On Invisible Trade Relations between Mesopotamian Cities during the Third Millennium B.C.

A.Bossuyt, L.Broze, V.Ginsburgh
(The Professional Geographer, Volume 53, Issue 3, 2001)

Presentation by I.Trubekhina
2012

Main ideas

- Increase in number of economic transactions +political complexity ⟺ writing
- Clay tablets as traces of trade links and transactions between cities
- Estimation of gravity model based on clay tablets

  ⟹

  Mesopotamia formed a strongly integrated market

Geographic, Historic, and Economic Background

- Mesopotamia ("between the rivers"): The Euphrates and The Tigris
- 4 millennium B.C. – emergence of **Uruk civilization** and the first sighs of urbanization (Sumer, Babylonia, …)
- Sargon empire (2370-2230 B.C.), City-states and anarchy, **dominance of Ur – third dynasty (2100-2003 B.C.)**

Map created for Gumilevica - A.Rodionov

Information

Problems:

- Non-systematic archeological excavations
- Regular floods in the delta cities
- Translation of tablets

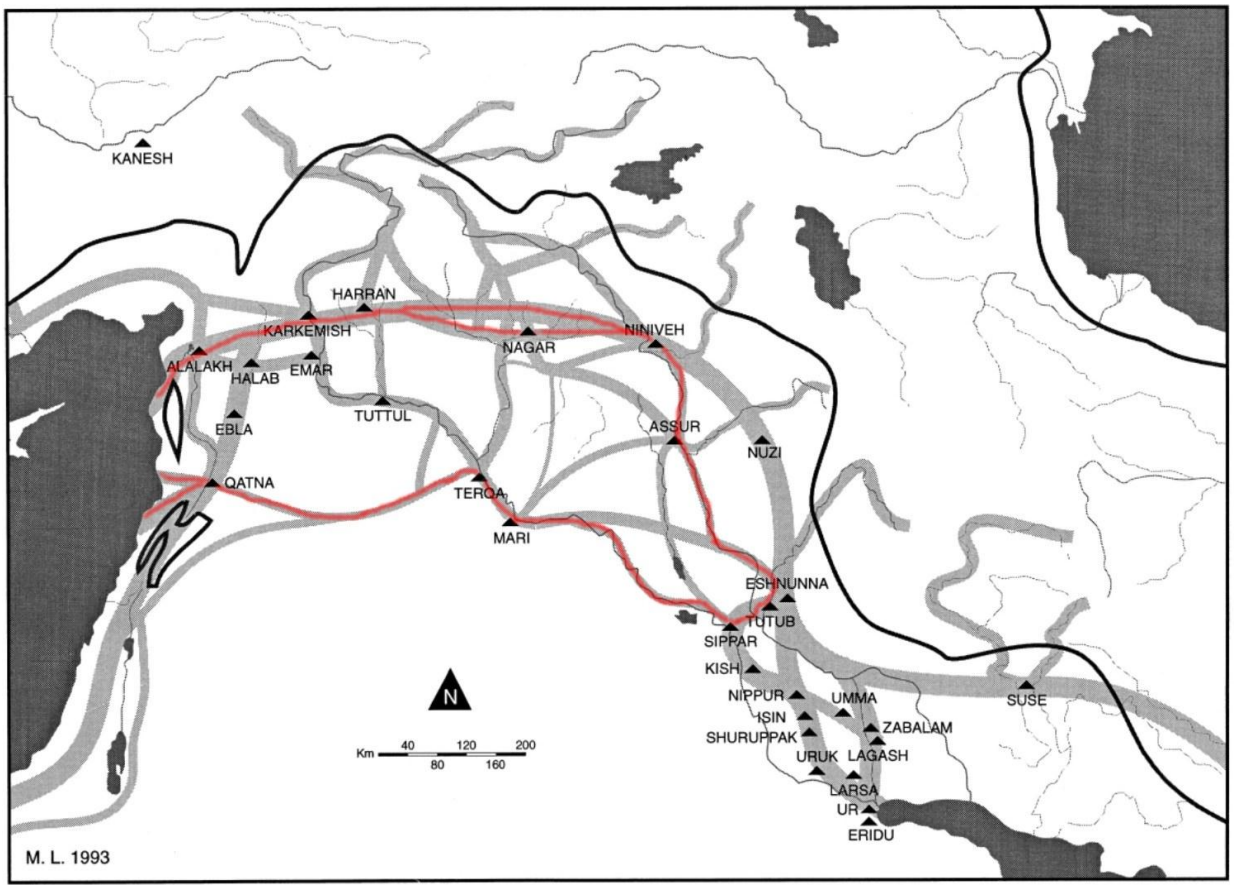
Content of tablets:

Records of transactions, contracts and inventories (bookkeepers of the temple or the palace, private merchants)

