Globalization? Trade War? A Counterbalance Perspective

Arthur Hu (Vanderbilt)

Xingwei Hu (IMF)

Hui Tong (IMF)

Outline

Outline

Competitive advantage also matters !

- Adam Smith: economy of scale.
- David Ricardo: comparative advantage.
- If all production factors were free of flow, then hopefully, the global GDP would be maximized.
- However, not all countries share the same well-off: some succeed over some time whereas others fail during the same period.
- They have to COMPETE for their own shares and, at the same time, COOPERATE to maximize the global GDP.

Empirical evidence from the past 50 years

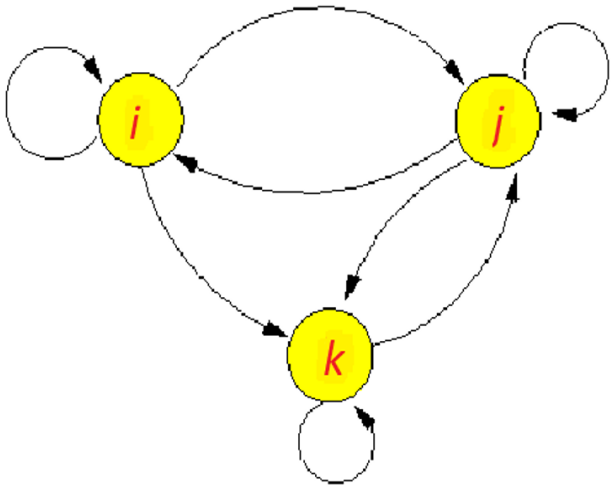
- 2 trade wars between the top 2 economies
- Never-ending trade frictions here and there
- Ebbing and flowing globalization & protectionism among economic superpowers
  - UK's Brexit in 2020
  - European Union and Euro
  - China's entry into the WTO in 2001
  - North America Free Trade Agreement (NAFTA)
  - Trump administration's exit from int'l organizations

Objectives of this research

- Quantify competitive advantage using a network counterbalance equilibrium
- Provide necessary conditions for globalization and trade wars
- Identify any country's right targets for collaboration or conflict
- Derive a fair resolution for trade conflict and national bargaining power
- Evaluate the side effects of trade friction and globalization

Outline

International trade system as a game on network



A simple network of trade

3 country nodes: *i, j, k*

Directional edges for exports

Trade volumes not shown

Let there be n countries in the system, labeled as $1, 2, \cdots, n$, and denote $\mathcal{N} = \{1, 2, \cdots, n\}$.

Denote the n-by-n matrix $P = [P_{ij}]$ where P_{ij} is the fraction of country i's GDP, which exports to country j.

P_{ij}: country j's power in i's production process

To model the progress of country i's production, we introduce the set function $v_i : 2^{\mathcal{N}} \to [0, 1]$ by

$$v_i(S) = \sum_{k \in S} P_{ik}$$

for any $S \subseteq \mathcal{N}$.

Then, P_{ij} is j's Shapley value (Shapley-Shubik power index) in the coalitional game $(\mathcal{N}, v_i)$.

Both the value and the power index are von Neumann-Morgenstern utility functions (Roth: Econometrica, 1977; JET, 1977).

P^{∞}: limit power in interlinked global value chains

Even though the final product bears the mark of being made in one country, its components or parts may come from elsewhere. One part may be made in a third country; a fourth country could provide the tools to make the part and another offers the raw material, etc.

P^2 is one-time transition of the power where

$$\left[P^2\right]_{ij} = \sum_{k=1}^{n} P_{ik} P_{kj}.$$

Similarly, we have P^3, P^4, $\cdots\cdots$. In the limit, $\lim_{t\to\infty} P^t$ has a constant vector, say π, for all rows.

The counterbalance equilibrium of power

π also satisfies the counterbalance equilibrium

$$\pi = \pi P,$$

as defined in Hu and Shapley (GEB, 2003).

The counterbalance:

inflow Country i absorbs power from all countries:

$$\pi_i = \sum_{j=1}^{n} \pi_j P_{ji};$$

outflow It also distributes its power to all countries:

$$\pi_k = \pi_i P_{ik} + \sum_{j \neq i} \pi_j P_{jk}.$$

Counterbalanced systems: ecological system, USA's government system, etc.

