

# **The Importance of Trade Costs: A Gravity Model Application**

*~ An ARTNeT Project*

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# Presentation outlines

- What is trade costs and why it is so important?
- Impact of trade costs on trade
  - A case study on Asia
- Methodology applied – Gravity Model
- Trade costs (bilateral) estimation
  - Transport costs – International
    - Ocean freight
  - Tariff
  - Infrastructure
- Regression - OLS

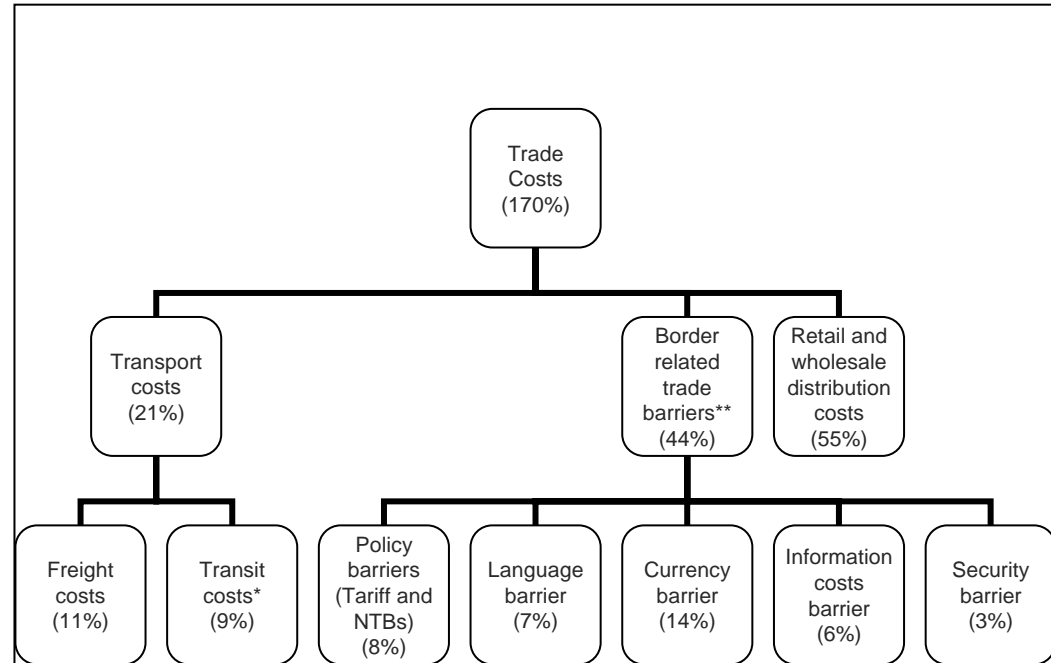
# [ Online demonstration ]

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- Maersk Sealand's database ([www.maersksealine.com](http://www.maersksealine.com))
- Transport costs estimations
  - Two models
- Gravity model (as an example)
  - Excel – Data compilation
  - Stata - OLS

# Definition of trade costs

- Trade costs include all costs incurred in getting a good to a final user other than the marginal cost of producing the good itself
  - Transportation costs (both freight costs and time costs), policy barriers (tariffs and non-tariff barriers), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail), etc.



Notes: \*Tax equivalent of the time value of goods in transit. Both are based on estimates for US data. \*\* The combination of direct observation and inferred costs, which, according to author, is an extremely rough breakdown.

Source: Drawn from Anderson and van Wincoop (2004)

# Theoretical discourse - Price vs. Non-price factors

- Ricardian model – Classical
  - Comparative advantage
- Hecksher-Ohlin-Samuelson (HOS) model – Neo-classical
  - Relative factor abundance [comparative advantage is determined by cross-country differences in relative abundance of factor endowments]
  - Assumptions - perfect competition, homogeneous goods, production with constant returns to scale, no transport costs, and mobility of factors between industries and not between countries. [price factor]
- Krugman model - New Trade Theory
  - Transport cost is incorporated as a factor of determinant,
  - Assumptions - Increasing returns to scale, and monopolistic competition (Dixit and Stiglitz, 1977)
  - Non-price factor => Transport costs
  - Transport costs play a pivotal role in integrating the countries and/or factors.

