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Alerts on Emerging Policy Challenges

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TRADE AND CLIMATE CHANGE – DEVELOPMENT OF THE EMISSION INTENSITY INDICES

Truong P. Truong and Mia Mikic [1]

Emissions Intensity Indices for Trade

The purpose of constructing 'Emissions Intensity Indices' (EIIs) for trade (import and export) is to identify how much trade contributes to emissions. Let M_{isr} be the import of commodity *i* from source *s* to destination *r*. Let EP_{is} and EP_{ir} be the emissions per unit of production of this commodity in regions[2] *s* and *r* respectively, and let ET_{isr} be the emissions associated with the transport of this commodity from region *s* to region *r*.[1] If there were *no* import, then region *r* would have to produce this commodity domestically, and assuming that this is possible[3], the emissions level would have been EP_{ir} per unit of M_{isr}. If, however, there *is* import, then the total emissions associated with this activity are (EP_{is} + ET_{isr}) per unit of M_{isr}. The Emissions Intensity Index associated with this import is therefore $MEII_{isr}$ = [(EP_{is} + ET_{isr})/(EP_{ir})], or the ratio of sum of emissions created through trade and local production. If the ratio is greater than 1, then the import of this commodity is more emission-intensive than domestic production. If it is less than 1, then the import of the commodity is less emission-intensive than domestic production. Ratio equal to 1 makes the import of commodity emission-neutral. To calculate the *total* Import Emissions Intensity Index for a particular region *r*, we sum up over the pattern of import for this region:

$$MEII_r = \sum_i \sum_s [(EP_{is} + ET_{isr}) * M_{isr}] / \sum_i (EP_{ir} * \sum_s M_{isr}) \quad (1)$$

In a similar manner, we can define an 'Export Emissions Intensity Index' (XEII) as follows. Let X_{isr} be the export of commodity *i* from source *s* to destination *r*. If there were *no* export from region *s* to region *r*, then region *r* would have to produce this commodity domestically, and assuming that this is possible, the emissions level would have been EP_{ir} per unit of X_{isr}. If, on the other hand, there *is* export, then the total emissions associated with this activity are (EP_{is} + ET_{isr}) per unit of X_{isr}. The Emissions Intensity Index associated with this export is therefore $XEII_{isr}$ = [(EP_{is} + ET_{isr})/(EP_{ir})] which is equal to the Import Emissions Intensity Index $MEII_{isr}$ for each individual item (*i*, *s*, *r*). [5]

However, since the pattern of export is different from the pattern of import for each region, when summed up over all commodities for a particular region, the *total* Export Emissions Intensity Index for region *r* will be different from its (total) Import Emissions Intensity Index, and is given by:

$$XEII_r = \sum_i \sum_r [(EP_{is} + ET_{isr}) * X_{isr}] / \sum_i \sum_r (EP_{ir} * X_{isr}) \quad (2)$$

and $XEII_r \neq MEII_r$.

[2] *"Regions" is used to designate any territory e.g. country or a group of countries.*

[3] *Clearly trade in services does not involve direct transport activities hence ET_{isr} is assumed to be zero for the case of services trade. Also, transport is a margin commodity hence it is assumed that trade in this activity does not involve any further 'transport margin' on this margin commodity.*

[4] *This may not be possible with the cases of primary energy resource extraction (coal, oil, gas), hence these are excluded from consideration in the construction of trade emissions intensity indices. Besides, it is unlikely that a country rich in a natural resource such as coal (Australia, South Africa, China) will want to import the resource (rather than export) simply because of climate change policies. Trade in these resources is dictated more by their needs as inputs into other production activities.*

[5] *As it should be because the import of one region is also the export of another region.*

[1] *Truong P. Truong is Honorary Professor of Sustainable Transport Systems, The Institute of Transport and Logistics Studies, The University of Sydney, Australia and an advisor of ARTNeT for work on Trade and Climate Change Linkages. Mia Mikic is an Economic Affairs Officer and ARTNeT Coordinator, Trade and Investment Division, ESCAP. The authors can be contacted at T.Truong@itls.usyd.edu.au and mikic@un.org The views expressed are those of the authors and should not be considered as reflecting the view or carrying the endorsement of the United Nations or ARTNeT members or partners.*

