



# CO2 EMISSIONS EMBODIED IN INTERNATIONAL TRADE

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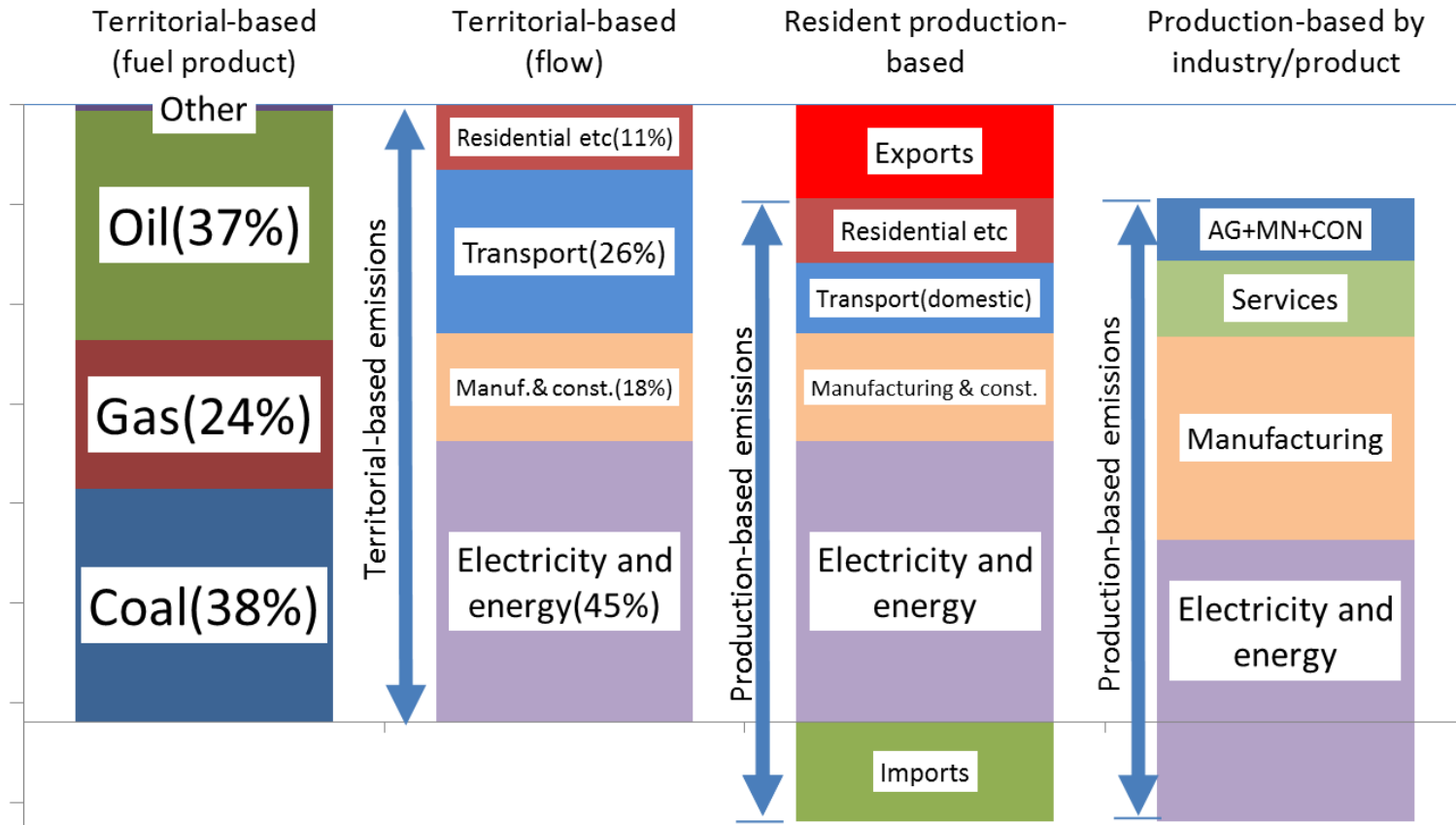
# Territorial-based CO<sub>2</sub> emissions and final demand-based emissions

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- How should carbon emissions be allocated ?  
Per capita? Per GDP? Per PPP-USD GDP?
- “*Carbon leakage*”: Acceleration of globalisation; development of global supply chains can result in domestic emissions being substituted for more carbon intensive production abroad.
- Increasing interest in measuring “virtual” CO<sub>2</sub> embodied in international trade and final demand