# [ Trade (transport) costs ]

- Explicit assumptions in trade equilibrium
  - Trade costs
    - Costs due to policy (tariff, NTB, Quota, ADD)
    - Costs due to environment (infrastructure)
- Positive relation
  - Infrastructure and trade

# Why it is so important?

- A growing literature has documented the negative impact of trade costs on the volume of trade
- Tariff barriers are now low in most countries -
  - Less than 5% for rich countries
  - Between 10 – 20% for developing countries
  - Between 6- 10% in Northeast Asian countries (>20% in 1991)
- Most of the studies show poor institutions and poor infrastructure penalize trade, differentially across countries.
- Many studies show that liberalisation of international transport services foster international trade very much the same way as tariff liberalization does
- Attention is now being focused on minimization of trade costs through facilitation of merchandise and services trade logistics, both inbound and outbound
- Strategy of trade thus goes beyond the traditional mechanisms of tariffs and quotas.

*Refer, De, P, 2007, ARTNeT Working Paper for the list of bibliography*

# Trade costs and infrastructure interventions

Type of Trade Costs	Type of Barriers	Infrastructure Intervention
Transport cost	Hard / Visible	Port, Shipping, Road, Rail, Aviation
Time in transit	Hard / Visible	Port, Shipping, Road, Rail, Aviation
Freight insurance	Soft / Invisible	Insurance regulation
Customs delays	Soft / Invisible	Harmonisation of customs procedures
Unofficial payments	Soft / Invisible	Governance reform
Information search	Soft / Invisible	Investment climate
Currency changes (cost of hedging)	Soft / Invisible	Financial sector regulation
Management of supply chain	Hard / Visible and Soft / Invisible	Telecommunications, investment climate, regulatory environment
Excess inventories	Hard / Visible and Soft / Invisible	Port, Shipping, Road, Rail, Aviation, Harmonisation of customs procedures



# “Transport costs temper steel” - *Economic Times: 25 January 2007*

“Why does L. N. Mittal, or, Ratan Tata, have to buy foreign companies to establish global presence and expand steel capacities when our (India) per capita consumption of steel is so low and there is so much opportunity here?” - *Dr. Manmohan Singh, Indian Prime Minister*, while laying foundation stone for a steel project in eastern part of India in December 2006.

It quoted in **Economic Times** recently:

“It costs US\$ 50 per tonne to transport steel from Mumbai to Kolkata overland for a distance of about 2200 km. You need to pay the same to take it US East Coast from Mumbai through sea. If your destination is Europe, the cost will be US\$ 10 less. And you can take it to Southeast Asia for only US\$ 30 a tonne.”

- India pays about 12% of merchandise import values towards import transaction costs every year: US\$ 18 billion in 2005-06FY. .... More than India's export earnings from IT services: US\$ 13.3 billion in 2006-07FY.

# Impact of trade costs on trade: case study on Asia – some reasons

- Asia's rising trade – intra-regional
  - 51% of Asia's exports are conducted within the region (2005)
  - 27% of world exports (2005) come from Asia [was about 18% when China started liberalising her economy in 1978 and about 26% when India adopted liberal trade regime in 1991]
- Rising production network in Asia
  - Vertical specialization in electronics (Korea –China- India) and auto components (Japan – Thailand – India)
- Trade in high-value low-weight items
  - Office and telecommunication items
  - 54% of world exports of EDP and office equipment come from Asia (2005) [was 48% in 2000]
  - 66% of world exports in integrated circuits are contributed by Asian countries [was 57.2% in 2000]

# Asia's rise in trade in goods (1/2)

Product	Share in Exports of Asia		Share in World Exports	
	(%)		(%)	
	2000	2005	2000	2005
Total merchandise exports	100.0	100.0	26.4	27.4
Manufactures	84.2	83.1	29.7	31.6
Iron and steel	2.2	3.0	24.9	26.5
Chemicals	6.1	7.4	17.3	18.5
Pharmaceuticals	0.5	0.6	8.1	6.2
Machinery and transport equipment	51.2	48.6	32.2	35.1
Office and telecom equipment	27.5	25.2	47.2	54.9
EDP and office equipment	10.7	9.0	47.7	53.9
Telecommunications equipment	6.2	8.0	35.8	47.7
Integrated circuits	10.6	8.2	57.2	66.0
Transport equipment	10.2	10.2	20.3	21.9