Mixed cooperative & noncooperative relations in $\mathcal{N}$

Noncooperative: As

$$\sum_{k=1}^{n} \pi_k = 1,$$

an increase of π_j may imply a decrease of π_i. So, in theory, there are $n(n-1)/2$ potential trade conflicts, either small or large, in the trade system.

Cooperative: By

$$\pi_i = \sum_{j=1}^{n} \pi_j P_{ji},$$

a rising π_j increases π_i. Therefore, i should help all other countries, including the poorest and the least competitive, to enhance their π_j.

π_i: country i's competitive advantage

- Assume no bilateral trade deficit in this slide ONLY.
- Let β_i be the ith row of P — countries's comparative advantage over country i. Since all countries compete exporting to country i, β_i is also the ranking score for competitiveness when i acts as the reference.
- Endogenously weight all β_i: competitive countries have larger weights than less competitive ones. Say, w_i is the weight for β_i. Then $\sum_{i=1}^{n} w_i \beta_i$ measures the global competitiveness for all countries.
- Since $(w_1, \cdots, w_n)$ are already the competitiveness, $(w_1, \cdots, w_n) = \sum_{i=1}^{n} w_i \beta_i = (w_1, \cdots, w_n)P$ and $w_i = \pi_i$.

Outline

dP_{ij} or dP_{ji}: country i's potential action on j

Before launching an attack on or collaboration with country j, country i expects the changes on its π_i.

Gaming on P,

- Say, i changes its exports to j by dP_{ij} or changes its imports from j by dP_{ji}.
- In retaliation for the dP_{ji} change on P_{ji}, country j changes P_{ij} by $\lambda_{ji} dP_{ji}$.
- In retaliation for the dP_{ij} change on P_{ij}, country j changes P_{ji} by $\lambda_{ij} dP_{ij}$.
- For consistency, $\lambda_{ij}\lambda_{ji} = 1$.

Response to the shock $\mathrm{d}P_{ji}$ in the equilibrium $\pi = \pi P$

The effects on π_i and π_j:

$$\begin{cases} \dfrac{\mathrm{d}\pi_i}{\mathrm{d}P_{ji}} = -\dfrac{(\lambda_{ji}\pi_i - \pi_j)\vec{1}'_{n-1}(I_{n-1}-Z_i)^{-1}\gamma_{ji}}{1+\vec{1}'_{n-1}(I_{n-1}-Z_i)^{-1}\alpha_i}, \\ \dfrac{\mathrm{d}\pi_j}{\mathrm{d}P_{ji}} = \dfrac{(\lambda_{ji}\pi_i - \pi_j)\vec{1}'_{n-1}(I_{n-1}-Z_j)^{-1}\gamma_{ij}}{1+\vec{1}'_{n-1}(I_{n-1}-Z_j)^{-1}\alpha_j}, \end{cases}$$

and the effects of $\mathrm{d}P_{ji}$ on other countries:

$$\frac{\mathrm{d}\pi_{-i}}{\mathrm{d}P_{ji}} = (\lambda_{ji}\pi_i - \pi_j)\,(I_{n-1} - Z_i)^{-1}\left[\gamma_{ji} - \frac{\vec{1}'_{n-1}(I_{n-1} - Z_i)^{-1}\gamma_{ji}}{1 + \vec{1}'_{n-1}(I_{n-1} - Z_i)^{-1}\alpha_i}\alpha_i\right]$$

Identify the collaborators or competitors using $\frac{\mathrm{d}\pi_i}{\mathrm{d}P_{ji}}$

