What can gravity models tell us about logistics and exports?

Alberto Behar

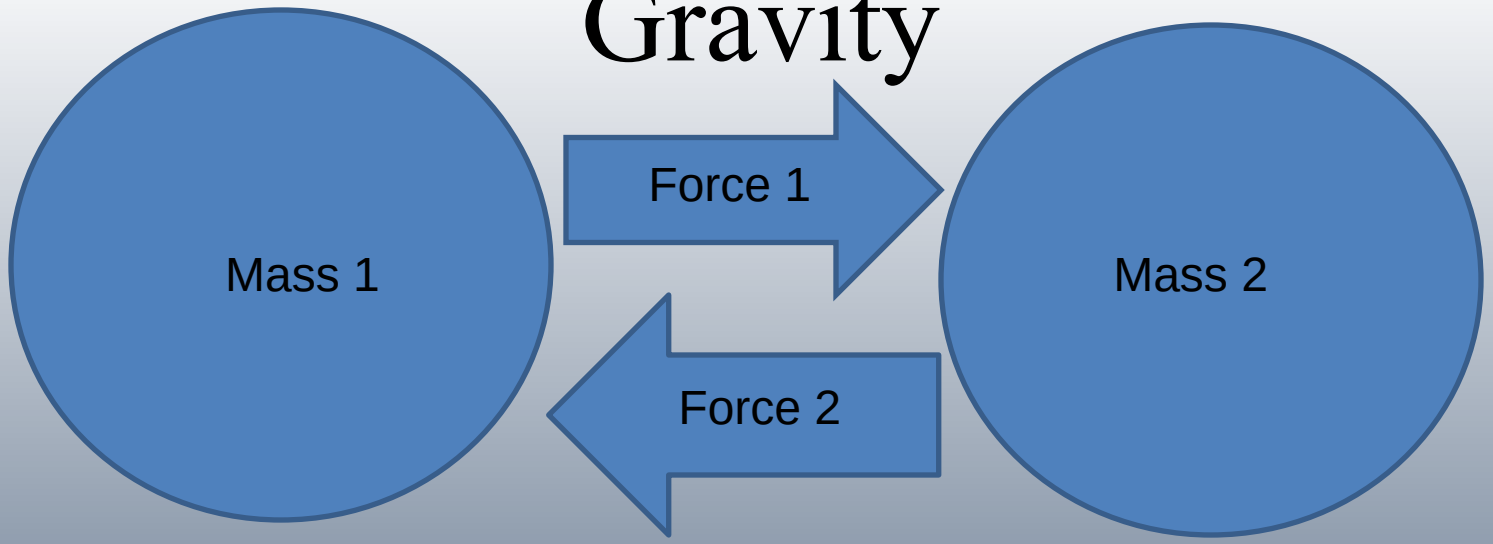
International Monetary Fund

abehar@imf.org

Outline

- Gravity vs trade
- Sources of transport costs
- Physics gravity vs economics gravity
- Logistics – typical gravity interpretation
- Extensions: 3rd country effects, macro vs micro
- Conclusion

Gravity



Exports

Gravity equation

$Exports_{12} = \beta_1 * GDP_1 + \beta_2 * GDP_2$ –"distance"

$Exports_{12} = \beta_1 * GDP_1 + \beta_2 * GDP_2$ –"trade costs"

$Exports_{12} = \beta_1 * GDP_1 + \beta_2 * GDP_2$ –"transport costs; other trade costs"

