The Carbon Responsibility of Nations

Alexandra Marques, João Rodrigues, Tiago Domingos

Instituto Superior Técnico
Lisbon, Portugal
tdomingos@ist.utl.pt

May 10, 2012

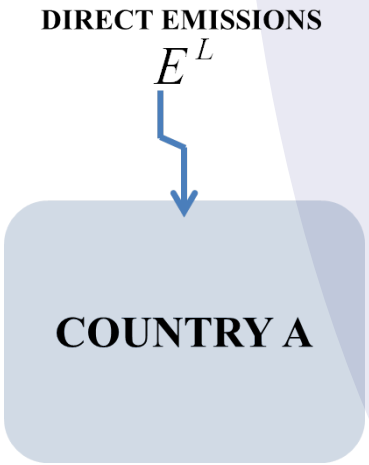
Introduction

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

Carbon accounting

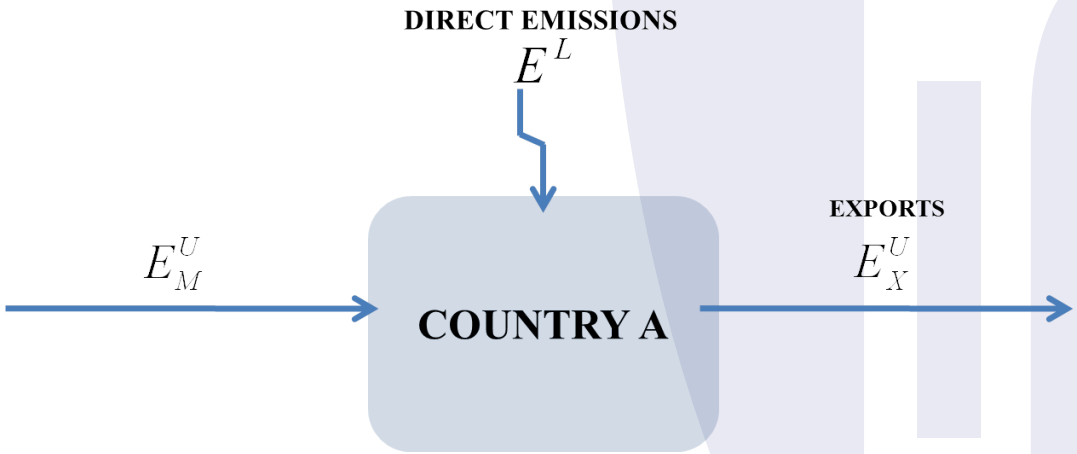
For that it is necessary to determine 'who is responsible for what'. It is commonly accepted that who derives an economic benefit from emissions should be responsible for them.

Territorial accounting - Direct emissions



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

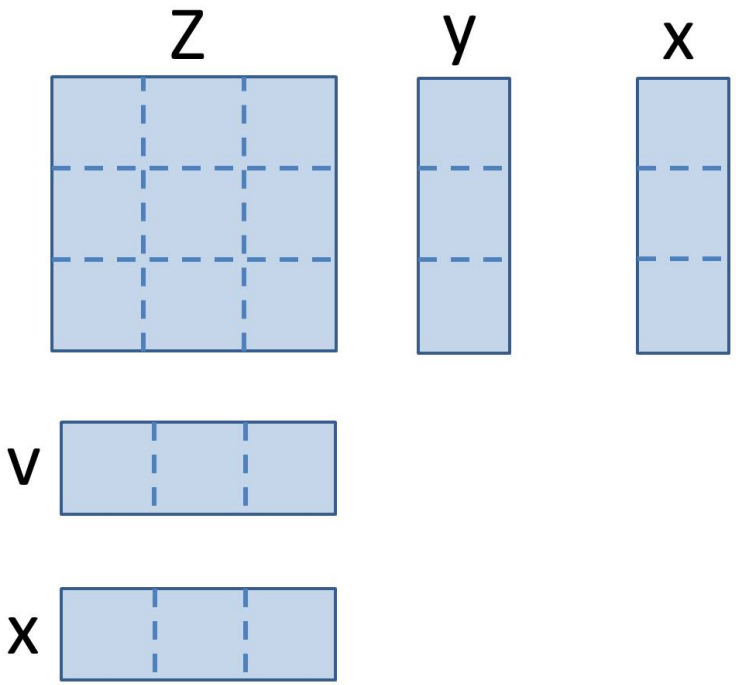


According to this type of accounting countries should hold responsibility for the emissions **embodied in their final demand or upstream emissions**:

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

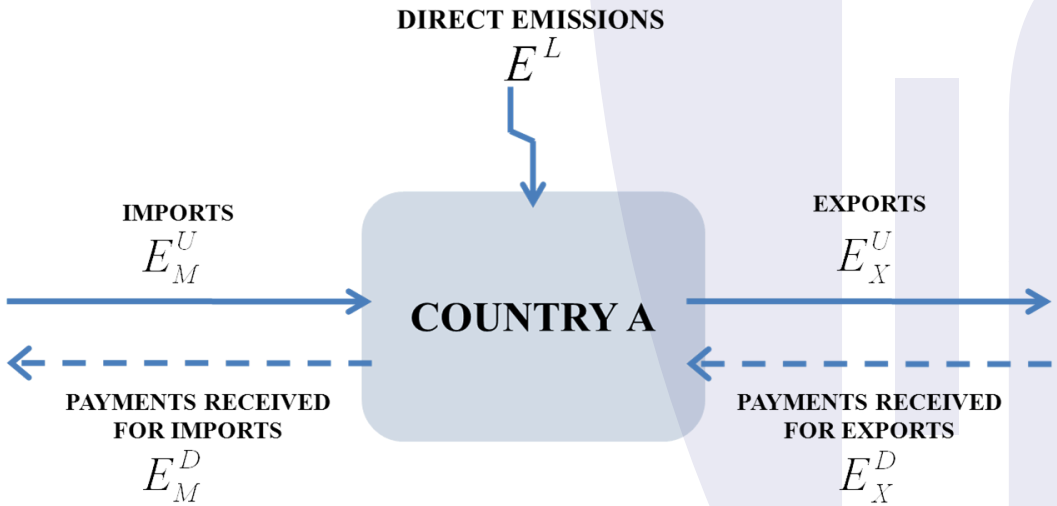
Rodrigues, J., Marques, A., Domingos, T. Carbon Responsibility and Embodied Emissions - Theory and Measurement (Routledge, London, UK, 2010).

Input-output model



$$x = Z1 + y$$

Income-based accounting - Downstream emissions

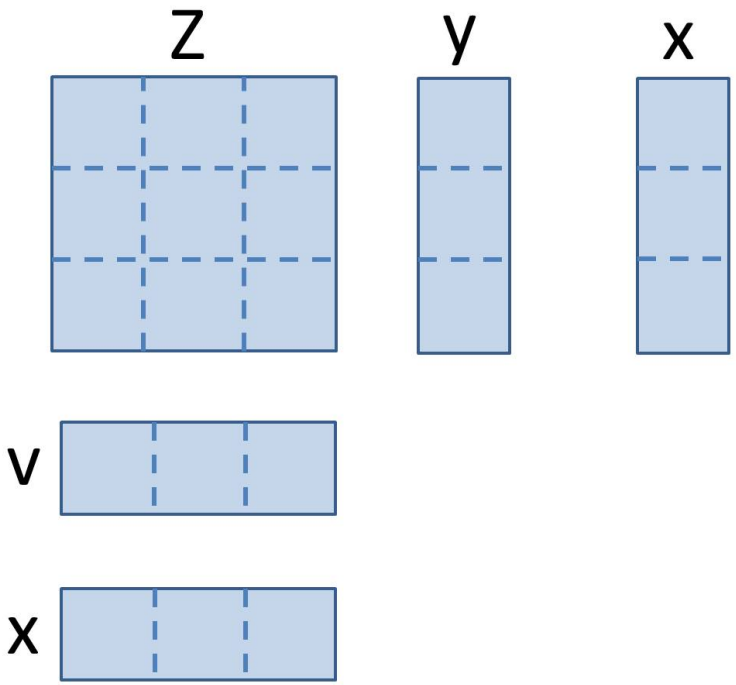


According to this type of accounting countries should hold responsibility for the emissions **embodied in their income or downstream emissions**:

