INSTITUTO SUPERIOR TÉCNICO
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The Income Perspective in Environmental Responsibility

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Introduction

Current climate policy aims at achieving an **international agreement for the reduction of greenhouse gas (GHG) emissions**
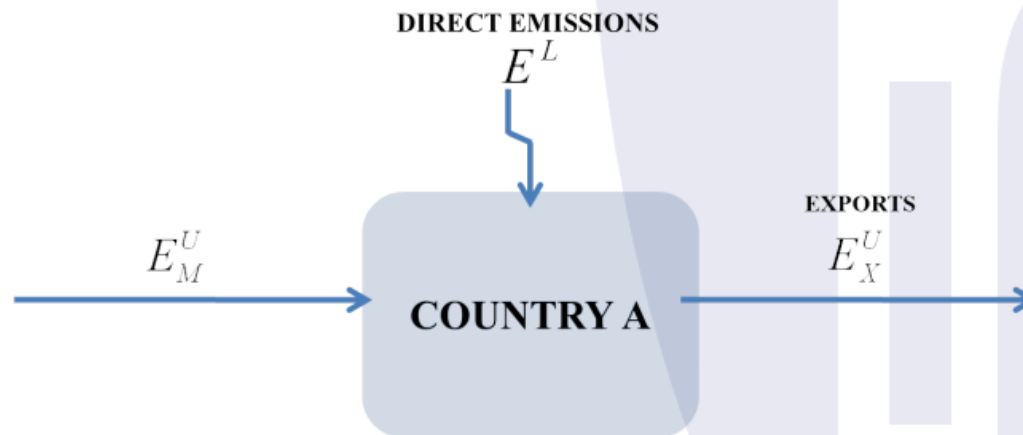
Carbon accounting

For that it is necessary to determine 'who is responsible for what'. It is commonly accepted that who derives an economic benefit from emissions should be responsible for them.

Territorial accounting - Direct emissions

DIRECT EMISSIONS

$$E^L$$
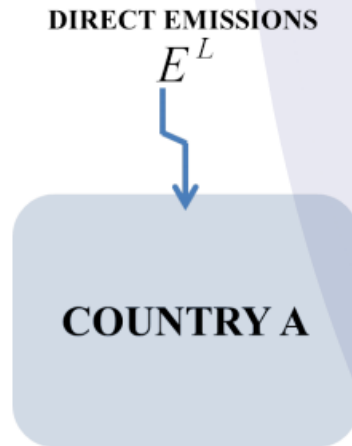
COUNTRY A

This is the type of accounting followed by Kyoto protocol. According to it a country is responsible for the **direct emissions** generated within its geographical borders.

Consumption-based accounting - Upstream emissions

DIRECT EMISSIONS
$$E^L$$

$$E_M^U \longrightarrow \boxed{\text{COUNTRY A}} \longrightarrow E_X^U \quad \text{EXPORTS}$$
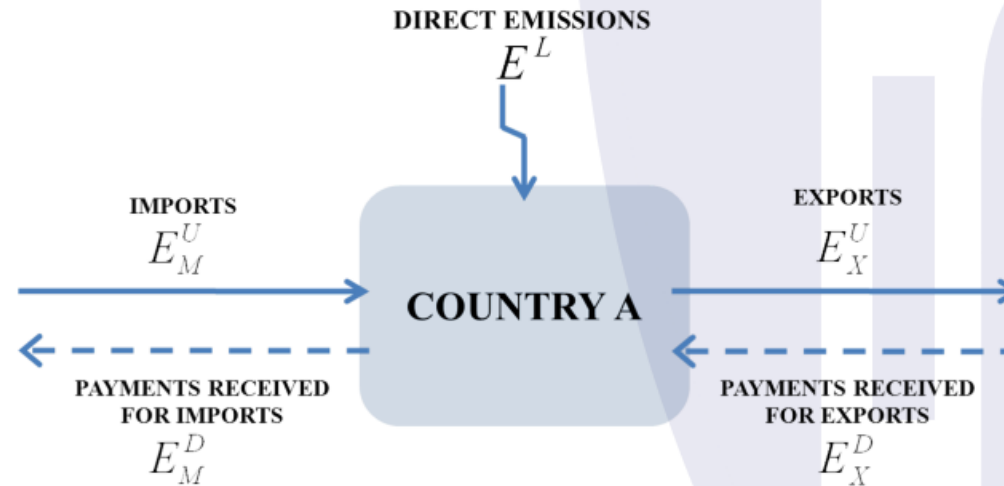
According to this type of accounting countries should hold responsibility for the emissions **embodied in their final demand or upstream emissions**:

$$E^U = E^L + E_M^U - E_X^U$$

Rodrigues, J., Marques, A., Domingos, T. Carbon Responsibility and Embodied Emissions - Theory and Measurement (Routledge, London, UK, 2010).

Income-based accounting - Downstream emissions

According to this type of accounting countries should hold responsibility for the emissions **embodied in their income or downstream emissions**:

$$E^D = E^L + E^D_X - E^D_M$$

Rodrigues, J., Marques, A., Domingos, T. Carbon Responsibility and Embodied Emissions - Theory and Measurement (Routledge, London, UK, 2010).

Data

We computed upstream and downstream emissions through a multi-regional input-output model, based on GTAP database, with a dissagregation level of 87 countries and 57 sectors. Results were aggregated in 6 world regions and 11 sectors.

