CO_2 emissions embodied in international trade in goods: evidence from OECD Input-Output tables

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Outline

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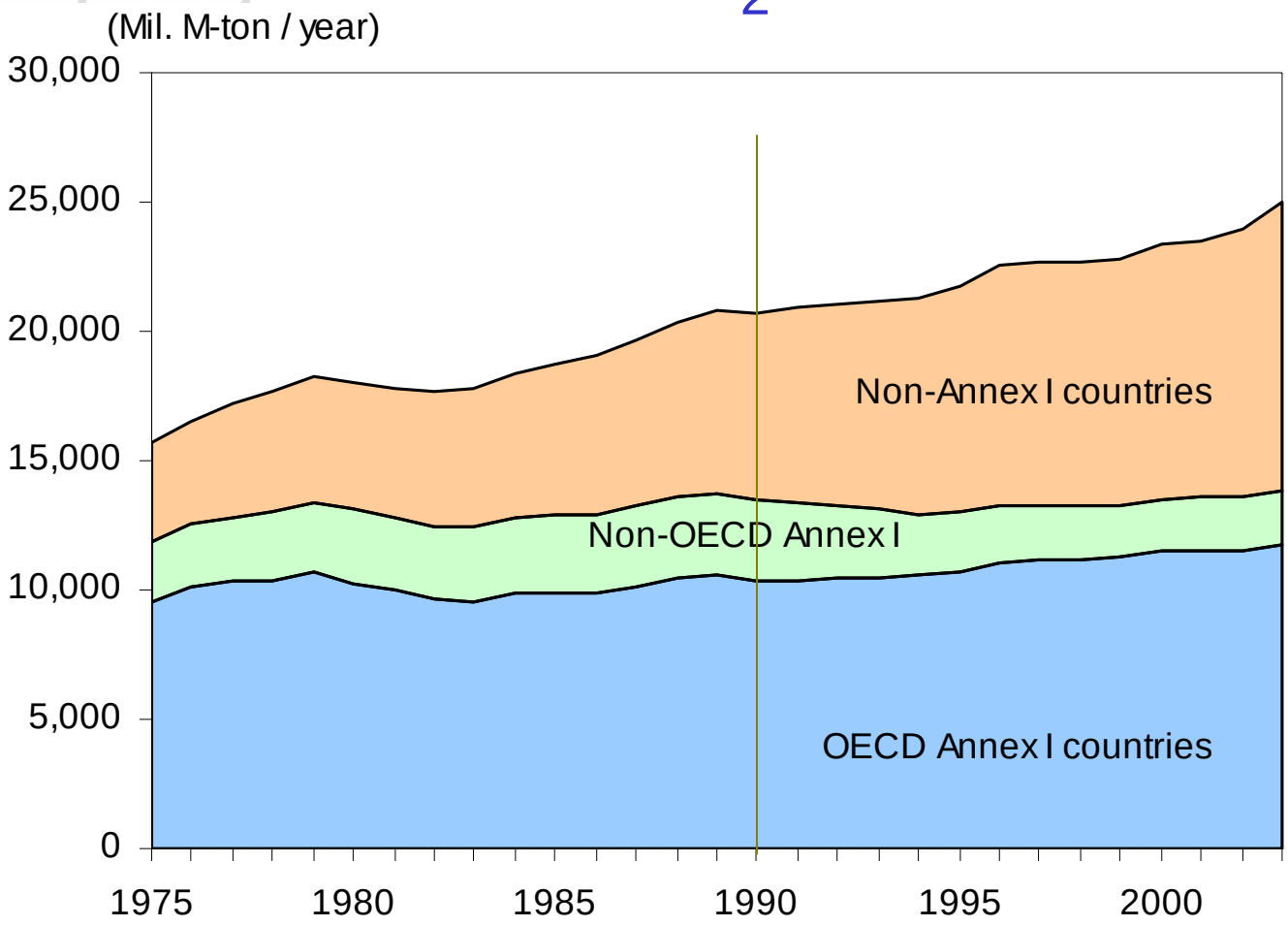
- Analytical framework
- Existing data sources
- Results
- Summary

Background

- Kyoto Protocol requires reduction in domestic greenhouse gas (GHG) emissions relative to a base year by Annex I countries.
- Encourage ‘cleaner’ production processes and promote transfer of technologies, using Joint Implementation & Clean Development Mechanisms.
- However, technological change has many forms: domestic emissions can be reduced by relocating production abroad, and/or by substitution of domestically produced goods with imports.
- Global emissions increase if production processes in Non-Annex I economies are more carbon-intensive than those they displace.

CO_2 emissions



Source: IEA CO_2 Emissions from Fuel Combustion

Croatia is not included for 1975-1989.

Part of Former USSR countries are estimated for 1975-1989.