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

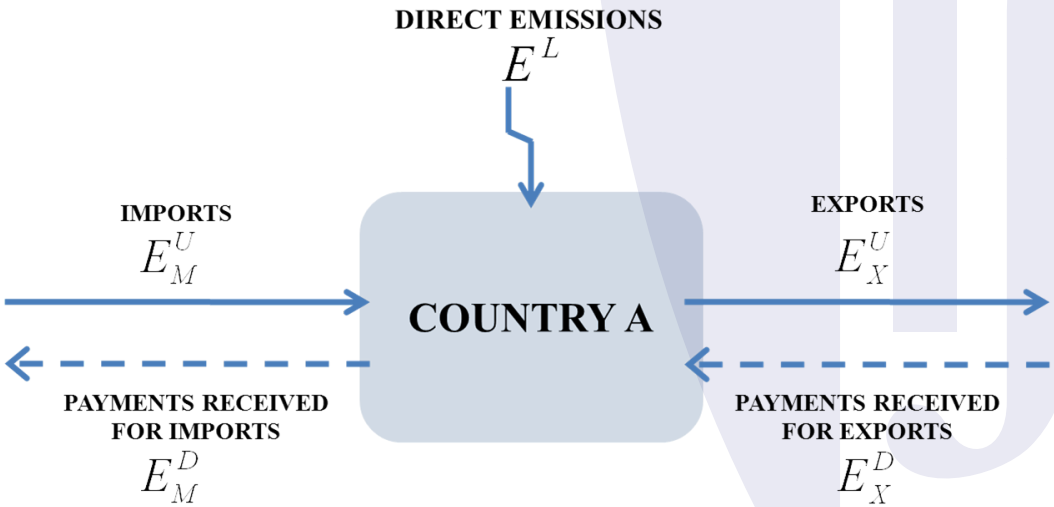
Rodrigues, J., Marques, A., Domingos, T. Carbon Responsibility and Embodied Emissions - Theory and Measurement (Routledge, London, UK, 2010).

Input-output model



$$\mathbf{x} = \mathbf{Z}'\mathbf{1} + \mathbf{v}'$$

Objective



Here we quantify the emissions embodied in final demand and enabled by primary factors of production.