Emissions associated with production and with international transport

Crucial in the calculation of the *MEII* and *XEII* are the estimation of emissions associated with production of an individual commodity *i* locally (EP_{is}), overseas (EP_{ir}), and for its transportation from region s to r (ET_{isr}). The estimation of *EP* (emission from production activity) is straightforward, as this is based on the use of energy inputs in the production of output of a particular commodity in a specific region. The estimation of *ET* (emissions from international transport activity), however, requires some additional assumptions. First, we can get information on the *total* (CO_2) emissions from marine bunker fuel[6] which we can then assume that this is the total emissions associated with all international shipping activities. Next, we try to distribute these total emissions to individual items of trade (M_{isr} or E_{isr})[7] and arrive at a level of emissions per unit of international transport shipping activity ET_{isr} (which is the same for both import and export). To do this, we use the GTAP information on "insurance and freight" (which is the difference between 'cif' and 'fob' prices) and assume that the *value* of "insurance and freight" (in a base year) is in fact a good proxy for "weight*distance" of international transport for each trading item (*i*, *s*, *r*).[8]

Results

Figure 1 shows the total emissions associated with import ("IMPORT") and international shipping ("TRANSPORT") for each region and also compares this with the hypothetical situation when imports are replaced by domestic production ("NO TRADE"). Figure 2 shows similar emissions for EXPORT and the emissions of associated "TRANSPORT" (shipping) and compare these with the "NO TRADE" situation when there are no exports (and countries receiving no exports have to produce these commodities domestically). From these two sets of data, we can also calculate the *MEII* and *XEII* for these regions (shown in Figures 3 and 4). From Figure 3, it can be seen that China, Indonesia, and Viet Nam (CHN, IDN, VNM) import commodities which are produced (overseas) with less emissions than if they were produced locally (*MEII*s are less than 1), while the reverse holds true for India, Bangladesh, and Thailand (IND, BGD, THA). This implies that China, Indonesia and Viet Nam (CHN, IDN, VNM) are importing from regions that use cleaner production techniques than they are, while the reverse holds true for India, Bangladesh and Thailand (IND, BGD, THA). It is interesting to note also that most other regions (with the exception of Russian Federation (RUS) and Rest of the World (ROW) are also importing from regions that use 'dirtier' production techniques than they are. Turning to export activities, Figure 4 shows that all of the studied regions (CHN, IND, BGD, IDN, THA,VNM) export commodities which are produced (in these regions) with more emissions than they would have been had they been produced locally (at the destination regions) The same applies to North and Latin America, Central and Eastern Europe, Russian Federation, and Australia and New Zealand, but the opposite is true for Japan, Republic of Korea, and EU15. This implies that there is some room for improvement on the techniques of production of export commodities in the studied countries and/or the pattern of export trade to reduce the total level of CO_2 emissions for the world as a whole.

Figures 5-8 shows the results for *climate friendly goods only* (sectors 1-8 only, see Table A2 in the Appendix), and Figures 9-12 shows the results for the *non climate friendly goods only* (sectors 9,15-17, see Table A2 in the Appendix). It can be seen from these Figures that the overall import picture for the studied countries is in fact dominated by the climate friendly goods which is *different* from the non climate friendly goods (compare Figures 7 and 11), but the export pictures of climate friendly goods and non climate friendly goods are similar (Figures 8 and 12).

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[6] *We have not accounted for emissions from air and other means of transport associated with international trade activities. This is a topic for future studies.*

[7] *Since import by one region is the export of another region, we only need to distribute total emissions to either Misr or Eisr but not both.*

[8] *Although we have information on the distance between trading regions, we do not have information on the weight and also the frequency of shipping for each trading item, hence we cannot use this information to distribute total emissions.*

Figure 1: Total carbon emissions from import and international transport as compared to hypothetical "no trade" situation where imports had to be replaced by domestic production (base year 2004).

