

# Augmented Gravity Models:

## (1) Intro to Gravity.

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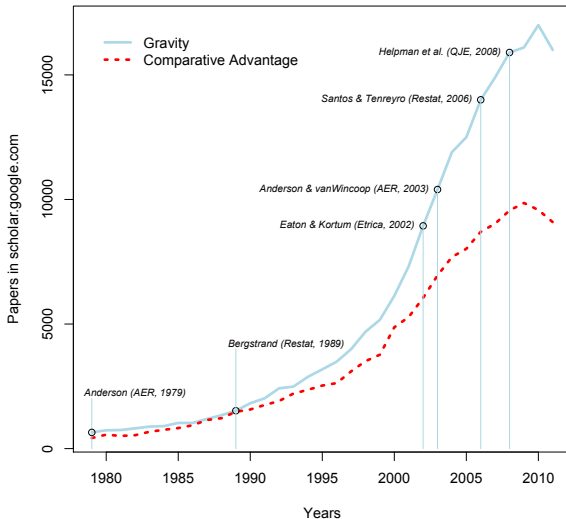
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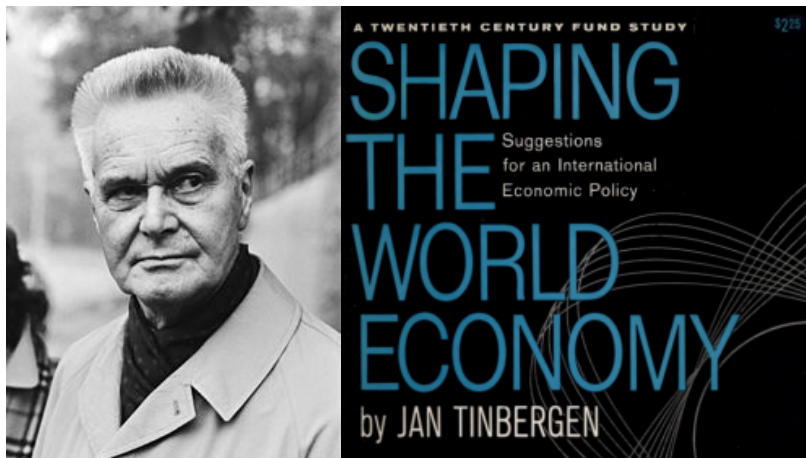
# Part I

## Gravity

# Gravity: Increasingly popular tool in the trade literature



# Jan Tinbergen



# Shaping the World Economy: Appendix VI

## A P P E N D I X V I

### An Analysis of World Trade Flows

#### VI.1 AIM AND NATURE OF THE ANALYSIS

The purpose of the present analysis is to determine the normal or standard pattern of international trade that would prevail in the absence of discriminating trade impediments. We assume that this pattern coincides with the "average" pattern actually prevailing; this means that

#### *World Trade Flows*

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of only one equation in which the value of total exports from one country to another is explained by a small number of variables. The explanatory variables that play a preponderant role are:

- (i) the Gross National Product (GNP) of the exporting country;
- (ii) the GNP of the importing country; and
- (iii) the distance between the two countries.

In several calculations other explanatory variables were introduced; however, their contribution to an explanation of the value of exports was very limited as compared to that of the three main variables. Other important characteristics of the explanatory variables are:

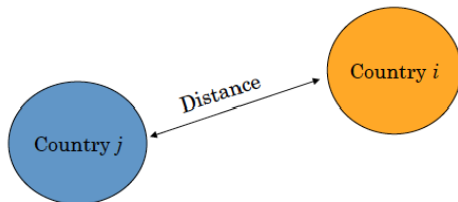
# Tinbergen “normal” trade

Specification Reminiscent of Newton's General Law of Gravitation

$$X_{ij} = G \frac{M_i M_j}{d_{ij}^2} \quad (1)$$

where

- ▶  $X_{ij}$ : trade flow from  $i$  to  $j$ ;
- ▶  $M_i$ : GDP of country  $i$ ;
- ▶  $M_j$ : GDP of country  $j$ ;
- ▶  $d_{ij}$ : distance (i.e., friction) between  $i$  and  $j$ ;
- ▶  $G$ : Newton's gravity constant.