# CO2 emissions from fuel combustion



(%) : world average for 2010

Exports = Direct fuel purchases by non-residents (industry and household) in domestic territory

Imports = Direct fuel purchases abroad by residents (industry and household)



# OECD studies using Input-Output Databases

- Combined OECD harmonised **Input-Output (I-O) tables**, bilateral trade and IEA CO<sub>2</sub> emissions
  - OECD STI Working Paper 2003(15)
  - OECD STI Working Paper 2009(3)
  - OECD Green growth horizontal project (2011 - )
  - OECD STI Working Paper 2016(5)
  - Data updated at <http://oe.cd/io-co2/>
- Main data sources
  - OECD Inter-Country Input-Output (ICIO) tables (2015 edition)
  - IEA CO<sub>2</sub> emissions from fuel combustion (2014 edition)
- Coverage
  - 61 Countries + Rest of the world (with flexible regional aggregates e.g. EU28, ASEAN)
  - 34 industries (two digit ISIC Rev. 3 – based)



# Equation for CO<sub>2</sub> embodied in final demand and production

Methodology: CO<sub>2</sub> multiplier analysis

$$eB = e(I - A)^{-1}$$

Where emissions factor,  $e_{c,i} = \frac{CO_2 \text{ emissions}_{c,i}}{Output_{c,i}}$ , for country  $c$ , industry  $i$

$A$  is the matrix of input coefficients (intermediate input per output) and  $B$  is the *global Leontief inverse matrix*