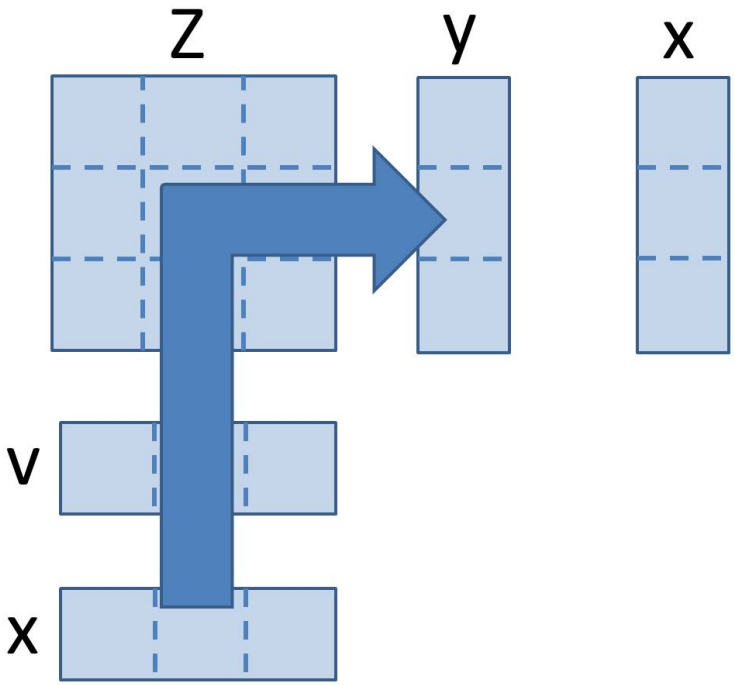
Data

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

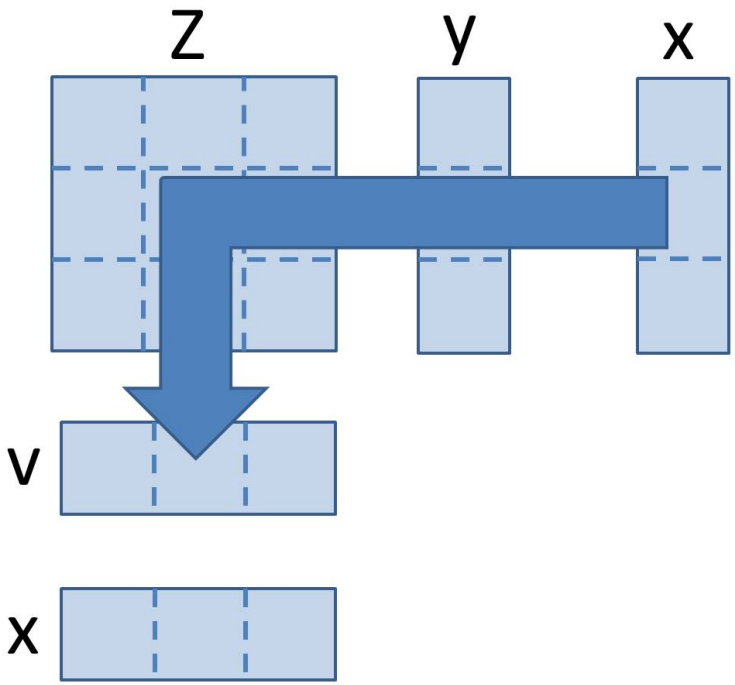
Input-output model



$$\mathbf{e^U} = \mathbf{e^L} + (\mathbf{E^U})'1$$

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

