Technology, Geography, and Trade

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1.Introduction (1)

- **AIM:**
- Analysis of the role of **technology** and **geography** in trade flows with the Ricardian model of Dornbusch, Fischer, and Samuelson (1977), which captures the two competing forces of **comparative advantage** and of **geographic barriers**.
- Data of bilateral trade in manufactures for a cross-section of 19 OECD countries in 1990
- Parameters:
  - each country's state of technology: absolute advantage: T_i
  - the heterogeneity of technology : comparative advantage: θ
  - geographic barriers: d_{ni}

1.Introduction (2) - Counterfactuals

- Analysis of:
  - gains from trade in manufactures
  - how technology and geography determine patterns of specialization
  - role of trade in spreading the benefits of new technology
  - consequences of tariff reductions on trade flows

2.Theoretical framework (1)

- Ricardian model with a continuum of goods
- Perfect competition and CRS
- Differences in technologies: differences in efficiency across goods and countries
- Same inputs across goods within a country
- Geographical barriers with Samuelson's iceberg form: $d_{ni} > 1$
- Consumer's utility is a CES function

2.Theoretical framework (2)

- Country *i*'s share in country *n*

$$\frac{X_{ni}}{X_n} = \frac{T_i \left(c_i d_{ni}\right)^{-\theta}}{\Phi_n} = \frac{T_i \left(c_i d_{ni}\right)^{-\theta}}{\sum_{i=1}^{N} T_i \left(c_i d_{ni}\right)^{-\theta}}$$

- X_n: total spending in country n
- X_{ni}: fraction of goods that country n buys from country i
- T_i: state of technology in country i
- c_i: input cost in country i
- d_{ni}: geographic barriers between i (exporter) and n (importer)
- Θ: parameter of heterogeneity of goods in production (comparative advantage)
- N: number of countries
- Φ_n: price parameter of country n

2.Theoretical framework (3)

- Country *i*'s normalized import share in country *n*

$$\frac{X_{ni}/X_n}{X_{ii}/X_i} = \frac{\Phi_i}{\Phi_n} d_{ni}^{-\theta} = \left(\frac{p_i d_{ni}}{p_n} \right)^{-\theta}$$

- **Prices**
  - If p_n ↓relative to p_i
- **Geographical barriers**
  - If *n* becomes more isolated from *i*

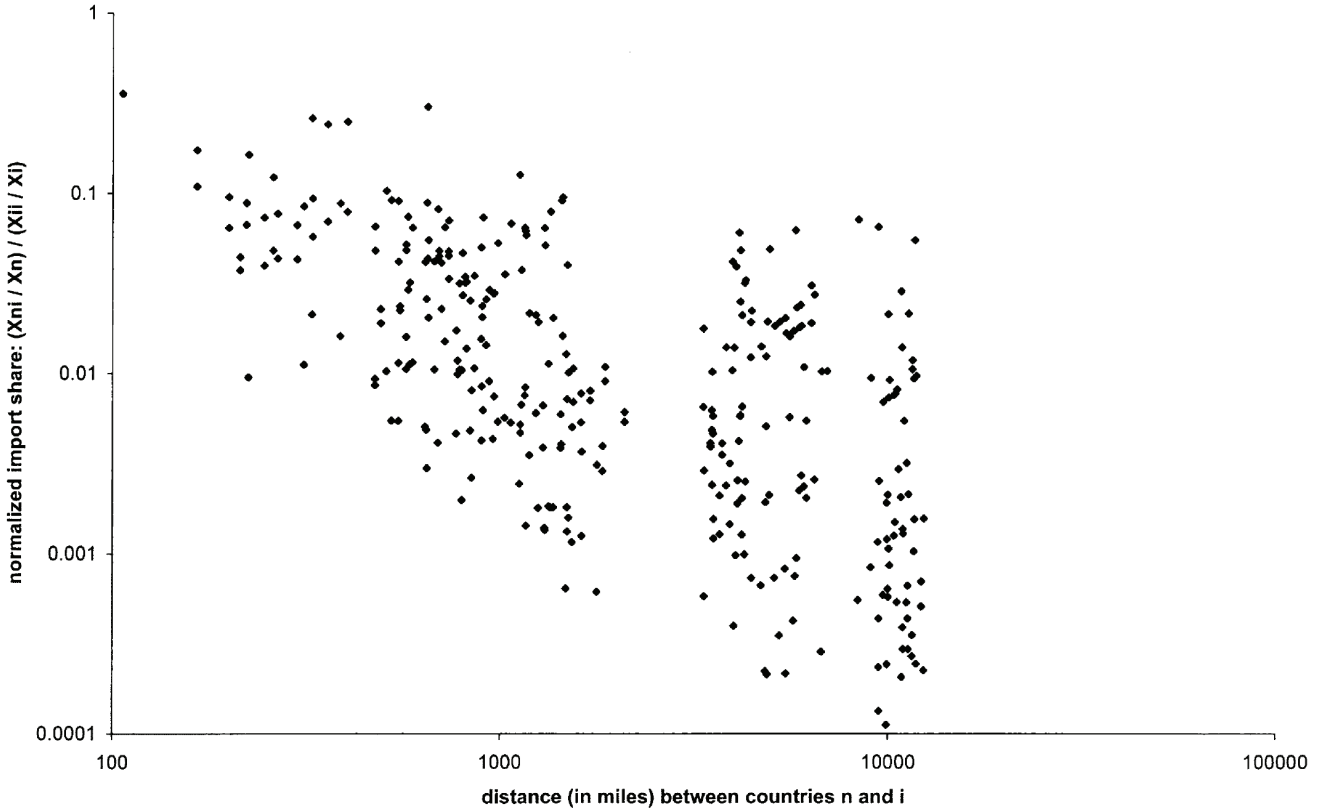
→ *i*'s normalized import share in country *n* declines