- Developed Economies
- Fossil Fuel Exporters
- Asia
- Eastern Europe
- Latin America
- Africa

- Construction and dwellings
- Fossil fuels
- Electricity
- Food
- Clothing
- Forest and forest products
- Minerals and metals
- Manufactured products
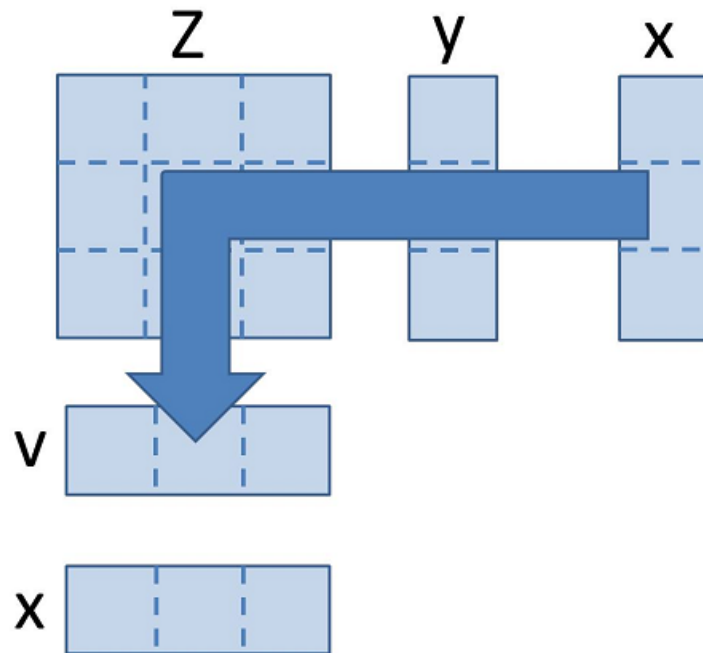- Transport
- Services
- Trade

Input-output model
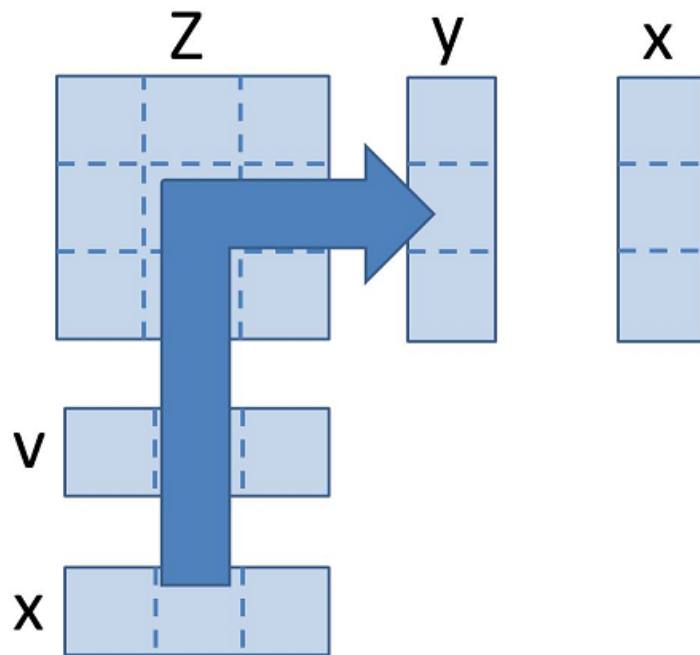
$$e^U = e^L + (E^U)' 1$$

We have determined emissions embodied in final demand, using the Leontief inverse.

