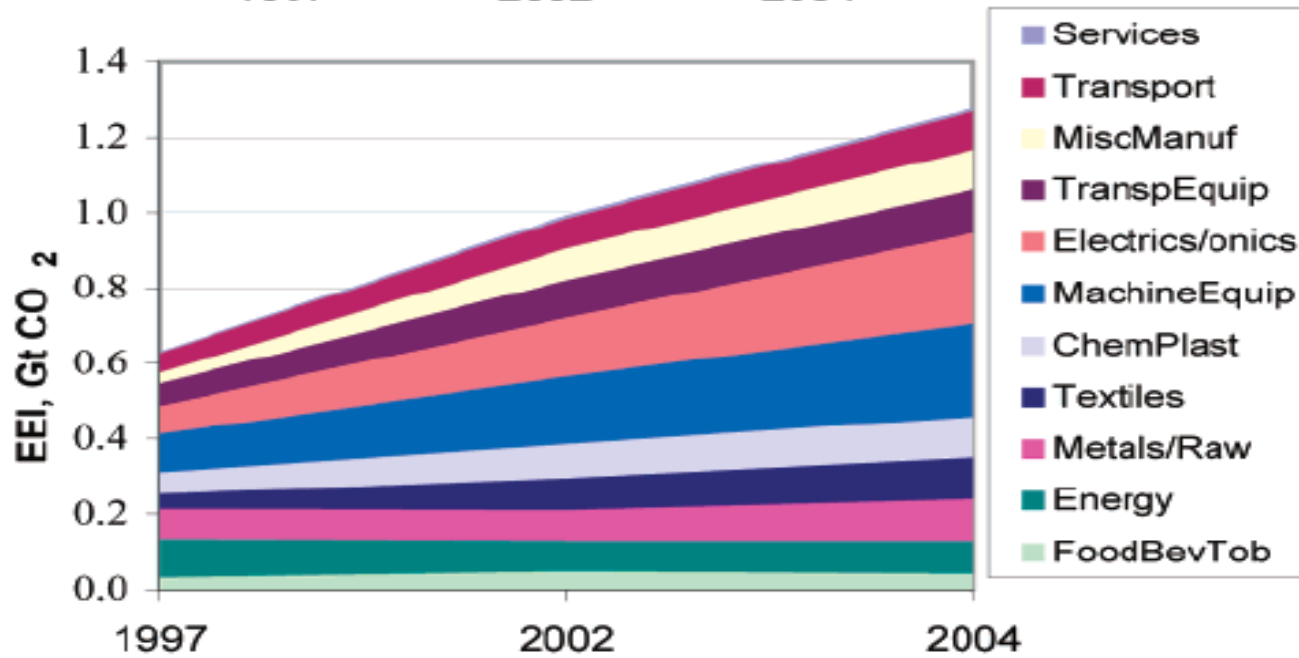
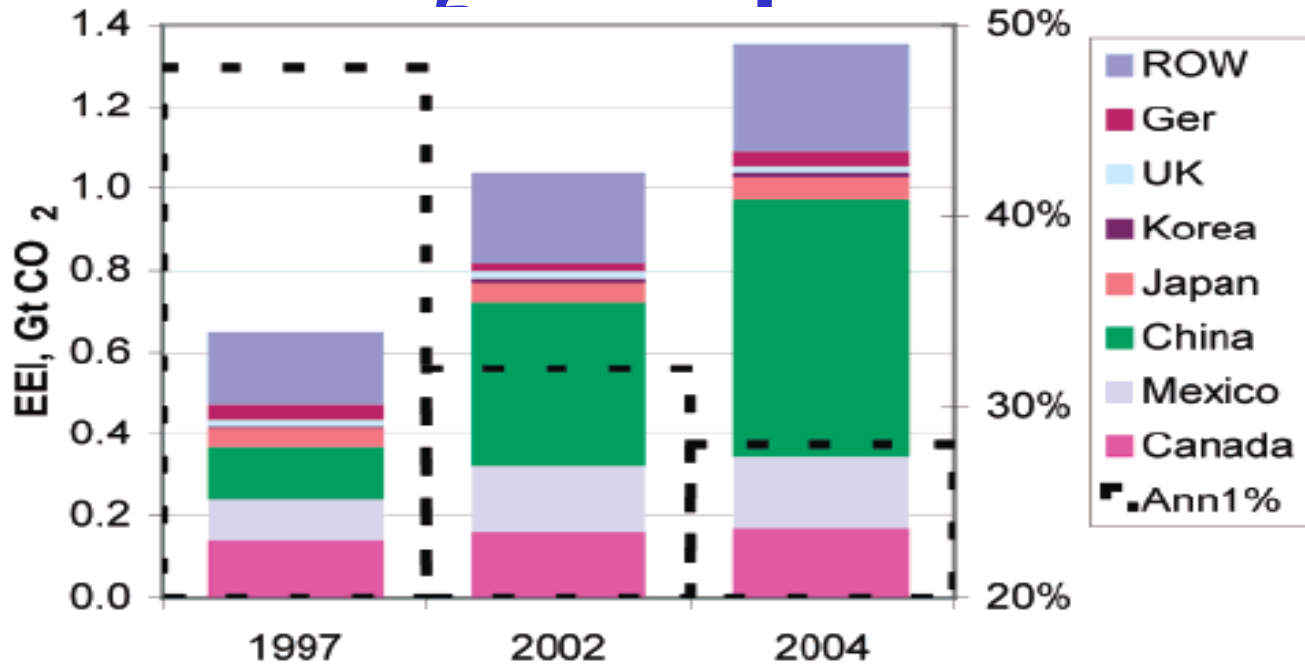
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&tid=4175&pid=12213

US household CO₂ and location of imports (2004)