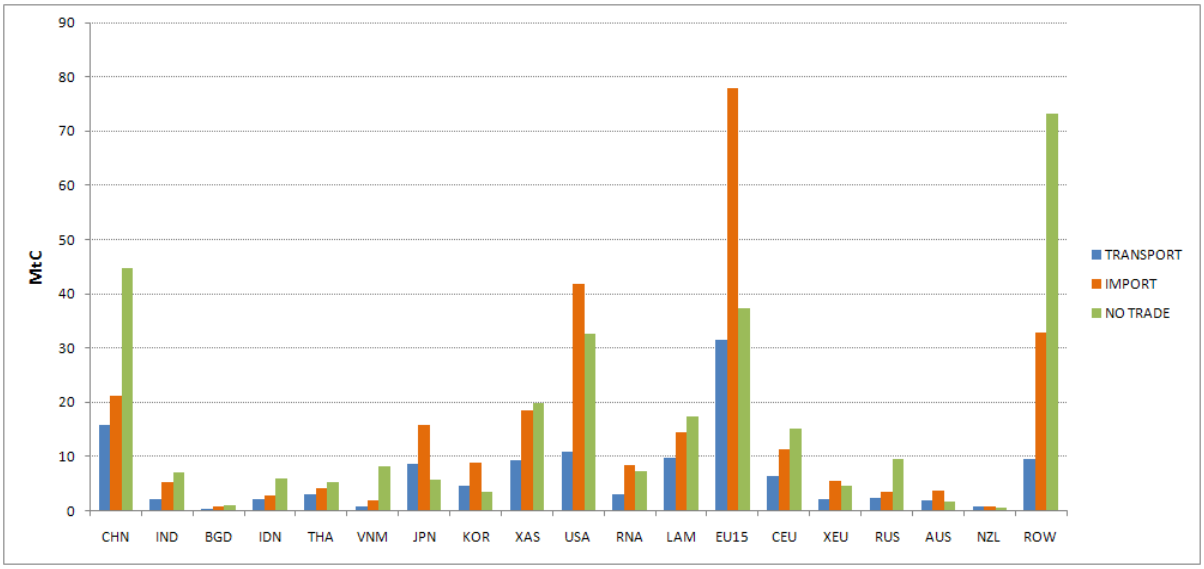


Figure 2: Total carbon emissions from export and international transport as compared to hypothetical "no trade" situation where imports had to be replaced by domestic production (base year 2004).

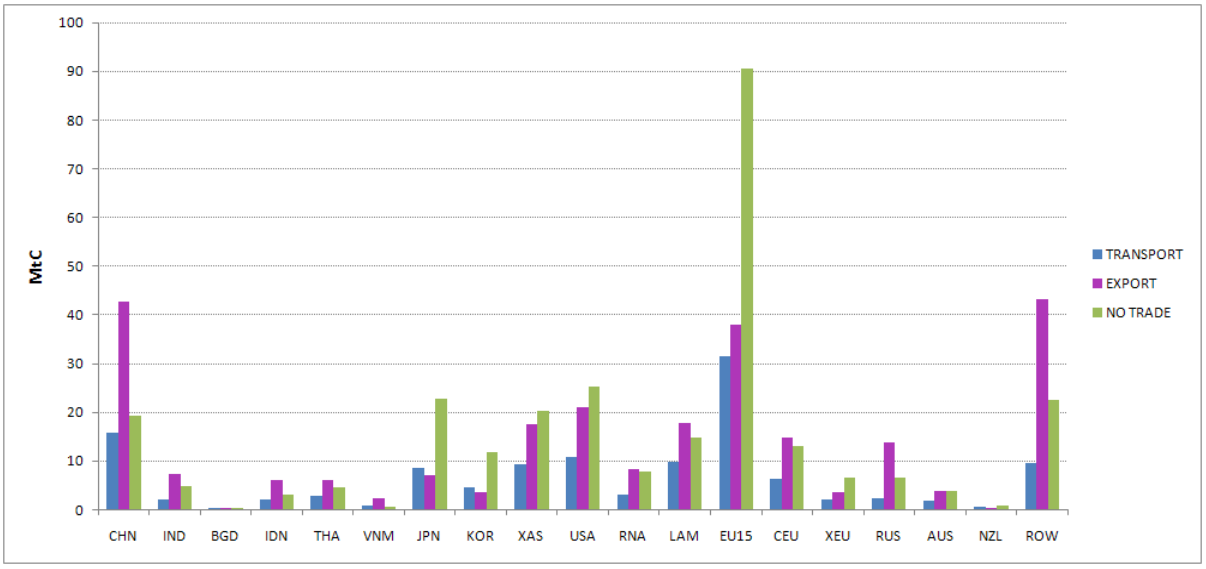


Figure 3: Import Emissions Intensity Index (base year 2004)