1990-2003 % change

Annex I: 3.1%
Non-Annex I: 52.6%

CAN 28.6%
FRA 9.6%
DEU -11.6%
JPN 18.6%
ITA 13.3%
UK -3.6%
USA 18.3%
RUS -24.5%

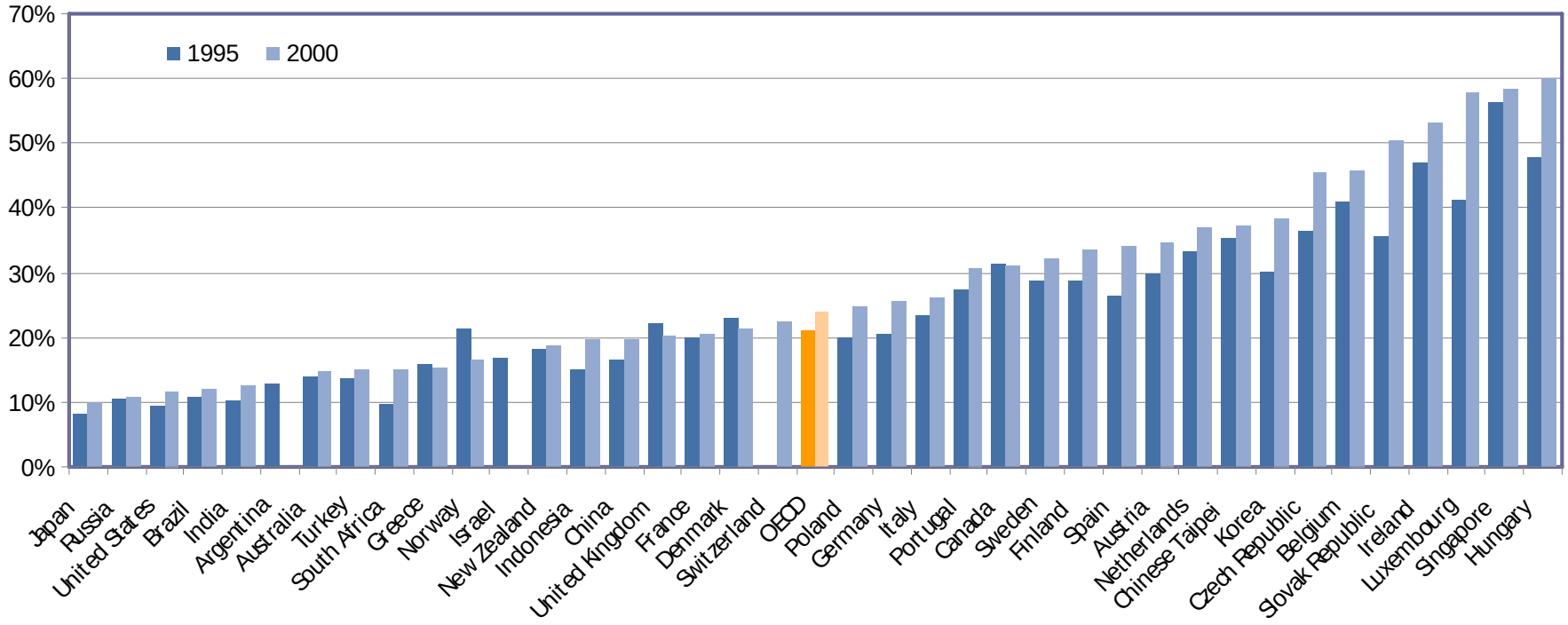
Issues related to CO_2 emissions

- Acceleration of globalisation – international outsourcing, fragmented production, global trade in goods and services etc.
- Increasing CO_2 emissions "embodied" in international trade
- Discrepancies between production based emissions and consumption based emissions
- The CO_2 balance

  = exported emissions– imported emissions

  = production based – consumption based

Import contents of exports (by country)



Source: OECD I-O 2006ed rev.1, De Backer and Yamano (2007)

-Increased in most countries
-Importance of imported goods increased.
-Larger economies have lower values

Studies of international CO_2 leakages

- Single country / Bilateral framework
  - Canada-Japan (Hayami and Nakamura , 2007)
  - China-USA (Shui and Harriss, 2005)
- Inter-country framework
  - G6 countries (Wyckoff and Roop, 1994)
  - Asian Environmental Input-Output tables

  (Hayami et al., 2000)
  - 24 countries for mid 1990s (Ahmad and Wyckoff, OECD, 2003)

OECD studies

- Ahmad and Wyckoff, 2003: combining OECD harmonised Input-Output (I-O) tables, bilateral trade and IEA CO_2 emissions: www.olis.oecd.org/olis/2003doc.nsf/linkto/dsti-doc(2003)15

  Main finding (using 'conservative assumptions'): estimates of CO_2 emissions generated to satisfy domestic demand in the OECD in 1995 were 5% higher than emissions related to production

- Follow up study (*forthcoming*):

  Yamano et al (OECD, Keio University and CRIEPI)

  – Increased country coverage: 41 countries;
  – Two data periods (rather than one)
  – 16 industries + final consumption (as before): agriculture, mining, 11 manufacturing sectors, utilities, construction, transport, other services, and final consumption;
  – Sensitivity simulations.