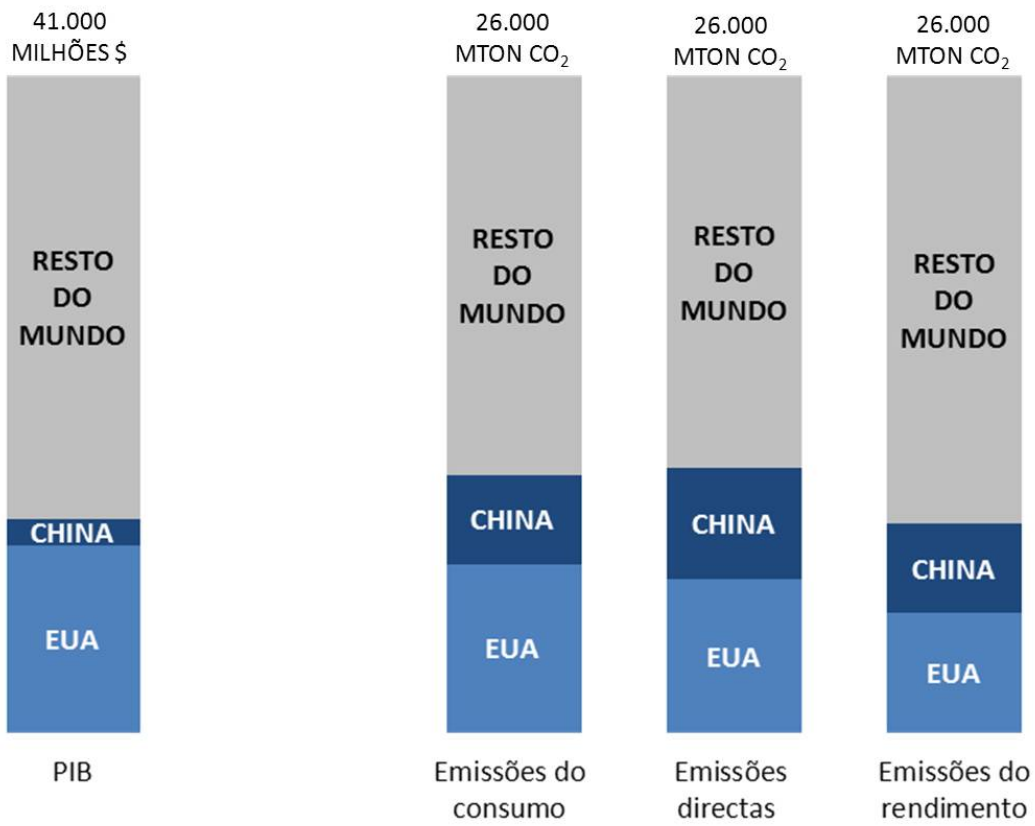
Input-output model



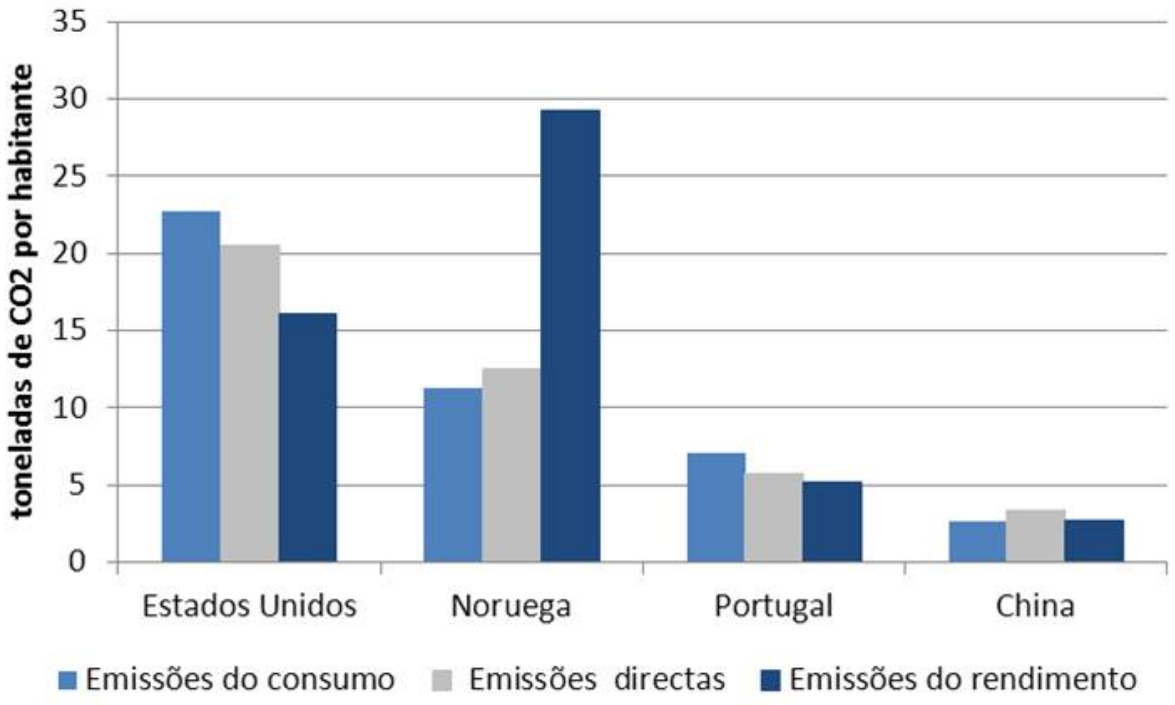
$$\mathbf{e}^{\mathbf{D}} = \mathbf{e}^{\mathbf{L}} + \mathbf{E}^{\mathbf{D}}\mathbf{1}$$

We have determined emissions enabled by value added or income, using the Ghosh inverse.