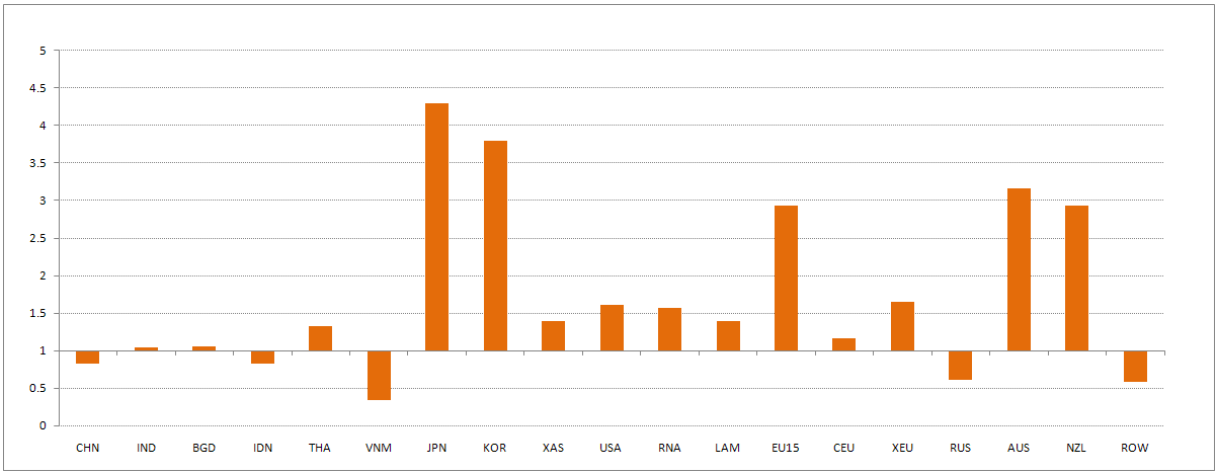


Figure 4: Export Emissions Intensity Index (base year 2004).

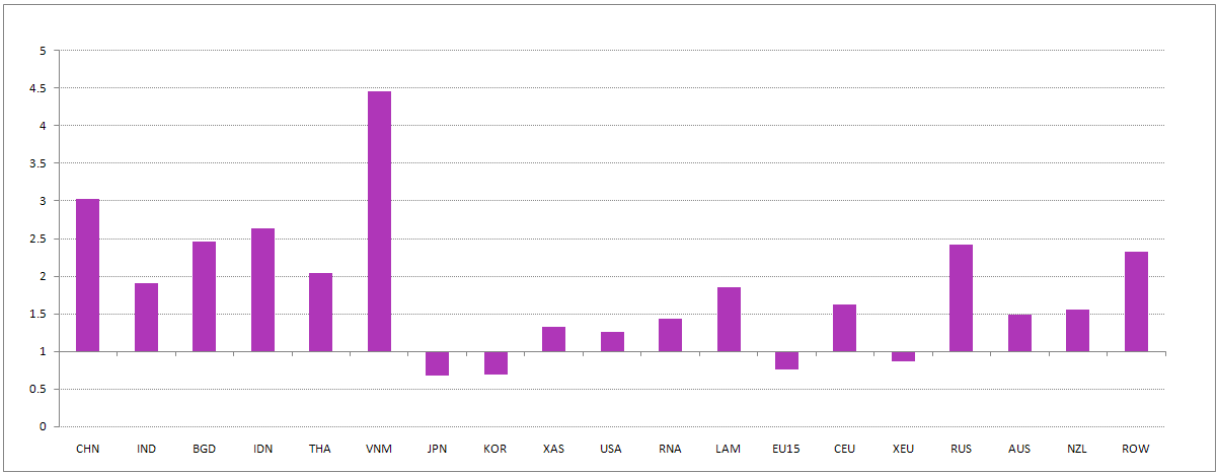


Figure 5: Total carbon emissions from import and international transport of *climate friendly goods only* as compared to hypothetical "no trade" situation where imports had to be replaced by domestic production (base year 2004).

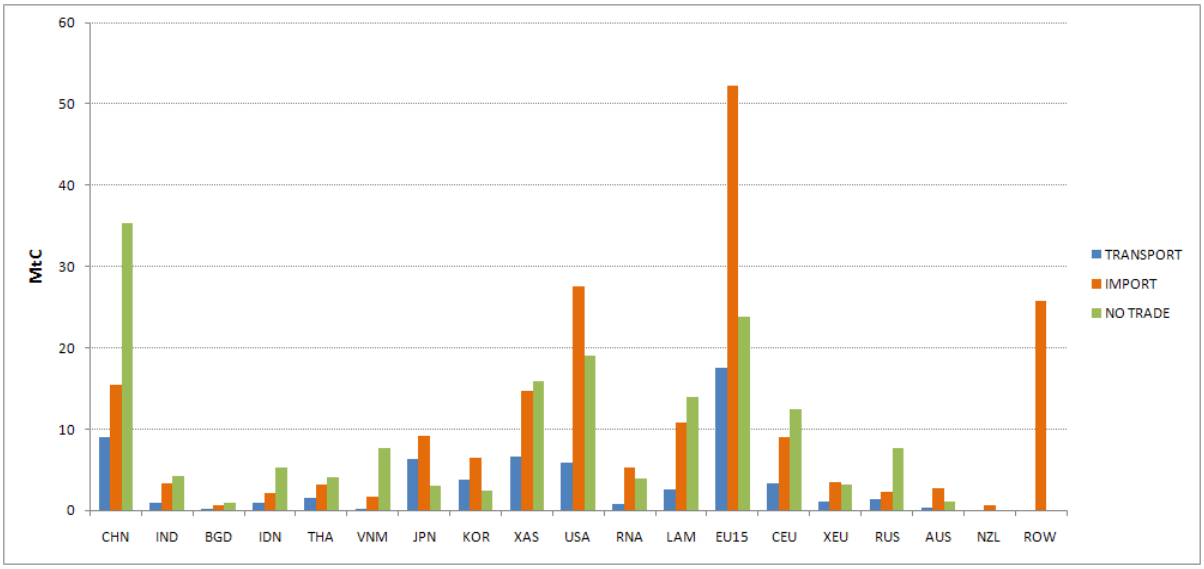


Figure 6: Total carbon emissions from export and international transport of *climate friendly goods only* as compared to hypothetical "no trade" situation where imports had to be replaced by domestic production (base year 2004).