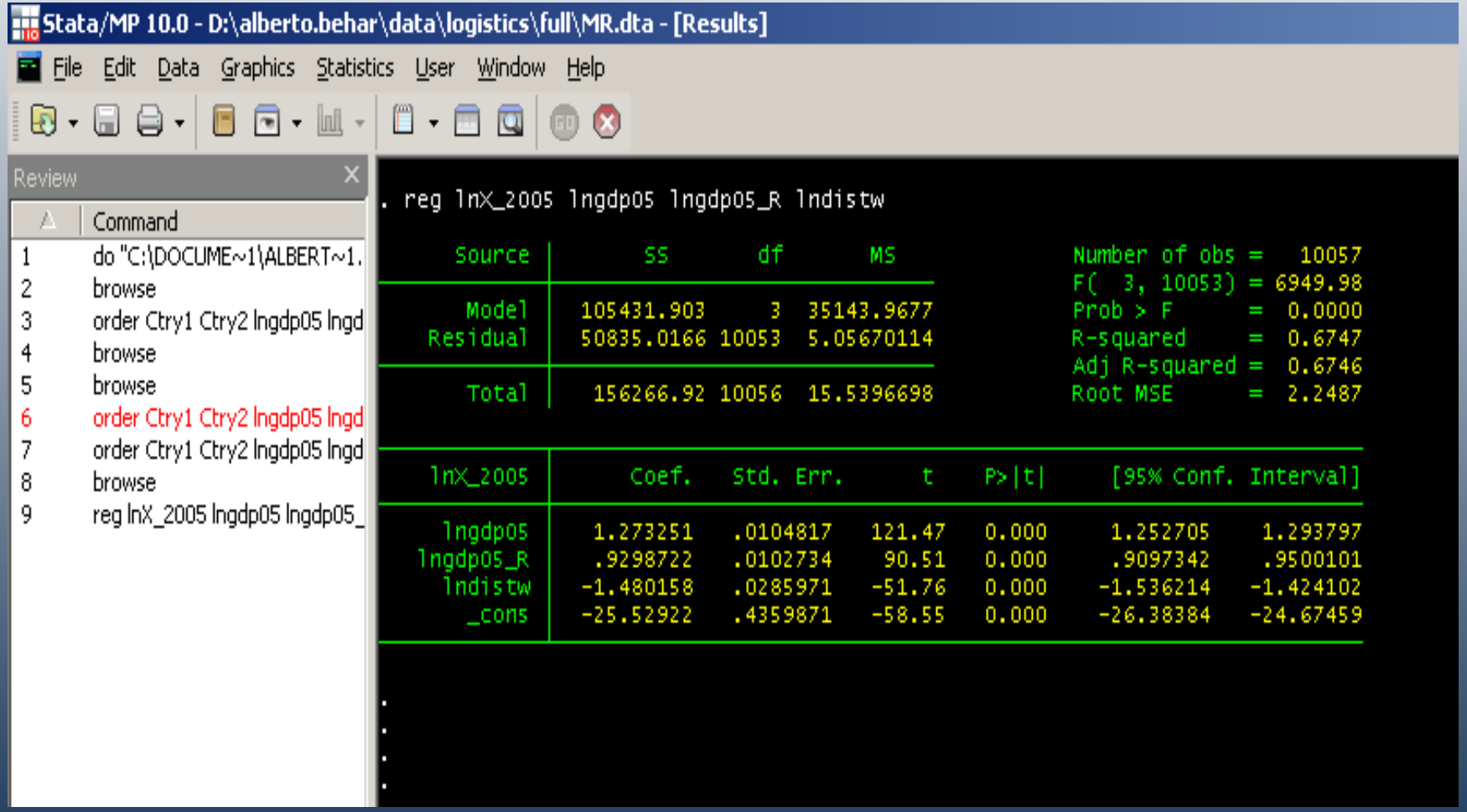
{channels: money, time, complexity, uncertainty}

$Exports_{12} = \beta_1 * GDP_1 + \beta_2 * GDP_2 - \gamma * distance_{12}$

$-\delta * signatures_1 + \lambda * infrastructure_1 + \xi * FTA_{12}$ ...

{"reduced form"}

Estimation ("econometrics")



Variations in transport costs

Region or Economy	US$ per container		Days	
	Import	Export	Import	Export
OECD Average	1146	1090	11	11
World Average	1625	1404	27	25
Singapore	439	456	3	5
Chad	6150	5497	100	75