Source: WTO

# Asia's rise in trade in goods (2/2)

Product	Share in Exports of Asia		Share in World Exports	
	(%)		(%)	
	2000	2005	2000	2005
Automotive products	6.9	7.0	19.8	21.3
Other transport equipment	3.3	3.2	21.3	23.2
Other machinery	13.4	13.2	26.7	28.7
Textiles	4.2	3.4	44.2	46.7
Clothing	5.5	4.7	46.4	47.7
Other manufactures	9.5	10.1	29.6	33.0
Personal and household goods	2.2	2.3	31.4	36.2
Scientific and controlling instruments	1.6	2.5	22.4	32.7
Miscellaneous manufactures	5.8	5.3	31.8	31.9

Source: WTO

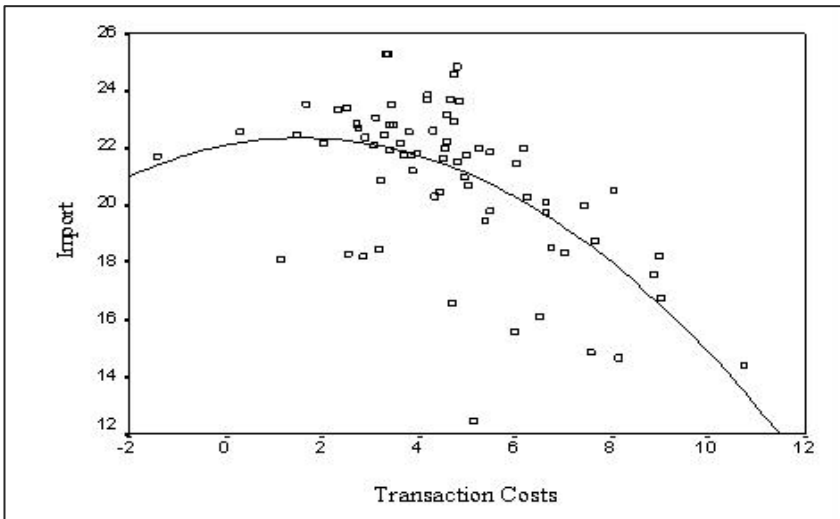
# Is rise in trade in Asia associated with fall in transport costs?

- Transport costs = domestic + international
- Fall in domestic transport costs (intra-country) in developed and middle to advanced level developing countries [improved logistics and physical infrastructure]
- Rise in international transport costs (inter-country) across the world [many factors involved – ocean freight, oil price, technological asymmetry, a.o.]
- Dealing international transport costs, Venables (2006) commented: “technical change in shipping is no longer faster than technical change in goods shipped, so freight rates relative to shipment value are no longer falling”.

Venables, A. J. 2006. “Shifts in Economic Geography and Their Causes”, *Economic Review*, Vol. 91, No. 4, pp. 61 - 85



# Relative importance of trade transaction costs in Asia



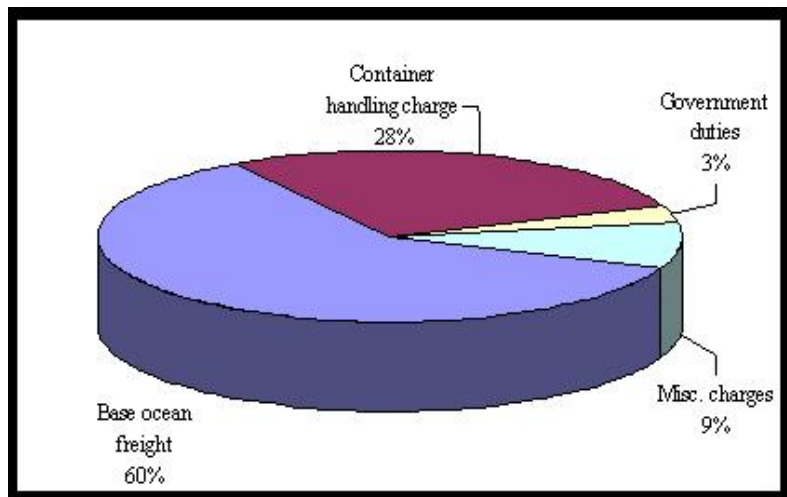
Source: De, P, (2006) "Trade Infrastructure and Transaction Costs: The Imperatives for Asian Economic Cooperation", *Journal of Economic Integration*, Vol. 21, No. 4, December, pp. 708 - 735