- If θ↑ : less heterogeneity implies ↓ comparative advantage force: normalized import shares become more elastic to the average relative price and to geographic barriers

2.Theoretical framework (4)

- Results (with 19 OECD (1990), 342 obs. for n ≠ i): Normalized import shares never exceed 0.2.

→ if distance (proxy for d_{ni}) between *n* and *i* ↑, normalized import share in country *n* ↓



3.Estimation equations (1)

- Gravity equation as function of wages, normalized by total of sales of country *n* at home:

$$\frac{X_{ni}}{X_{nn}} = \frac{T_i}{T_n}\left(\frac{w_i}{w_n}\right)^{-\theta\beta}\left(\frac{p_i}{p_n}\right)^{-\theta(1-\beta)} d_{ni}^{-\theta}$$

- The logarithm is given by:

$$\ln\frac{X'_{ni}}{X'_{nn}} = -\theta \ln d_{ni} + \frac{1}{\beta}\ln\frac{T_i}{T_n} - \theta \ln\frac{w_i}{w_n}$$

- X_{nn}: total of sales of country *n* at home
- w_i, w_n: wage in country i, resp. in country n
- p_i, p_n: prices in country i, resp. in country n
- β: constant share of labour, value = 0.21
- Θ: parameter of comparative advantage, values = 8.28 (3.60, 12.86)

3.Estimation equations (2)

- where

$$\ln X'_{ni} \equiv \ln X_{ni} - [(1-\beta)/\beta] \ln(X_i / X_{ii})$$

- and defining the competition equation:

$$S_i \equiv \frac{1}{\beta} \ln T_i - \theta \ln w_i$$

- Basis for the estimation:

$$\ln \frac{X'_{ni}}{X'_{nn}} = -\theta \ln d_{ni} + S_i - S_n$$

3.Estimation equations (3)

- *Equation with specification of geographic barriers (GLS):*

$$\ln \frac{X'_{ni}}{X'_{nn}} = S_i - S_n - \theta m_n - \theta d_k - \theta b - \theta l - \theta e_h + \theta \delta^2_{ni} + \theta \delta^1_{ni}$$

- d_k: effect of the distance between *n* and *i* lying in the *k*th interval
- b: effect of *n* and *i* sharing a border
- l: effect of *n* and *i* sharing a language
- e_h:effect of *n* and *i* both belonging to trading area h, (h = 1, 2)
- m_n: overall destination effect, (n = 1, …,19)
- intervals *k* (in miles): [0, 375); [375, 750); [750, 1500); [1500, 3000); [3000, 6000); [6000, maximum]
- 2 trading areas: EC and EFTA
- δ_n: error term captures geographic barriers arising from all other factors and is composed of:

$$\delta_{ni} = \delta^2_{ni} + \delta^1_{ni}$$

- δ^2_{ni} affects two-way trade, so that $\delta^2_{ni} = \delta^2_{in}$ and δ^1_{ni} affects one-way trade.