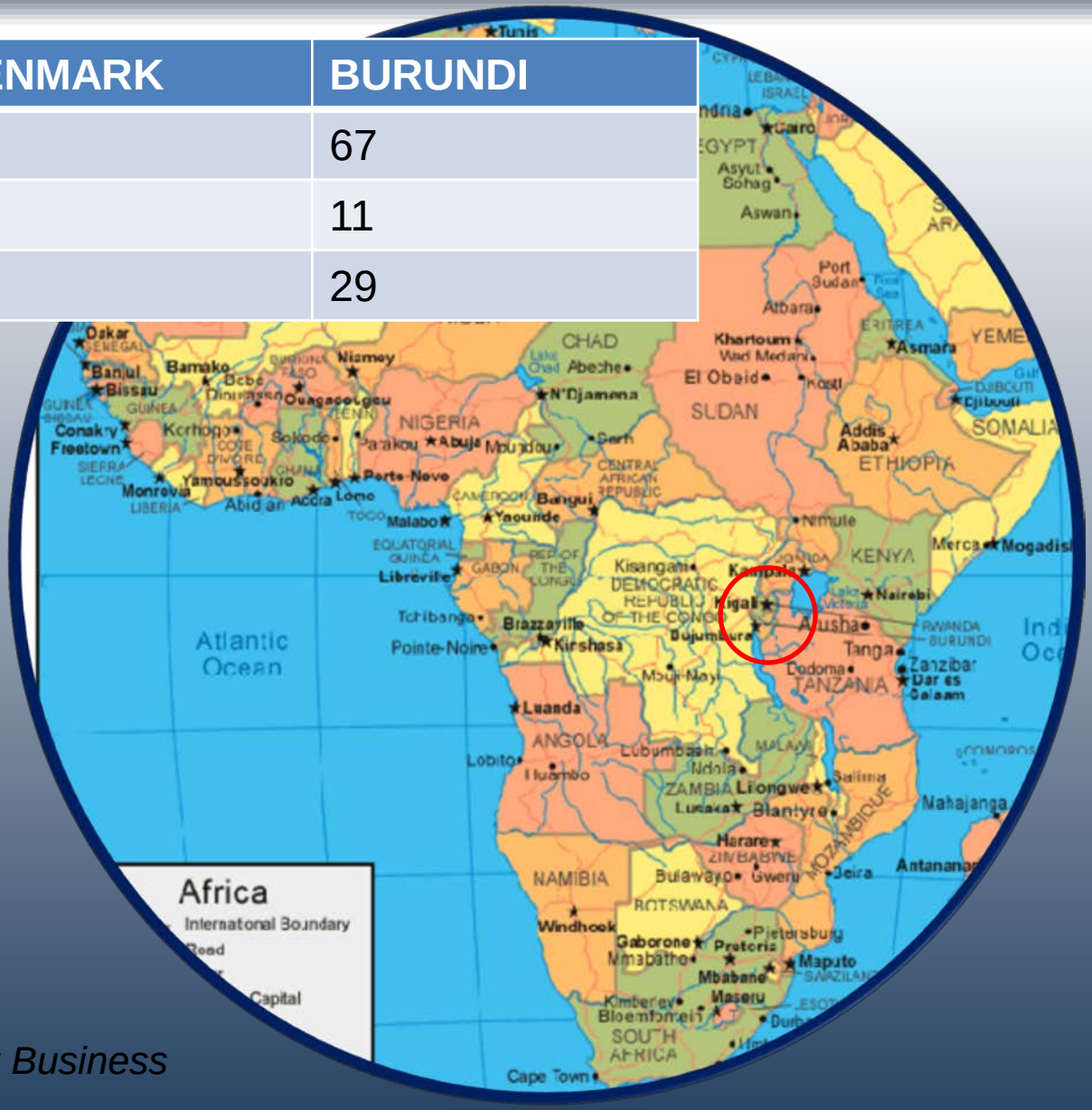
Table 1, the costs of transporting goods - source: World Bank *Doing Business Indicators*; http://www.doingbusiness.org/ExploreTopics/TradingAcrossBorders/

Impediments to exports

- Natural/geographical
- Political (borders, free trade agreements)
- Technological (eg infrastructure, logistics)

Behar & Venables (2011), Anderson & van Wincoop (2004)

	DENMARK	BURUNDI
DAYS	5	67
DOCUMENTS	3	11
SIGNATURES	2	29



Source: World Bank *Doing Business*

Exports are not Physics

- Firms *choose* to sell and people *choose* to buy
  - Exports = f(demand)= $f(p/P)^{-1}$ =f(distance/remoteness, *relative logistics quality*)$^{-1}$
- Countries *choose* to improve logistics
  - $Exports_{12}$ =

    $\beta_1 * GDP_1 + \beta_2 * GDP_2 + \xi * Logistics_2$ +(unobserved factor)
    - "Endogeneity" / "reverse causality"
    - "Does better infrastructure lead to more exports or do higher trade volumes lead to more infrastructure?"

Effects usually assumed (log) linear

$Exports_{12} = \beta_1 * GDP_1 + \beta_2 * GDP_2 - \gamma * distance_{12} - \delta * signatures_1$

$+ \lambda * infrastructure_1 + \xi * FTA_{12}$ ...

- What about “binding” constraints, supply-chain analysis, optimization, interactions between factors?