- Emissions embodied in final demand

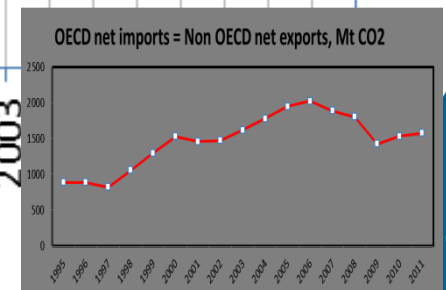
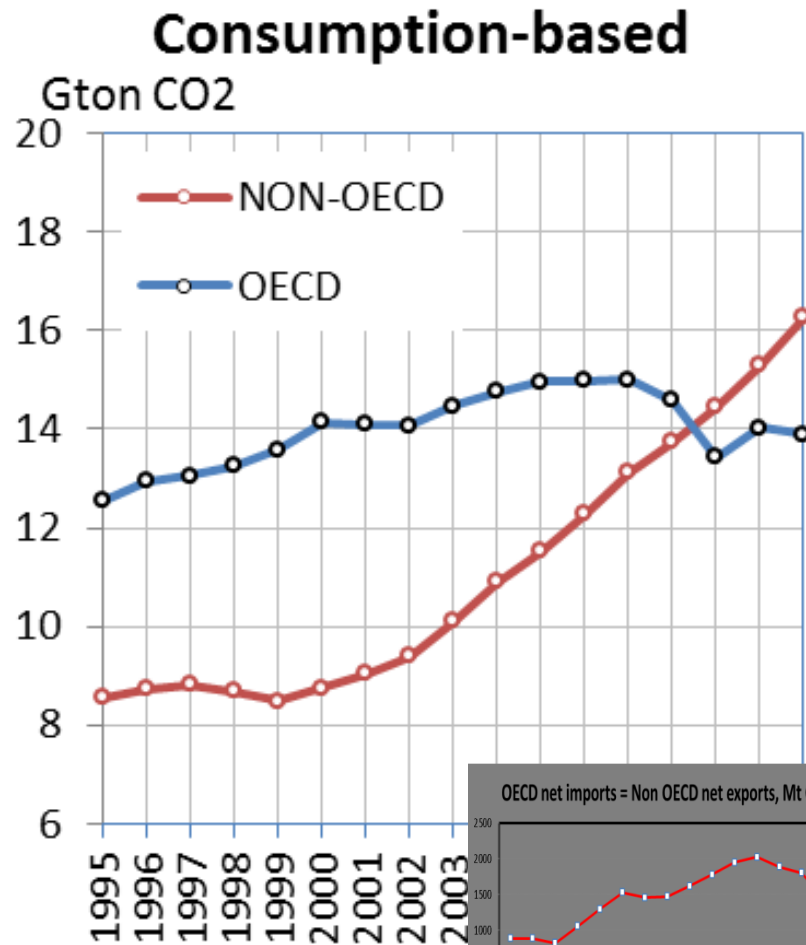
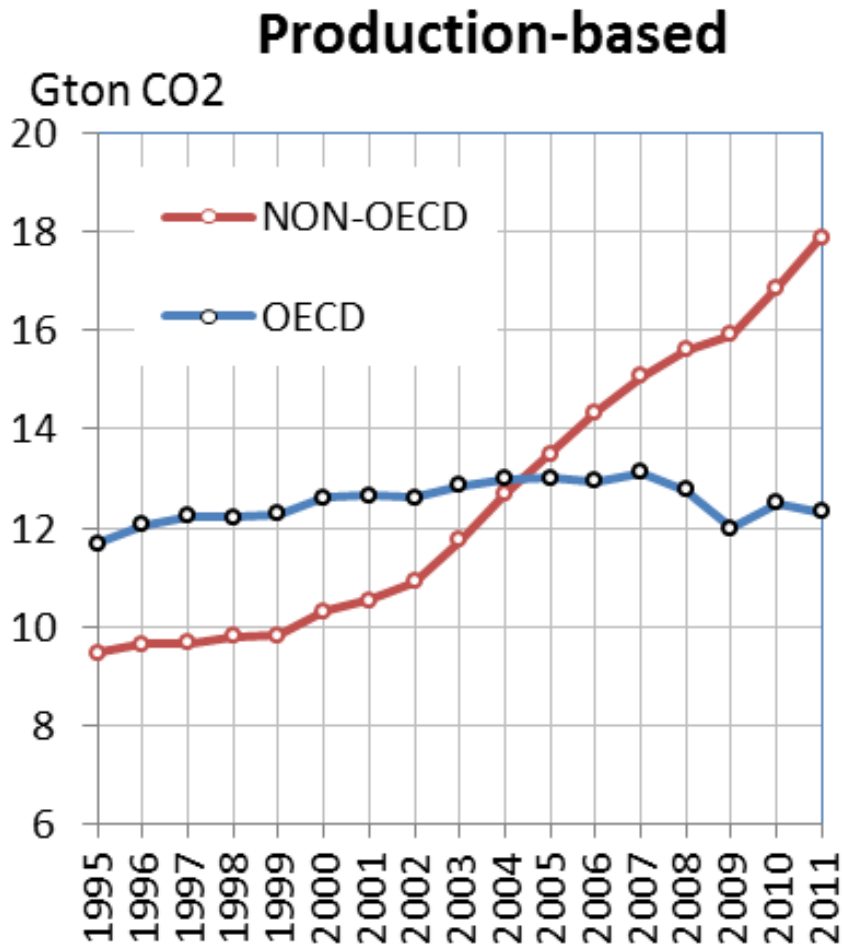
$$eB Y = \text{Global final demand} \begin{cases} \text{Domestic final demand} \\ \text{Foreign final demand} \end{cases}$$

- Emissions embodied in products (exports)

