Paris After Trump: An Inconvenient Insight

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An Inconvenient Insight

Carbon tariffs do not provide a credible threat to US withdrawal.

"A carbon tariff now would backfire. Is Trump the sort of person who would back down or would he retaliate? He seems like the kind of person who would retaliate. And then you'd have a trade war. That would be an example of the cure being worse than the disease."

Robert Stavins (Harvard)

New York Times “Climate Pact Negotiators Confront a New Peril”, November 19, 2016.

Climate Policy: Will Paris Be Trumped?

- Paris Agreement (2015):
  - Global consensus: 2°C target
  - Intended Nationally Determined Contributions (INDCs) by more than 190 countries (incl. US, China, India, EU)
  - In force since November 4, 2016 (after ratification by at least 55 countries that produce at least 55% of the world's greenhouse gas emissions in 2015)
  - Voluntary nature of INDCs in the spirit of "name and shame"

- Will Paris be trumped by US withdrawal?
  - Candidate Trump: "Climate change is a *hoax* – scrap Paris!"
  - On June 1, 2017 President Trump announces US withdrawal from the Paris Agreement.
  - Other key parties to the Paris Agreement confirm compliance.

Carbon Tariffs as Anti-Trump Measures?

- The case for carbon tariffs:
  - Economists: 2nd-best policy to reduce carbon leakage and improve global cost-effectiveness of sub-global climate policy (Markusen 1975, J. Int. Econ.)
  - Environmentalists: Taxing the carbon footprint (Peters and Hertwich 2008, Environ. Sci. Technol.)
  - Industrial lobbyists: Leveling the playing field in export-intensive and trade-exposed industries (Böhringer, Balistreri, and Rutherford 2012, Energy Econ.)
  - Policy makers: A potential stick in policy negotiations (Böhringer, Carbone, and Rutherford 2016, Am. Econ. J. Econ. Policy)

- The case against carbon tariffs:
  - Blunt instruments when based on industry-average emissions tariffs - the main effect is redistributive (Böhringer, Balistreri, and Rutherford 2012, Energy Econ.)
  - Re-routing of emission-intensive goods (Böhringer, Carbone and Rutherford 2017, Scand. J. Econ.)
  - "Back-door" trade policy: The risk of a trade war (Böhringer, Rutherford, WIP)

Strategic Carbon Tariffs

- Are tariffs a credible sanctioning instrument?
  - Do they benefit users?
  - Do they punish targets?
  - What is a target's best response?
  - And what is the outcome of iterated strategic (best) responses?

- “Paris after Trump”:
  - Will carbon tariffs make the US worse off than compared to compliance?
  - What if the US retaliates with optimal tariffs?
  - What if we end up with a trade war (Nash tariff game)?

Climate Policy Scenarios

Scenario	Characteristics
Paris	CO_2 emission reductions (in %) from 2011 levels are implemented via domestic emission pricing in the following regions: USA (19%), China (5%), Europe (30%), Other OECD (27%), Remaining G20 (8%)
USA_out	Same as *Paris* but without US compliance
CarbonTariff	Same as *US_out* but with embodied carbon tariffs on US imports levied by Europe and China
Retaliation	Same as *CarbonTariff* but with retaliating optimal tariffs of USA against China and Europe
TariffWar	Same as *CarbonTariff* but with Nash tariff war between the USA versus China and Europe (N.B.: no tariff changes between China and Europe)