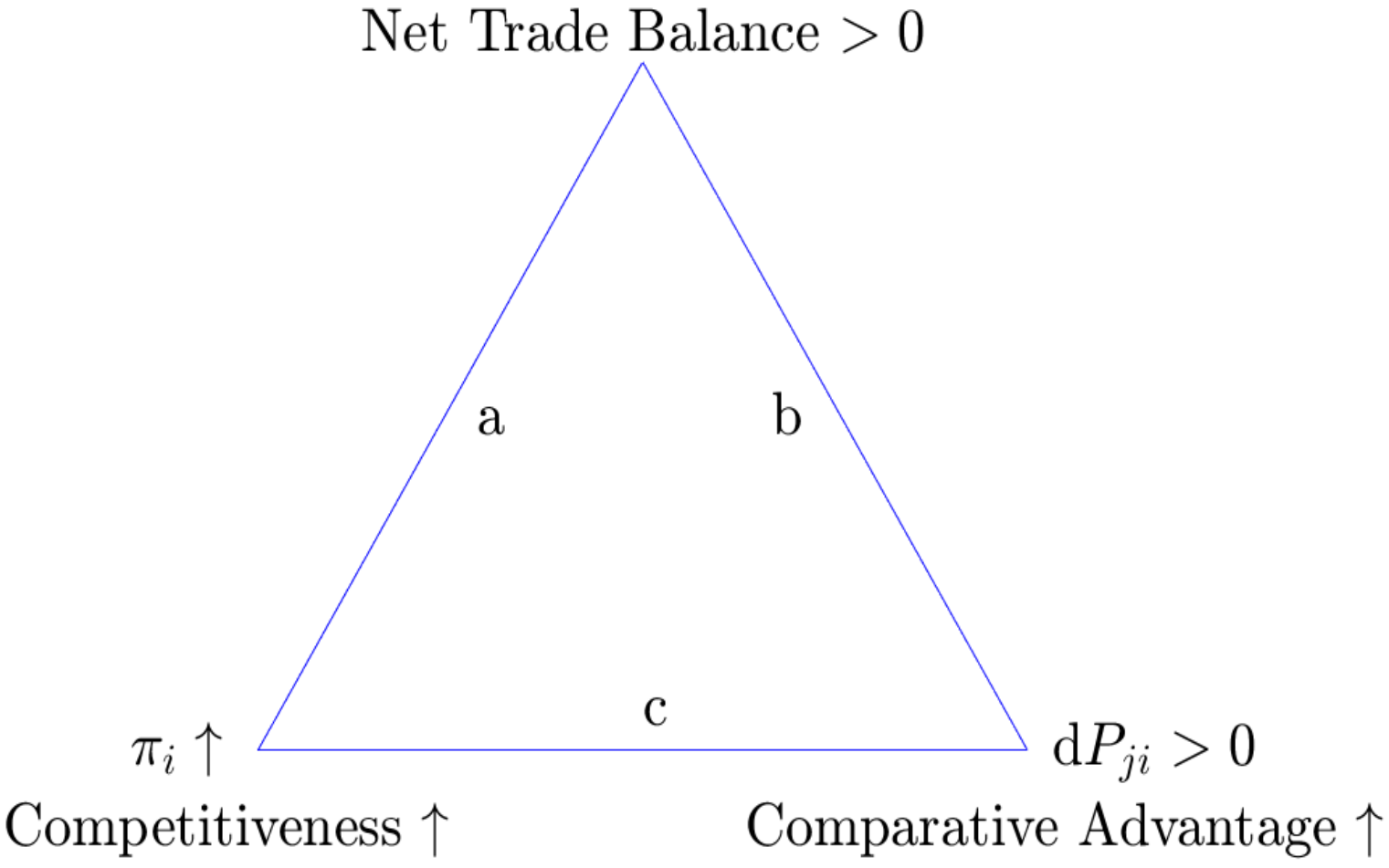
- No zero-sum game: the gain and loss are not equal. Other countries share the discrepancy.
- If $\lambda_{ji} = \frac{\pi_j}{\pi_i}$, no changes on π for any small $\mathrm{d}P_{ji}$.
- If $\lambda_{ji} > \frac{\pi_j}{\pi_i}$, a negative $\mathrm{d}P_{ji}$ increases π_i, i.e. j is a competitor and i should reduce P_{ji}.
- If $\lambda_{ji} < \frac{\pi_j}{\pi_i}$, a positive $\mathrm{d}P_{ji}$ increases π_i, i.e., j is a collaborator and i should increase P_{ji}.
- Look for the best competitor or collaborator by choosing j to minimize or maximize the derivatives in percentage: $\frac{\mathrm{dlog}\pi_i}{\mathrm{dlog}P_{ji}} = \frac{P_{ji}}{\pi_i}\frac{\mathrm{d}\pi_i}{\mathrm{d}P_{ji}}$.