$$eB EXPO$$



# Production-based and consumption-based emissions (1995-2011)





## CO2 emissions embodied in imports and exports (selected countries, 2011)

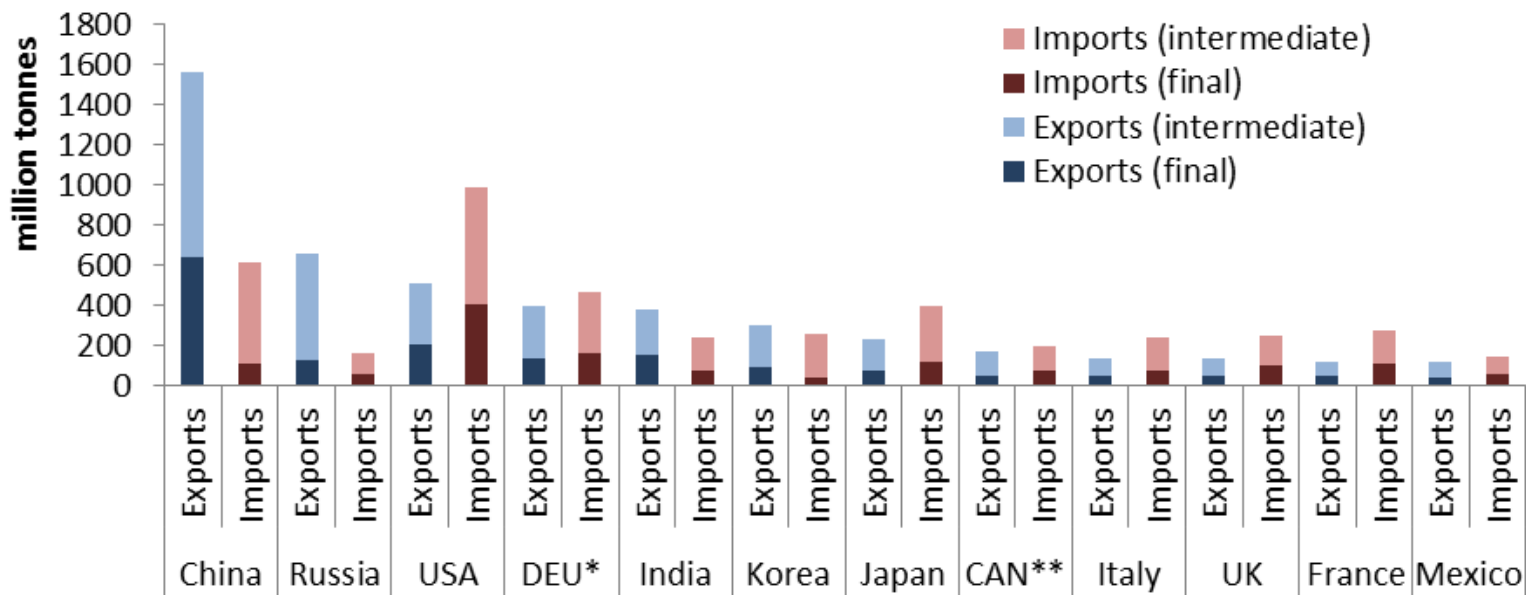


Table 3: Global discrepancy in CO2 intensity in exports (kg CO2 per gross exports in USD)

	WOR	RUS	CHN	IND	MEX	CAN	KOR	USA	ITA	DEU	GBR	FRA	JPN
2000	0.84	7.81	1.99	2.32	0.56	0.71	0.86	0.57	0.49	0.53	0.36	0.41	0.31
2005	0.64	2.83	1.70	1.30	0.47	0.51	0.66	0.43	0.35	0.37	0.26	0.29	0.36
2011	0.44	1.25	0.87	0.90	0.39	0.34	0.56	0.32	0.26	0.31	0.21	0.20	0.29



# Identifying “CO2 intensive” sectors

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- Territorial –based (by product and flow)  
*Fuel type: Coal, oil, gas*  
*Flow: electricity, transport*
- Production-based (by industry & household)  
*Electricity, manufacturing*
- Consumption-based (by final demand type)  
*Manufacturing, services*
- Emissions embodied in gross exports and imports (footprint by exported product)  
*Products: Material manufacturing and machinery*  
*Country: Emerging, G7s*