3.Estimation equations (4)

Table 1

BILATERAL TRADE EQUATION

Variable		est.	s.e.
Distance [0, 375)	$-\theta d_1$	−3.10	(0.16)
Distance [375, 750)	$-\theta d_2$	−3.66	(0.11)
Distance [750, 1500)	$-\theta d_3$	−4.03	(0.10)
Distance [1500, 3000)	$-\theta d_4$	−4.22	(0.16)
Distance [3000, 6000)	$-\theta d_5$	−6.06	(0.09)
Distance [6000, maximum]	$-\theta d_6$	−6.56	(0.10)
Shared border	$-\theta b$	0.30	(0.14)
Shared language	$-\theta l$	0.51	(0.15)
European Community	$-\theta e_1$	0.04	(0.13)
EFTA	$-\theta e_2$	0.54	(0.19)

3.Estimation equations (5)

Country	Source Country	est.	s.e.	Destination Country	est.	s.e.
Australia	S_1	0.19	(0.15)	$-\theta m_1$	0.24	(0.27)
Austria	S_2	−1.16	(0.12)	$-\theta m_2$	−1.68	(0.21)
Belgium	S_3	−3.34	(0.11)	$-\theta m_3$	1.12	(0.19)
Canada	S_4	0.41	(0.14)	$-\theta m_4$	0.69	(0.25)
Denmark	S_5	−1.75	(0.12)	$-\theta m_5$	−0.51	(0.19)
Finland	S_6	−0.52	(0.12)	$-\theta m_6$	−1.33	(0.22)
France	S_7	1.28	(0.11)	$-\theta m_7$	0.22	(0.19)
Germany	S_8	2.35	(0.12)	$-\theta m_8$	1.00	(0.19)
Greece	S_9	−2.81	(0.12)	$-\theta m_9$	−2.36	(0.20)
Italy	S_{10}	1.78	(0.11)	$-\theta m_{10}$	0.07	(0.19)
Japan	S_{11}	4.20	(0.13)	$-\theta m_{11}$	1.59	(0.22)
Netherlands	S_{12}	−2.19	(0.11)	$-\theta m_{12}$	1.00	(0.19)
New Zealand	S_{13}	−1.20	(0.15)	$-\theta m_{13}$	0.07	(0.27)
Norway	S_{14}	−1.35	(0.12)	$-\theta m_{14}$	−1.00	(0.21)
Portugal	S_{15}	−1.57	(0.12)	$-\theta m_{15}$	−1.21	(0.21)
Spain	S_{16}	0.30	(0.12)	$-\theta m_{16}$	−1.16	(0.19)
Sweden	S_{17}	0.01	(0.12)	$-\theta m_{17}$	−0.02	(0.22)
United Kingdom	S_{18}	1.37	(0.12)	$-\theta m_{18}$	0.81	(0.19)
United States	S_{19}	3.98	(0.14)	$-\theta m_{19}$	2.46	(0.25)

Total Sum of squares	2937	Error Variance:	
Sum of squared residuals	71	Two-way $(\theta^2\sigma_2^2)$	0.05
Number of observations	342	One-way $(\theta^2\sigma_1^2)$	0.16

Notes: Estimated by generalized least squares using 1990 data. The specification is given in equation (30) of the paper. The parameter are normalized so that $\sum_{i=1}^{19} S_i = 0$ and $\sum_{n=1}^{19} m_n = 0$. Standard errors are in parentheses.