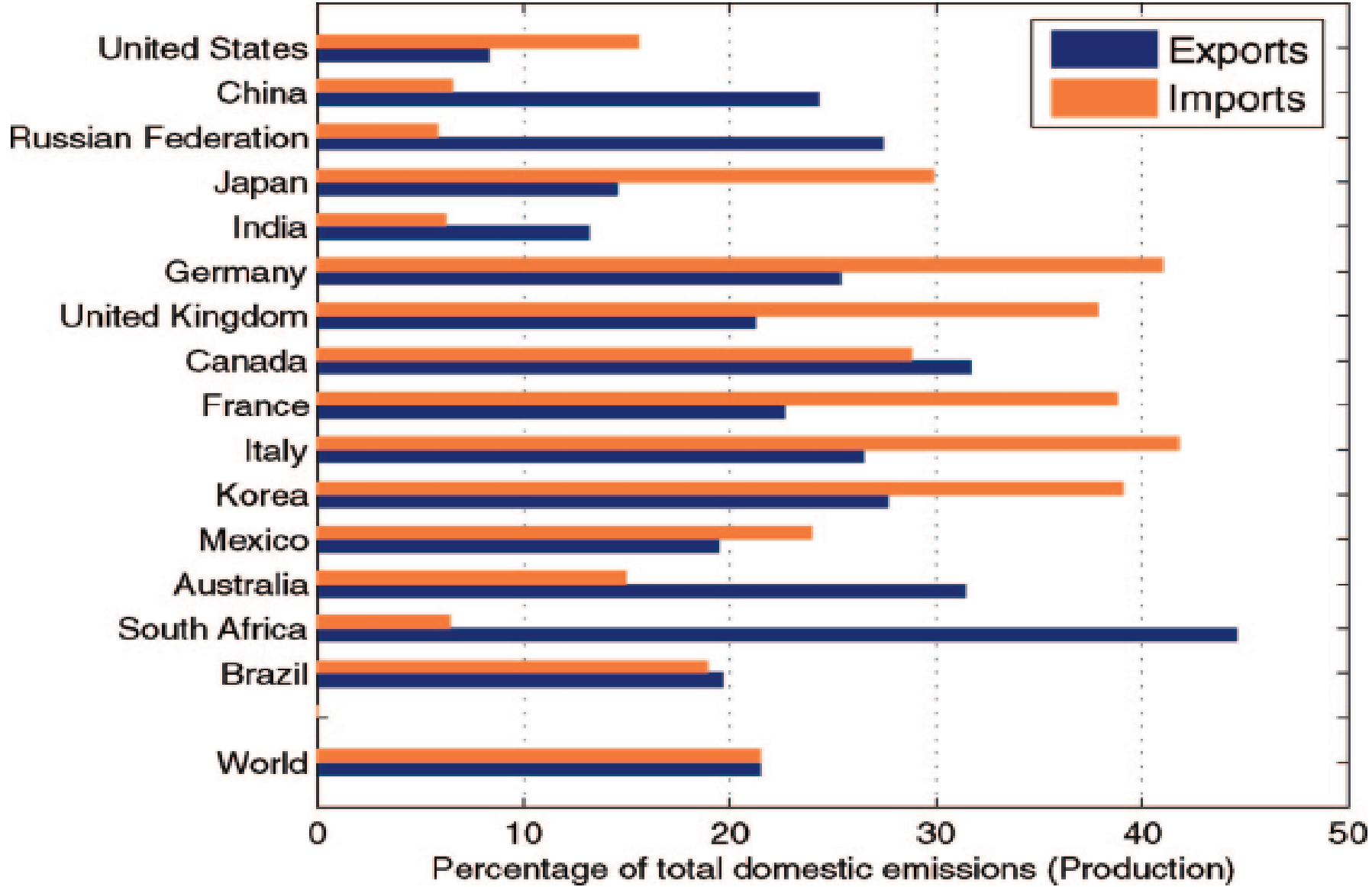


(Weber and Matthews 2008)

Embodied CO₂ in imports (Weber and Matthews, 2008)

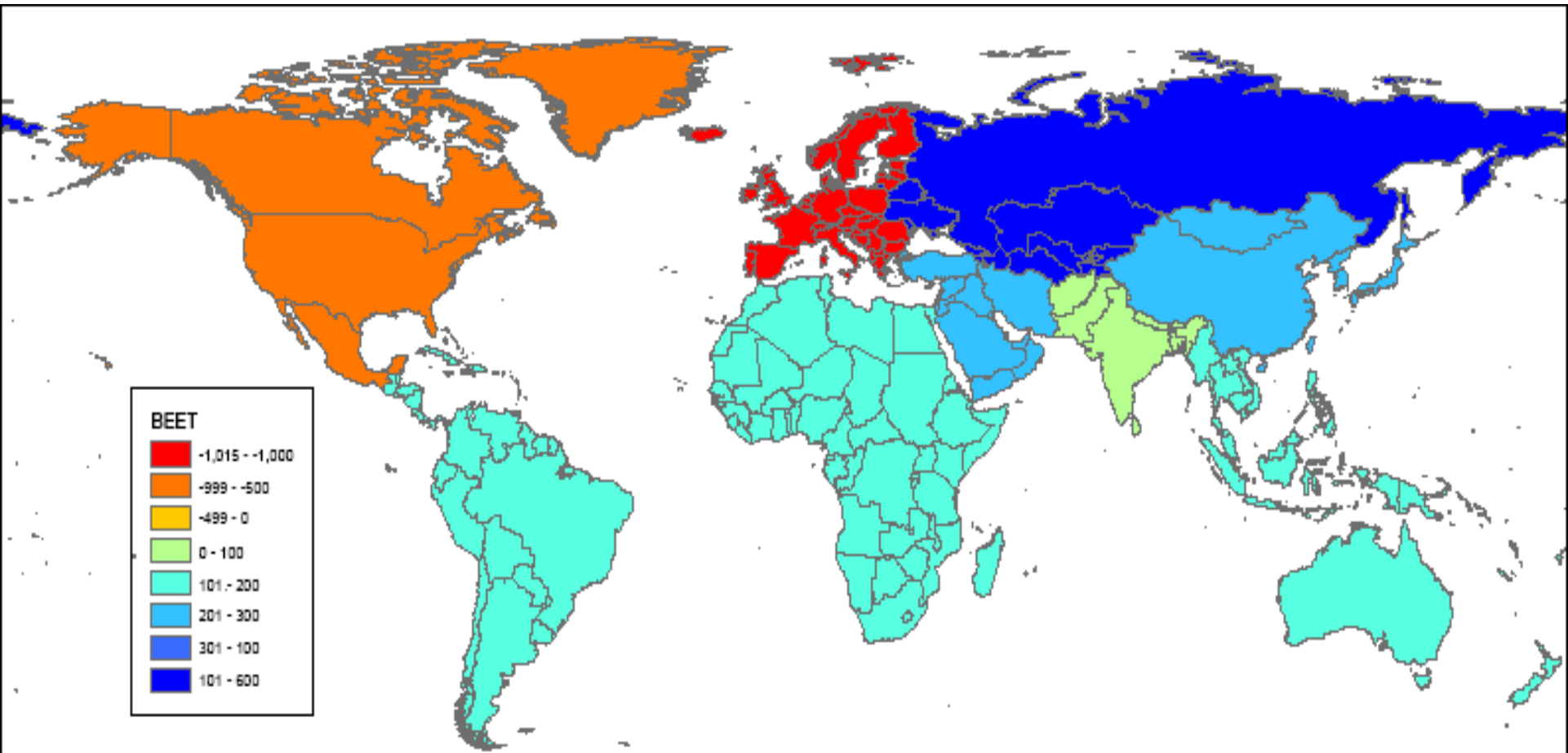


Embodied CO2 in exports and imports (2001)

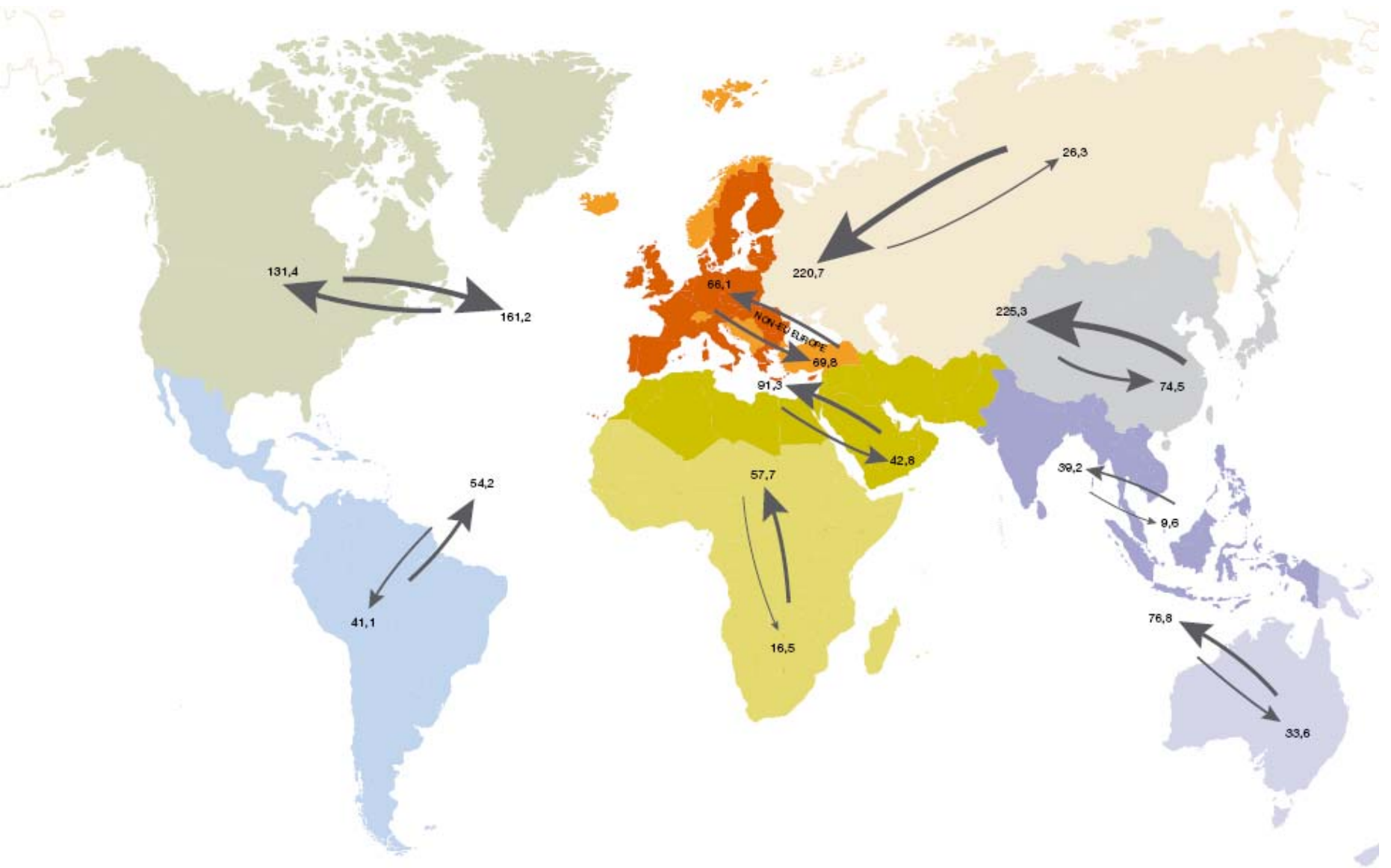


(Peters and Hertwich 2008)