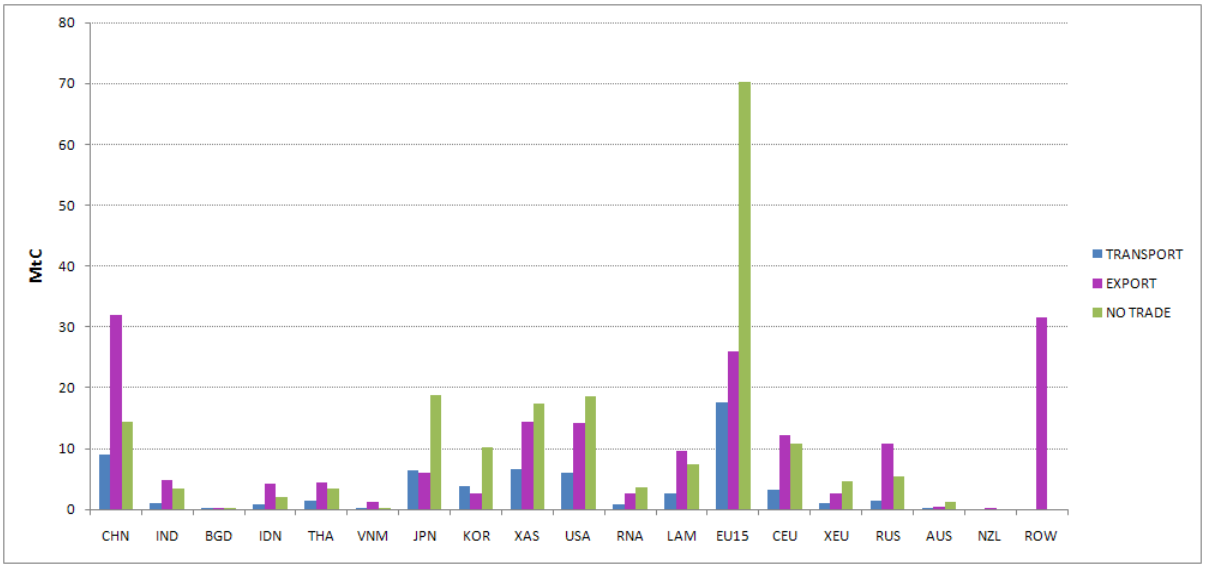


Figure 7: Import Emissions Intensity Index of *climate friendly goods only* (base year 2004).

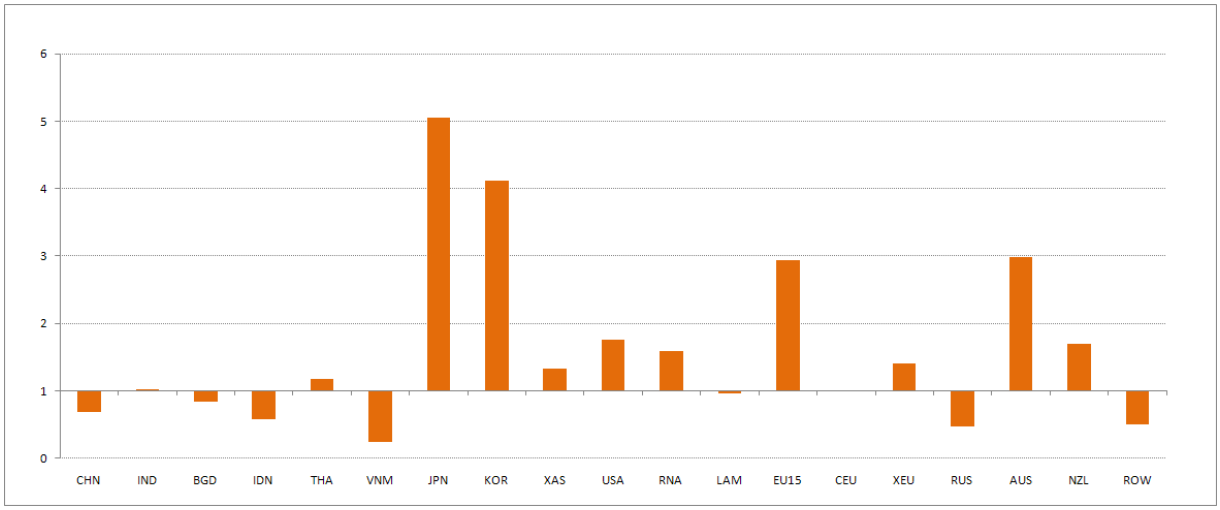


Figure 8: Export Emissions Intensity Index of *climate friendly goods only* (base year 2004).