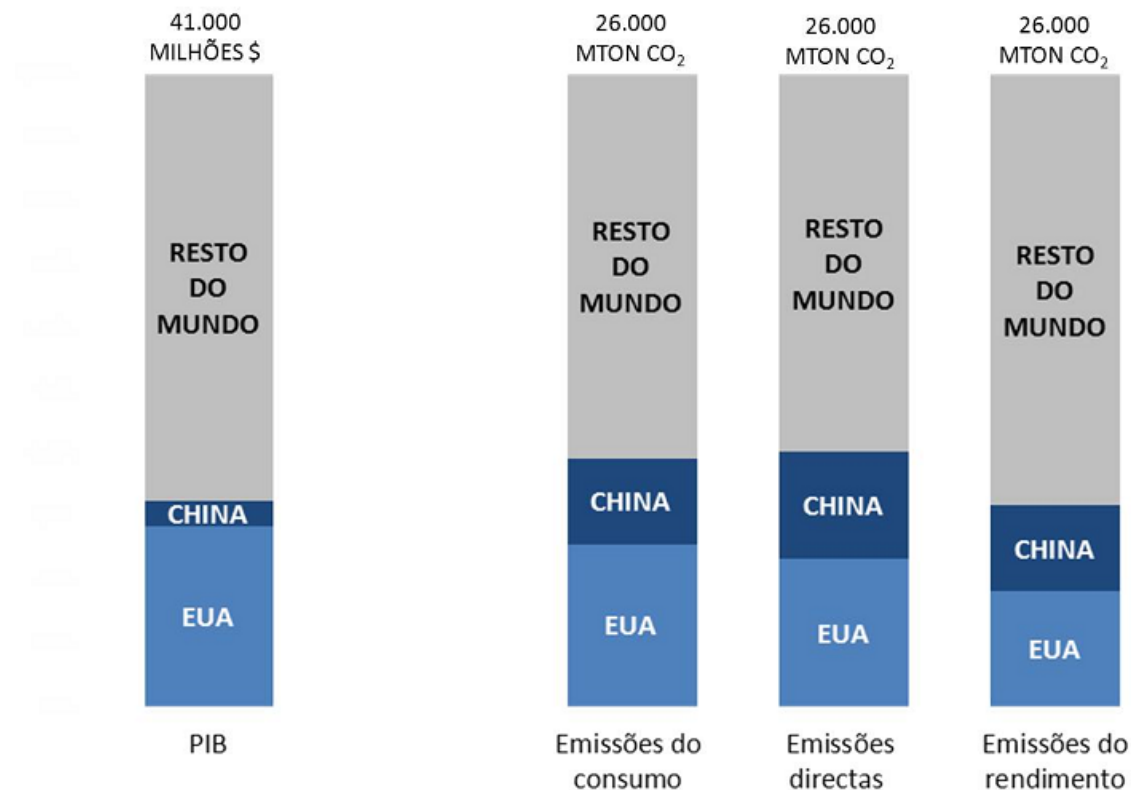# Input-output model

$$e^D = e^L + E^D 1$$
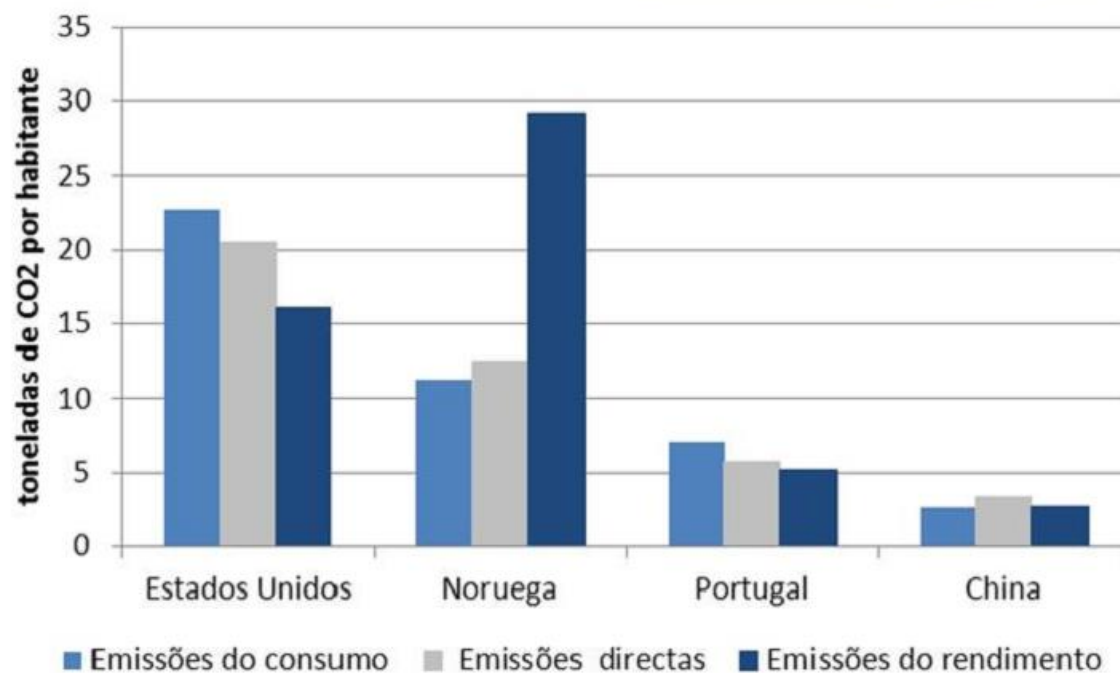
We have determined emissions enabled by value added or income, using the Ghosh inverse.