Key elements in international transport costs  
- Ocean freight

## Estimates of ocean freight costs for imports

Year	Developed	Developing	Developing Asia
	(% )		
1990	2.9	6.7	6.9
2000	2.9	5.9	6.5
2003	2.9	6.1	6.7
2004	3.0	5.9	6.5

Note: \*As a percentage of import value (taken at *cif*).  
Source: UNCTAD



# Assessment – Methodology

- Estimate transport costs
  - Domestic
  - International
- Other barriers
  - Tariffs, a.o
- Gravity model
  - Trade = f (market size, barriers, distance)
  - Augmented gravity model

# International transport costs: Model 1

- Model I
  - Very popular
  - High data errors
  - $T_{ij}$  - costs of transportation between country  $i$  and  $j$ ,  $IM_{kij}$  - import price of country  $i$  from country  $j$  for the commodity  $k$ ,  $EX_{kji}$  - export price of country  $j$  to country  $i$  for the commodity  $k$ ,  $S_{ik}$  - value-share of commodity  $k$  in country  $i$  in the bilateral trade.
  - We use *cif* values to represent  $IM_{kij}$ , and *fob* values for  $EX_{kji}$ .

$$t_{ij}^k = \left( \frac{IM_{ij}^k}{EX_{ji}^k} - 1 \right) S_i^k$$

Open the Excel File: Transport Costs Model 1



# International transport costs: Model 2

- Model 2
  - Empirically tested first by David Hummels (1999a, 1999b)
  - Relatively superior than Model 1, if supported by correct data
  - $Q_{kij}$  - import in quantity of country  $i$  from country  $j$  for the commodity  $k$ ,  $f_{jik}$  - shipping costs of per unit of import of commodity  $k$  by country  $i$  from country  $j$ ,  $Q_{ij}$  is country  $i$ 's total import from country  $j$ .

$$t_{ij}^k = \frac{Q_{ij}^k f_{ji}^k}{Q_{ij}}$$

Open the Excel File: Transport Costs Model 2

# Domestic transport costs

- Logistics costs
  - Data mismatch
- Infrastructure costs
  - Difficult to estimate
- Infrastructure availability – as a proxy
  - Create an Index
- Representative indicators – as a proxy
  - Railway length, road length, port capacity or performance
- Time of transportation
  - Data mismatch

# Augmented gravity model

- The gravity model provides the link between trade barriers and trade flows.
- Partial equilibrium model
- $Y_i$ ,  $Y_j$  and  $Y_w$  - the aggregate size of countries  $i$ ,  $j$  and the world, respectively;  $T_{ij}$  - trade costs and other trade barriers;  $P_i$  and  $P_j$  - implicit aggregate equilibrium prices; and  $\sigma$  - the constant elasticity of substitution (CES) between all goods in the consumption utility function.
- $P_i$  and  $P_j$  - resistance term or remoteness [ trade weighted average distance from rest of the world]

$$X_{ij} = \frac{Y_i Y_j}{Y_w} \left( \frac{T_{ij}}{P_i P_j} \right)^{1-\sigma}$$



$$\ln IM_{kij} = \alpha_0 + \alpha_i + \beta_1 \ln Y_i Y_j + \beta_2 \ln I_i + \beta_3 \ln I_j + \beta_4 \ln TC_{kij} + \beta_5 \ln T_{kij} + \beta_6 \ln R_i + \beta_7 \ln R_j + \beta_8 \ln D_{ij} + \beta_9 d_1 + \beta_{10} d_2 + \beta_{11} d_3 + \epsilon_{ij}$$