Outline

Net trade balance

- Focus on two sides: countries i and j.
- A positive $\mathrm{d}P_{ij}$ or $\mathrm{d}P_{ji}$ creates jobs and capitalizes on the economy of scale.
- Good trade balance also creates jobs, increase production scale, and expand comparative advantage.
- Zero-sum game on bilateral net trade balance: one country's net surplus equals the counterpart's net deficit of the same amount.
- For zero net trade balance: $\lambda_{ji} = \frac{g_j}{g_i}$ where g_i is country i's GDP.

Impossible Trilemma: $\pi_i \uparrow$, trade surplus, $\mathrm{d}P_{ji} > 0$



Cooperative solutions for λ_{ji}

Under the veil of ignorance of other countries:

- When both i and j compete for competitiveness: $\lambda_{ji} = \frac{\pi_j}{\pi_i}$.
- When both i and j compete for trade balance: $\lambda_{ji} = \frac{g_j}{g_i}$.
- When one seeks for competitiveness while another for trade balance, we get the Nash bargaining solution [see next two slides]:

$$\lambda_{ji} = \sqrt{\frac{\pi_j g_j}{\pi_i g_i}}.$$

When i seeks for $\pi_i \uparrow$ while j for trade surplus

Nash Bargaining solution of λ_{ji}:

$$\underset{\lambda_{ji}}{\text{argmax}} \left\{ \left(\lambda_{ji} - \frac{g_j}{g_i} \right) \left(\lambda_{ij} - \frac{\pi_i}{\pi_j} \right) \middle| \lambda_{ij} = \frac{1}{\lambda_{ji}} \right\} = \sqrt{\frac{\pi_j g_j}{\pi_i g_i}}.$$

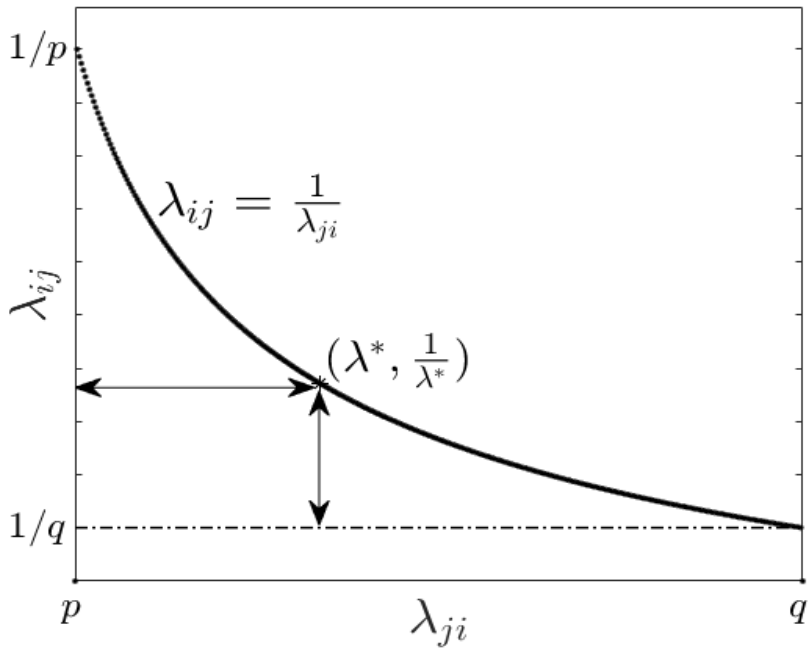
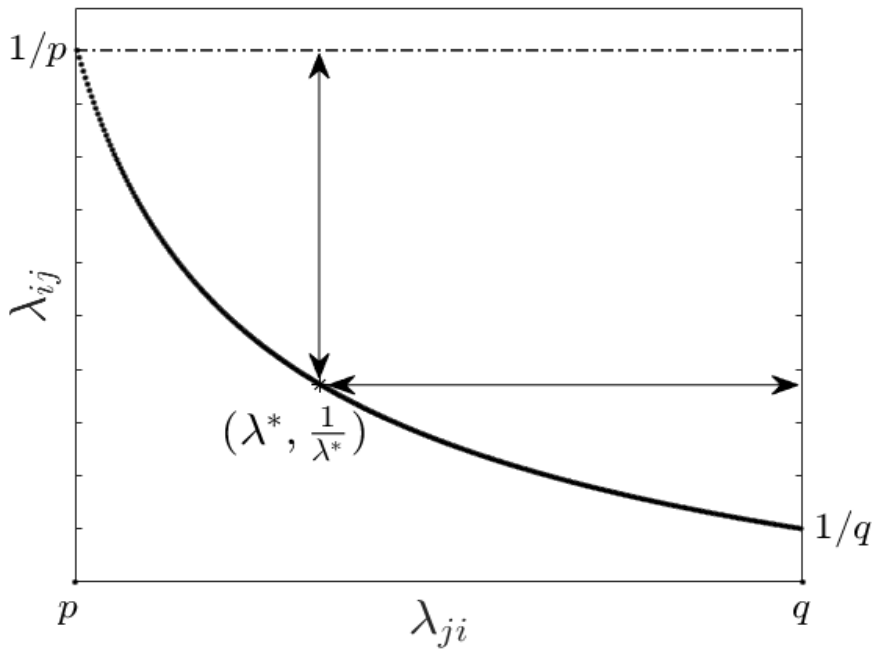