Direct, embodied and enabled emissions

41.000
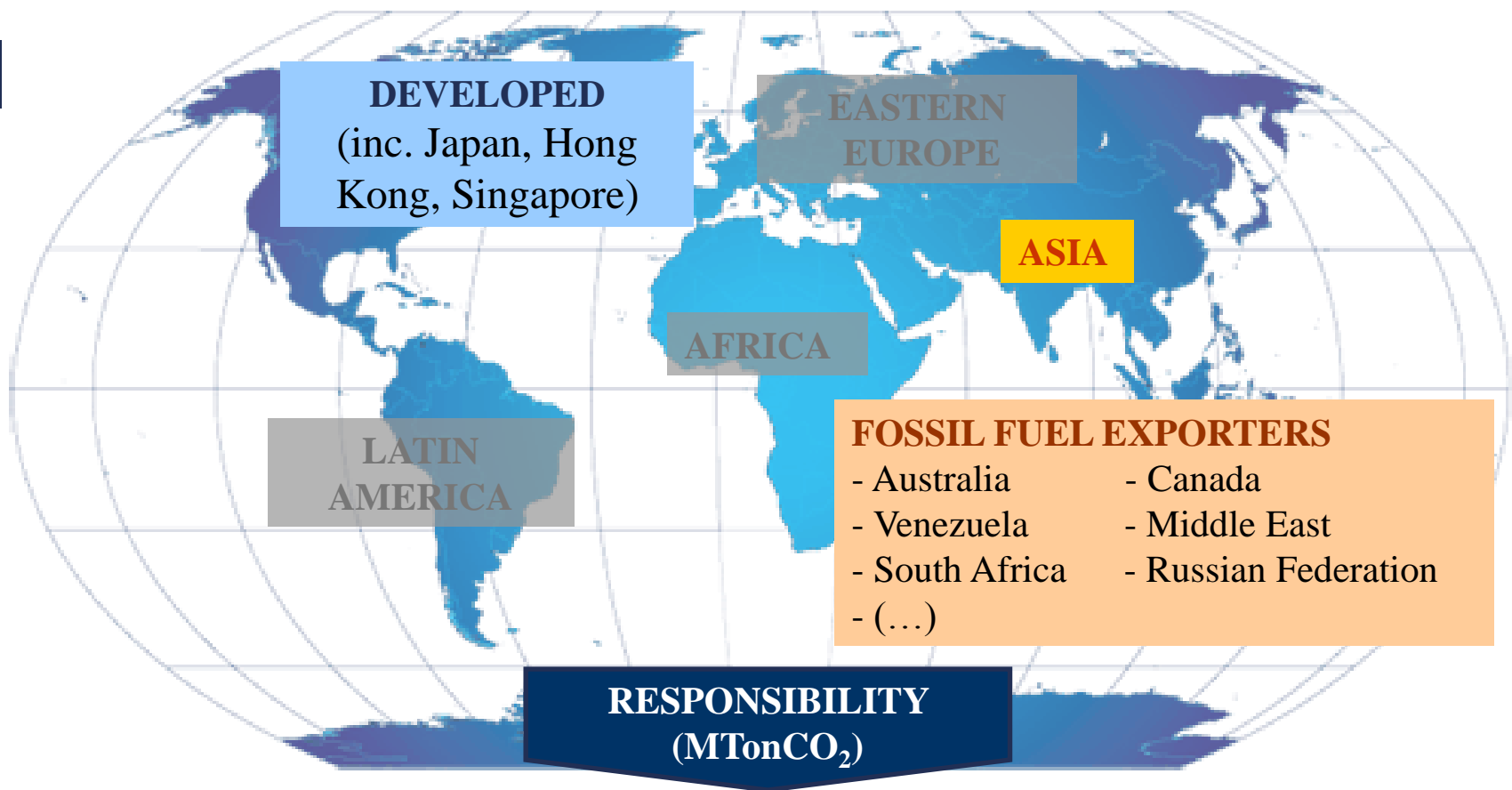MILHÕES $

26.000
MTON CO_2

26.000
MTON CO_2

26.000
MTON CO_2

RESTO DO MUNDO

CHINA

EUA

PIB

Emissões do consumo

Emissões directas

Emissões do rendimento

Direct, embodied and enabled emissions

World regions

DEVELOPED
(inc. Japan, Hong Kong, Singapore)

EASTERN EUROPE

ASIA

AFRICA

LATIN AMERICA

FOSSIL FUEL EXPORTERS
- Australia   - Canada
- Venezuela   - Middle East
- South Africa   - Russian Federation
- (…)

RESPONSIBILITY (MTonCO$_2$)
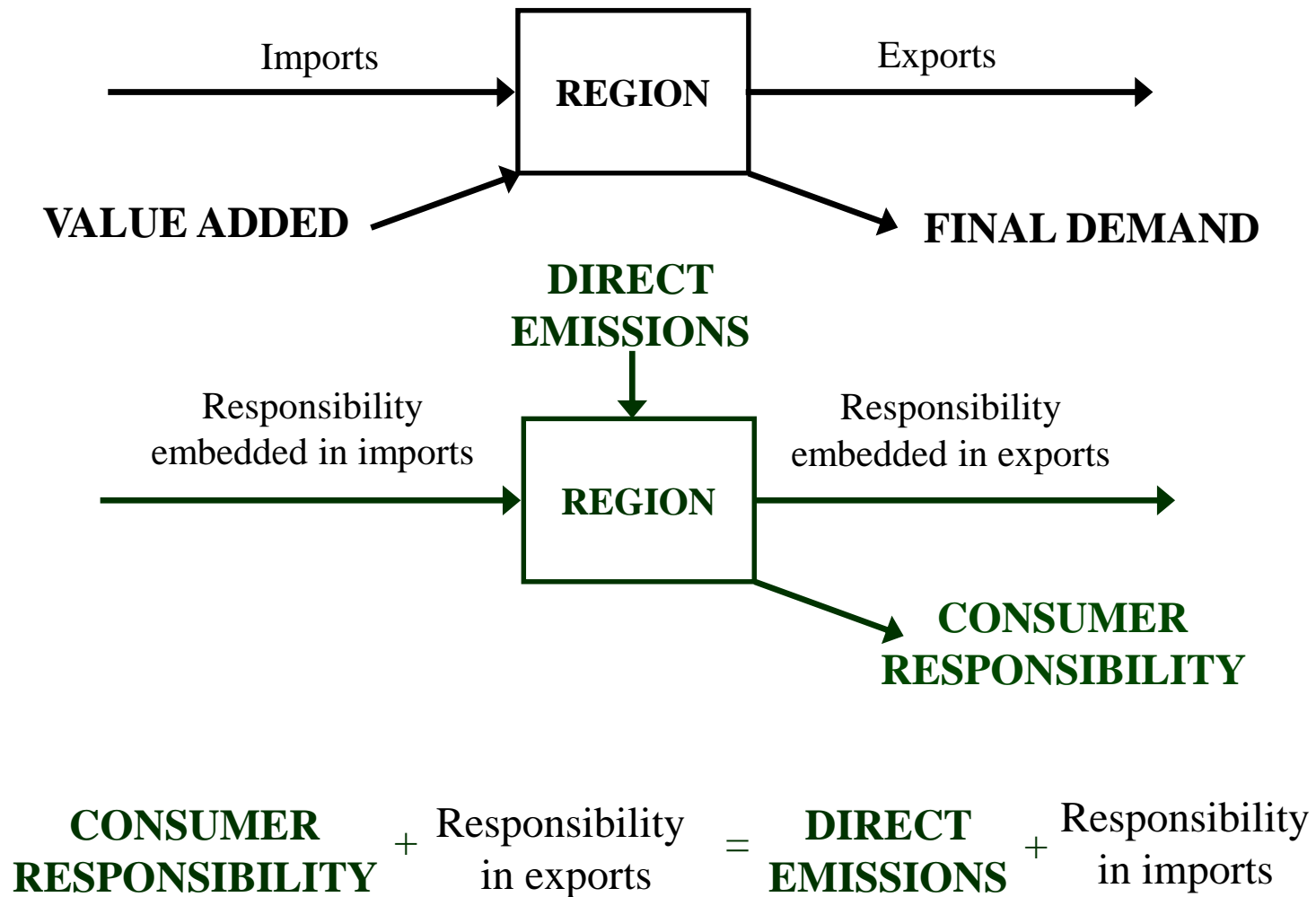
	DIRECT	INT. TRADE
World	24,750	4,996
A+D+F	21,720	3,360