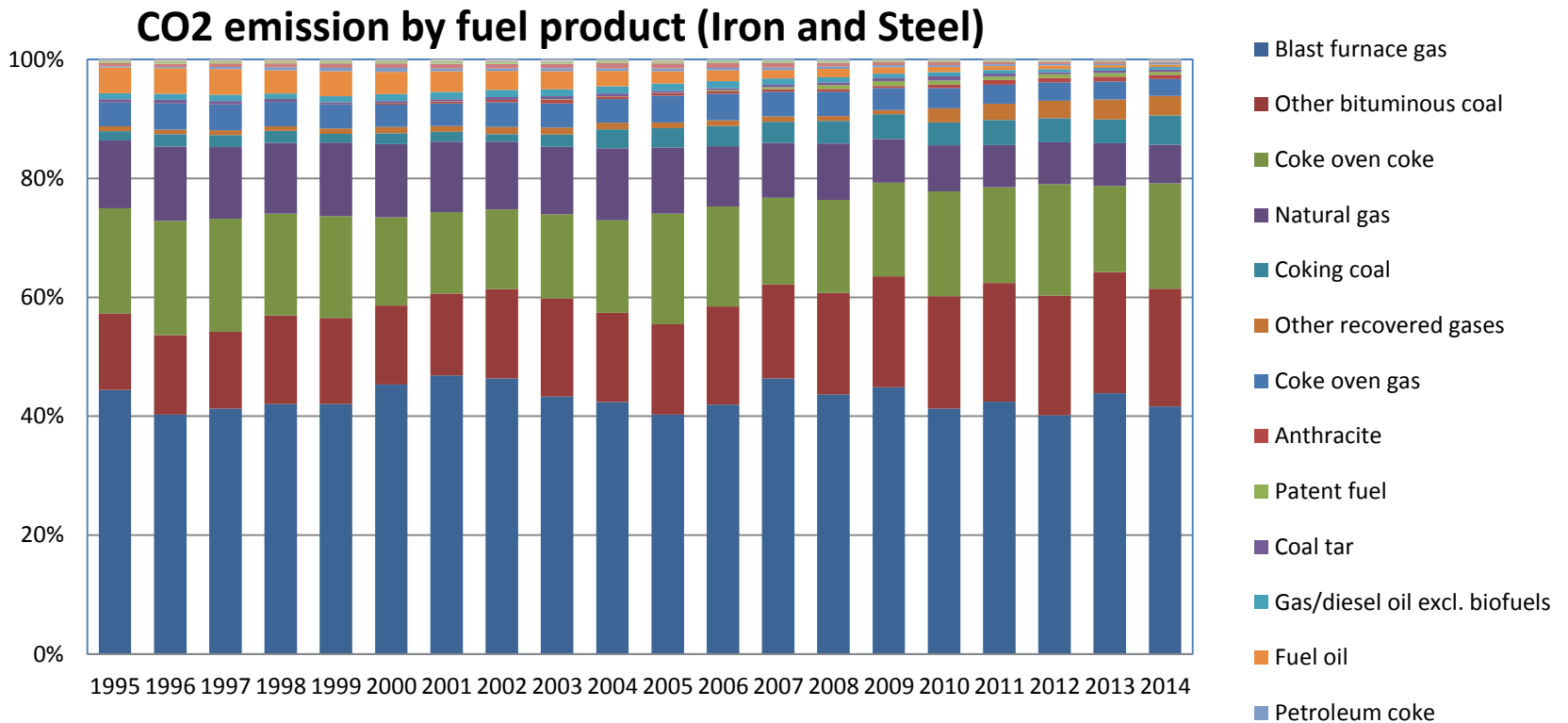




# HOW ABOUT IRON AND STEEL ?



# CO2 emissions from Iron and Steel Industry (production structure)

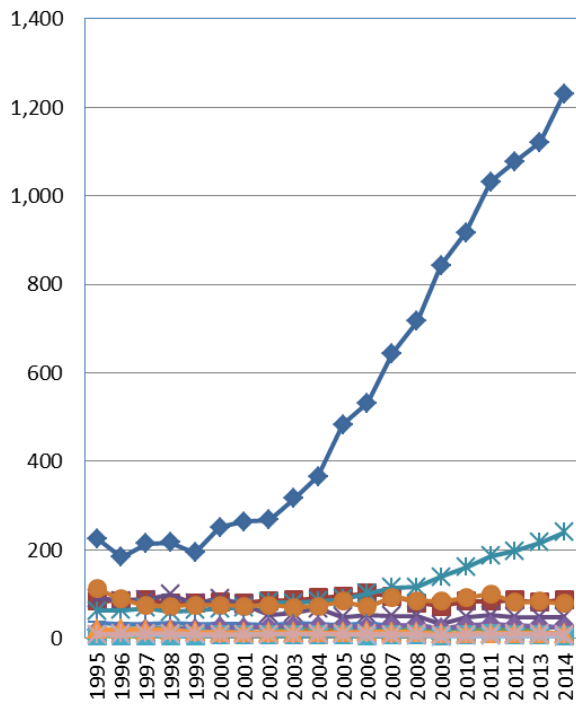


IEA (2016) CO2 emissions from fuel combustion



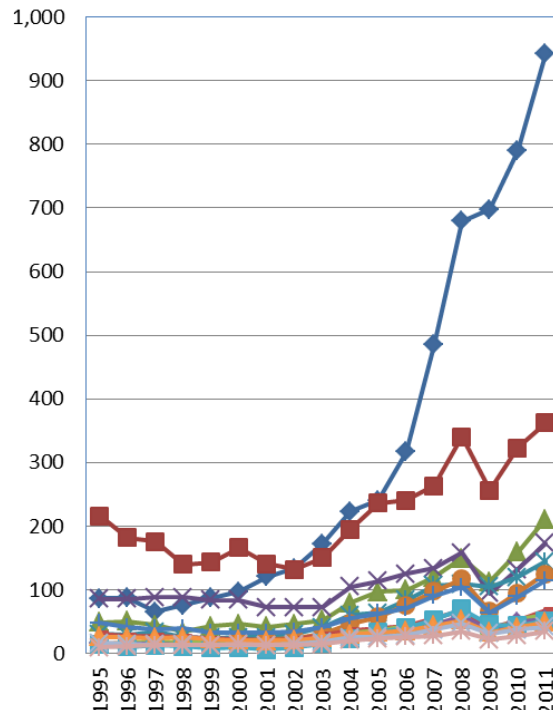