# Tinbergen “normal” trade

From being a “fact of life” (Deardorff, 1980) without a theory ...:

- ▶ It accords well with basic intuition about the drivers of international trade;
- ▶ its structure fits well with some important stylized facts.

... to being an **unavoidable element of most trade theories**:

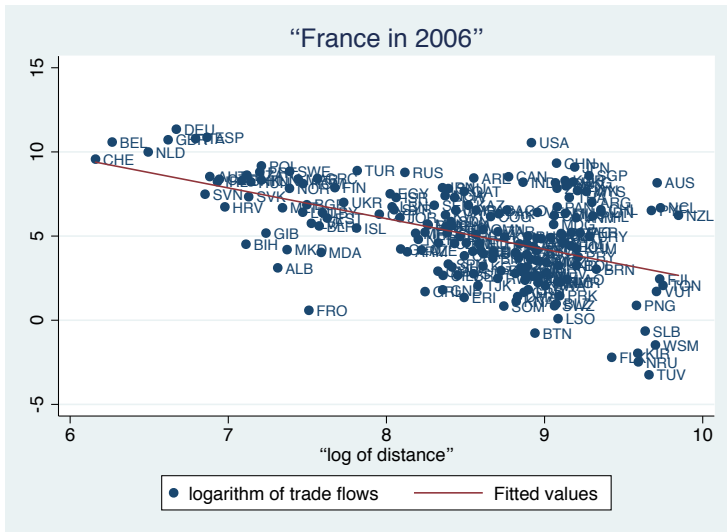
- ▶ most trade models require gravity to work!
- ▶ Ingredients: Dixit-Stiglitz; Iceberg trade costs; ...

How to operationalize it?

- ▶ Make the equation **linear**: logarithmic transformation;
- ▶ make the equation **stochastic**;
- ▶ extend the framework to **time:  $t$**  and **sectoral data,  $k$** .
- ▶ Econometric model: find (ex-post)  $\hat{X}_{ij}$  minimizing the SSE;

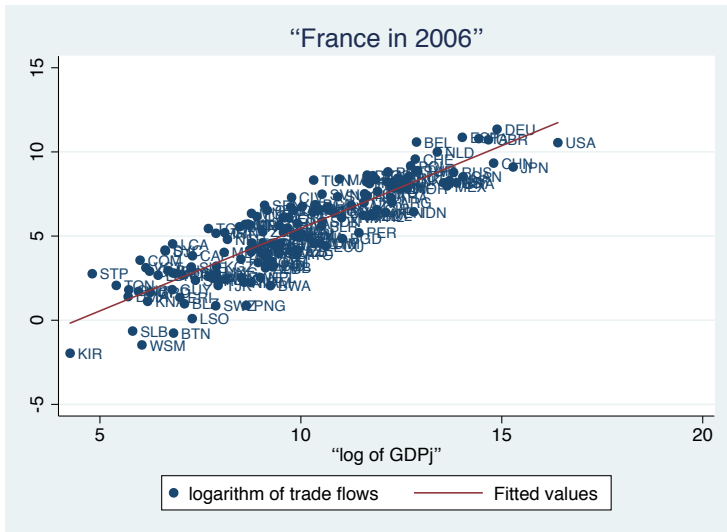
$$\ln X_{ijt}^k = \ln G + \beta_1 \ln M_i + \beta_2 \ln M_j + \delta \ln d_{ij} + \epsilon_{ij} \quad (2)$$

# Bivariate regressions: Trade flows vs Distance.





## Bivariate regressions: Trade flows vs GDP.



# Why is the Gravity modes useful?

It can be used to say interesting and useful things about the interactions between economic mass, behind-the-border policies and trade flows.