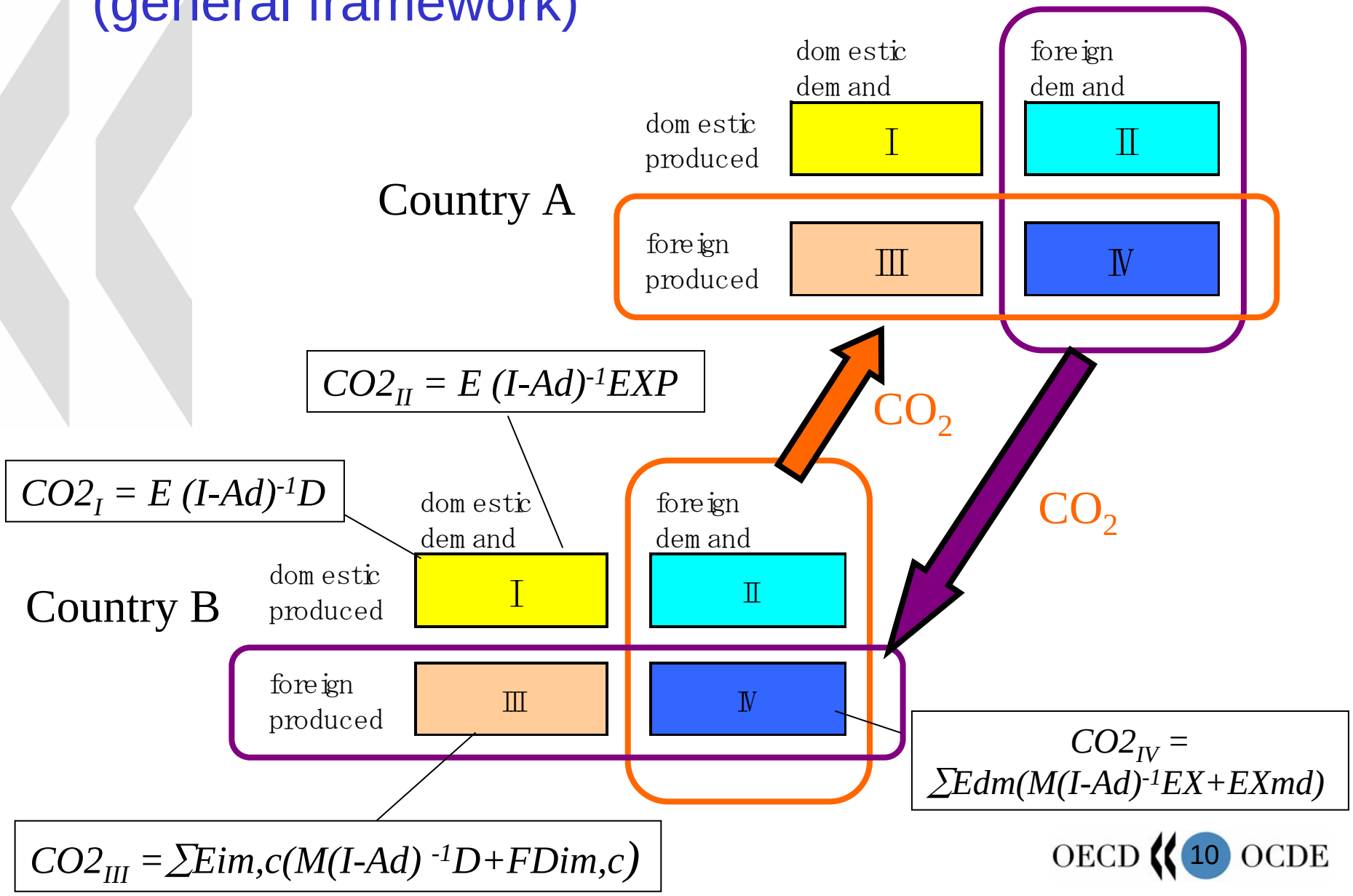
Analytical framework

- Embodied CO_2 emissions include total indirect and direct CO_2 emitted in the production of any product
- Production based and consumption based emissions are explicitly derived:
  - National I-O tables converted to USD are linked by bilateral trade
  - CO_2 emission factors (M-ton / Output) by industry are based on IEA data on CO_2 emissions from fuel combustion
  - CO_2 embodied in domestic consumption and production are calculated by I-O structure (*via Leontief inverse:* $CO2_I = E\ (I\text{-}Ad)^{-1}D$)
  - CO_2 embodied in *exports* and *imports* are eventually derived through iterative simulations.
  - The CO_2 balance