3.Estimation equations (6)

Table 2

GEOGRAPHIC BARRIERS

Source of Barrier	Estimated Geography Parameters	Implied Barrier's % Effect on Cost		
		$\theta = 8.28$	$\theta = 3.60$	$\theta = 12.86$
Distance [0, 375)	−3.10	45.39	136.51	27.25
Distance [375, 750)	−3.66	55.67	176.74	32.97
Distance [750, 1500)	−4.03	62.77	206.65	36.85
Distance [1500, 3000)	−4.22	66.44	222.75	38.82
Distance [3000, 6000)	−6.06	108.02	439.04	60.25
Distance [6000, maximum]	−6.56	120.82	518.43	66.54
Shared border	0.30	−3.51	−7.89	−2.27
Shared language	0.51	−5.99	−13.25	−3.90
European Community	0.04	−0.44	−1.02	−0.29
EFTA	0.54	−6.28	−13.85	−4.09

3.Estimation equations (7)

Destination country:				
Australia	0.24	−2.81	−6.35	−1.82
Austria	−1.68	22.46	59.37	13.94
Belgium	1.12	−12.65	−26.74	−8.34
Canada	0.69	−7.99	−17.42	−5.22
Denmark	−0.51	6.33	15.15	4.03
Finland	−1.33	17.49	44.88	10.94
France	0.22	−2.61	−5.90	−1.69
Germany	1.00	−11.39	−24.27	−7.49
Greece	−2.36	32.93	92.45	20.11
Italy	0.07	−0.86	−1.97	−0.56
Japan	1.59	−17.43	−35.62	−11.60
Netherlands	1.00	−11.42	−24.33	−7.51
New Zealand	0.07	−0.80	−1.83	−0.52
Norway	−1.00	12.85	32.06	8.10
Portugal	−1.21	15.69	39.82	9.84
Spain	−1.16	14.98	37.85	9.40
Sweden	−0.02	0.30	0.69	0.19
United Kingdom	0.81	−9.36	−20.23	−6.13
United States	2.46	−25.70	−49.49	−17.40

Notes: The estimated parameters governing geographic barriers are the same as those shown in Table III. For an estimated parameter $\hat{d}$, the implied percentage effect on cost is $100(e^{-\hat{d}/\theta} - 1)$.

4.Counterfactuals (1)

- **AIM:**
- Examine the counterfactuals according to the welfare criterion, measured as real GDP: $W_n = Y_n / p_n^{\alpha}$
- Decomposing the change in welfare into income and price effects gives:

$$\ln \frac{W'_n}{W_n} = \ln \frac{Y'_n}{Y_n} - \alpha \ln \frac{p'_n}{p_n} \approx \left(\frac{w'_n - w_n}{w_n} \right) \frac{w_n L_n}{Y_n} - \alpha \ln \frac{p'_n}{p_n}$$

- α: average demand for final manufactured goods as a fraction of GDP, value = 0.13
- X'_n: counterfactual value of a variable X_n

4. 1st Counterfactual

THE GAINS FROM TRADE: RAISING GEOGRAPHIC BARRIERS

	Percentage Change from Baseline to Autarky					
	Mobile Labor			Immobile Labor		
Country	Welfare	Mfg. Prices	Mfg. Labor	Welfare	Mfg. Prices	Mfg. Wages
Australia	−1.5	11.1	48.7	−3.0	65.6	54.5
Austria	−3.2	24.1	3.9	−3.3	28.6	4.5
Belgium	−10.3	76.0	2.8	−10.3	79.2	3.2
Canada	−6.5	48.4	6.6	−6.6	55.9	7.6
Denmark	−5.5	40.5	16.3	−5.6	59.1	18.6
Finland	−2.4	18.1	8.5	−2.5	27.9	9.7
France	−2.5	18.2	8.6	−2.5	28.0	9.8
Germany	−1.7	12.8	−38.7	−3.1	−33.6	−46.3
Greece	−3.2	24.1	84.9	−7.3	117.5	93.4
Italy	−1.7	12.7	7.3	−1.7	21.1	8.4
Japan	−0.2	1.6	−8.6	−0.3	−8.4	−10.0
Netherlands	−8.7	64.2	18.4	−8.9	85.2	21.0
New Zealand	−2.9	21.2	36.8	−3.8	62.7	41.4
Norway	−4.3	32.1	41.1	−5.4	78.3	46.2
Portugal	−3.4	25.3	25.1	−3.9	53.8	28.4
Spain	−1.4	10.4	19.8	−1.7	32.9	22.5
Sweden	−3.2	23.6	−3.7	−3.2	19.3	−4.3
United Kingdom	−2.6	19.2	−6.0	−2.6	12.3	−6.9
United States	−0.8	6.3	8.1	−0.9	15.5	9.3