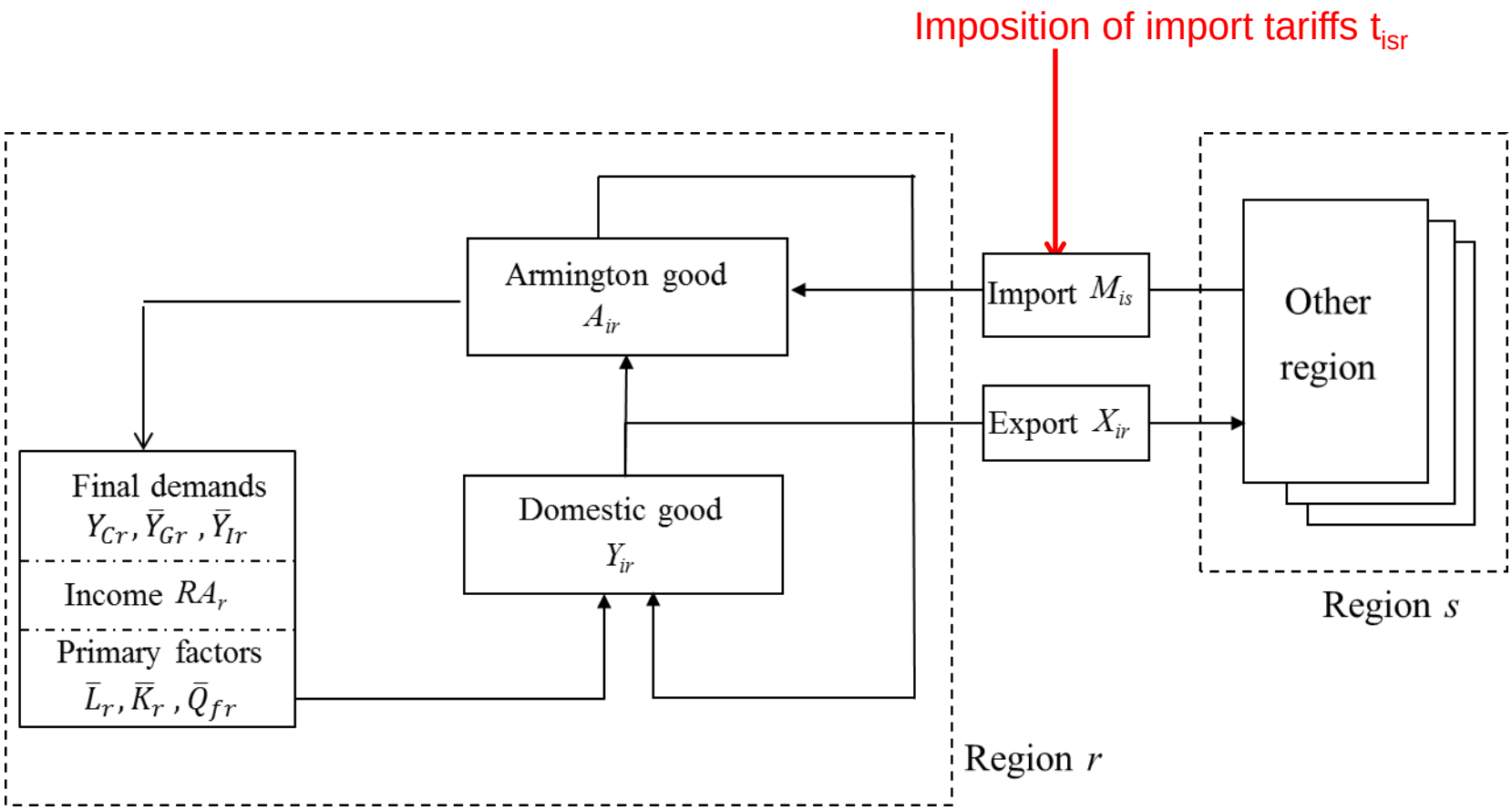
Policy Implementation

- Compliant countries apply domestic carbon pricing to meet targets.

- Carbon tariffs are levied on US imports to Europe and China with domestic carbon prices applied to the embodied carbon content (direct emissions plus indirect emissions from electricity).

- Global emissions are kept to the ***Paris*** level, i.e. complying regions compensate for US withdrawal and emission leakage.

GTAP-Based CGE Analysis



$Y_{Cr}, \bar{Y}_{Gr}, \bar{Y}_{Ir}$	=	Final demands (private *C*, public *G*, investment *I*)	Y_{ir}	=	Domestic production of good *i*
$\bar{L}_r$	=	Labor endowment	X_{ir}	=	Export supply of good *i*
$\bar{K}_r$	=	Capital endowment	A_{ir}	=	Armington production of good *i*
$\bar{Q}_{fr}$	=	Endowment with specific resource *f*	M_{is}	=	Import of good *i*

Optimal Policy (Tariff) Choice

Welfare (U) maximization by strategic agent *r* (region) based on the choice of a strategic policy instrument *t* (tariffs) :

$$\max U_{\hat{r}}(t)$$

s.t.

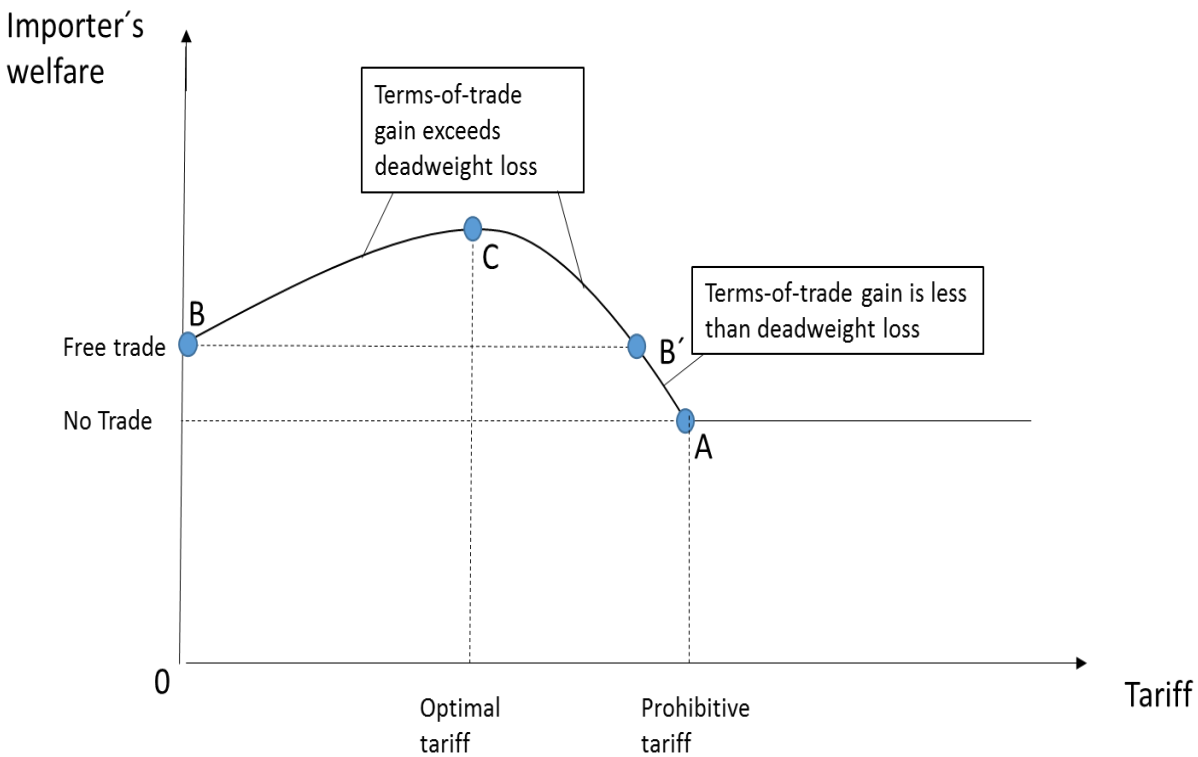
$$F(z;t) = 0$$

where:

- $z = \begin{pmatrix} p \\ y \end{pmatrix}$:= variables (prices and activity levels) determined by the equilibrium problem
- *F(z;t)* := system of equations representing (general) equilibrium conditions

Mathematical Programming
with Equilibrium Constraints
(MPEC)

Optimal Tariffs: Textbook Intuition



- At the optimal tariff the marginal gain from improved terms of trade just equals the marginal efficiency loss from production and consumption distortion.
- The optimal tariff is equal to the inverse of the elasticity of foreign export supply.
- This elasticity is a variable pending on the GE structure of the economy (e.g. cross-country import elasticity of substitution). (Balistreri and Markusen 2009, Econ. Modelling)