Balance of Emissions embodied in trade (= Production - Consumption)

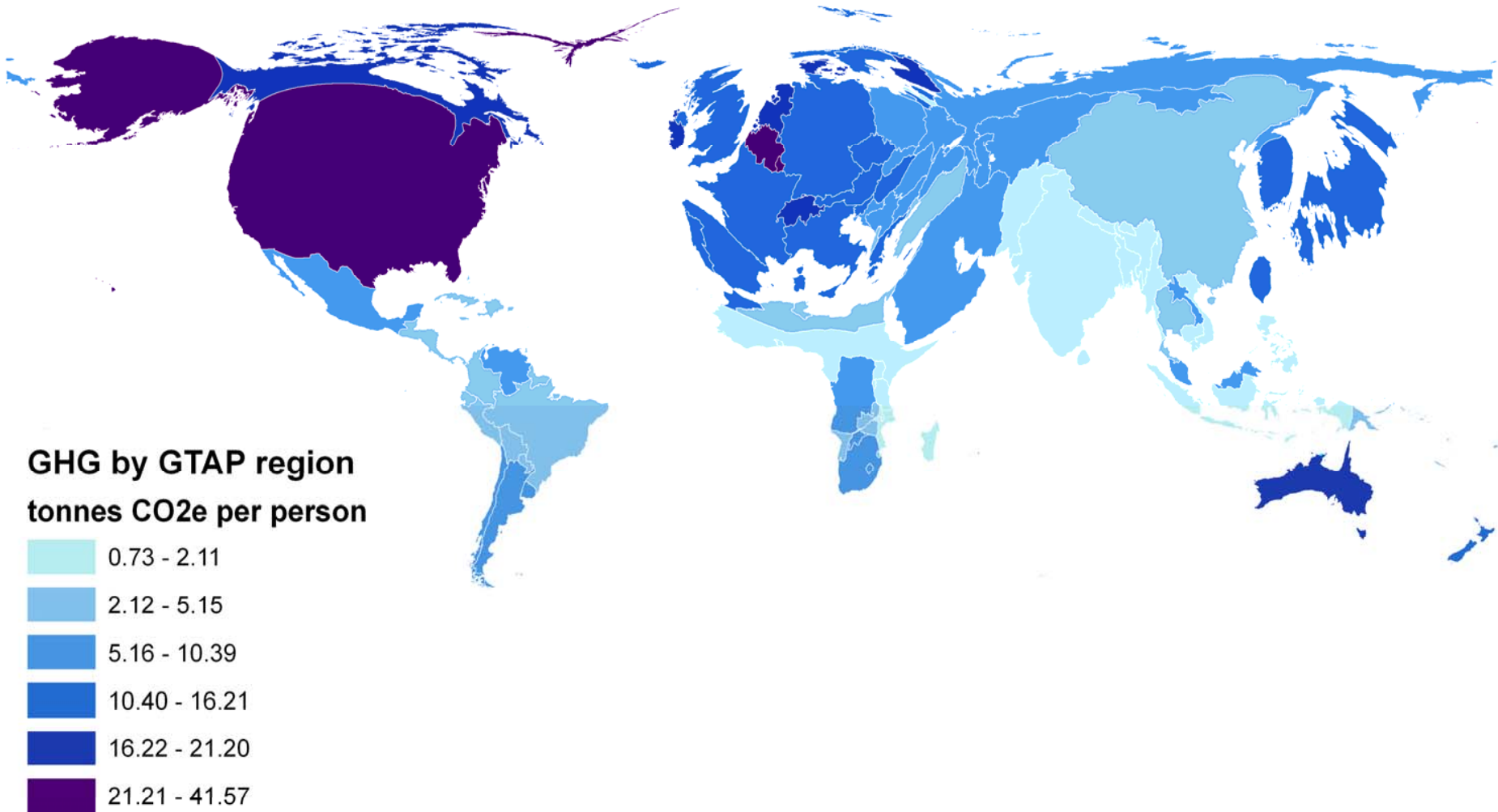


EU CO2 Trade Balances

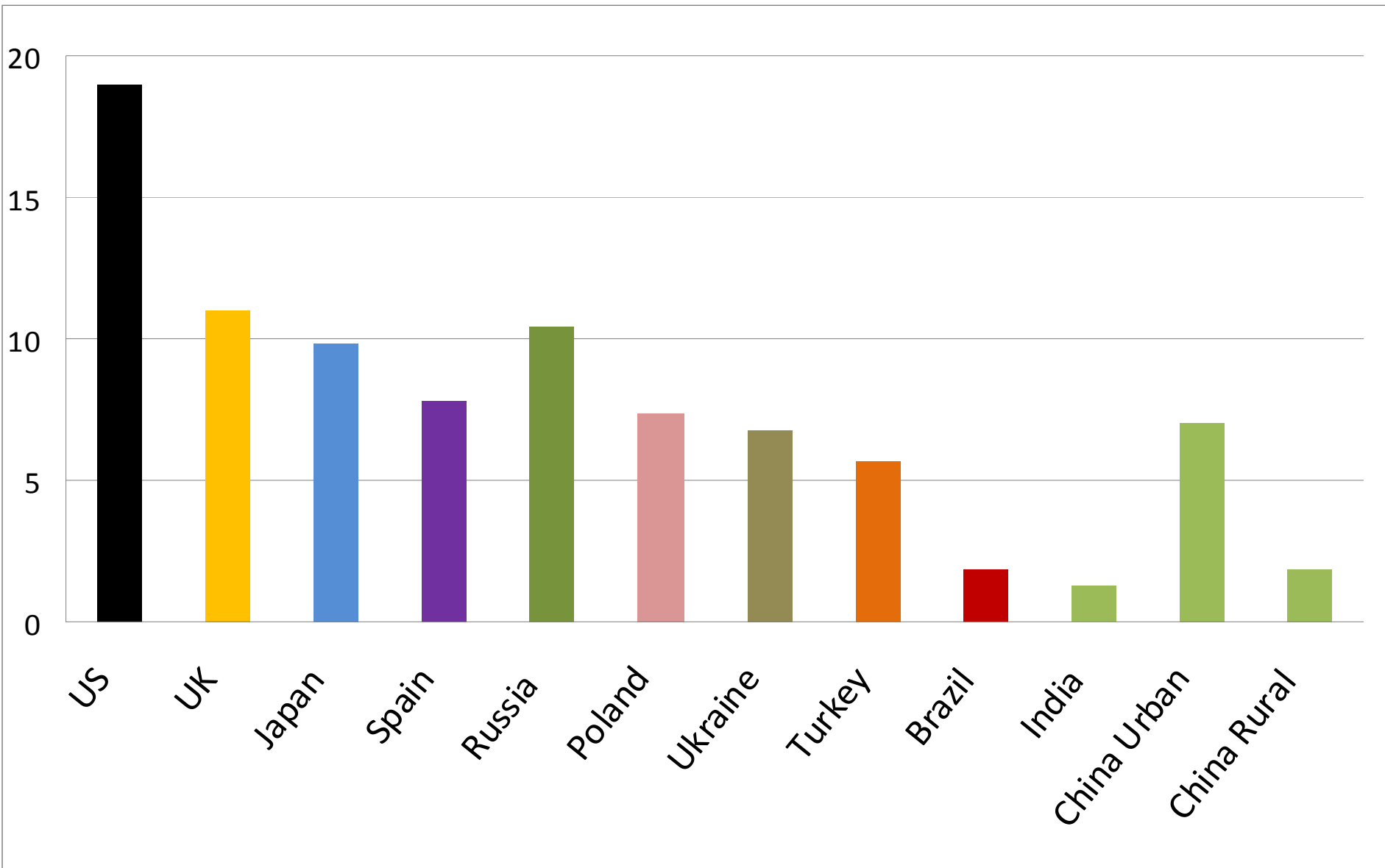


Source: Komerup Bang et al. (2008)