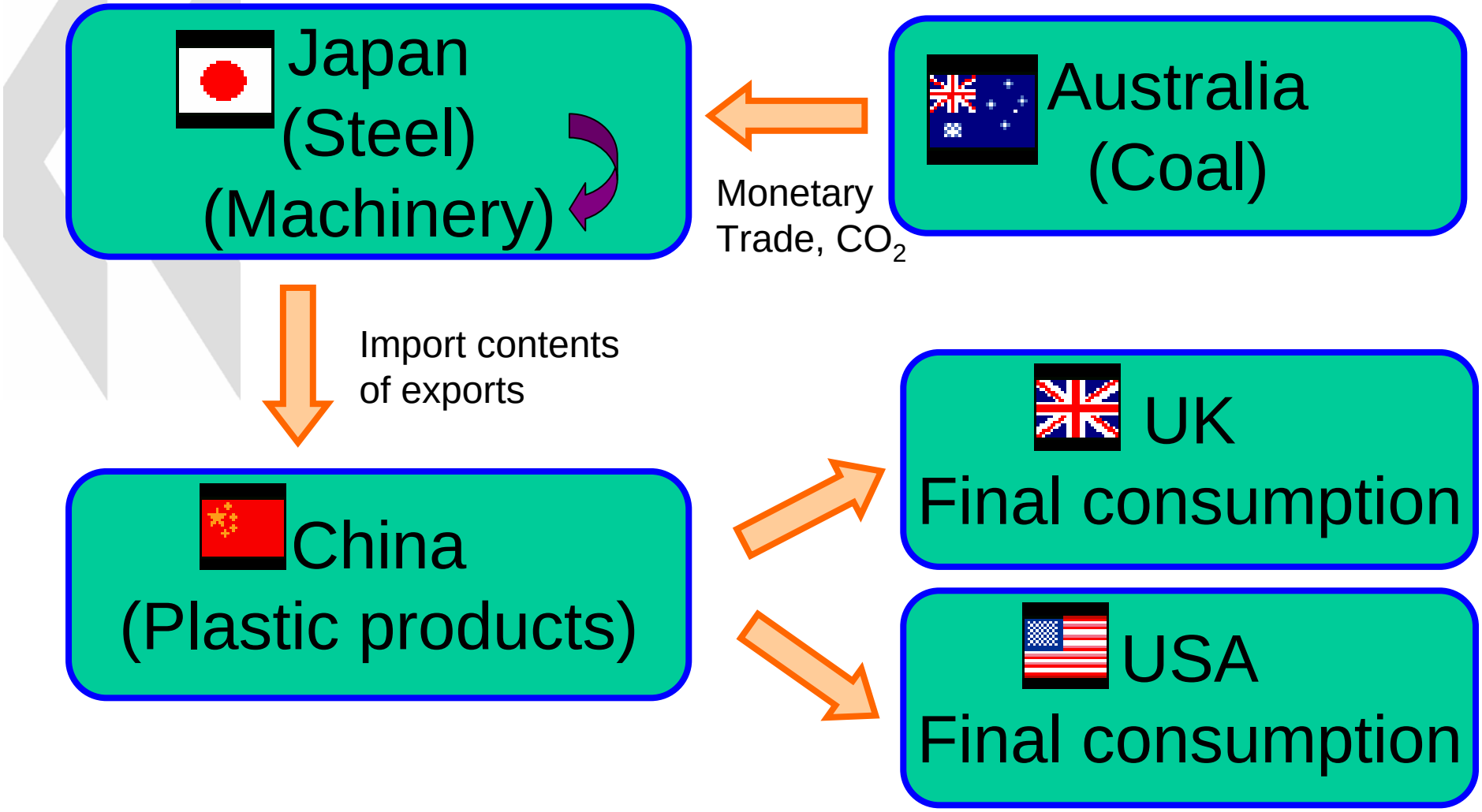
    = exported emissions– imported emissions

    = production based – consumption based

CO_2 embodied in international trade (general framework)



Intercountry-interindustry framework (example)



Existing data sources

	GHG Emissions	Input-Output	Bilateral Trade in goods	Bilateral Trade in services (BoP)
Sources	IEA	NSOs	OECD,UN, Eurostat	IMF, OECD,UN, Eurostat
Sector	Aggregated sectors only	OK for most countries	Very detailed (HS 6-digit)	Not harmonised with Industry classification
Year	Good	Recent years not available	Good	Only recent years
Country coverage	Good	Good	Good	Poor
International comparability	Good	Various formats	Mirror statistics problems (re-exports)	Mirror statistics problems