Consumer Responsibility

$$\textbf{CONSUMER RESPONSIBILITY} + \text{Responsibility in exports} = \textbf{DIRECT EMISSIONS} + \text{Responsibility in imports}$$
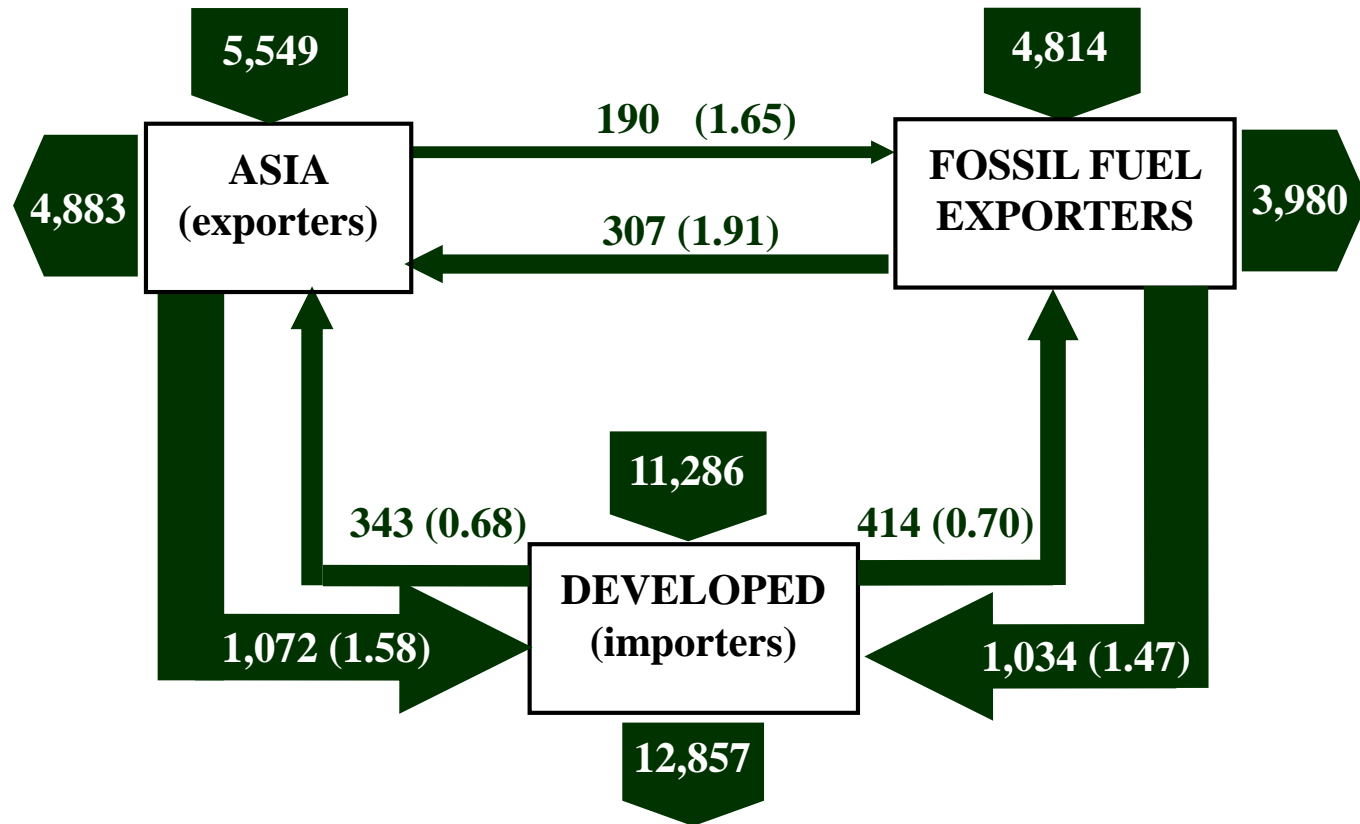
[1]Rodrigues, J, Domingos, T, Giljum, S, Schneider, F. Designing an Indicator of Environmental Responsibility. Ecological Economics 59, 2006: 256-266.

5,549

190   (1.65)

4,814

4,883   **ASIA (exporters)**   **307 (1.91)**   **FOSSIL FUEL EXPORTERS**   **3,980**

11,286

343 (0.68)   **414 (0.70)**

DEVELOPED (importers)

1,072 (1.58)   **1,034 (1.47)**

12,857

CONSUMER RESPONSIBILITY _ **DIRECT EMISSIONS** = Responsibility in imports _ Responsibility in exports

Income responsibility

PRODUCER RESPONSIBILITY + Responsibility in payment for imports = DIRECT EMISSIONS + Responsibility in payment for exports

[1]Rodrigues, J, Domingos, T, Giljum, S, Schneider, F. Designing an Indicator of Environmental Responsibility. Ecological Economics 59, 2006: 256-266.

