

How Further Trade Liberalization Would Change Greenhouse Gas Emissions from International Freight Transport

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Trade and Climate Change

- Literature largely focuses on production related emissions
 - How does trade affect where emissions occur?
 - How would mitigation change specialization?
- This paper...
 - International transportation of goods (by air, ship, rail, truck) produces emissions.
 - How would further trade liberalization impact emissions?

Transport and Emissions: Channels

- Scale
 - more trade => more transport => more emissions
- Country composition
 - Shifting trade from near to distant partners increases transportation services (measured in tonnes-km)
- Product composition
 - Trade in crude oil, simple manufactures, microchips use different transport modes with varying emissions

The specific exercise

- Simulate a full trade liberalization – set all existing tariffs and subsidies to zero.
 - This generates changes in trade volumes for each origin (o)-destination (d) – and goods sector (g)
- Given existing modal shares for trade in each o-d-g, calculate growth in modal use
- Combine with modal data on CO₂ per tonnes-km performed to generate growth in emissions

Two caveats, qualifications...

- This is not a projection of future trade growth
 - Does not factor in possible economic growth unrelated to trade liberalization
 - Experiment asks: imagine the world of today, only with no tariffs or subsidies. What would emissions from international transport be?
- Modal shares and emissions for o-d-g are fixed
 - Abstracts from feedback loops operating through changes in fuel prices (exogenous or policy induced)

Four Data Components

- GTAP Model Trade Liberalization Experiment
- Weight-value (kg/\$) measures
 - Need to translate trade values into consistent units relevant to transport
- Modal shares (air, sea, rail, truck) for each country pair and product
- Emissions data for each mode

GTAP Model

- Widely used tool for analyzing changes in trade and trade policy
 - “Transport aggregation”: 40 regions, 27 sectors
- Policy shock: remove all tariffs, subsidies.
 - Avg tariff 3.2 percent, but varies widely across products, regions, and trading partners.
- KEY: preferential tariffs.
 - Trading blocs are regional, so rates are lowest for proximate partners and those sharing land borders
 - E.g. EU, NAFTA

Trade Growth, by product

		Weight/value	Growth in		
	Tariff	KG/\$	Value	Weight	Tonnes-Km
Bulk Agriculture	18.3	3.0	33.7	38.7	70.0
Processed Agric.	10.9	0.9	20.1	26.0	42.6
Textiles	7.8	0.3	22.6	1.7	24.2
Wearing Apparel	9.4	0.1	26.6	24.7	57.2
Other Manufactures	2.8	0.5	4.5	6.1	10.7
TOTAL	3.2	0.8	5.8	6.8	11.8

Trade Growth, by Export Region

		Weight/value	Growth in		
	Tariff	KG/\$	Value	Weight	Tonnes-km
Europe	2.0	0.5	1.5	4.1	10.2
North America	2.7	1.0	4.8	9.1	19.8
South America	7.0	2.8	10.7	11.1	20.8
South Asia	5.8	0.4	31.4	34.0	34.9
Asia	5.0	0.5	11.6	7.6	6.2
Africa	2.7	2.3	8.2	4.6	4.1
Oceania	6.6	2.9	8.5	3.2	2.6
WORLD	3.2	0.8	5.8	6.8	11.8

Tariff Liberalization and Trade Growth

- World trade grows 6%
- Large tariff reductions => more trade growth
 - Agriculture, textiles, wearing apparel
 - Asia, Latin America
- Tonnes-km of trade grow twice as fast as trade by value or trade by weight
 - Elimination of bilateral tariff preferences
 - Tonnes-km of bulk agriculture grows 70%

Modal Shares

- Based on trade data with modal detail
 - US, EU, LAC imports with 5000-17000 products
 - I have explicit modal data (o-d-g) for 2/3 of trade
- Need to estimate remaining 1/3 of trade
 - Out of sample prediction based on existing data
- Steps
 - is land transport an option? Estimate rail, truck shares using US, EU, LAC data
 - Split remaining trade between air v ocean

Modal Data Coverage

Importer→	EU	US	LAC	Rest of Europe	ASIA	Africa	Other
EU	X	X	X	X	X	X	X
US	X	X	X	X	X	X	X
LAC	X	X	X	A/O	A/O	A/O	A/O
Rest of Europe	X	X	X	L/A/O	A/O	A/O	A/O
Asia	X	X	X	A/O	L/A/O	A/O	A/O
Africa	X	X	X	A/O	A/O	L/A/O	A/O
Other	X	X	X	A/O	A/O	A/O	A/O

X – modal data explicitly observed; 65% of total

A/O -- air/ocean splits estimated; 33% of total

L/A/O – land/air/ocean splits estimated; 2% of total

Notes/Caveats on Estimation

- Estimation relates modal shares to
 - product weight/value, distance, adjacency, and vectors of origin, destination, product fixed effects
- Air/Ocean splits are estimated with high precision, but land transport is idiosyncratic and difficult to estimate
- The 27 sector model uses broad aggregates
 - Significant variability in air/ocean use across individual products within sectors