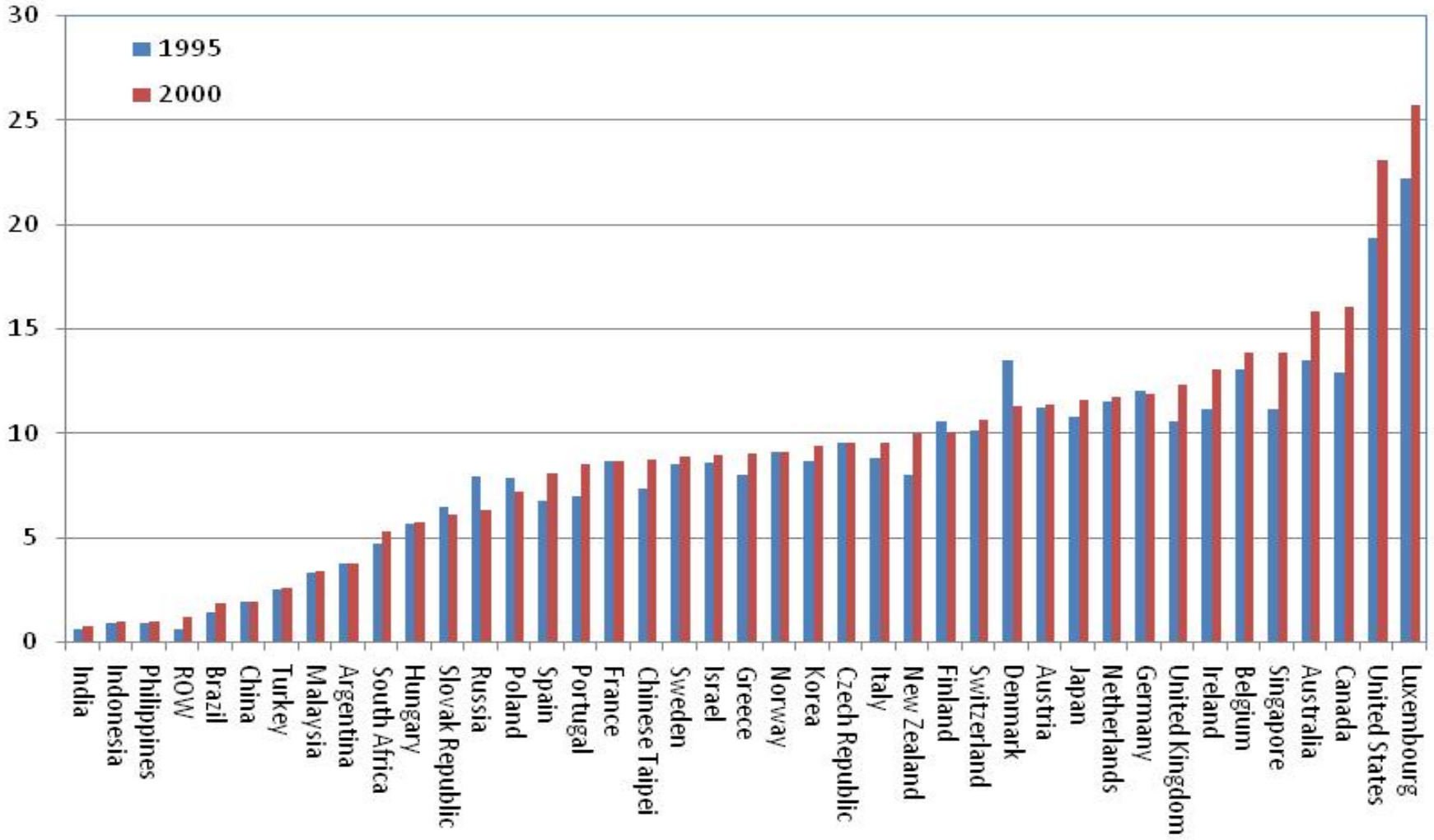
OECD data coverage

- Input-Output
  - Harmonised classification (48 activities based on ISIC Rev.3) and common price valuation
  - 38 countries(95%+ of global GDP and 70%+ of world population) from *OECD I-O 2006ed Rev.1*
  - Other sources
- Bilateral trade of goods
  - OECD STAN BTD (HS product data converted to ISIC Rev.3 classification - *goods producing industries*) supplemented by OECD ITCS, UN Comtrade
- CO_2 emissions from fuel combustion (IEA)
  - 16 industries (limits coverage of embodied CO_2 analyses)