Impacts on Emissions and Carbon Leakage

	Paris	***USA_out***	***CarbonTariff***	***Retaliation***	***TariffWar***
			A. Emissions (in % change from *BaU*)		
USA	-19.0	3.2	2.5	2.7	2.4
China	-5.0	-11.8	-11.7	-11.7	-11.7
Europe	-30.0	-35.0	-34.9	-34.9	-34.9
Other OECD	-27.0	-32.3	-32.1	-32.1	-32.1
Remaining G20	-8.0	-14.6	-14.5	-14.5	-14.5
Rest of World	5.2	6.0	6.1	6.0	6.2
Global	-11.8	-11.8	-11.8	-11.8	-11.8
			B. Leakage rates (in %)		
USA		4.2	3.4	3.5	3.3
Rest of World	6.7	7.4	7.6	7.5	7.7
Global	6.7	11.6	11.0	11.1	11.0

CO_2 Prices and Economic Adjustment Cost

	Paris	*USA_out*	*CarbonTariff*	*Retaliation*	*TariffWar*
			C. Emission price ($US per ton of CO_2)		
USA	36				
China	5	11	10	10	10
Europe	162	221	223	221	220
Other OECD	102	141	141	141	141
Remaining G20	11	19	19	19	19
			D. Welfare change (in % HEV)		
USA	-0.25	-0.01	-0.21	-0.04	-0.49
China	0.09	-0.28	-0.16	-1.43	-1.18
Europe	-0.92	-1.39	-1.30	-1.51	-1.41
Other OECD	-0.53	-0.87	-0.82	-0.66	-0.59
Remaining G20	-0.89	-1.17	-1.13	-0.95	-0.87
Rest of World	-1.07	-1.32	-1.23	-1.14	-0.92
Global	-0.63	-0.84	-0.84	-0.87	-0.90

Key Insights

- Paris Agreement imposes non-negligible gross economic cost for US.
- Withdrawal restores *BaU* situation for the US.
- Carbon tariffs harm the US and benefit the sending regions (Europe and China) but may not be sufficient to induce US cooperation. In this case the global efficiency gains from tariffs are negligible.
- Unilateral retaliation by optimal tariffs restores the *BaU* situation for the US and is particularly harmful for China.
- A (Nash) tariff war between the US with Europe and China makes US worse off as compared to Paris compliance but both Europe and especially China would be worse off compared to US withdrawal (even when compensating for foregone US emission reductions).

Sensitivity Analysis

- Dimensions (in selection):
  - Ease of carbon substitution (energy demand elasticity)
  - Trade responsiveness (Armington elasticity)
  - Capital market closure
  - Stringency of emission reduction targets (INDs)
  - Embodied carbon metric
  - No compensating abatement efforts in case of US withdrawal
  - Comprehensive trilateral tariff war

- Key insights remain robust.

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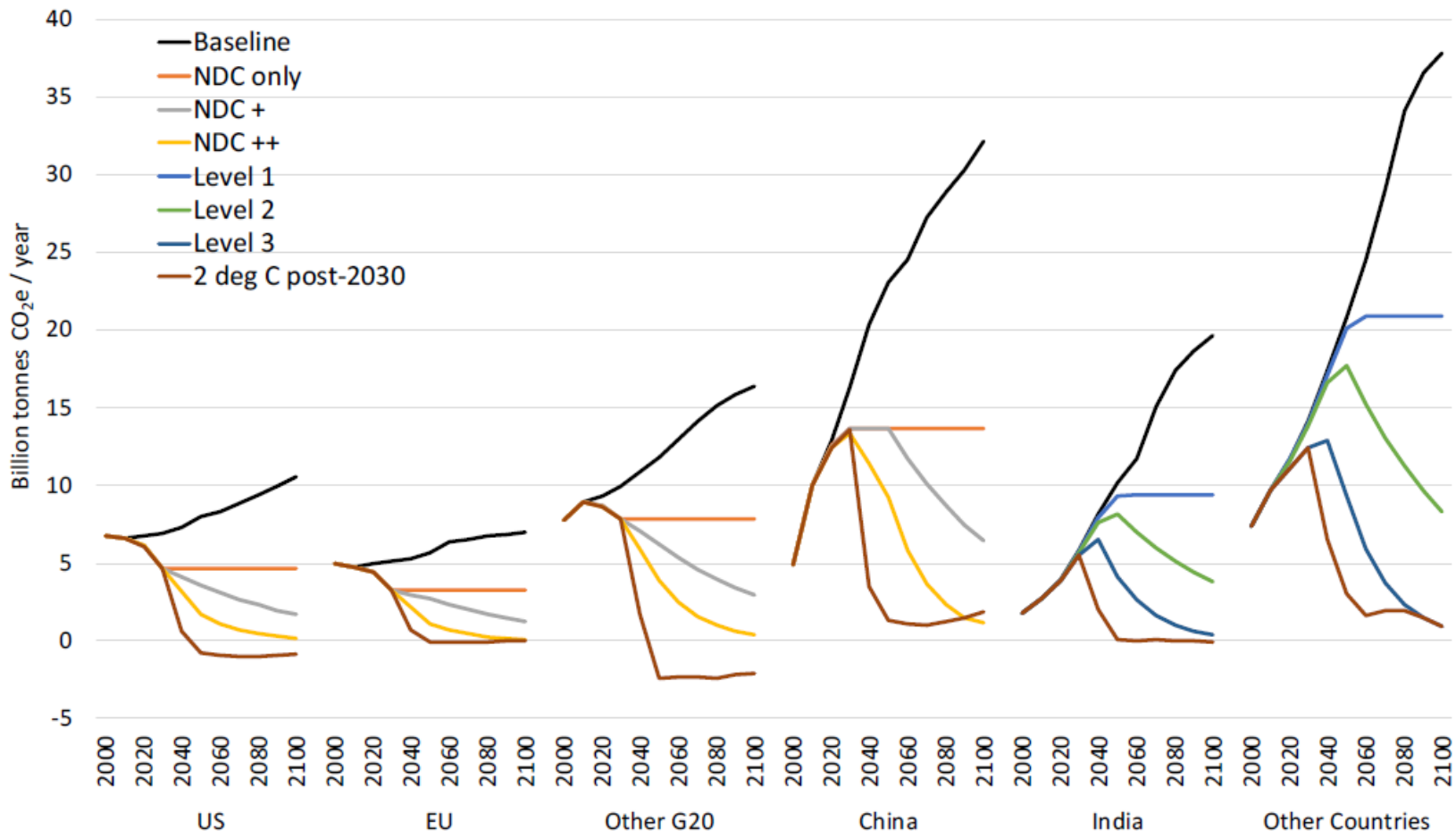
Supplemental Slides