# Carbon emissions and production of iron and steel industry

### Carbon emissions from fuel combustion (Mton CO<sub>2</sub>)



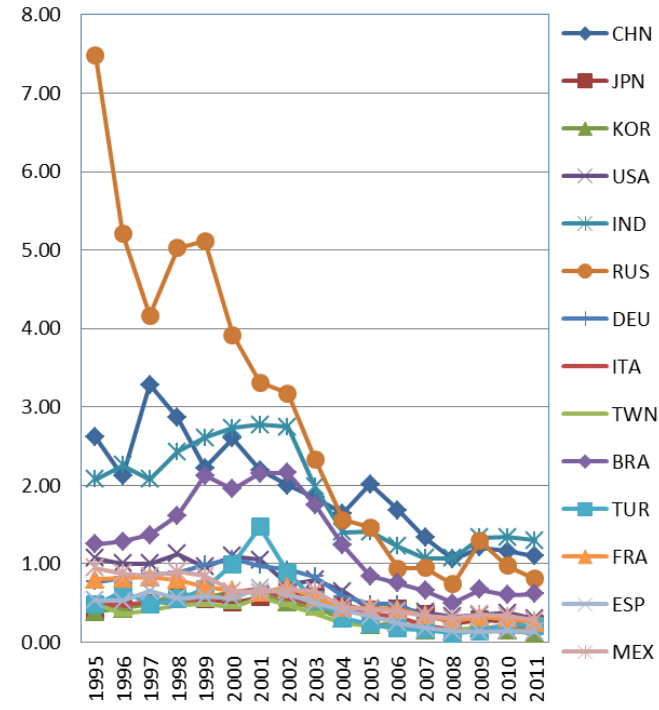
IEA (2016) CO<sub>2</sub> emissions from fuel combustion

### Production (USD Billion)



OECD (2016) Steel extended ICIO

### Emissions factor (CO<sub>2</sub>/1000 USD)



OECD (2016) & IEA (2016)