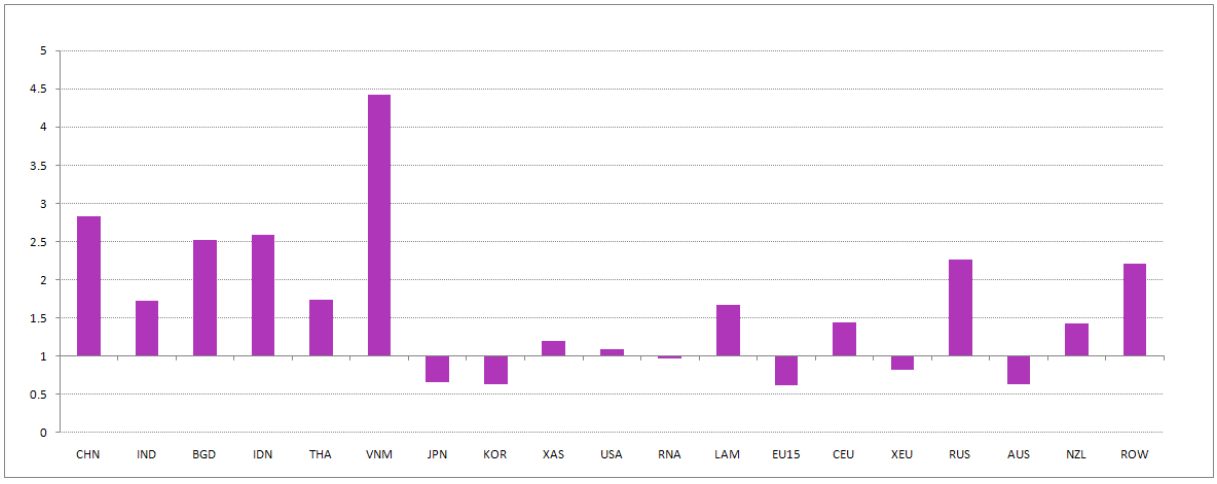


Figure 9: Total carbon emissions from import and international transport of *non climate friendly goods only* as compared to hypothetical "no trade" situation where imports had to be replaced by domestic production (base year 2004).

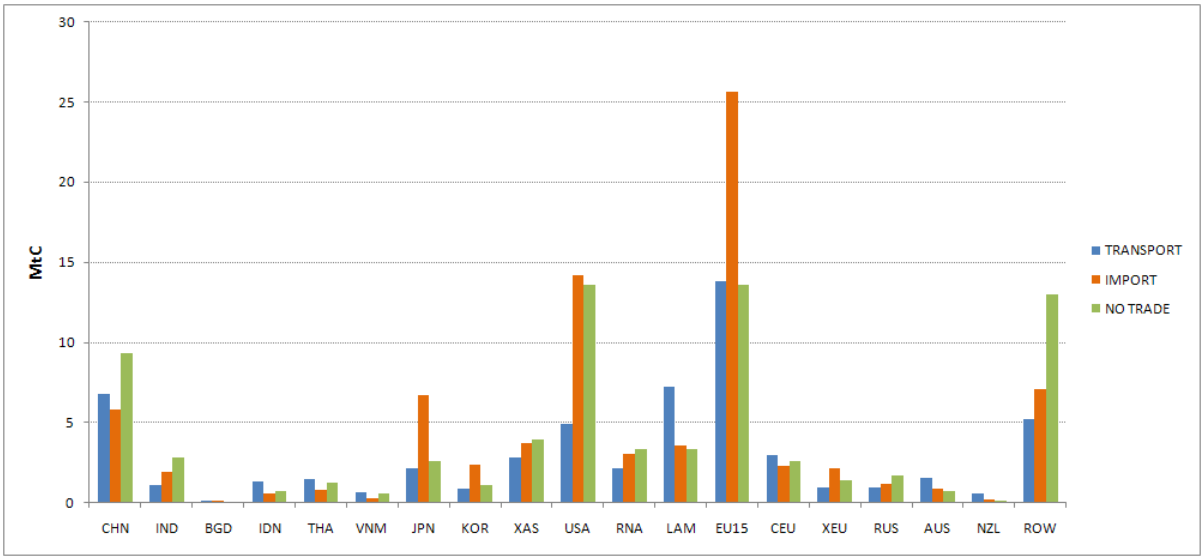


Figure 10: Total carbon emissions from export and international transport of *non climate friendly goods only* as compared to hypothetical "no trade" situation where imports had to be replaced by domestic production (base year 2004).