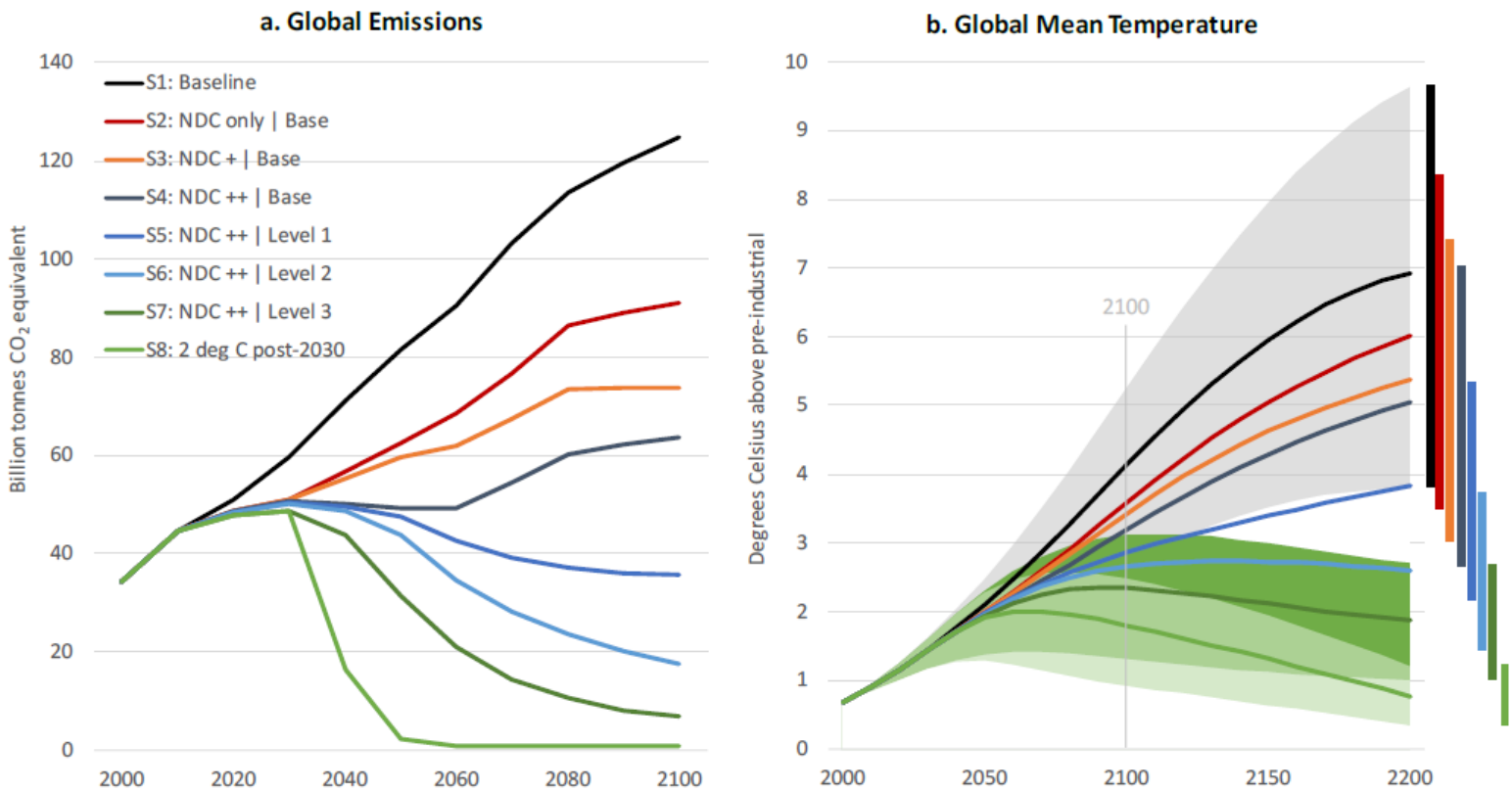
INDCs and the 2 Degrees C Target



Rose, S.K., Richels, R., Blanford, G., and T.F. Rutherford (2017): The Paris Agreement and Next Steps in Limiting Global Warming, Climatic Change, 142 (1), 255-270.

INDCs and the 2 Degrees C Target

Looking beyond the NDCs to explore potential post-2030 regional emissions reduction participation and ambition. For each scenario, we examine the implications for global emissions and long-term temperature. We then evaluate the regional consequences for energy systems and ensuing costs.



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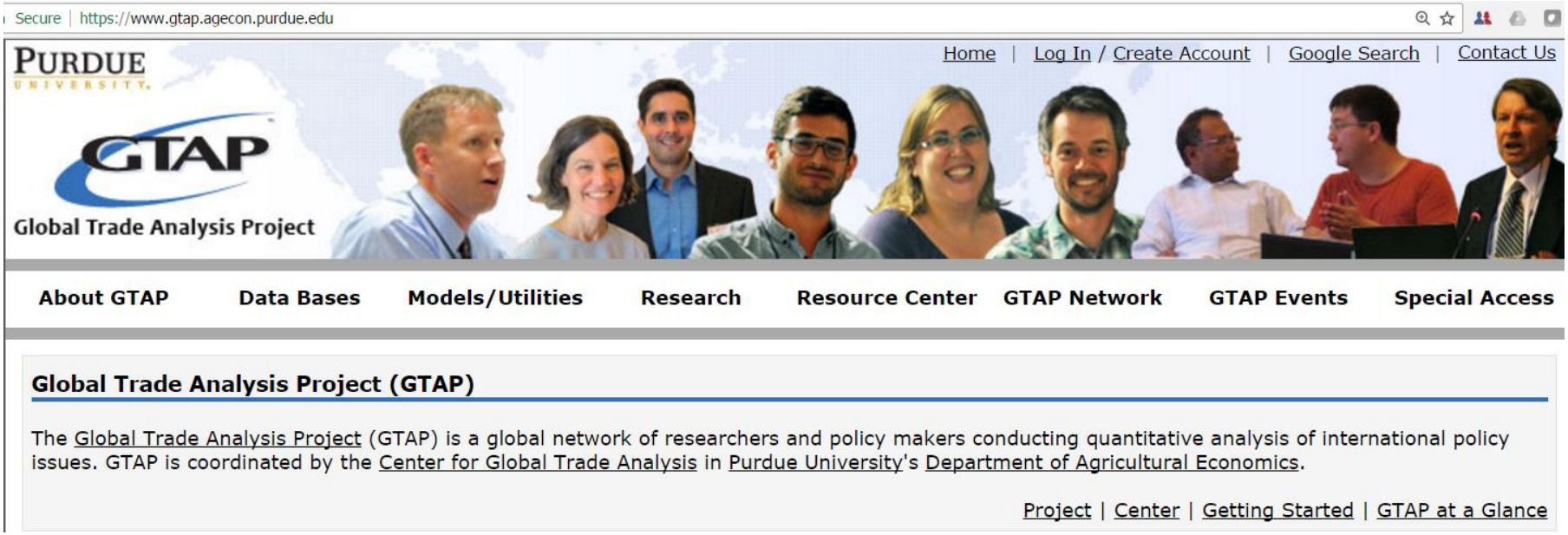
Carbon Tariffs