Notes: All percentage changes are calculated as $100\ln(x'/x)$ where x' is the outcome under autarky ($d_{ni} \to \infty$ for $n \neq i$) and x is the outcome in the baseline.

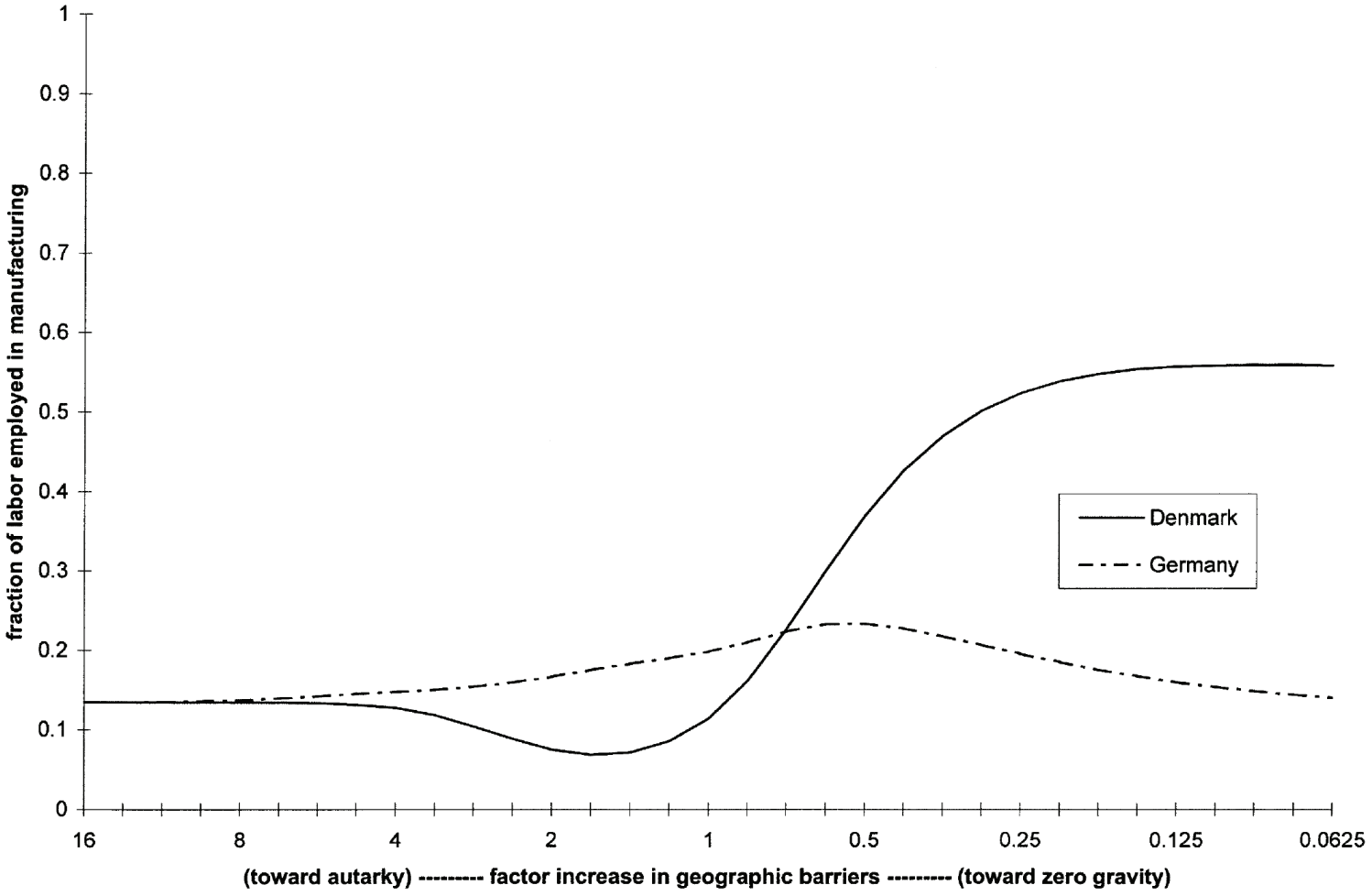
4. 1st Counterfactual

THE GAINS FROM TRADE: LOWERING GEOGRAPHIC BARRIERS

	Percentage Changes in the Case of Mobile Labor					
	Baseline to Zero Gravity			Baseline to Doubled Trade		
Country	Welfare	Mfg. Prices	Mfg. Labor	Welfare	Mfg. Prices	Mfg. Labor
Australia	21.1	−156.7	153.2	2.3	−17.1	−16.8
Austria	21.6	−160.3	141.5	2.8	−20.9	41.1
Belgium	18.5	−137.2	69.6	2.5	−18.6	68.8
Canada	18.7	−139.0	11.4	1.9	−14.3	3.9
Denmark	20.7	−153.9	156.9	2.9	−21.5	72.6
Finland	21.7	−160.7	172.1	2.8	−20.9	44.3
France	18.7	−138.3	−7.0	2.3	−16.8	15.5
Germany	17.3	−128.7	−50.4	1.9	−14.3	12.9
Greece	24.1	−178.6	256.5	3.3	−24.8	29.6
Italy	18.9	−140.3	6.8	2.2	−16.1	5.7
Japan	16.6	−123.5	−59.8	0.9	−6.7	−24.4
Netherlands	18.5	−137.6	67.3	2.5	−18.5	65.6
New Zealand	22.2	−164.4	301.4	2.8	−20.5	50.2
Norway	21.7	−161.0	195.2	3.1	−22.9	69.3
Portugal	22.3	−165.3	237.4	3.1	−22.8	67.3
Spain	20.9	−155.0	77.5	2.4	−18.0	−4.4
Sweden	20.0	−148.3	118.8	2.7	−19.7	55.4
United Kingdom	18.2	−134.8	3.3	2.2	−16.4	28.5