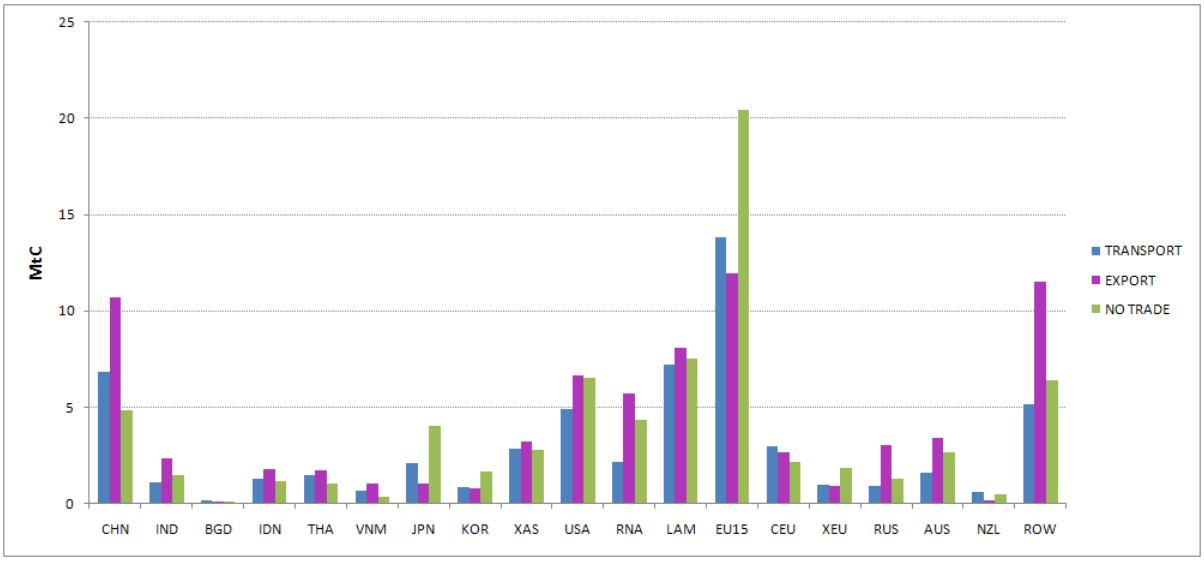


Figure 11: Import Emissions Intensity Index of *non climate friendly goods only* (base year 2004).

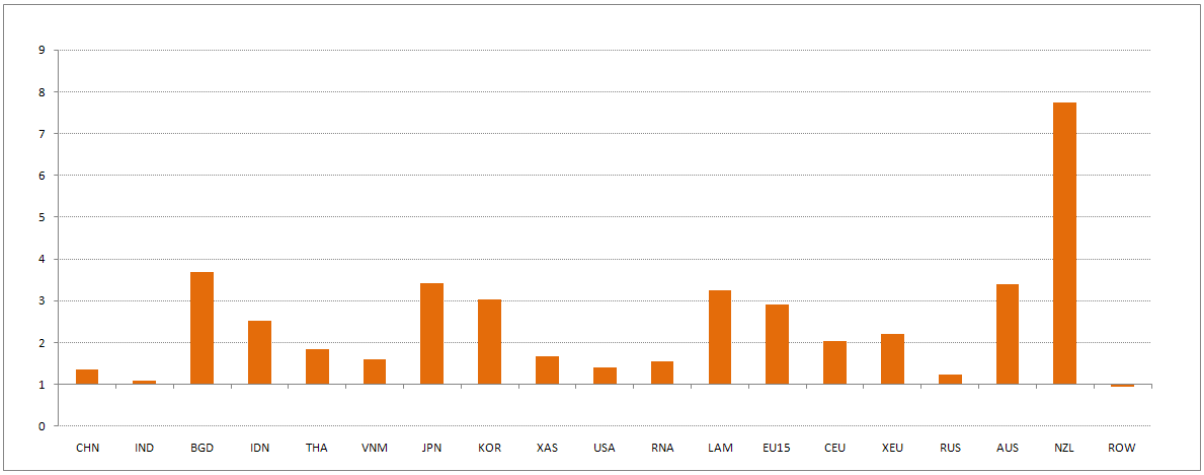
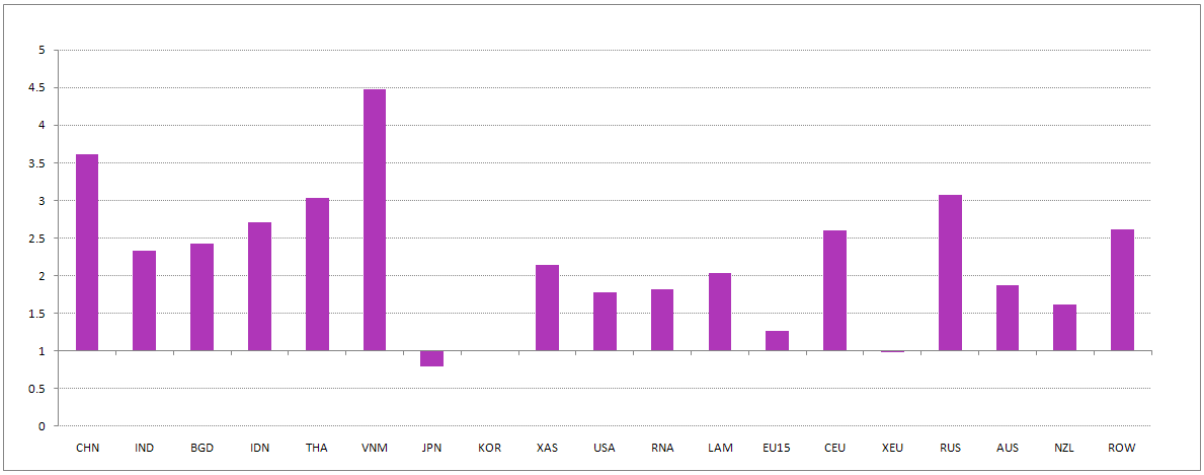