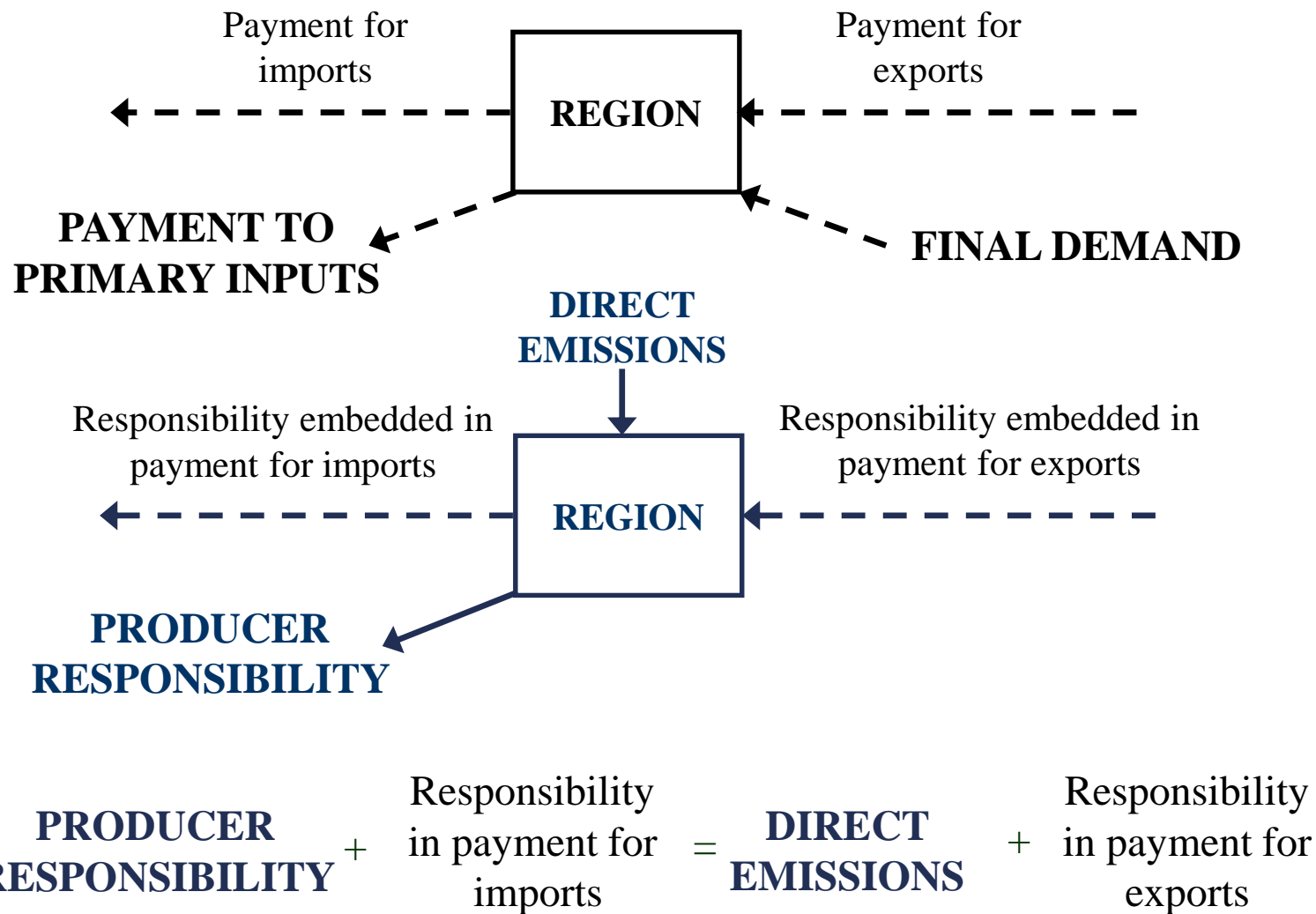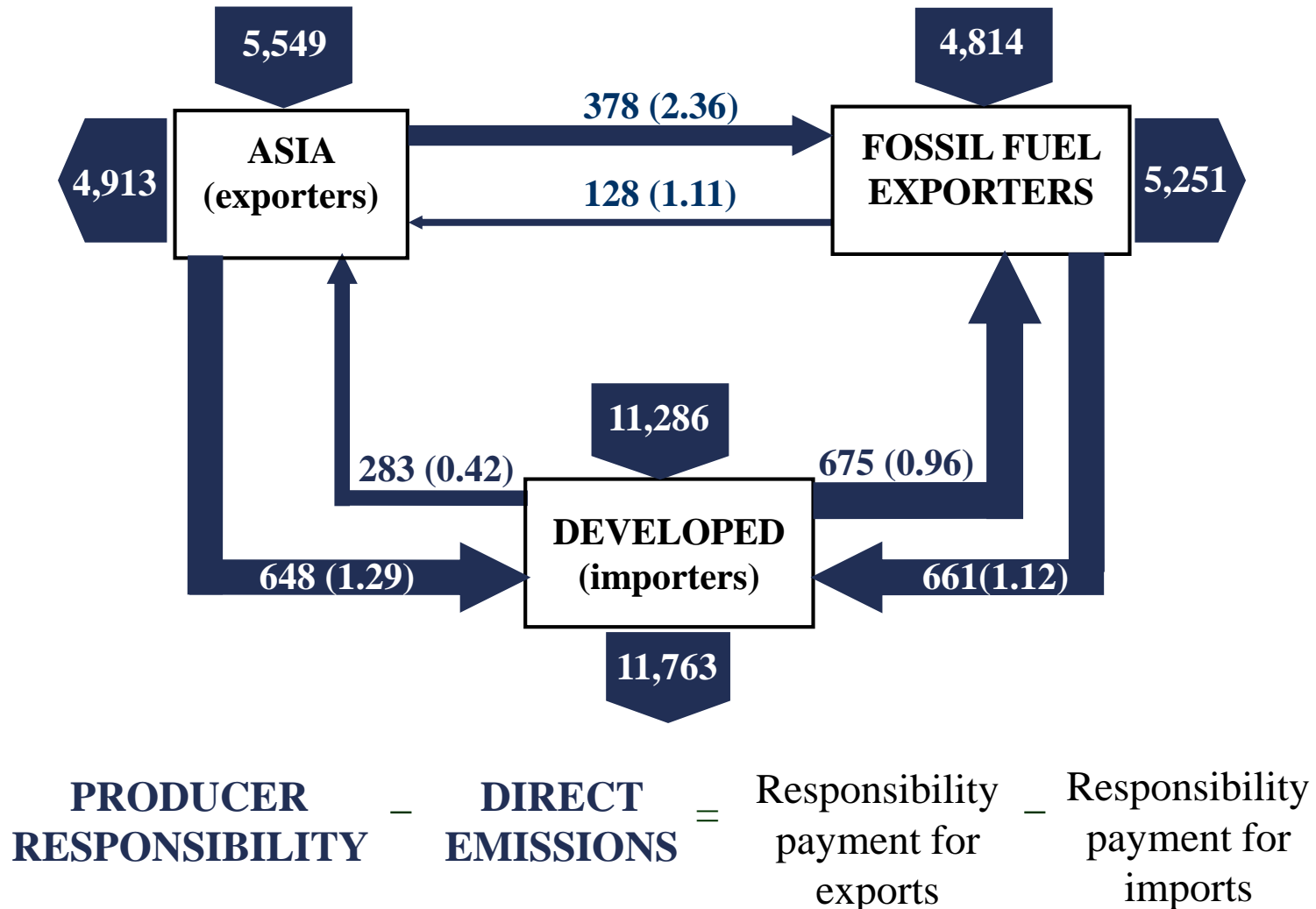# Transfer of producer responsibility in inter-regional trade (MtonCO$_2$)