Figure: $p = \min\{\frac{g_j}{g_i}, \frac{\pi_j}{\pi_i}\}$ and $q = \max\{\frac{g_j}{g_i}, \frac{\pi_j}{\pi_i}\}$

When i seeks for trade surplus while j for $\pi_j \uparrow$

Nash Bargaining solution of λ_{ji}:

$$\underset{\lambda_{ji}}{\text{argmax}} \left\{ \left(\lambda_{ji} - \frac{\pi_j}{\pi_i} \right) \left(\lambda_{ij} - \frac{g_i}{g_j} \right) \middle| \lambda_{ij} = \frac{1}{\lambda_{ji}} \right\} = \sqrt{\frac{\pi_j g_j}{\pi_i g_i}}.$$



Global bargaining power

Among the n(n-1)/2 potential trade conflicts, most countries would not choose to compete but cooperate.

In either Nash bargaining case, $\lambda_{ji} = \sqrt{\frac{\pi_j g_j}{\pi_i g_i}}$. So, we define i's global bargaining power by

$$\sqrt{\pi_i g_i}.$$

- Result in a linear ordering of the countries.
- Consistent transitivity of Nash bargaining solutions: $\lambda_{jk} = \lambda_{ji}/\lambda_{ki}$ for any i.
- You may normalize it by: $\frac{\sqrt{\pi_i g_i}}{\sum_{j=1}^{n} \sqrt{\pi_j g_j}}$.

Outline

Global integration or disintegration by changing P_{ii}

Before going further or less globalization, country i considers the expected change on its π_i.

Gaming on P:

- Change P_{ii} by $\mathrm{d}P_{ii}$: $\mathrm{d}P_{ii} < 0$ for further globalization while $\mathrm{d}P_{ii} > 0$ for protectionism.
- No specific target country to cooperate or conflict with.
- Assume $\mathrm{d}P_{ii}$ triggers proportional changes on all other elements in P.

Response of π w.r.t. $\mathrm{d}P_{ii}$ in the equilibrium $\pi = \pi P$

Effects on π_i:

$$\frac{\mathrm{d}\pi_i}{\mathrm{d}P_{ii}} = -\frac{\vec{1}'_{n-1}(I_{n-1} - Z_i)^{-1}(\pi M_i)'}{1 + \vec{1}'_{n-1}(I_{n-1} - Z_i)^{-1}\alpha_i}$$

and effects on all other countries:

$$\frac{\mathrm{d}\pi_{-i}}{\mathrm{d}P_{ii}} = (I_{n-1} - Z_i)^{-1}\left[(\pi M_i)' - \frac{\vec{1}'_{n-1}(I_{n-1} - Z_i)^{-1}(\pi M_i)'}{1 + \vec{1}'_{n-1}(I_{n-1} - Z_i)^{-1}\alpha_i}\alpha_i\right].$$

Globalization policy implications using $\frac{\mathrm{d}\pi_i}{\mathrm{d}P_{ii}}$