Cartogram morphed by total GHG emissions from consumption



Per capita Carbon Footprints

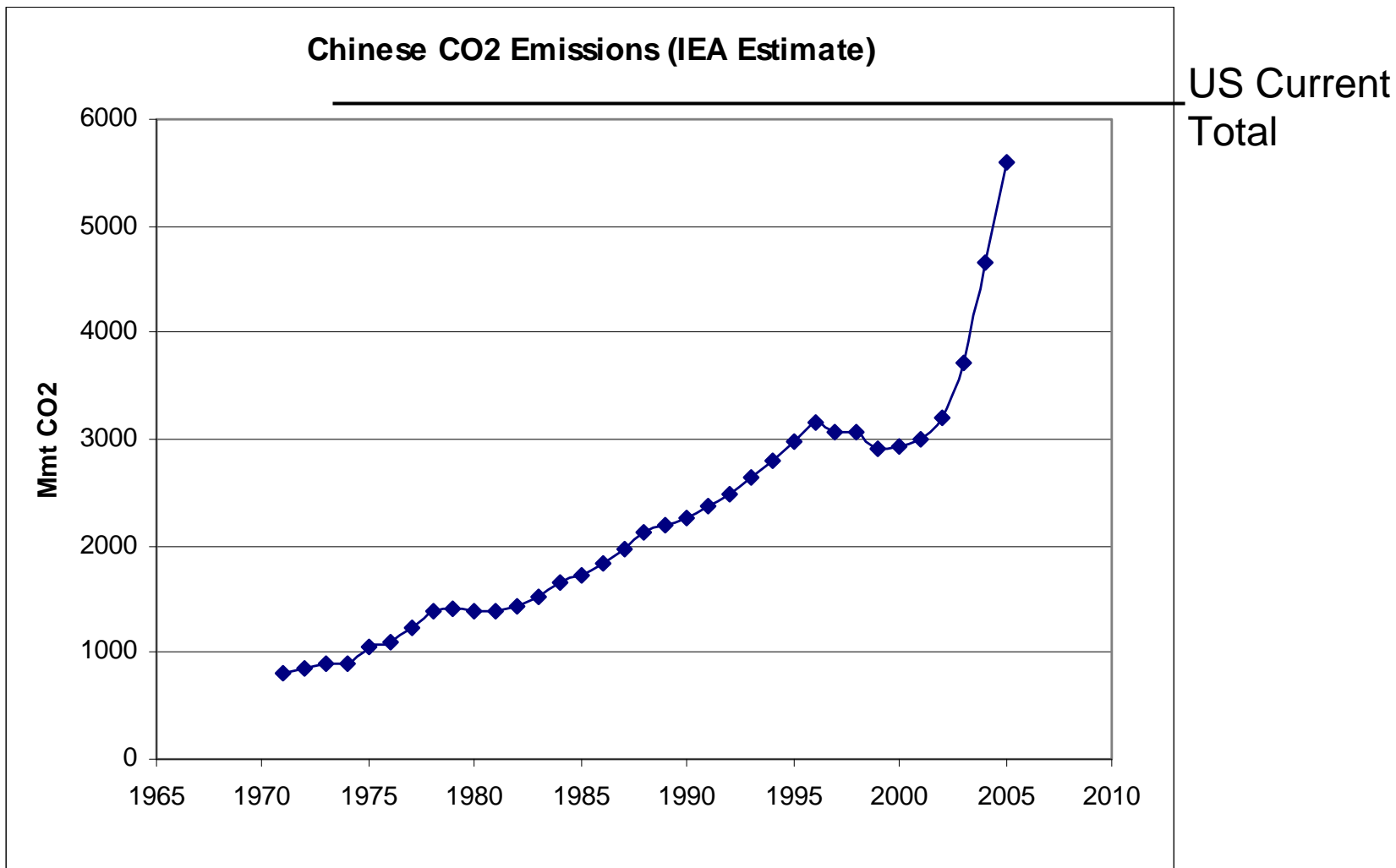


(Various sources)