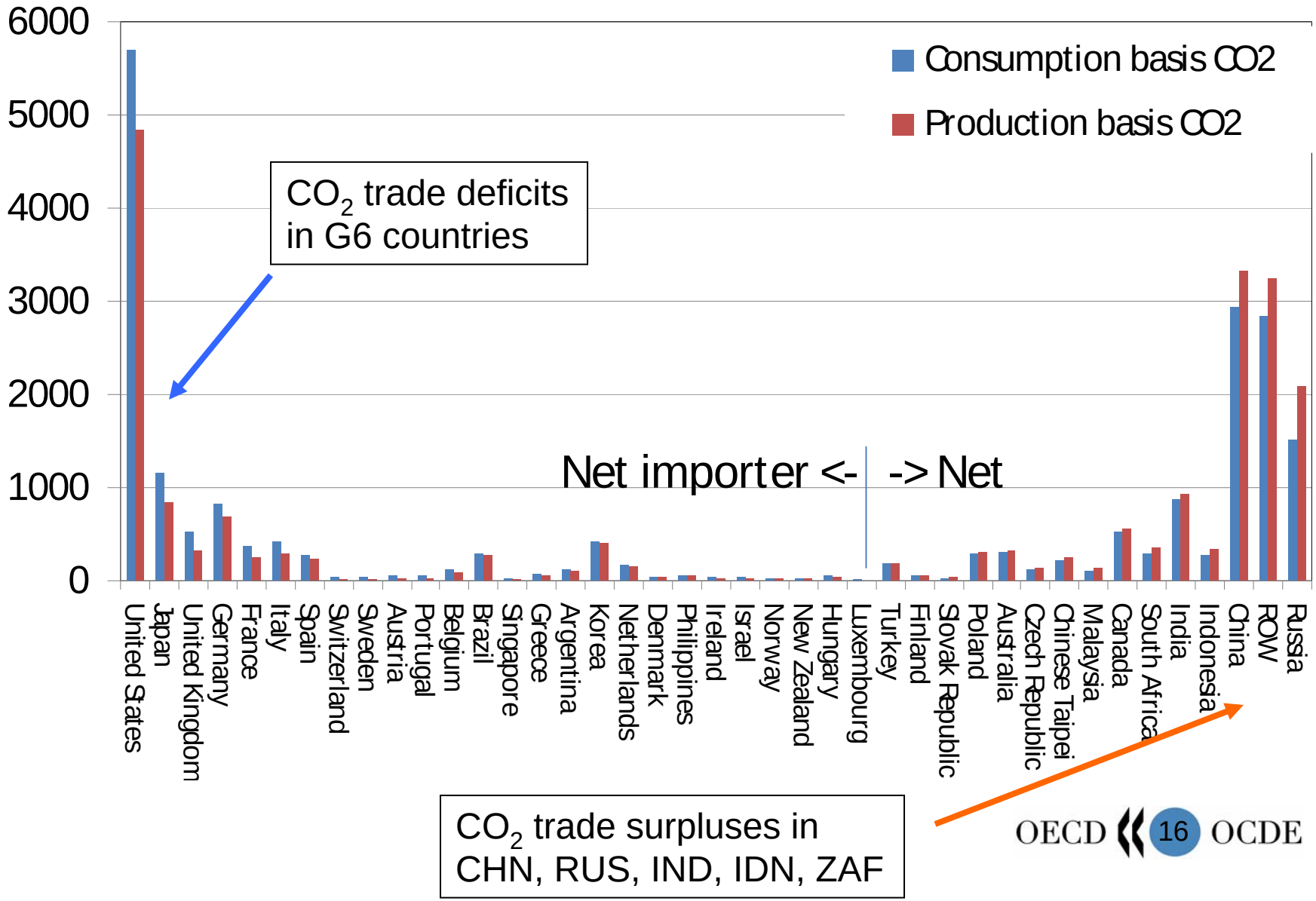
Exogenous and endogenous variables

- Exogenously given
  - CO_2 emission factors by industry
  - Ratio of imported to domestic sources
  - International trade pattern (procurement patterns) by industry
  - Final demand in each country is fixed
- Endogenously determined
  - CO_2 embodied in imports and exports
  - Economic variables (output, import, etc)

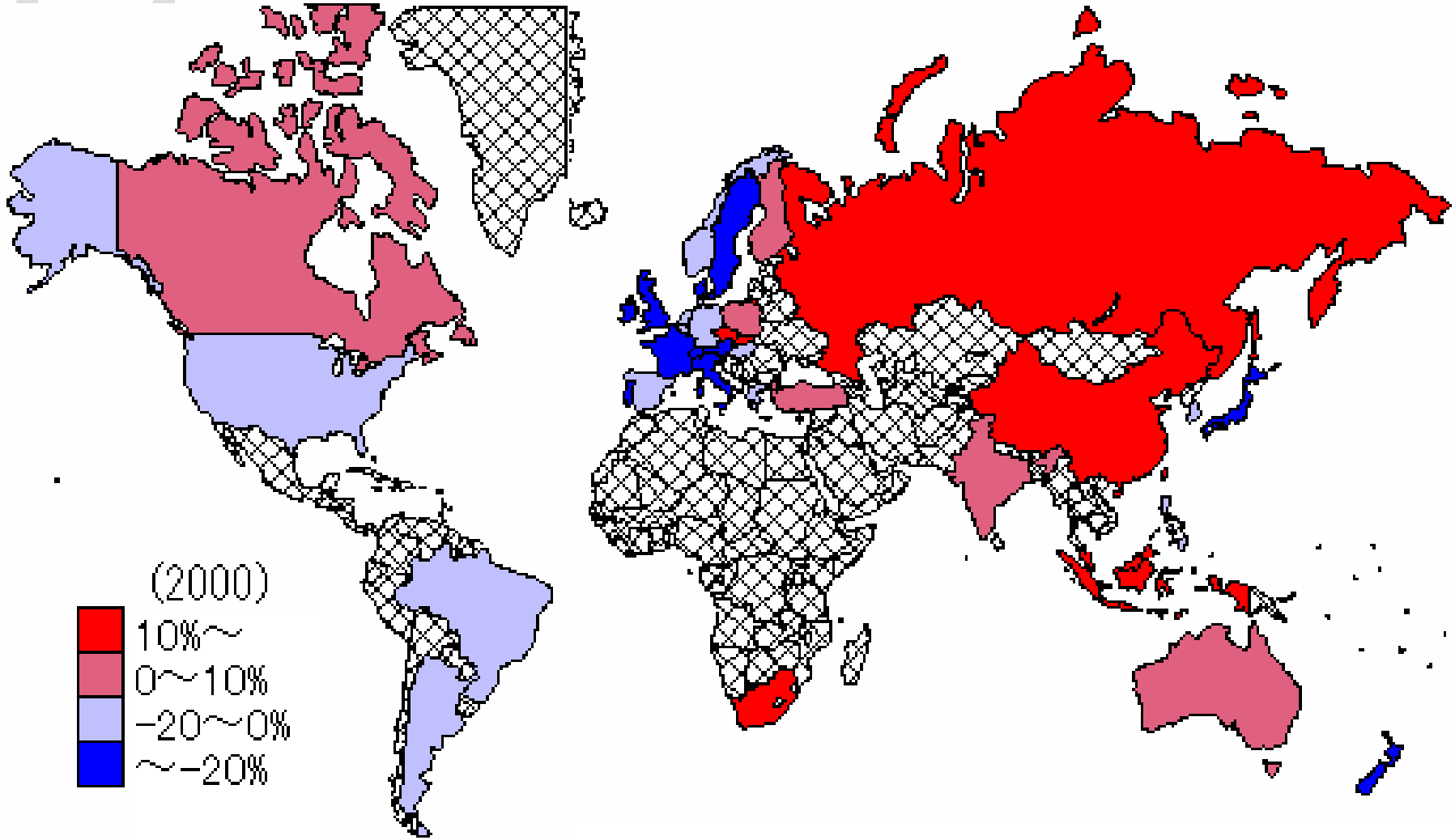
Consumption based emissions per capita mid-90s and early-00s



Consumption and production based CO_2 emissions (early 2000s)



CO_2 trade balance as % of production-based emission



The trade deficit in CO_2 embodied in trade has increased in most OECD countries as consumption has increased.