- Carbon tariffs are levied on the carbon content embodied in imported goods (from regions without emission regulation).
- Carbon tariffs discourage foreign emissions by pricing the emissions generated in the production of imported goods.
- Embodied carbon (carbon footprint) is a measure of the average emissions generated directly and indirectly in production.
  - Direct - combustion of fossil fuels in production
  - Indirect - combustion of fossil fuels required to produce electricity (or any other good) that is used as an input in production

GTAP Database



- Latest version GTAP9: global economic dataset with base-year 2011
- Input-output economic accounts for 57 sectors and 140 regions
- Production, consumption and bilateral trade data
- Initial taxes (factor inputs, intermediate inputs, imports, exports)
- Fuel- and sector-specific CO_2 emissions
- Elasticities (value-added, trade)

Regions in the Analysis

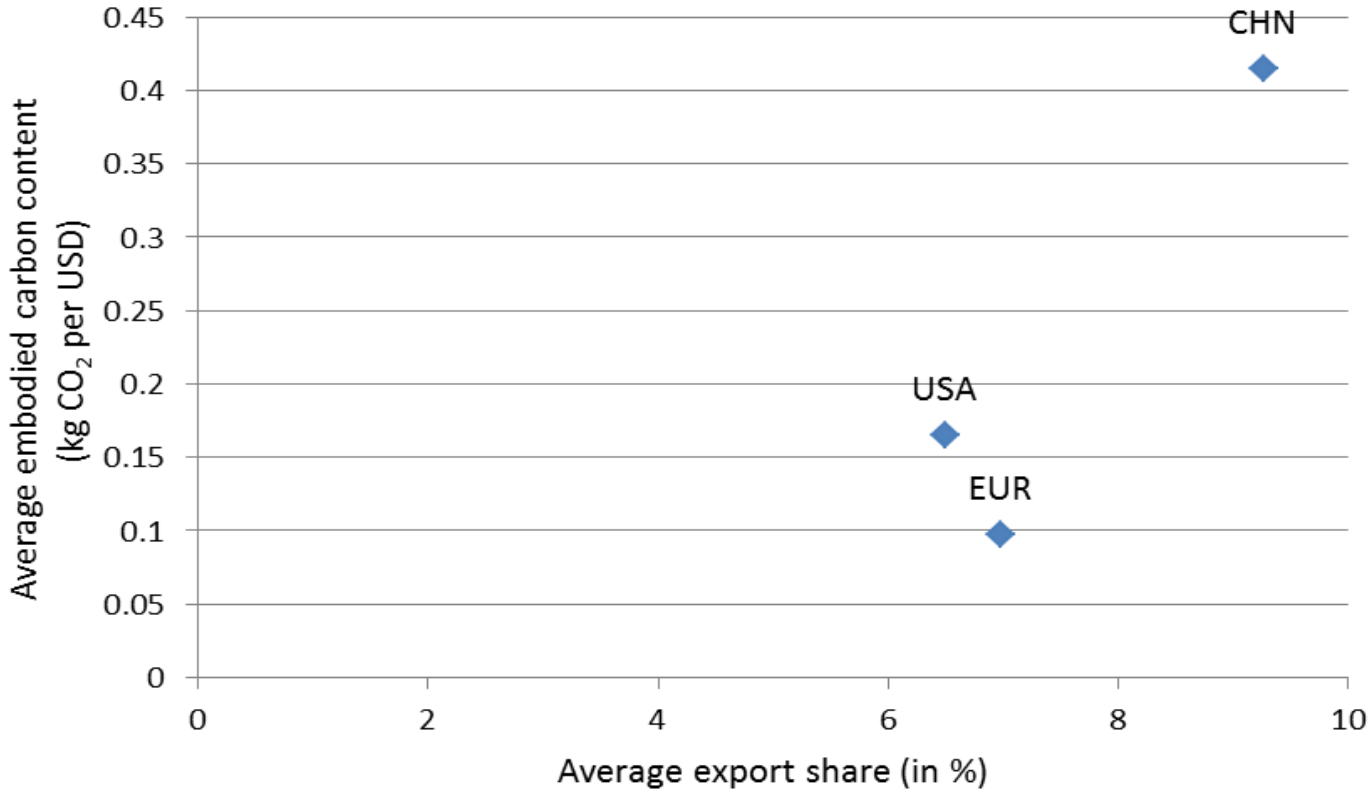
STRATEGIC REGIONS	
USA	United States of America
CHN	China (incl. Hong Kong)
EUR	EU-28 and EFTA
OTHER COMPOSITE (NON-STRATEGIC) REGIONS	
OOE	Other OECD countries: Australia, Canada, Japan, New Zealand, South Korea, Turkey
G20	Remaining G20 countries: Argentina, Brazil, India, Indonesia, Mexico, Russia, South Africa
OEX	Oil exporting countries: Bahrain, Iran, Kuwait, Qatar, United Arab Emirates, Venezuela, Iran, Saudi Arabia
MIC	Other middle income countries
LIC	Other low income countries