China

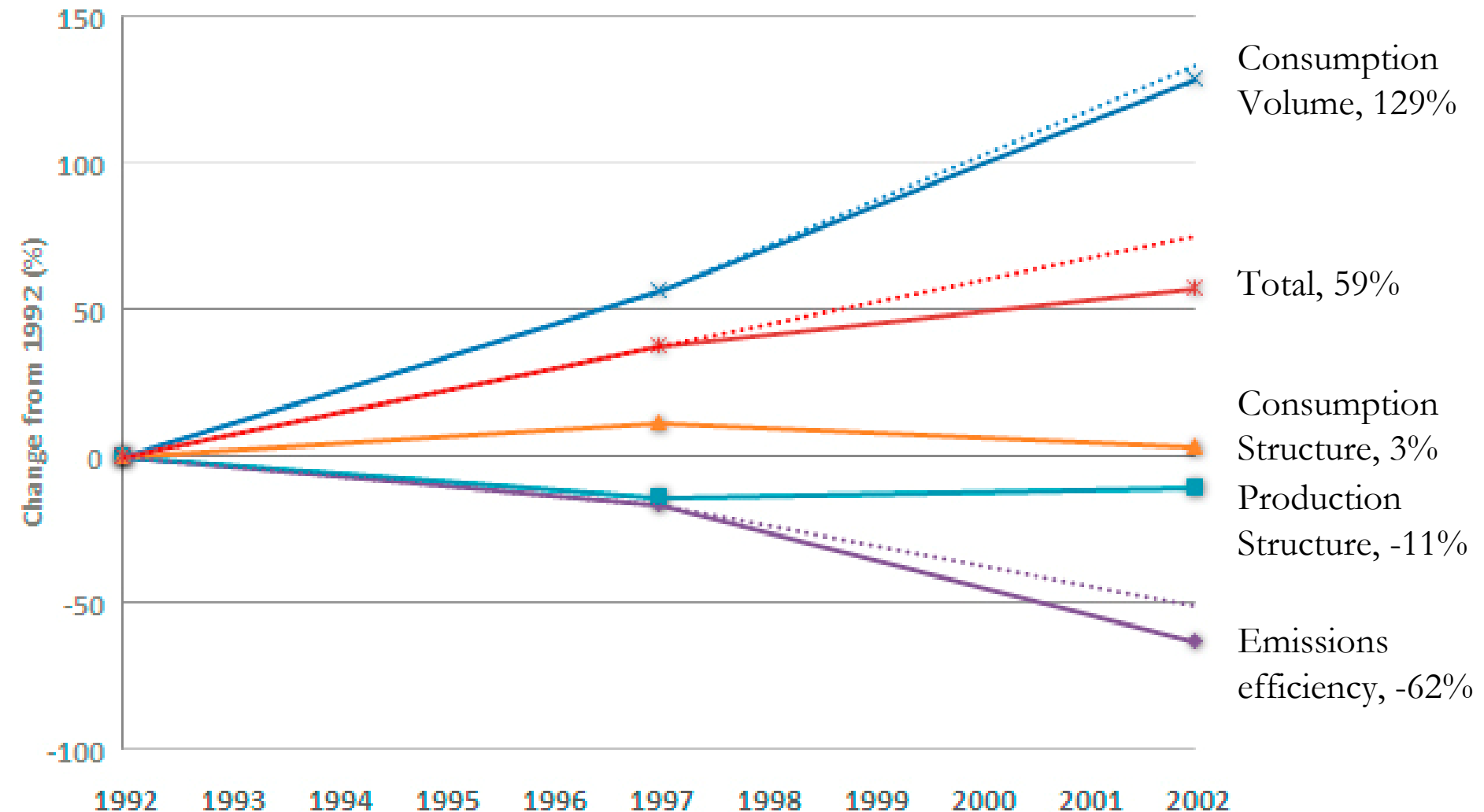


Motivation: China's CO₂ Emissions



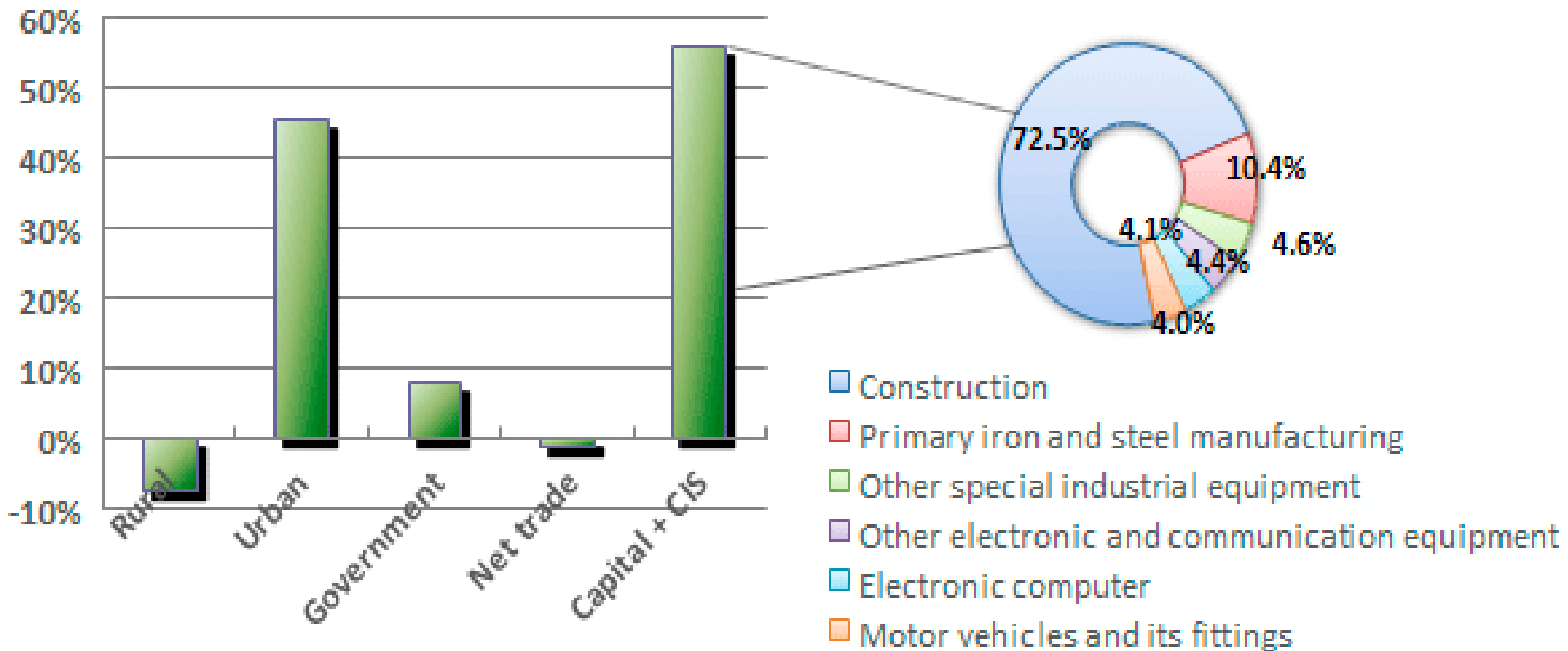
China: Structural Decomposition Analysis

- From 1992 to 2002, 59% increase in CO₂



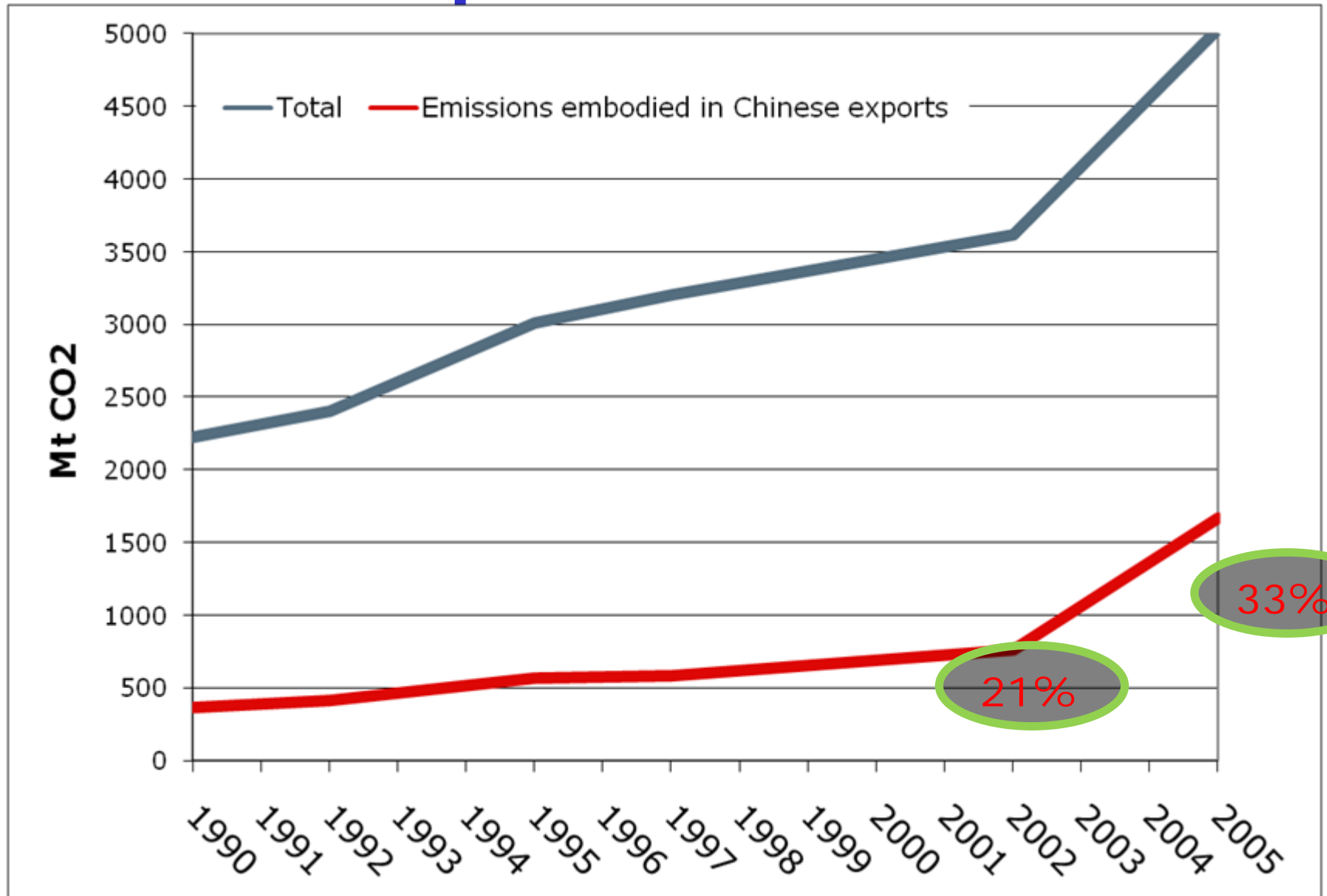
Drivers of change (1992-2002)

The contribution of the different final demands to changes in the SDA



Peters, Weber, Guan, Hubacek (2007) "China's growing CO2 emissions - a race between lifestyle changes and efficiency gains". Environmental Science and Technology 41, pp.5939-5944.