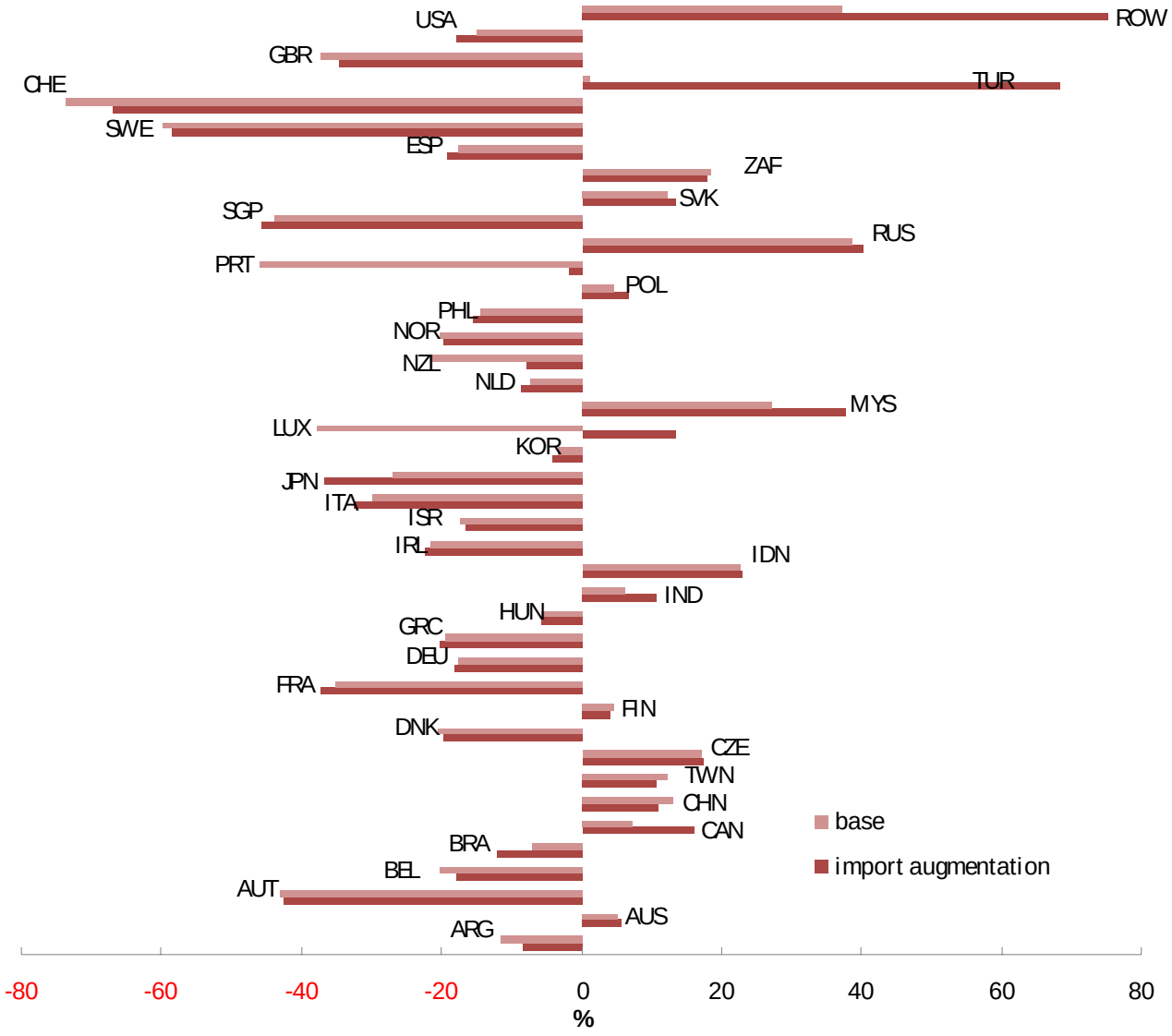
Measurement results

- In the late 1990s, the consumption based emissions increased in 20 OECD countries
- Two-thirds of world increases in emissions originated in non-OECD economies
- Half of the global increase is due to OECD consumption
- In the early 2000s, the G6 economies (G7- Canada) were net importers of CO_2.
- Five major non-OECD countries (Russia, China, India, Indonesia, South Africa) account for 80% of CO_2 trade surplus.