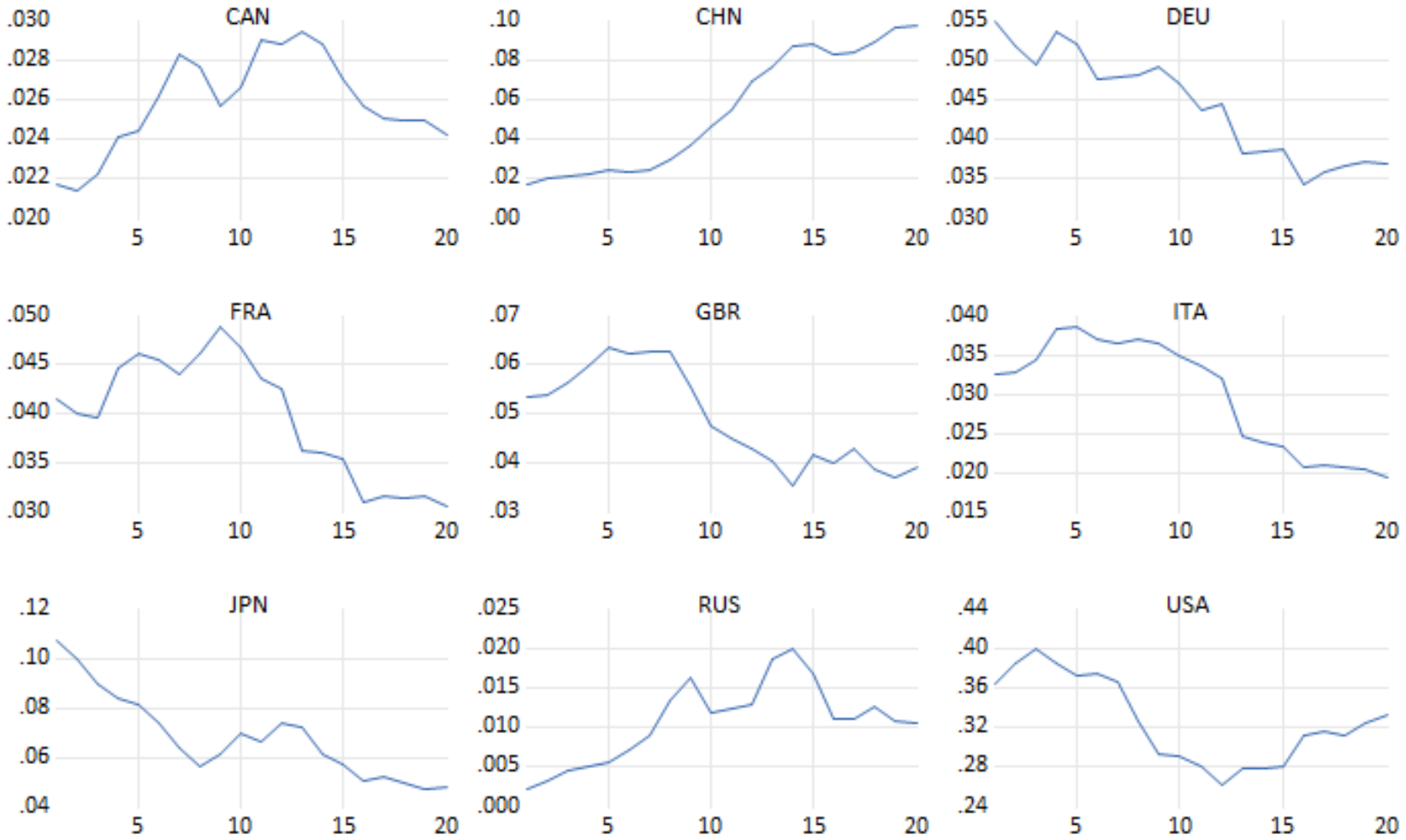
- Less globalization if $\frac{\mathrm{d}\pi_i}{\mathrm{d}P_{ii}}$ is significantly positive, say, $\frac{\mathrm{d}\log\pi_i}{\mathrm{d}\log P_{ii}} = \frac{P_{ii}}{\pi_i}\frac{\mathrm{d}\pi_i}{\mathrm{d}P_{ii}} > 1\%$.
- More globalization if it is significantly negative.
- In-between, look for best collaborators, regional trade agreements, or preferential trade agreements.
- The effects on other countries could be substantial.
- Optimal levels of globalization: over-globalized countries increase P_{ii} by 1% while under-globalized reduce P_{ii} by 1%. Continue this process until stable.