Figure 12: Export Emissions Intensity Index of *non climate friendly goods only* (base year 2004).



Appendix

Table A1: Details on Regional Aggregation.

No.	Region	Description
1	CHN	China and Hong Kong
2	IND	India
3	BGD	Bangladesh
4	IDN	Indonesia
5	THA	Thailand
6	VNM	Vietnam
7	JPN	Japan
8	KOR	Korea
9	XAS	Rest of South and East Asia
10	USA	United States of America
11	RNA	Canada, Rest of North America
12	LAM	Latin America
13	E15	EU15
14	CEU	Central and Eastern Europe
15	XEU	Rest of Europe
16	RUS	Russia
17	AUS	Australia
18	NZL	New Zealand
19	ROW	Rest of the World (Middle East, Africa, Western Asia)

TableA2: Details on Sectoral Aggregation.

No.	Code	GTAP Sector Description	Harmonised System Code (for climate friendly goods only)(*)
1	TEX	Textiles	560314
2	CRP	Chemical, rubber, plastic	38021, 392690, 392010
3	NMM	Mineral products nec	701931, 700800
4	I_S	Ferrous metal	730431, 730441, 730451,730900
5	FMP	Metal products	730820, 730900, 732490, 761290, 840219, 840290, 840410, 840490
6	OTN	Transport equipments nec	890790
7	ELE	Electronic equipments	854140
8	OME	Machinery, equipments nec	732111, 732190, 840510, 840681, 841011, 841012, 841013, 841239, 841090, 841181, 841182, 841581, 841861, 841869, 841919, 841940, 841950, 841989, 841990, 842129, 842139, 847989, 848340, 848360, 850161, 850162, 850163, 850164, 850231, 850300, 850440, 850680, 850720, 850720, 850720, 850720, 853710, 853931, 900190, 900290, 902830, 903020, 903031, 903039, 903210, 903220,
9	AGR	Agriculture, forestry and fishing	
10	COA	Coal mining	
11	OIL	Crude oil	
12	GAS	Natural gas extraction & gas distribution	
13	P_C	Refined oil products	
14	ELY	Electricity	
15	NFM	Non-ferrous metal	
16	MIN	Minerals nec	
17	OMF	Manufactures nec	
18	TRP	Transportation	
19	SER	Services	
TEX			textile 60314
CRP			CRP 38021 392690 392010
NMM			Minerals 701931 700800
I_S			ferrous metal 730431/441/451
FMP			metal prod 730820/900 732490 761290 840219/290/410/490
OTN			transport equip 890790
ELE			electronic equip 854140
OME			machinery/equip 732111/190 840/1/2/7/8- 850/3-900/3-
agr			Agriculture forestry and fishing
coa			Coal mining
oil			Crude oil
gas			Natural gas extraction + Gas distribution
p_c			Refined oil products
ely			Electricity
nfm			Non-ferrous metal
min			Minerals nec (supposed to include uranium mining)
omf			manufactures nec and all other manufactures
trp			transportation
ser			services

(*)The set of climate-friendly goods contains 64 items defined at the 6 digit classification of the Harmonized Scale and is based on APTIR 2010 (forthcoming)