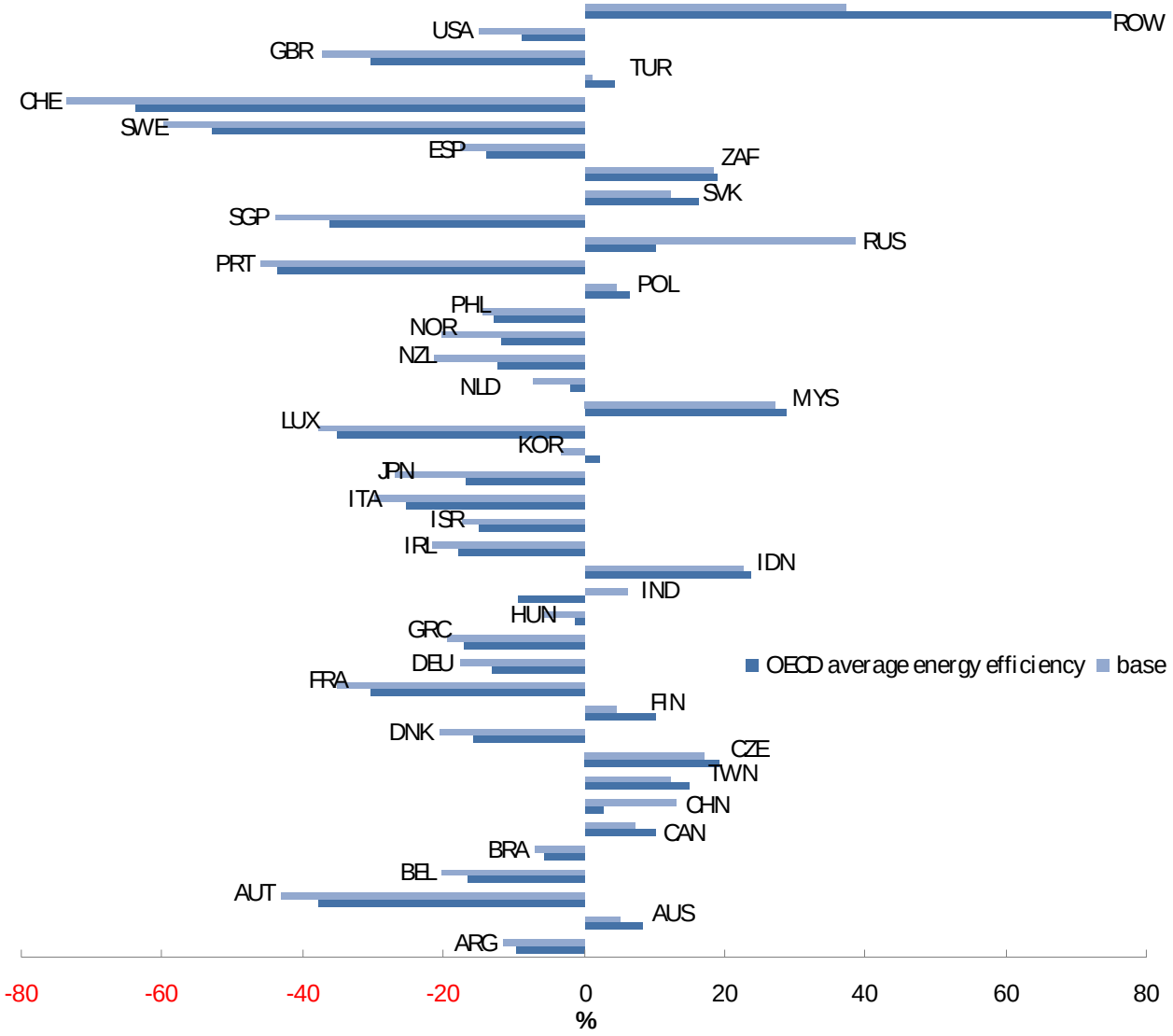
Simulation examples

1. Base case for the mid 1990s and the early 2000s
2. Increase in import coefficients
   - The sensitivity analysis on changes in import coefficients is available for the globalisation effects
3. Increase in energy efficiency
   - Increased energy efficiency in non-member country reduces the global emissions and CO_2 trade

1 . Increase in import coefficients (5%)
(% of production based emission, early2000s)



2 . Increase in energy efficiency (% of production based emission, early2000s)



Are NSO statistics adequate?

Data wish list

- Input-Output
  - More timely Supply-Use / I-O tables
  - More industry detail for some countries
  - Common price valuation
  - Investment flows
- Bilateral trade (goods)
  - Improved information to address mirror statistics problems and better capture trade from recent production:
    - Data on re-exports (a significant % of exports for some countries)
    - Composition of 'un-allocated' trade (i.e. HS 99 .. n.e.c.)
    - Better identification of trade in scrap, waste and second-hand goods
    - Identification of exports from recycling industry
- Bilateral trade (services)
  - Improved country and time series coverage
  - Links to industry classification
- CO_2 (and other GHG) emissions - more industry detail
- Improved measures of transport emissions
- Industry specific conversion rates (PPPs)

Subject of OECD project to adjust trade data for linking I-O tables

Summary

- Despite limitations of the underlying data, this methodology provides an important diagnostic tool for understanding dynamics of worldwide CO_2 emissions
- The methodology can be applied to other international embodied analyses e.g. other GHG, virtual water, ecological footprint, technology spillovers (embodied R&D / innovation / skills) etc.
- Analyses would benefit significantly from improved data sources

Thank you

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For further reading

- Basic overview of use of I-O tables - http://www.oecd.org/dataoecd/6/34/37349386.pdf
- Description of latest version of OECD I-O database - http://www.oecd.org/dataoecd/46/54/37585924.pdf
- Measuring globalisation with I-O tables - http://www.oecd.org/dataoecd/41/18/39936529.pdf
- Embodied CO_2 - http://www.olis.oecd.org/olis/2003doc.nsf/linkto/dsti-doc(2003)15
- Datasources
  - www.oecd.org/sti/btd
  - www.oecd.org/sti/inputoutput