Exports and logistics

Behar, Manners and Nelson (forthcoming)

- Gravity model using Logistics Performance Index (LPI) based on 6 sub-indicators (Arvis et al, 2007) - specifically 4 referring to international logistics “International Logistics Index”.

i. Efficiency of the clearance process by customs and other border agencies
ii. Transport and information technology infrastructure
iii. Local logistics industry competence
iv. Ease and affordability of international shipments
v. The facility to track and trace shipments
vi. The timeliness with which shipments reach their destination

(New and improved versions now available)

Dependent variable: Log bilateral exports	
Log GDP	0.922***
	[0.0157]
Logistics (ILI)	0.597***
	[0.0556]
Log Distance	-1.467***
	[0.0496]
Border	1.071***
	[0.176]
Colony	0.501***
	[0.133]
Language	0.646***
	[0.0956]
Samecountry	0.398
	[0.243]
Religion	0.826***
	[0.143]
Landlocked	-0.648***
	[0.0653]
Island	-0.410***
	[0.0694]
Constant	-33.18***
	[0.602]
N	6939

Significance levels: * p<0.1, ** p<0.05, *** p<0.01. Std errors in brackets.

$$\frac{\partial \ln(\text{exports}_{12})}{\partial \text{logistics}_2} = \hat{\lambda}$$

1 standard deviation improvement in logistics (0.4) would increase a country's exports by:
exp(0.4*0.597)-1=27%
(typical interpretation).

Third country effects

- Most gravity models are used to assess what happens to exports after a change in logistics (transport costs) between two countries ***assuming no change by anybody else***.
- But the trade between two countries depends **not only on logistics of one country but on how this compares to everybody else**, so the effect of improved logistics must take this into account.
- Anderson & van Wincoop (2003): ignoring 3rd country effects can lead to a **20**-fold overestimate of the effects of international border!
- Behar and Nelson (2012): if everybody reduces trade costs, trade **falls** between most country pairs. 3rd country effects reduce the impact on global trade by **two thirds**.

The algebra of gravity

$$M_{12} = Y_1 Y_2 \left(\frac{T_{12}}{P_1 P_2} \right)^{1-\sigma} , \sigma > 1$$

$$m_{12} = y_1 + y_2 - (\sigma - 1) t_{12} + (\sigma - 1)[p_1 + p_2]$$

$$\frac{\partial m_{12}}{\partial Logistics_2} = -(\sigma - 1) \frac{\partial t_{12}}{\partial Logistics_2}$$

$$\frac{dm_{12}}{dLogistics_2} = -(\sigma - 1) \left\{ \frac{\partial t_{12}}{\partial Logistics_2} - \frac{\partial [p_1 + p_2]}{\partial Logistics_2} \right\}$$

$$\{...\}$$

Third country effects and logistics

$$\frac{\partial \ln(\text{exports}_{12})}{\partial \text{logistics}_2} \approx (\text{GDP share})_2 \lambda,$$

$$\text{but gravity coefficient } \hat{\lambda} \approx \frac{\lambda}{\text{number of countries}}$$

Exporter	Share	Homogeneous	Heterogeneous	Exporter	Share	Homogeneous	Heterogeneous
China	5.34%	3.50	3.93	Djibouti	0.00%	0.001	0.002
Brazil	1.90%	1.29	1.53	Gambia	0.00%	0.001	0.002
India	1.82%	1.24	1.45	Liberia	0.00%	0.001	0.001
Mexico	1.81%	1.23	1.35	Solomon	0.00%	0.001	0.001
Russia	0.99%	0.68	0.81	Guinea-Bissau	0.00%	0.000	0.001
Argentina	0.89%	0.61	0.72	Comoros	0.00%	0.000	0.001

Source: Behar, Manners & Nelson, *Exports and International Logistics* , Oxford Bulletin of Economics and Statistics

Trade costs and the margins of trade

- Intensive margin: quantity of a product exported (to a particular destination) by a firm
- Extensive margin: new products / firms exporting (to a particular destination)
- Empirical studies:
  - Gravity/macro data + theory (eg logistics)
  - Firm-level data (Bernard et al)
- Transactions level data (customs authorities):

  http://econ.worldbank.org/exporter-dynamics-database (many countries, not France…)

References

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- Alberto Behar and Anthony J. Venables. "Transport Costs and International Trade" *Handbook of Transport Economics*. Ed. André de Palma, Robin Lindsey, Emile Quinet & Roger Vickerman. Edward Elgar, 2011.
- Bernard, A., Jensen, J., Redding, S. & Schott, P. (2007), “Firms in International Trade”, *Journal of Economic Perspectives*

Conclusion

- Economists study the impact of transport costs on trade using gravity models
- Countries with better logistics export more
- But:
  - This varies between countries
  - Further work needed on micro data
- Log-linear specification is a major simplification