Modal Shares, Base Year

	Value Shares					Tonnes-km shares			
	Sea	Air	Rail	Truck		Sea	Air	Rail	Truck
Bulk Agriculture	77.7	3.0	3.3	16.0		96.8	0.4	1.6	1.3
Processed Agric.	58.5	2.9	1.9	36.5		92.0	0.7	0.8	6.5
Textiles	57.0	9.9	0.7	32.4		76.8	6.8	0.1	16.3
Wearing Apparel	53.2	19.1	0.5	27.1		71.1	20.4	0.1	8.4
Other Manufactures	42.0	24.5	4.1	29.3		87.3	4.9	1.3	6.4
TOTAL	47.4	20.6	3.7	28.2		93.4	2.0	1.1	3.5

Modal Shares Base Year

	Value Shares					Tonnes-km Shares			
	Sea	Air	Rail	Truck		Sea	Air	Rail	Truck
Europe	34.3	15.1	4.6	45.8		83.5	1.7	5.0	9.7
North America	25.3	27.9	8.6	38.2		86.1	6.1	1.6	6.3
South America	80.4	10.8	0.1	8.7		98.4	0.4	0.0	1.1
South Asia	73.0	23.1	0.7	3.2		97.3	1.7	0.2	0.8
Asia	70.9	27.5	0.3	1.2		98.3	1.3	0.0	0.4
Africa	77.3	14.0	0.0	8.7		97.3	0.1	0.0	2.5
Oceania	87.6	12.4	0.0	0.0		99.8	0.2	0.0	0.0

Generating Modal Growth

- Take simulated trade growth in values for each origin-destination-sector (o-d-g)
- Convert to KG using weight/value
- Convert into modal growth by multiply weight growth by modal shares for each o-d-g.
 - Assumes modal share distribution remains constant for each o-d-g.
 - Modal use changes in the aggregate because of compositional change in amount of trade by product, country pairs

Modal Growth

(% change in tonnes-km)

	Sea	Air	Rail	Truck
Bulk Agriculture	71.8	32.7	15.3	7.8
Processed Agric.	46.2	43.9	5.3	-3.7
Textiles	37.8	20.7	-24.4	-38.2
Wearing Apparel	68.6	60.9	3.0	-46.9
Other Manufactures	12.1	10.3	2.7	-7.6
TOTAL	12.6	12.4	4.0	-6.6

Modal Growth

(% change in tonnes-km)

	Sea	Air	Rail	Truck
Europe	11.5	16.4	6.8	-0.7
North America	23.5	10.7	-0.4	-17.3
South America	21.1	18.3	-13.8	-7.1
South Asia	34.7	38.1	48.0	48.0
Asia	6.1	12.9	-15.8	14.7
Africa	4.0	32.0		6.4
Oceania	2.6	30.6		
WORLD	12.6	12.4	4.0	-6.6

Key Result

- Before liberalization, tariff preferences favor neighboring countries
 - Land-adjacent neighbors can use rail, truck to transport goods
- After liberalization, trade shifts toward distant countries.
 - Tonnes-km grow. The use of ocean and air cargo grow. Rail and road modes shrink, especially for Europe and North America.

Emissions

- To perform calculations, need a measure of emissions per unit of transportation that is consistent across mode
 - CO2 grams per tonnes-km performed
 - Literature search for most recent estimates
 - Provide own estimates for air cargo based on fleet composition, fuel use and use characteristics by plane type.
- Combine with data on growth of tonnes-km traded for each mode (in each o-d-g).

Emissions Data

Maritime	CO2 per tonnes-km		Source:
Dry Bulk	4.5		University of Athens 2008
Container	12.1		University of Athens 2008
Crude Oil	5		University of Athens 2008
LNG	16.3		University of Athens 2008
LPG	12.7		University of Athens 2008
Chemical	10.1		University of Athens 2008
Land			
Road	119.7		Giannouli and Mellios, EEA, 2005
Rail	22.7		
Air			
Boeing 747	552		Maersk
Various	476-1020		California Climate Change 2006
US Cargo Fleet	963.45		Author's calculations based on ATA fuel usage data
US Cargo Fleet	912		Authors' calculations based on Aircraft Economics 1999 data

Emissions Growth

origcont	Total Emissions Growth		Modal Share in Total Emissions Growth, LOW			
	HIGH	LOW	Sea	Air	Rail	Truck
EUR	10.0	8.5	27.3	33.9	3.7	35.1
NA	9.0	8.1	17.8	69.8	0.7	11.7
SA	16.9	16.7	68.4	21.3	0.1	10.3
S ASIA	38.0	38.0	46.6	47.5	0.2	5.6
Asia	10.9	10.3	52.7	44.6	0.0	2.7
Africa	9.9	8.9	62.2	8.1	0.0	29.7
Oceania	9.1	7.1	84.2	15.8	0.0	0.0
WORLD	10.2	9.4	33.6	49.6	1.0	15.8

Conclusions

- Trade liberalization experiment predicts 6% growth in trade by value.
 - Trade grows most where tariffs fall most.
 - “Trade at a distance” rises, land modes fall.
- Emissions from international cargo transport rise 9-10 percent
 - Air cargo share equals 50-62 percent of total emissions depending on emissions data used.

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