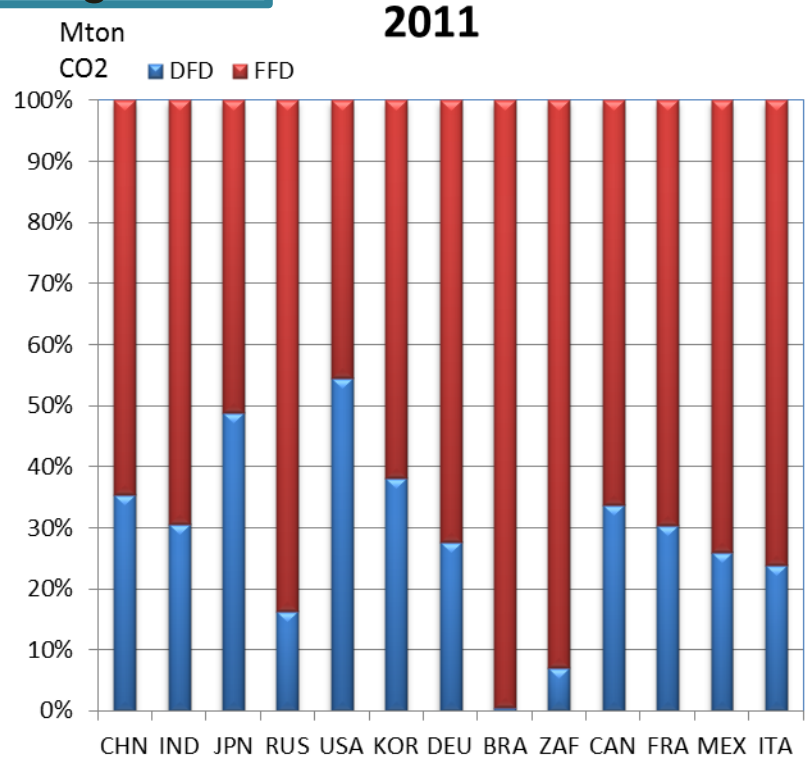
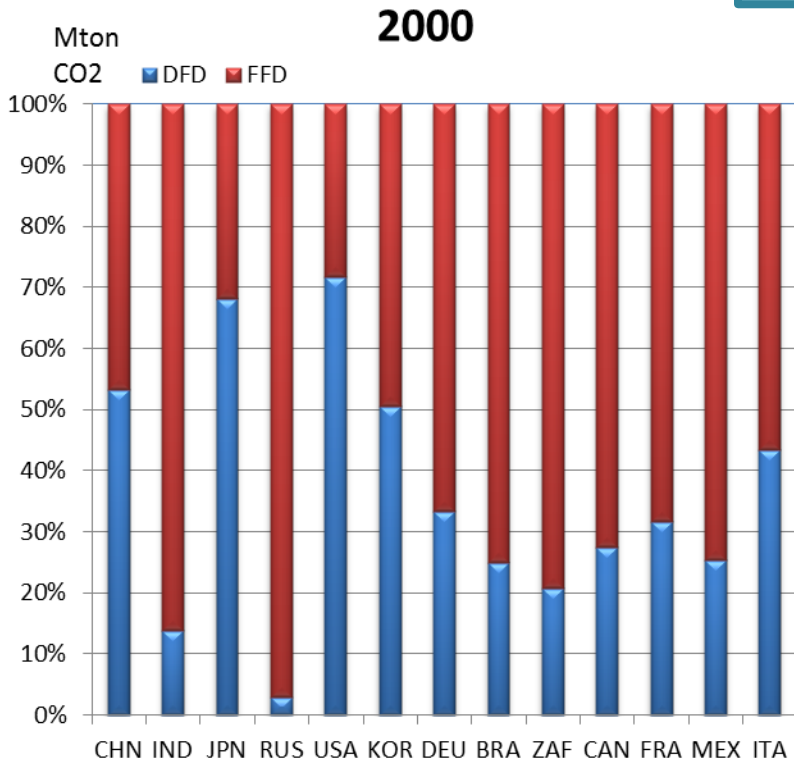
# Result1: Domestic CO<sub>2</sub> embodied in domestic and foreign final demand

Domestic CO<sub>2</sub>  
(Iron and steel)