China's exports



Guan, Peters, Weber, Hubacek (2009). "Journey to world top emitter – an analysis

of the driving forces of China's recent CO2 emissions surge." Geophysical Research Letters. 36, L04709.

Destinations of China's exports

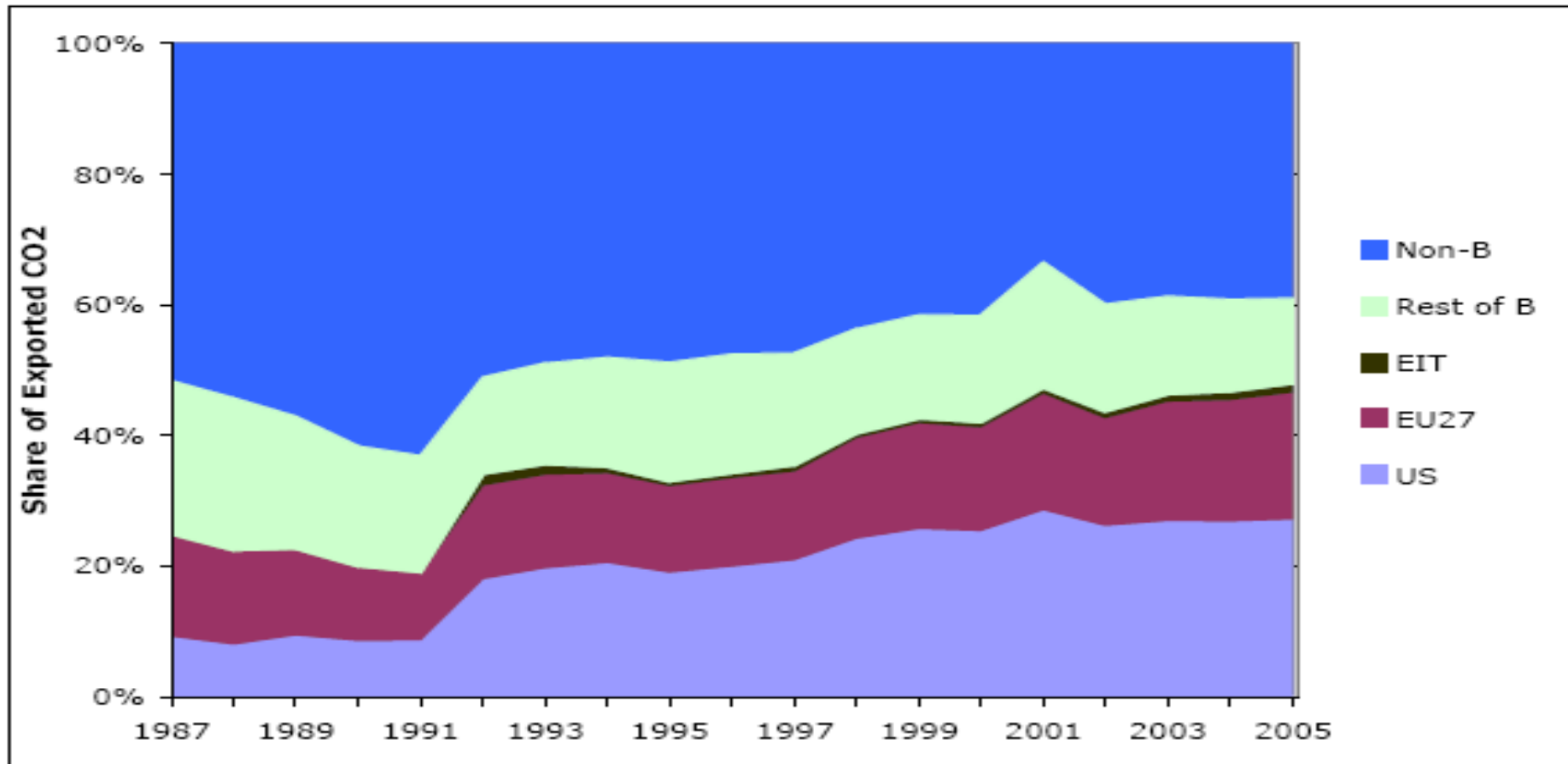
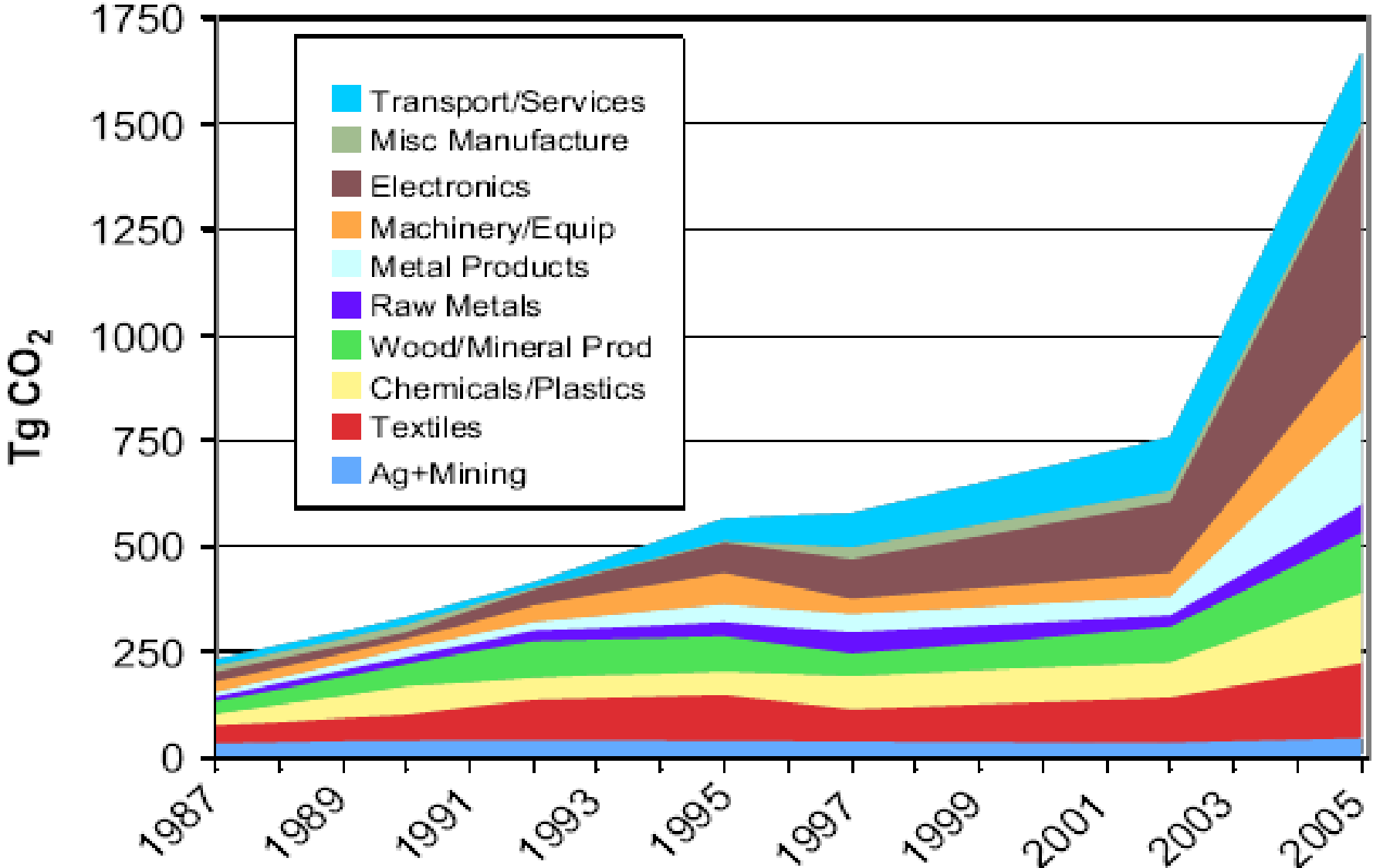


Figure 1: Region of destination for Chinese CO2 emissions embodied in exports by year. EU27 does not include any economies in transition (EIT), and "Rest of B" represents all remaining Annex B countries which do not fall into another group.