Direct, embodied and enabled emissions



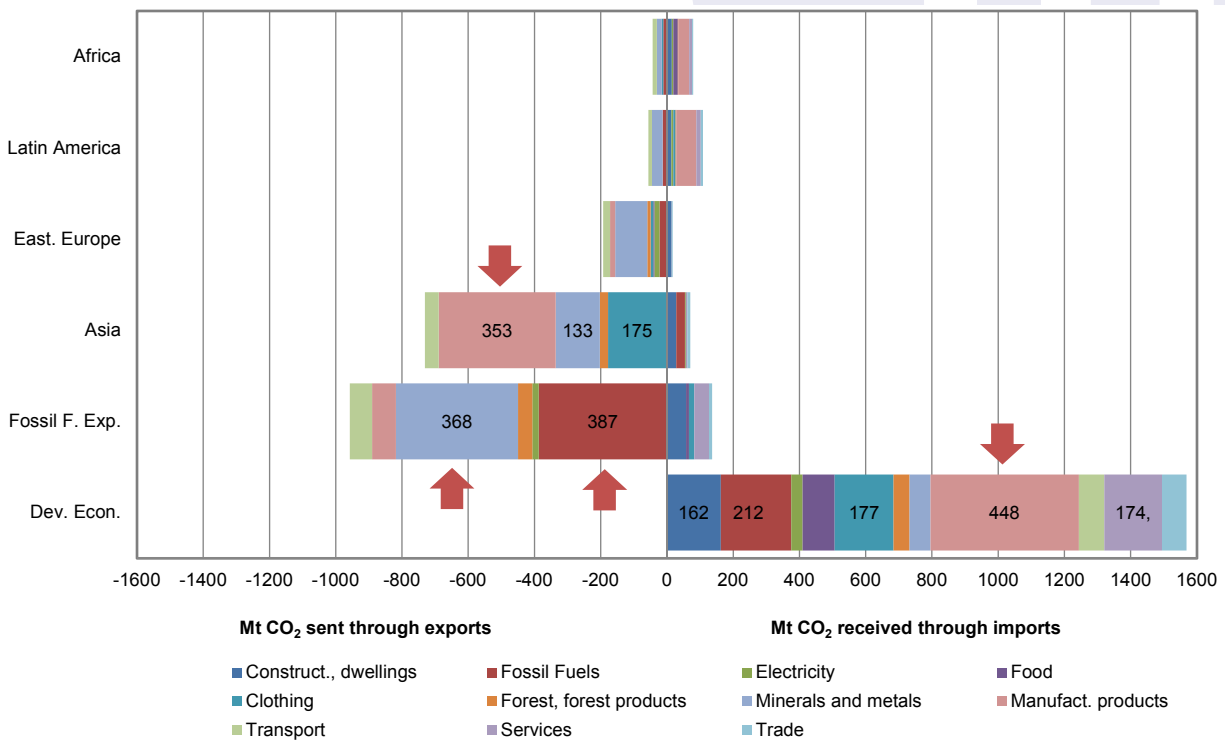
Direct, embodied and enabled emissions



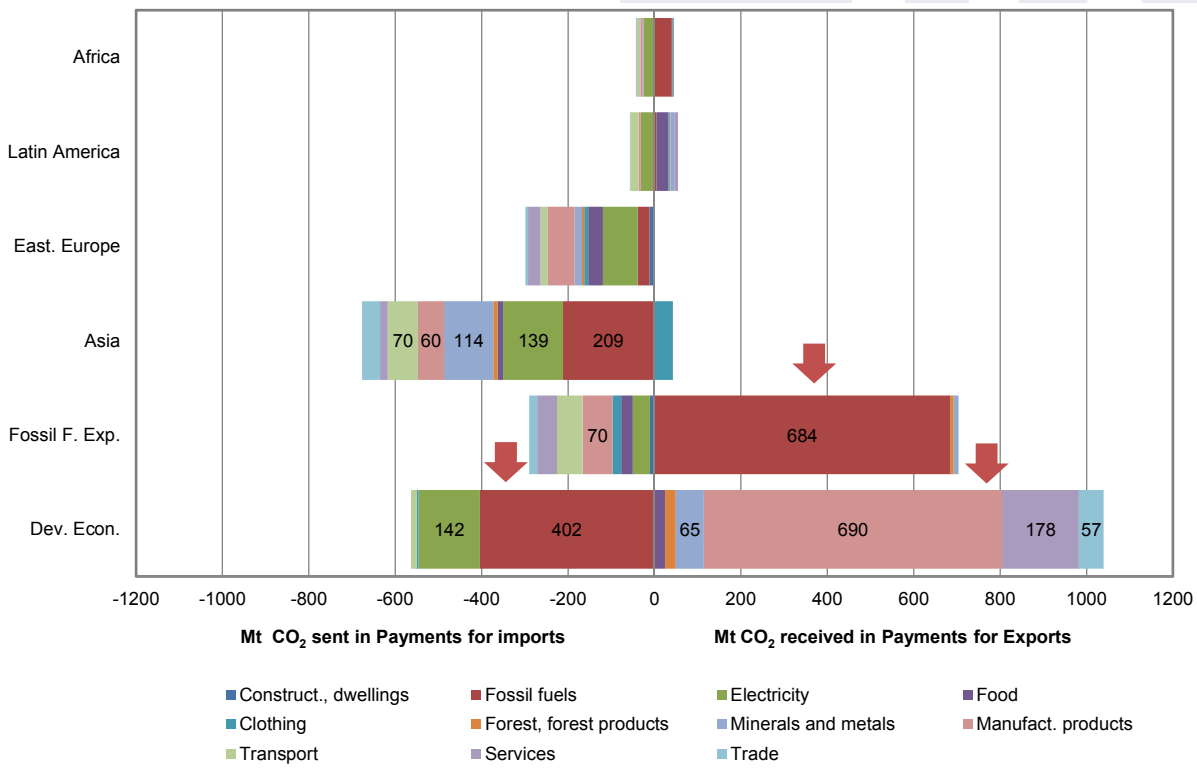
Direct, embodied and enabled emissions

Rank	GDP		Direct emissions		Enabled emissions	
1	EU-25	31%	United States	22%	United States	21%
2	United States	28%	China	19%	China	16%
3	Japan	11%	EU-25	14%	EU-25	15%
4	China	4%	Russia	6%	Russia	7%
5	Canada	2%	Japan	4%	Middle East	5%
6	Middle East	2%	India	4%	Japan	5%
7	Mexico	2%	Middle East	4%	India	4%
8	Korea	2%	Canada	2%	Canada	2%
9	India	2%	Korea	2%	Australia	2%
10	Australia	2%	South Africa	2%	Korea	2%