United States	16.1	−119.1	−105.1	1.2	−9.0	−26.2

Notes: All percentage changes are calculated as $100\ln(x'/x)$ where x' is the outcome under lower geographic barriers and x is the outcome in the baseline.

4. 2nd Counterfactual



4. 3rd Counterfactual

THE BENEFITS OF FOREIGN TECHNOLOGY

	Welfare Consequences of Improved Technology			
	Higher U.S. State of Technology		Higher German State of Technology	
Country	Mobile Labor	Immobile Labor	Mobile Labor	Immobile Labor
Australia	27.1	14.9	12.3	4.4
Austria	9.3	2.9	61.8	5.4
Belgium	13.2	3.0	50.7	4.8
Canada	87.4	19.9	9.3	1.3
Denmark	12.2	6.2	62.5	7.1
Finland	11.3	4.3	37.5	3.0
France	10.1	4.2	39.2	3.0
Germany	9.7	−11.6	100.0	100.0
Greece	14.0	18.3	38.9	8.0
Italy	9.7	3.9	38.4	3.0
Japan	6.6	−0.8	5.9	−0.2
Netherlands	12.8	6.8	63.5	8.3
New Zealand	33.8	13.5	15.6	3.9
Norway	13.2	11.7	43.8	6.1
Portugal	14.3	8.6	39.6	4.7
Spain	9.6	7.0	27.3	3.3
Sweden	12.8	1.1	42.7	2.3
United Kingdom	14.6	0.5	38.3	1.6
United States	100.0	100.0	9.7	1.4

Notes: All numbers are expressed relative to the percentage welfare gain in the country whose technology expands. Based on a counterfactual 20 per cent increase in the state of technology for either the United States or Germany.