(Weber et al. 2008)

Chinese export emissions by commodity group

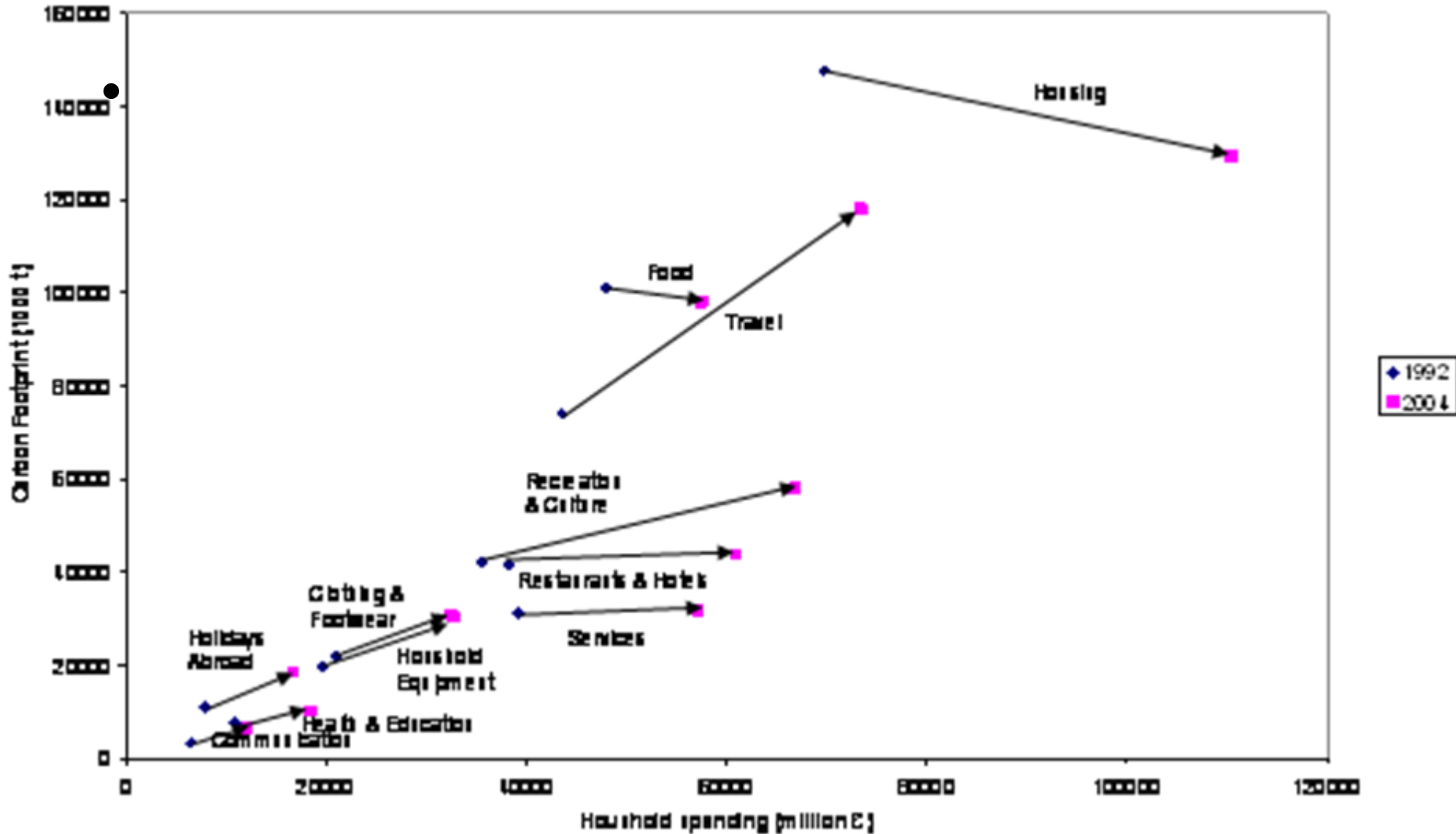


(Weber et al. 2008)