Goods

- Copper (Anatolia), tin (Persia), silver (Armenia), gold (mines between India and Egypt), wood (Lebanon), stone (Zargos), luxuries - precious stones, oils, slaves
- Textiles (wool), leather, fish, grain
- Bronze (invented at the end of 4 m.), potter's wheel->earthware

Transportation



- Boats and donkeys
- Two main roads (the southern delta-the west):

1. Sippar – Mari – (desert) - Qatna and the Phoenician ports of Mediterranean Sea
2. Sippar – (the Tigris) – Nineveh – Nagar - Harran

The Problem and the Database

30 cities (active during the last centuries of the 3rd millennium)

- different regions (the northwest, the southern delta, the center along the Tigris)
- known precise location (distance – factor of intensity of trading relations)
- **Proxying unknown trade flows by number of times each city is quoted in the documents discovered in every other city**

Documents

4 types of activities:

- Letters exchanged between the king and his diplomats or other monarchs
- Texts related to the administration of the city itself (population censuses, tax collections, stocks of raw materials and agricultural produce)
- Texts dealing with the administrative management of the provinces (letters from the king to his agents and administrators)
- Texts concerned with the administration of the king's palace (including inventories of cellars and storerooms)

Compendia: number of times a city is mentioned in the archives of the other cities

Subperiods and distances

- To avoid “creating” non-existent trade relations two subperiods were distinguished:

1. Pre-Sargonic
2. The Third Dynasty of Ur

- Distances in days of travel (walking; sailing): plausible routs, velocity (25; 50 km/day)

Excavations

- Intensity with which excavations were carried out in each city (through/superficial)

- Accessibility of the documents (how deep did excavations have to go in order to find documents related to the 3rd millennium)

Data overview (1)

1. Cities quoted (30), cities where tablets were found (11)
2. Period (1, 2)
3. Location (North, South, Center)
4. Area (Hectares): Nuzi – 4, Uruk – 400 (s_i)
5. Sited in Delta: yes=1, no=0
6. Housed Harbor: yes=1, no=0 (p_j)
7. Located on River: yes=1, no=0 (r_i)

Data overview (2)

8. Excavations:

•Intensity (1-high, 2-medium, 3-low) - I_i

•Accessibility (1-high, 2-low) - a_i

9. Citations:

•Number: Tutur – 1, Nippur – 625 (cities quoted);

Assur - 1, Ur - 765 (cities where tablets were found)

•Self-cites (citations of a city found in the city itself): Assur – 1, Lagash – 469

Objective: **to check whether intercity trades (citations) can be explained by a certain number of factors**

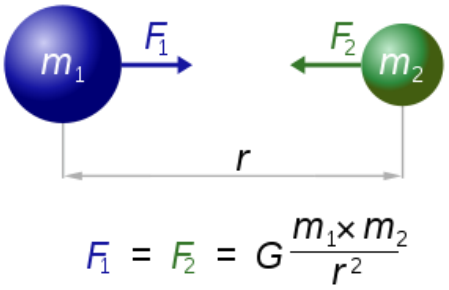
x_{ij}

Model

- Classical gravity model, based on **Newton's gravity law**:

  The attraction force $\boldsymbol{x_{ij}}$ between two bodies *i* and *j* is directly related to $\boldsymbol{m_i}$, $\boldsymbol{m_j}$ (masses) and inversely related to (square of the) distance $\boldsymbol{d_{ij}}$

$$x_{ij} = \alpha_0 m_i m_j d_{ij}^{-2}$$



- **In logarithmic form:**

$$\log x_{ij} = \log \alpha_0 + \alpha_1 \log m_i + \alpha_2 \log m_j + \alpha_3 \log d_{ij} + u_{ij}$$

α_i - Estimated parameters

u_{ij} - Error, usual assumptions

Model

$$\log x_{ij} = \log \alpha_0 + \alpha_1 \log m_i + \alpha_2 \log m_j + \alpha_3 \log d_{ij} + u_{ij}$$

The trade flow from j to i can be explained by wealth in both regions and (negatively) by some measure of the distance that separates them

- x_{ij} – trade flow (exports) from *j* to *i*, $x_{ii}=x_{jj}=0$
- m_i, m_j – wealth, income
- d_{ij} – "distance" between *i* and *j*
- m_i – total exports of i
- m_j – total imports of j

$$m_i = \sum_k x_{ik}$$

$$m_j = \sum_k x_{kj}$$

Criticism

- No other spatial patterns besides distance
- Hierarchical interactions

Solution:

- Estimating separate equation for each origin
- Introducing for each destination a variable that measures its accessibility with respect to all alternative destinations

Reasons for not implementing:

- Number of observations
- Missing observations (no excavations, lost,…)