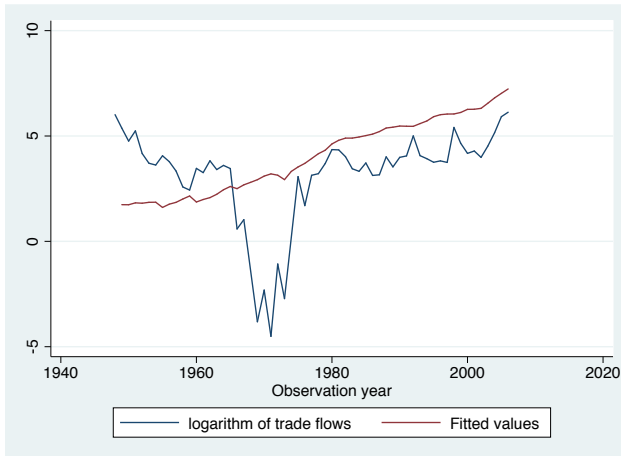
Numerous applications looking at **different types of trade costs**, and their impacts on trade flows:

- ▶ Regional integration agreements, currency unions, and the GATT/WTO.
- ▶ Tariffs and non-tariff barriers.
- ▶ Transport costs.
- ▶ Time delays at export/import and trade facilitation.
- ▶ Governance, corruption, and contract enforcement.

It can be used as a **benchmark** to detect important deviation from general gravity rules.

# The India-Pakistan case.

veloping countries either. It is true that India, Pakistan, the United Arab Republic, and Turkey show a negative deviation on the export side (less exports than expected theoretically) in at least four calculations, but in some instances the deviation is barely



## Part II

### Data for Gravity

# Data for Gravity

The **Gravity equation** has become the “workhorse of international trade” (Deardorff, 1998) and is considered “the most stable empirical relationship in economics” (Leamer and Levinsohn 1995).

The Minimum:

- ▶ **Trade** (imports or exports) time series;
- ▶ **GDP** and/or other economic mass time series;
- ▶ **Distance**, trade frictions.

Sources:

- ▶ Comtrade, WITS, IMF Direction of Trade Statistics (Trade data);
- ▶ World Bank, WDI (Economic Mass data):
- ▶ Nominal GDP in a common numeraire
- ▶ Value added in manufacturing
- ▶ WTO, CEPII or other open data sources, WDI, Doing Business (trade frictions)
- ▶ Correlates of War (political variables)

# Data for Gravity (the easy way)

Use the [public good](#) that other researchers have created.

The Head and Mayer (2014) *Handbook of International Economics*, vol. IV chapter webpage (<http://>):

- ▶ [Many informations](#) on data, methods, scripts;
- ▶ [links to gravity datasets](#).

The Andrew K. Rose's *webpage*:

- ▶ [Many informations](#) on its own papers (data, logs, do files);
- ▶ Some discussion and references on particular aspects of the [literature](#).

Some [journals](#) require the authors of published papers to make the data used in the papers available for [replication purposes](#):

- ▶ American Economic Review/Journals;
- ▶ Journal of Applied Econometrics
- ▶ Review of Economics and Statistics

## Part III

### One note of Caution

# Caution!

The data availability make gravity looks easy to do. All you need is the basic specification (e.g., The Minimum) and **your favorite explanatory variable**

- ▶ **Practical**: develop a new proxy for your preferred policy-related variable and use a really big dataset;
- ▶ Success is not warranted, but **you're likely to find significance**, since **standard errors** involve the inverse of the square root of the number of observations.

Always good to **be guided by theory**.

Empirical pitfalls:

- ▶ The problem of **omitted variables bias** (value chain trade, third country effect, relative costs, market demand or openness);
- ▶ **Selection bias** (persistence, sunk costs).
- ▶ **Dynamics** (heterogeneity, zeroes).
- ▶ **Interdependence** (third country effect and network, clustering) .
- ▶ Plus, **data issues** ....

More on that will follow!



## Part IV

Let's move to the Stata Lab  
(After Lunch)