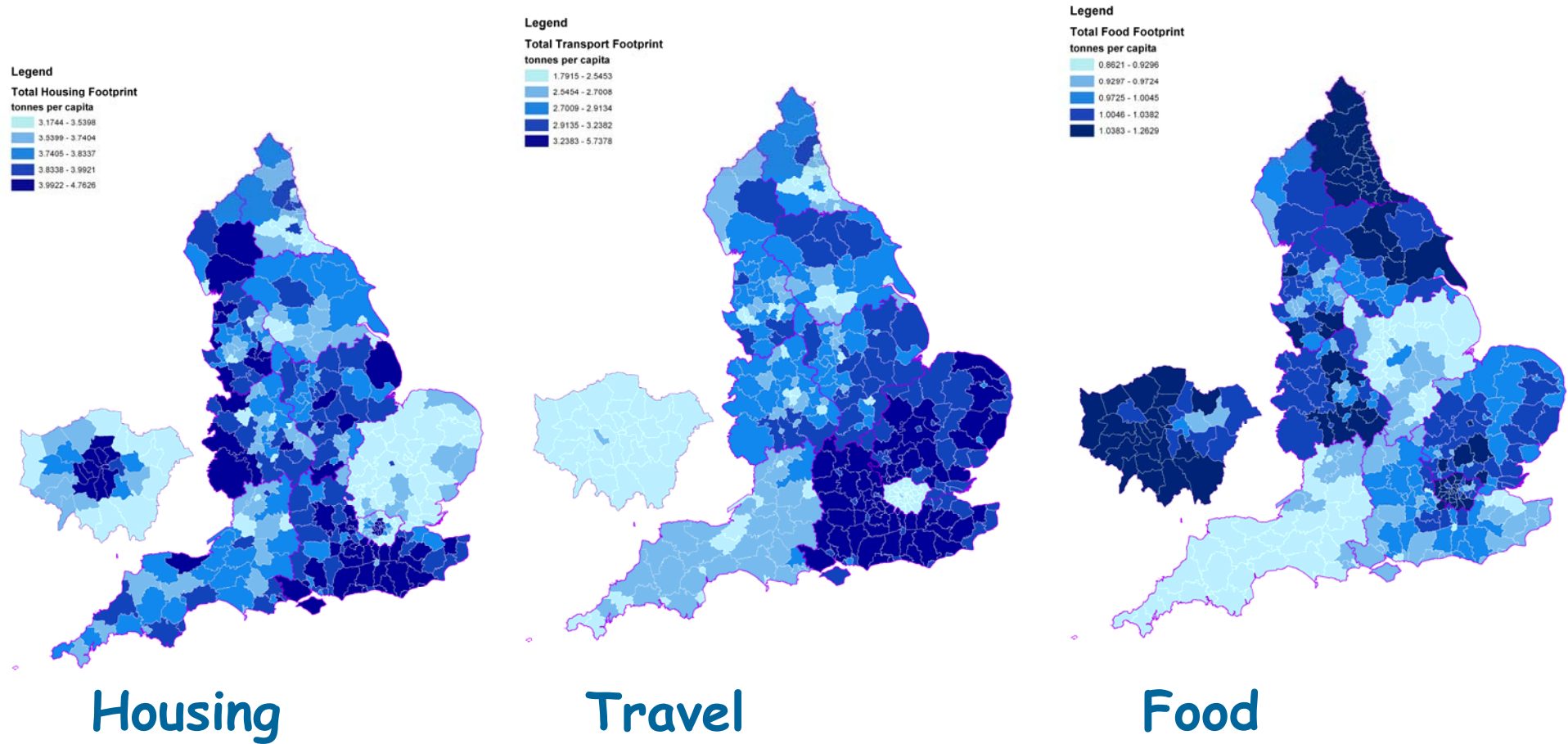
UK

RULES BRITANNIA

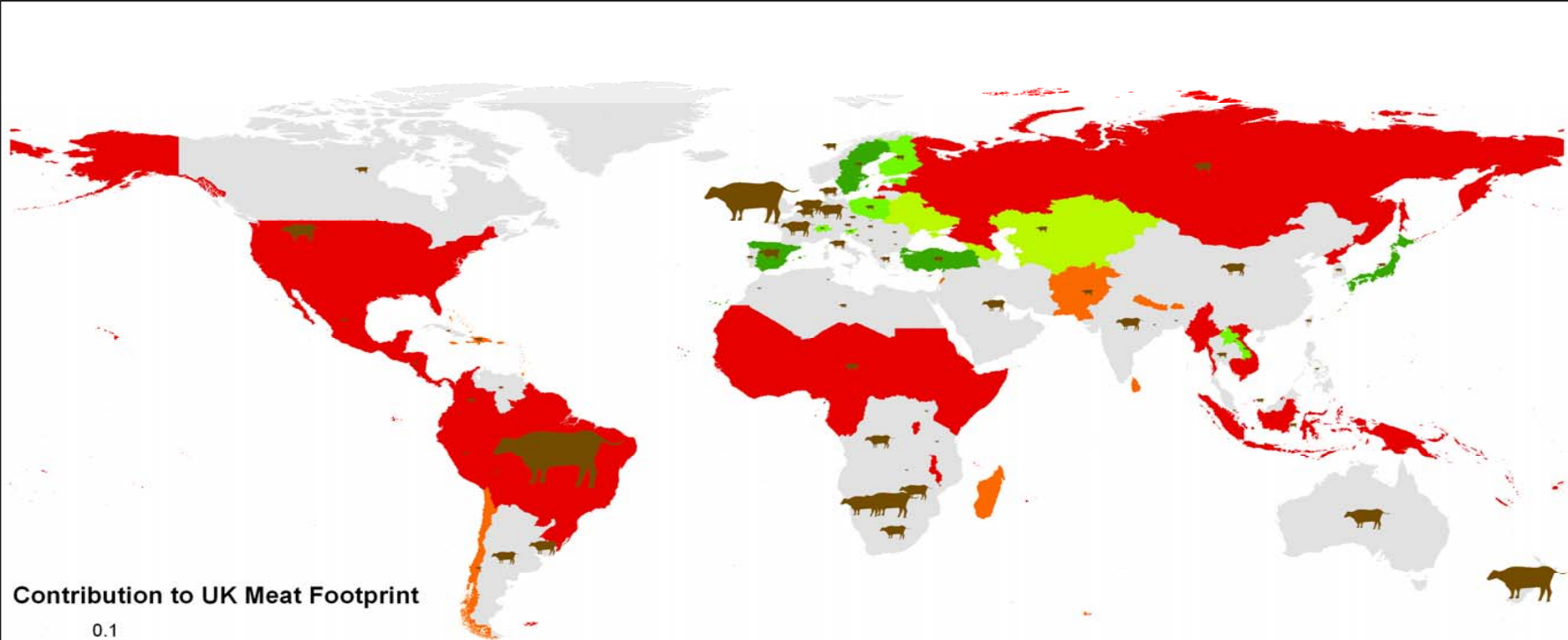
UK Final demand decomposition



Specific carbon footprints



Carbon emissions from meat consumption



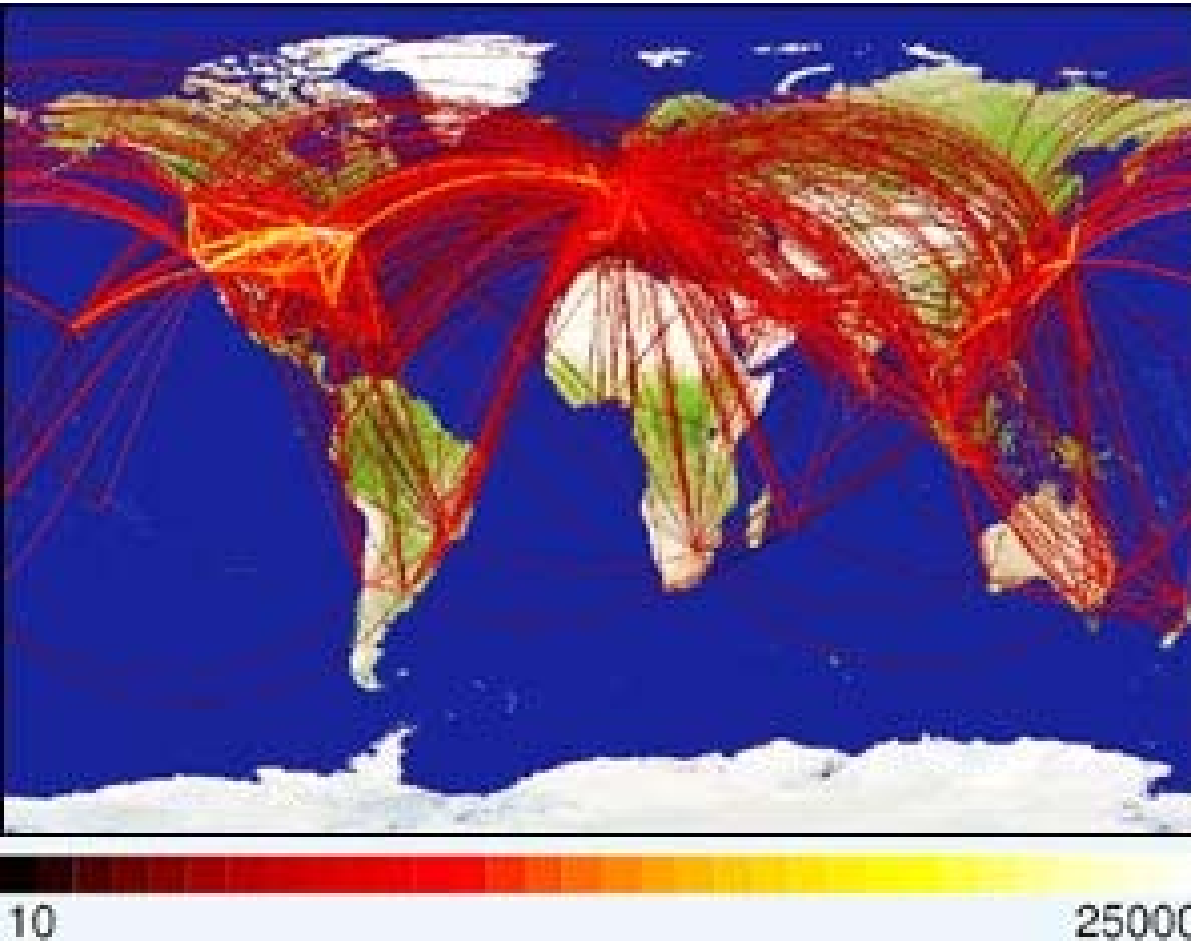
Contribution to UK Meat Footprint

- 0.1
- 10
- 1,000 1000t CO2 per year

Forest Change

- hectares per year
- 3500000 to -10000
 - 10000 to -100
 - 100 to 0
 - No Change or No Data
 - 0 to 100
 - 100 to 10000
 - 10000 to 110000

Conclusions



Approach allows linking the global and the local

Conclusions cont...

- * Rich countries tend to have:
 - Stabilized production-based emissions
 - Increased consumption-based emissions
- * Brings into question decoupling of economy and emissions
- * Who owns China's pollution?

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Conclusions cont...

- **Scientific challenges**
 - Uncertainty, data, methods, definitions, ...
- **Policy and Regulatory Challenges**
 - “Shadow Consumption based Indicator” alongside official accounting
 - Actors operate outside of their “territory”

A photograph of a Starbucks coffee shop located inside a traditional Chinese building with a red facade and a yellow-tiled roof. A group of people is sitting on the steps in front of the entrance. A man in a green military-style uniform is in the foreground on the left. The text "Thank You" is written in a large, black, handwritten font across the upper middle of the image.

Thank You

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Selected References

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- Weber Christopher L. and Scott H. Matthews (2008). Quantifying the global and distributional aspects of American household carbon footprint. *Ecological Economics*, 66, 379 - 391