1. Open the Excel File: Gravity Model Data
2. Open Stata

# Data sources

Particular	Source
Bilateral trade	UN COMTRADE, IMF DOTS
Bilateral tariff	WB WITS
GDP, GDP per capita, surface area, population	WB WDI 2006
Distance	Great circle distance, capital to capital distance, port to port distance
Infrastructure variables: (i) railway length, (ii) road length, (iii) air transport freight, (iv) air transport passengers carried, (v) aircraft departures, (vi) container traffic, (vii) fixed line and mobile phone subscribers, (viii) internet users, and (ix) electric power consumption	WB WDI 2006
Shipping freight	Maersk Sealand, <a href="http://www.maerskline.com">www.maerskline.com</a>

# Regression results and explanations - OLS (1/2)

	Model 1 <sup>#</sup>		Model 2 <sup>\$</sup>	
	Coefficient	t-value	Coefficient	t-value
GDP of importing countries	0.107***	3.720	0.059**	2.350
GDP of exporting countries	0.488***	20.440	0.394***	21.230
Infrastructure of importing countries	-0.421***	-7.500	-0.586***	-12.090
Infrastructure of exporting countries	-0.054*	-1.990	-0.148***	-5.930
Weighted tariff	-0.276***	-13.830	-0.161***	-9.450
Trade-weighted transport costs <sup>\$</sup>			-0.571***	-11.620
Trade-weighted transport costs <sup>#</sup>	-0.021*	-1.940		
Remoteness of importing countries	-0.001	-0.010	-0.680***	-8.260
Remoteness of exporting countries	-0.638***	-8.720	-0.929***	-15.150
Distance	-0.420***	-9.970	-0.573***	-15.570
FTA Dummy	0.323***	5.900	0.179***	3.970
Adjacency Dummy	0.163**	2.260	0.072	1.290
Language Dummy	0.114	1.570	0.117*	2.000
No of observations	20533		12051	
Adjusted R <sup>2</sup>	0.130		0.555	

# Regression results and explanations – OLS (2/2)

	Model 1 <sup>#</sup>		Model 2 <sup>\$</sup>	
	Coefficient	t-value	Coefficient	t-value
FTA Dummy	0.323***	5.900	0.179***	3.970
Adjacency Dummy	0.163**	2.260	0.072	1.290
Language Dummy	0.114	1.570	0.117*	2.000
<i>Country effect</i>				
China	0.693***	4.940	0.579***	9.580
Hong Kong	Insignificant		Insignificant	
India	Insignificant		Insignificant	
Indonesia	0.087	1.080	-0.212**	-2.810
Japan	Insignificant		Insignificant	
Korea	-0.488***	-6.340	-0.964***	-13.750
Malaysia	Insignificant		Insignificant	
Singapore	Insignificant		Insignificant	
Thailand	0.119*	1.940	0.241***	4.570
No of observations	20533		12051	
Adjusted R <sup>2</sup>	0.130		0.555	

# Concluding remarks

- Infrastructure quality, transport costs, and tariffs, have statistically significant negative impact on the volume of imports.
- 10% saving in international transport costs and 10% reduction in tariffs will likely to increase imports by about 6 and 2 percents, respectively.
- 10% improvement in infrastructure quality (domestic transport costs) will increase exports by 2 percent (in exporting countries) and imports by 3 percent (in importing countries).
- Among the sectors, except transport equipment, trade in all other sectors is influenced by tariffs, transport costs and infrastructure quality.
- We need to solve omitted variable bias and endogeneity – 2SLS
- Tariff is no more THE important barrier.
- Tariff liberalisation should be supported by trade facilitation
  - Objective – Minimise trade frictions
- Policy should be focused on trade facilitation– both software and hardware aspects of TF
- Revisit *a la* Krugman => Distance not yet dead!

# Selected TF indicators – example

Exporter /Origin	Importer / Destination	Documents for export (number)	Time for export (days)	Shipping cost (US\$ per container) <sup>1</sup>	Documents for import (number)	Time for import (days)
Japan	China	5	11	498.11	7	11
China	Japan	6	20	1165.90	11	24
Japan	Korea	5	11	563.68	7	11
Korea	Japan	5	12	662.25	8	12
Korea	China	5	12	570.33	8	12
China	Korea	6	20	739.86	11	24
World Average <sup>2</sup>		7	30		11	37
Asian Average <sup>3</sup>		7	23		10	26

Source: Doing Business Database, World Bank, 2007





**Thanks**