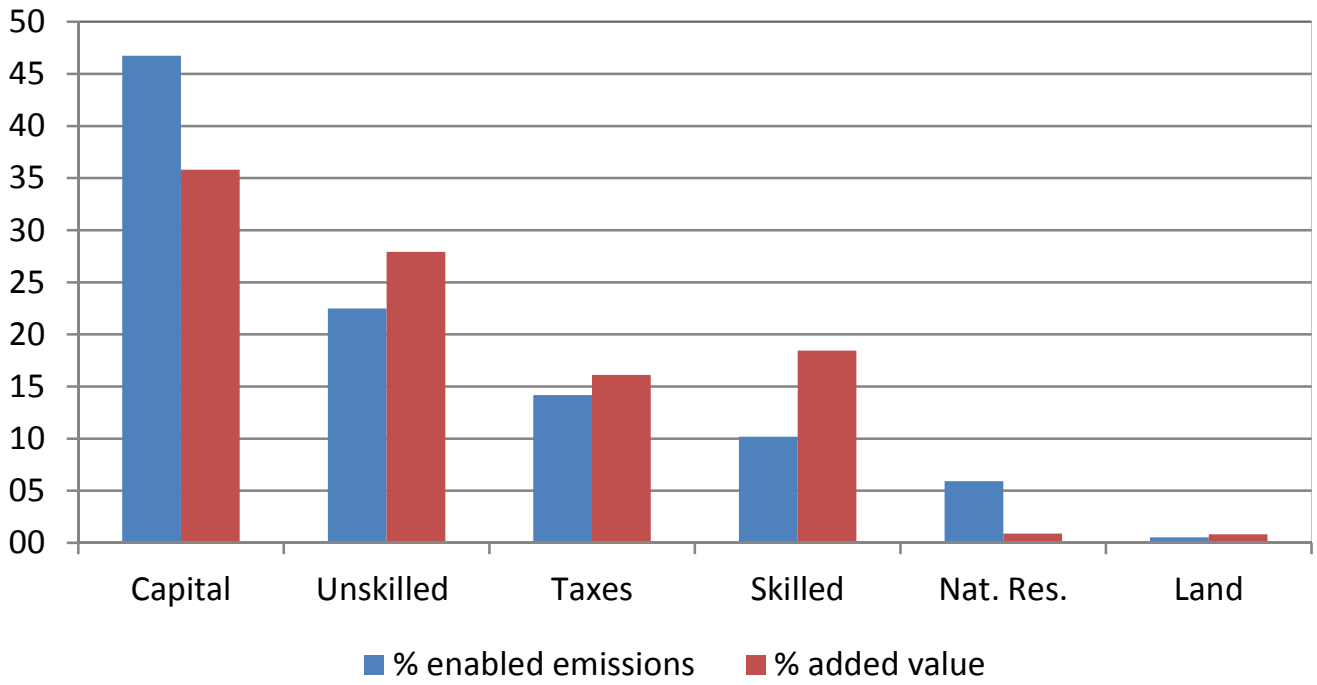
Upstream carbon trade balance (in Mt CO_2)



Downstream carbon trade balance (in Mt CO_2)



Emissions enabled by primary factors of production (in % of world total)



Conclusions

In this work we have quantified **upstream and downstream emissions embodied in international trade**, and have analyzed how they are **transferred between world regions**.

Developed Economies and Asia are the regions that receive more upstream emissions, meaning that these are the regions whose consumption generates more emissions elsewhere.

Developed Economies and Fossil Fuel Exporters are the regions that receive more downstream emissions, meaning that these are the regions whose sales enable more emissions elsewhere.

With this type of accounting it is possible to understand the environmental impacts associated with each agent income.

The Carbon Responsibility of Nations

Alexandra Marques, João Rodrigues, Tiago Domingos

Instituto Superior Técnico
Lisbon, Portugal
tdomingos@ist.utl.pt

May 10, 2012