5,549

4,814

378 (2.36)

4,913 **ASIA (exporters)** 5,251

128 (1.11)

FOSSIL FUEL EXPORTERS

11,286

283 (0.42)

675 (0.96)

DEVELOPED (importers)

648 (1.29)

661 (1.12)

11,763

PRODUCER RESPONSIBILITY − **DIRECT EMISSIONS** = Responsibility payment for exports − Responsibility payment for imports
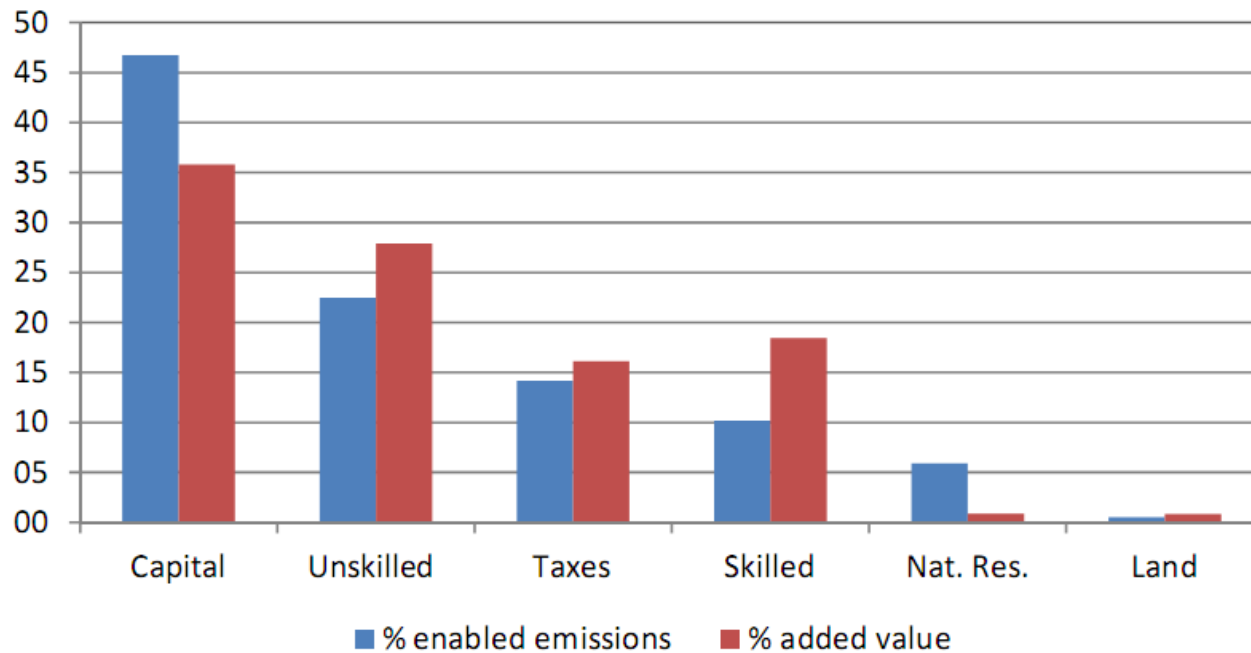
Upstream carbon trade balance (in Mt CO_2)
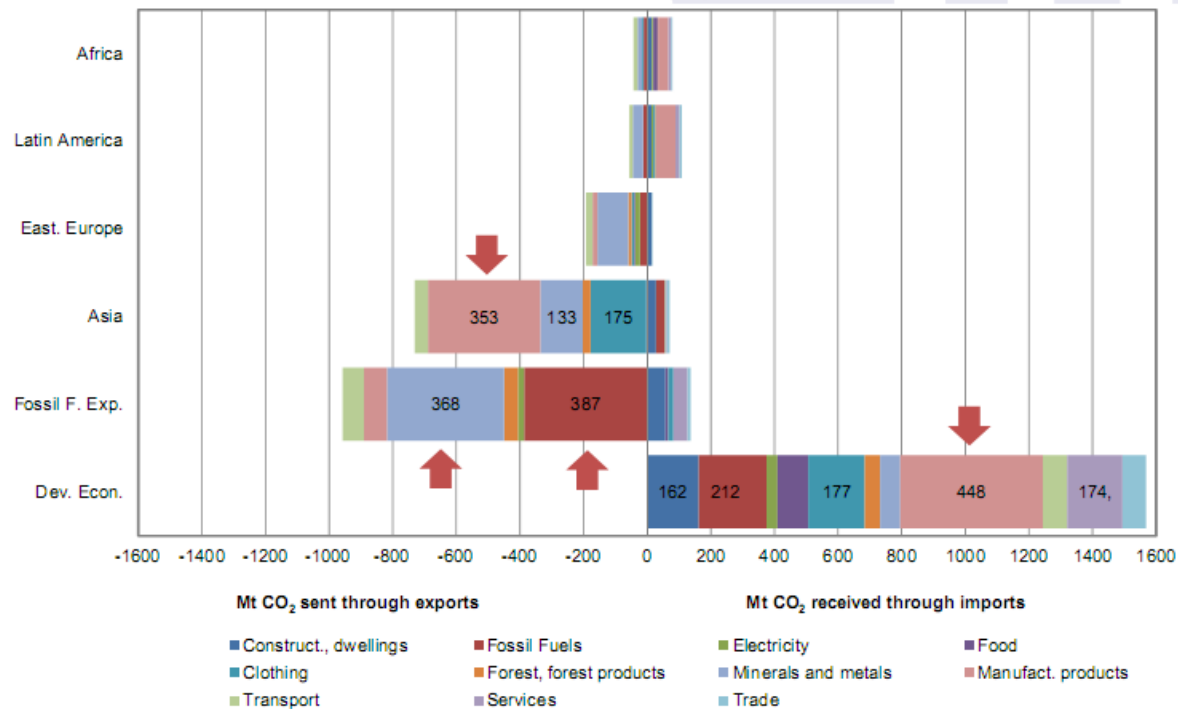
Downstream carbon trade balance (in Mt CO_2)
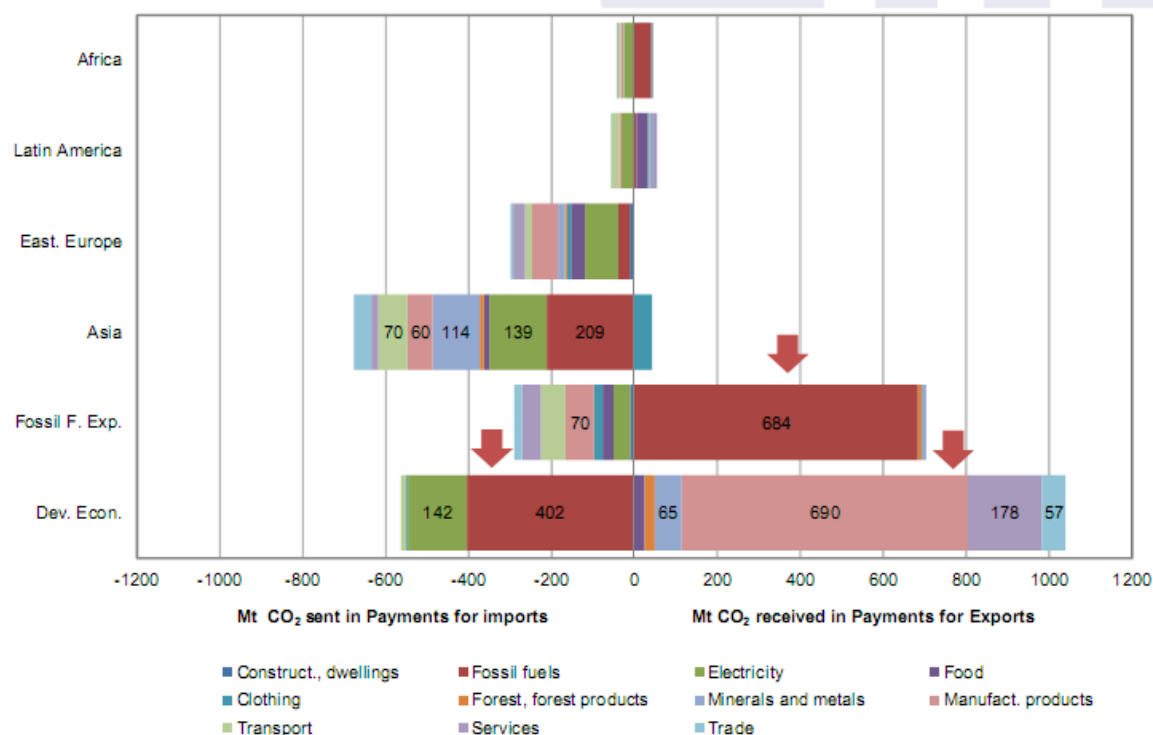
Emissions enabled by primary factors of production (in % of world total)

A Formal Approach: Six Properties

1. Additivity: the responsibility of two countries is equal to the sum of each countries' responsibility

2. Normalisation: the carbon responsibility of the world is equal to world emissions

3. Monotonicity: *ceteribus paribus,* a country's responsibility increases or stays constant if the direct emissions of any sector in any country increase.

4. Locality: a country's responsibility is just a function of the responsibility flows entering and leaving it.

5. Economic Causality: all economic flows leaving (entering) a sector have the same upstream (downstream) intensity

6. Symmetry: two countries with symmetric upstream and downstream responsibility flows have the same responsibility

A Formal Approach: Result

Carbon Responsibility =

$$\frac{1}{2}\text{Consumer Responsibility} + \frac{1}{2}\text{Income Responsibility}$$

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