Domestic FD

Foreign FD

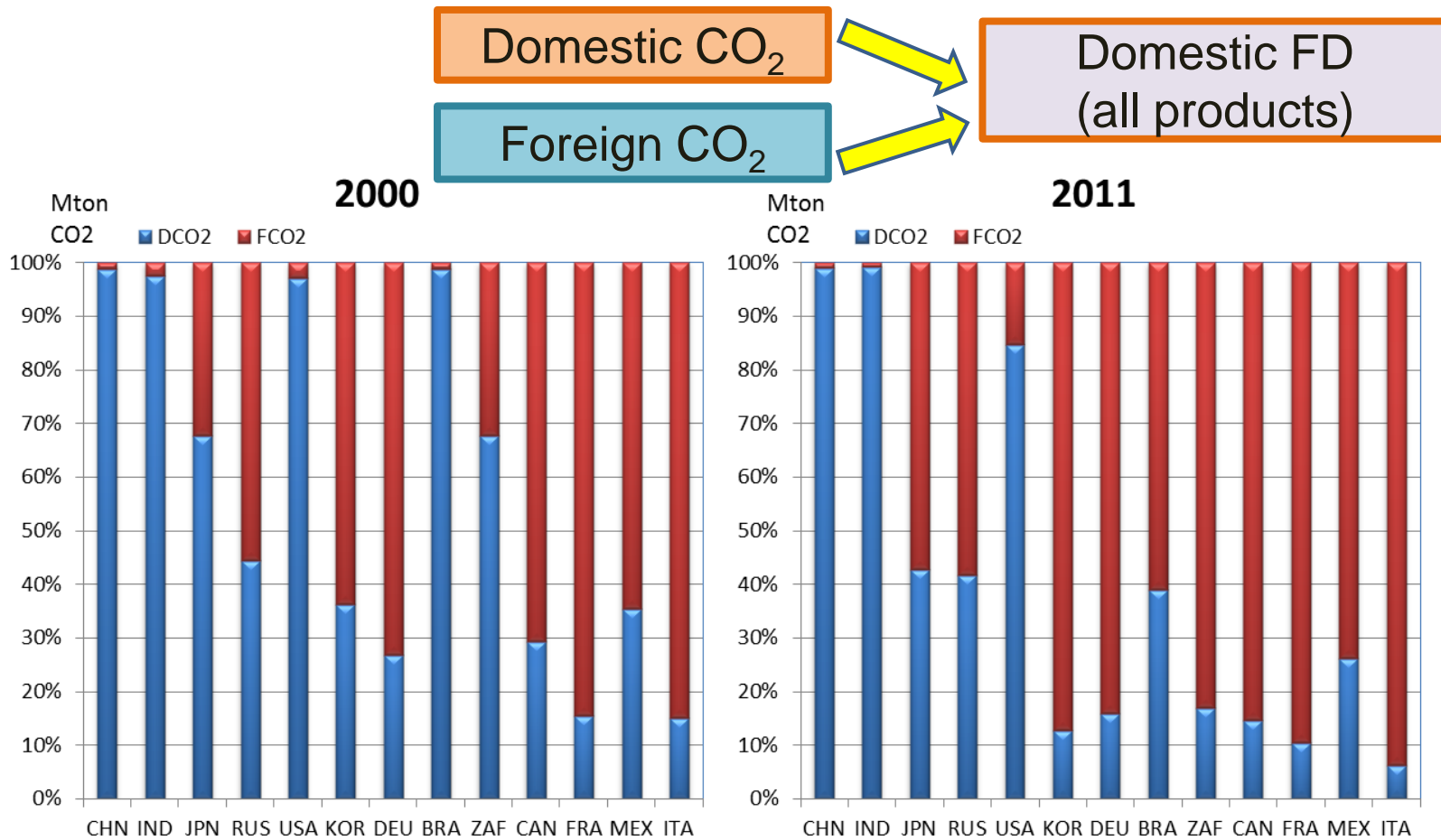


Source: OECD Inter-Country IO (2016);  
IEA (2016) CO<sub>2</sub> from fuel combustion

Source: OECD Inter-Country IO (2016);  
IEA (2016) CO<sub>2</sub> from fuel combustion



# Result2: Domestic and foreign CO<sub>2</sub> embodied in domestic final demand



Source: OECD Inter-Country IO (2016);  
IEA (2016) CO<sub>2</sub> from fuel combustion

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IEA (2016) CO<sub>2</sub> from fuel combustion



## Summary

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- Global IO analysis can identify “CO<sub>2</sub> intensive” sectors
- CO<sub>2</sub> embodied in steel products **can be allocated** to domestic and foreign upstream industries **(result 2)**
- CO<sub>2</sub> emitted by **domestic** steel industry **can be attributed to** domestic and foreign final demand **(result 1)**
- Extensions: more countries, more recent years, quality enhancement



# THANK YOU

<http://oe.cd/io-co2>



# Appendix: Industry list (S-extended ICIO2016)

Agriculture, Mining	Agriculture [01,05], Mining [10,14]	
Manufacturing	Food products [15,16], Textiles & apparel[17,19] Wood [20] Paper print publishing [21,22] Coke, petroleum[23] Chemicals[24] Rubber & plastics[25] Non-metallic minerals[26]	<b>Iron and steel[271]</b> <b>Non-ferrous[272]</b> Fabricated metals[28] Machinery [29] ICT & electronics [30,32,33] Electrical machinery [31] Motor vehicles [34] Other transport equipment [35] Other manufacturing [36,37]
Utility and Construction	Utilities [40T41], Construction [45]	
Business services	Wholesale & retail [50,52] Hotels & restaurants [55] Transport & storage [60-63] Post & telecoms [64] Finance & insurance [65-67]	Real estate [70] Renting of machinery [71] IT services [72] Other business services [73,74]
Other services	Public admin [75]; Education [80]; Health [85];	Other services [90-93]; Private households [95]