GTAP Commodity Classification

PDR	Paddy rice,	LUM	Wood Products
WHT	Wheat,	PPP	Paper products, publishing,
GRO	Cereal grains nec,	**OIL**	**Petroleum, coal products,**
V_F	Vegetables, fruit, nuts,	CRP	Chemical, rubber, plastic products,
OSD	Oil seeds,	NMM	Mineral products nec,
C_B	Sugar cane, sugar beet,	I_S	Ferrous metals,
PFB	Plant-based fibers,	NFM	Metals nec,
OCR	Crops nec,	FMP	Metal products,
CTL	Bovine cattle, sheep and goats, horses,	MVH	Motor vehicles and parts,
OAP	Animal products nec,	OTN	Transport equipment nec,
RMK	Raw milk,	EEQ	Electronic equipment,
WOL	Wool, silk-worm cocoons,	OME	Machinery and equipment nec,
FRS	Forestry,	OMF	Manufactures nec,
FSH	Fishing,	**ELE**	**Electricity,**
COL	**Coal,**	GDT	Gas manufacture, distribution,
CRU	**Crude Oil,**	WTR	Water,
GAS	**Gas,**	CNS	Construction,
OMN	Minerals nec,	TRD	Trade,
CMT	Bovine meat products,	OTP	Transport nec,
OMT	Meat products nec,	WTP	Water transport,
VOL	Vegetable oils and fats,	ATP	Air transport,
MIL	Dairy products,	CMN	Communication,
PCR	Processed rice,	OFI	Financial services nec,
SGR	Sugar,	ISR	Insurance,
OFD	Food products nec,	OBS	Business services nec,
B_T	Beverages and tobacco products,	ROS	Recreational and other services,
TEX	Textiles,	OSG	Public Administration, Defense, Education, Health,
WAP	Wearing apparel,	DWE	Dwellings
LEA	Leather products,		

Base-year Statistics

- Average embodied carbon content and average export share:



Base-year Statistics

Table: CO_2 emissions, GDP, and trade openness for the 2011 base year

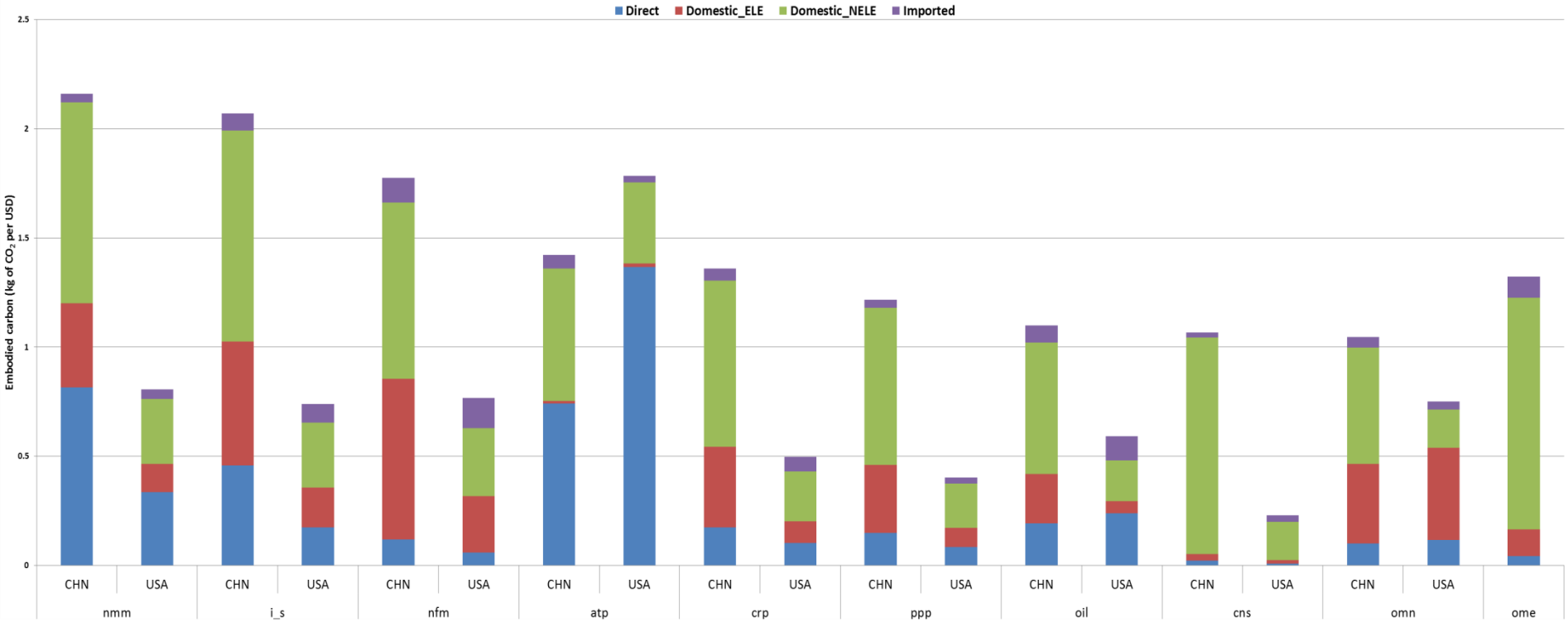
	CO_2 share (% of global $C0_2$ emissions)	GDP share (% of global GDP)	Trade openness (trade in % of GDP)
USA	17.7	21.7	29.5
CHN	25.4	10.6	50.3
EUR	11.8	23.0	36.7

Table: Export shares and bilateral tariff rates from row region to column region

Average export shares (in %)					
	USA	CHN	EUR	Rest	Total
USA		0.5	1.8	4.2	6.5
CHN	2.1		2.2	5.0	9.3
EUR	1.5	0.8		4.7	7.0
Average bilateral tariff rates (in %)					
	USA	CHN	EUR		
USA		4.3	1.3		
CHN	2.7		3.2		
EUR	0.9	6.2			

Embodied Carbon

- Multi-region input-output (MRIO) calculation:

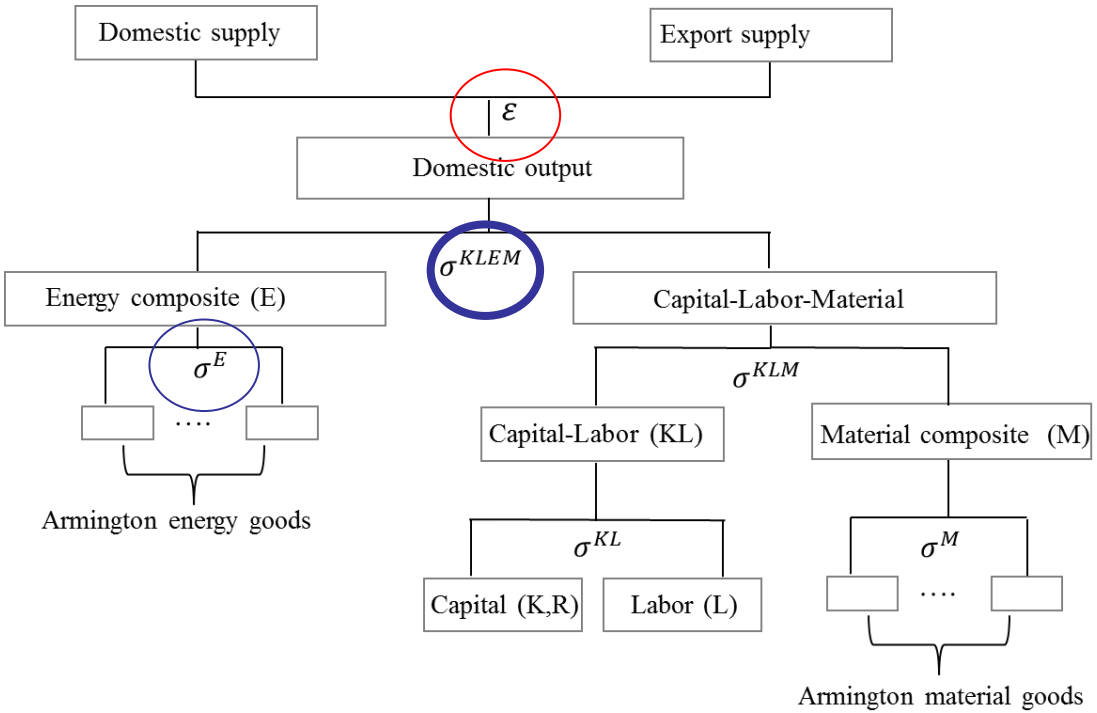


nmm – non-metallic minerals; **i_s** – iron and steel; **nfm** – non-ferrous metals; **atp** – air transportation; **crp** – chemical products; **ppp** – paper, pulp and print; **oil** – refined oil products; **cns** – construction; **omn** – mining; **ome** – other manfacturing

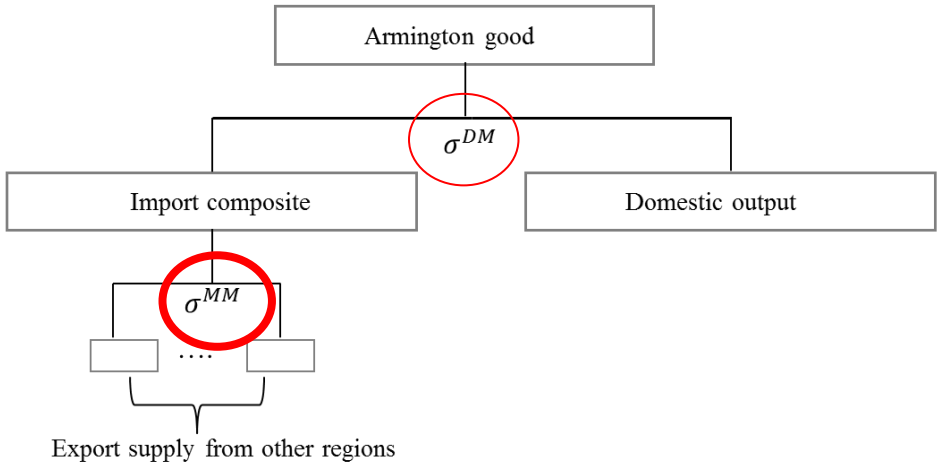
- Impacts of carbon tariffs:
  - Indirect emissions – in particular from electricity – are substantial
  - Embodied carbon in Chinese goods is generally much higher than in US goods

Flexible Functional Forms (Nested CES)

- Production:

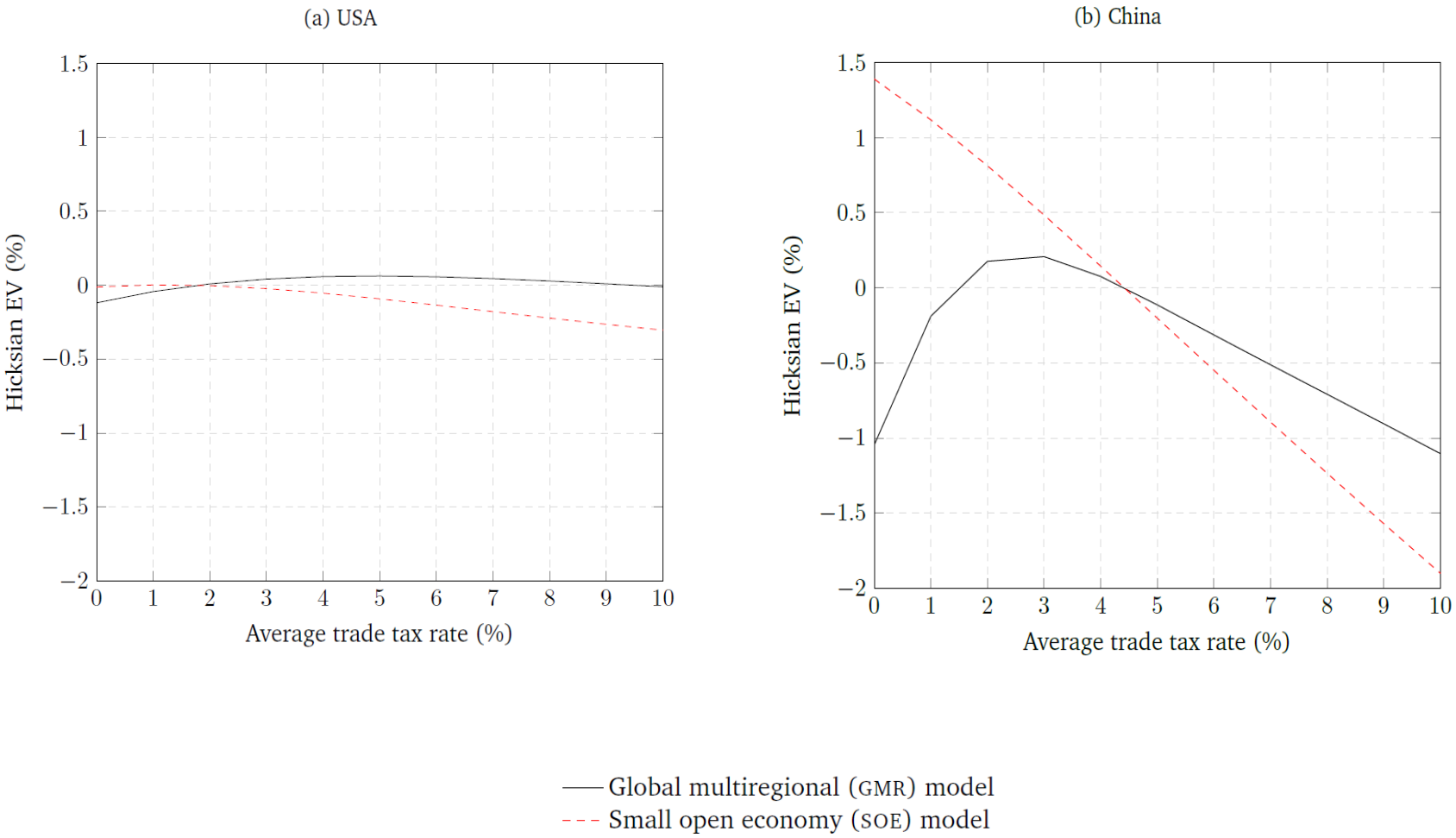


- Armington:



- Key elasticities for strategic tariff setting
- Key elasticities for ease of carbon abatement

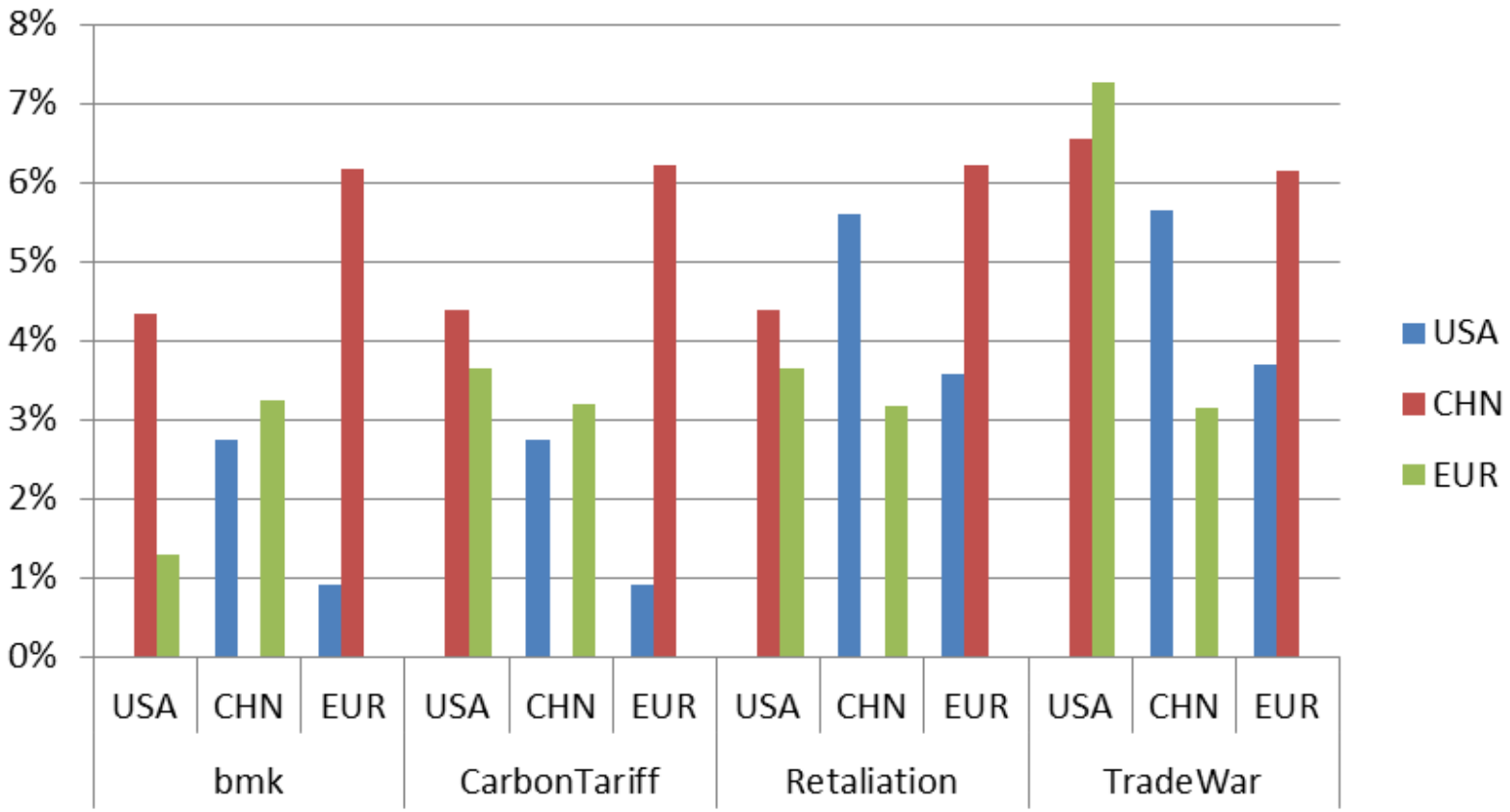
Scope for Optimal Tariff: GTAP Database and Elasticities



(Lanz and Rutherford 2016, J. Global Econ. Analysis)

Average Bilateral Tariff Rates

Average bilateral tariff rates (%) applied on imports from X-axis region



- Carbon tariffs on US imports (i) to China are negligible (ii) to Europe are substantial.
- Optimal tariffs for US remain robust across unilateral retaliation and trade war.
- Nash game leads to markedly higher average bilateral tariff rates.