Specification

$$\log x_{ij} = \log \alpha_0 + \underset{(+)}{\alpha_1} \log m_i + \underset{(+)}{\alpha_2} \log m_j + \underset{(-)}{\alpha_3} \log d_{ij} + \underset{(+)}{\alpha_4} \log x_{ii} +$$

$$+ \underset{(-)}{\alpha_5} r_i + \underset{(+)}{\alpha_6} I_i + \underset{(+)}{\alpha_7} a_i + \underset{(+)}{\alpha_8} p_j + \underset{(+/-)}{\alpha_9} s_i + u_{ij}$$

- x_{ij} – the number of times city *j* is cited in the archives found in city *i*
- m_i – importance of "importing" city, the total number of citations found there (including/excluding self-citations)
- m_j – importance of "exporting" city, the number of citations of *j*, found elsewhere

Specification

$$\log x_{ij} = \log \alpha_0 + \underset{(+)}{\alpha_1} \log m_i + \underset{(+)}{\alpha_2} \log m_j + \underset{(-)}{\alpha_3} \log d_{ij} + \underset{(+)}{\alpha_4} \log x_{ii} +$$

$$+ \underset{(-)}{\alpha_5} r_i + \underset{(+)}{\alpha_6} I_i + \underset{(+)}{\alpha_7} a_i + \underset{(+)}{\alpha_8} p_j + \underset{(+/-)}{\alpha_9} s_i + u_{ij}$$

- r_i – dummy variable (river), negative effect of floods
- I_i - dummy variable (Intensity), expected sign is positive
- a_i - dummy variable (Accessibility), expected sign is positive
- p_j - dummy variable (housed a harbor), expected sign is positive
- s_i – area of the city, expected sign is positive (larger cities->larger libraries) or negative (likelihood of finding tablets is inversely related to the area of the city)

Estimation

- OLS – biased results: missing x_{ij} (no intensive excavations in city *i*, no tablets found) – censored data
- T_i is not observed

  If $T_i > T$ (threshold), then $x_{ij} > 0$, otherwise $x_{ij} = 0$

$$T_i = \delta_0 + \delta_1 r_i + \delta_2 I_i + \delta_3 a_i + \delta_4 s_i + v_i$$

Final model

$$\log x_{ij} = \log \alpha_0 + \underset{(+)}{\alpha_1} \log m_i + \underset{(+)}{\alpha_2} \log m_j + \underset{(-)}{\alpha_3} \log d_{ij} + \underset{(+)}{\alpha_4} \log x_{ii} +$$

$$+ \underset{(-)}{\alpha_5} r_i + \underset{(+)}{\alpha_6} I_i + \underset{(+)}{\alpha_7} a_i + \underset{(+)}{\alpha_8} p_j + \underset{(+/-)}{\alpha_9} s_i + u_{ij} \qquad (1)$$

$$T_i = \delta_0 + \delta_1 r_i + \delta_2 I_i + \delta_3 a_i + \delta_4 s_i + v_i \qquad (2)$$

- X_{ij} is observed only if $T_i > T$, T_i and T are unobserved
- (U_{ij}, v_i) – independently normally distributed with zero means, variances - σ_u^2, σ_v^2 , covariance – $\rho \sigma_u \sigma_v$

- One of variables in (2) should be absent in (1) for identification
- Estimation method: maximum likelihood

Results

- S_i – excluded from (1)
- Likelihood ratio test (p-value=0.000), pseudo-R^2 (1.000)– very good
- Expected signs of coefficients
- Some coefficients are not significantly different from 0 (self-citations, river, intensity of excavations)

Eq.		Coefficient	St. Error
(1)	Intercept (α_0)	-2.9292*	0.6005
	Importance of city i (α_1)	0.3483*	0.0672
	Importance of city j (α_2)	0.7897*	0.0431
	Distance between cities j and i (α_3)	-0.2062*	0.0546
	Self – citations in city i (α_4)	0.1178	0.0848
	River in city i (α_5)	-0.4186	0.2590
	Intensity of excavations in city i (α_6)	0.2388	0.2314
	Accessibility of remains in city i (α_7)	0.4204*	0.2191
	Port in city j (α_8)	0.4468*	0.2196
(2)	Intercept (δ_0)	-1.0008*	0.3248
	River in city i (δ_1)	0.1309	0.2924
	Intensity of excavations in city i (δ_2)	0.4146*	0.2111
	Accessibility of remains in city i (δ_3)	0.2978	0.2729
	Area in city i (δ_4)	0.0049*	0.0008

Results

- Distance was less of a problem: 0.2 (0.7-0.8 in international trade, intercity travels today) –> strongly integrated market

  Reason: lack of raw materials (timber, minerals) -> import from other regions (export: textile, grain)
- Total number of citations – positive (city *j* – larger effect)
- Accessibility of remains, port – positive effect

Thank you for your attention!