Outline

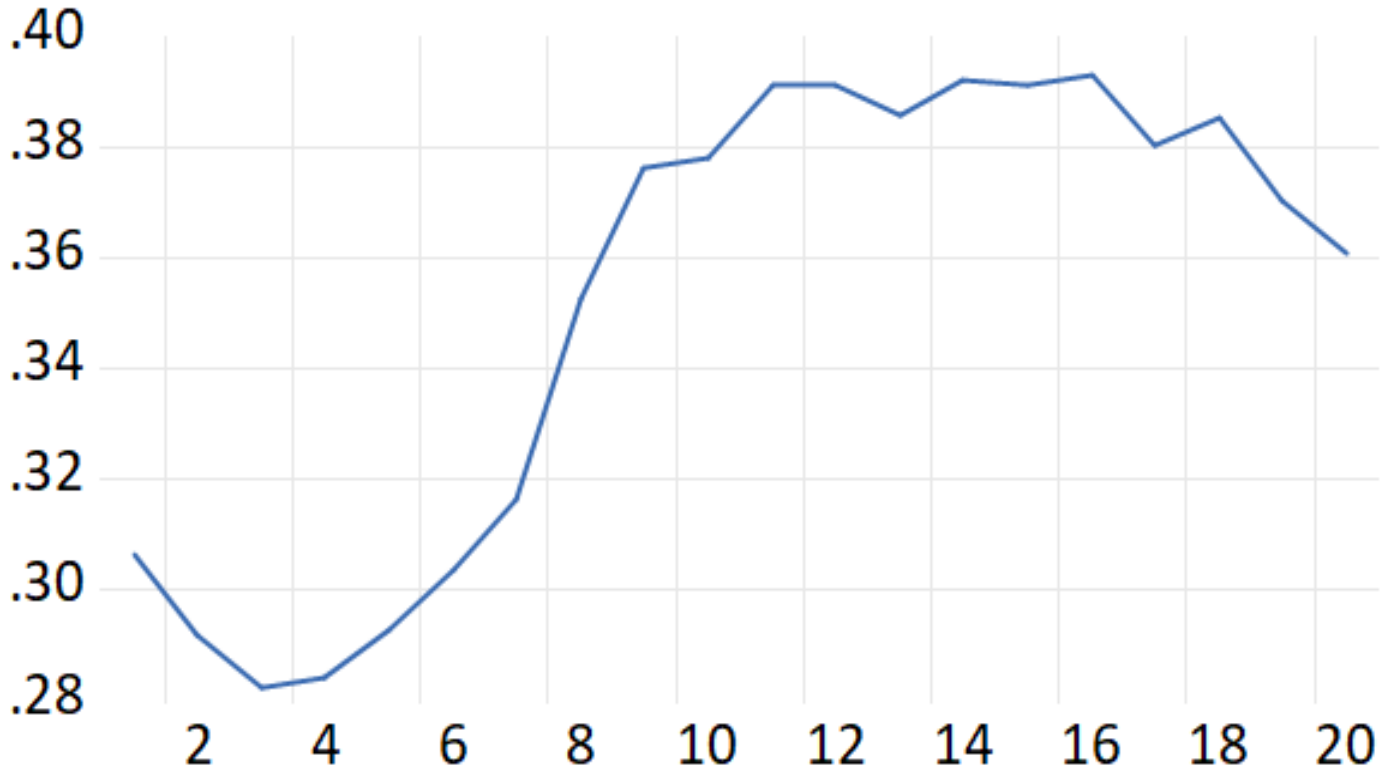
Data in the empirical studies

- 190 country members of IMF
- Twenty years from 2000 to 2019
- Exports data from UN's ComTrade database
- Annual GDP for the countries and the years
- Data already reflect political, territorial, ideological, cultural, war, national security, and other geopolitical considerations, as well as resource endowment, industrial distribution, location advantages, climate, and weather.

Estimated π_i for China, Russia, and G7 Countries



The combined π_i for all other countries



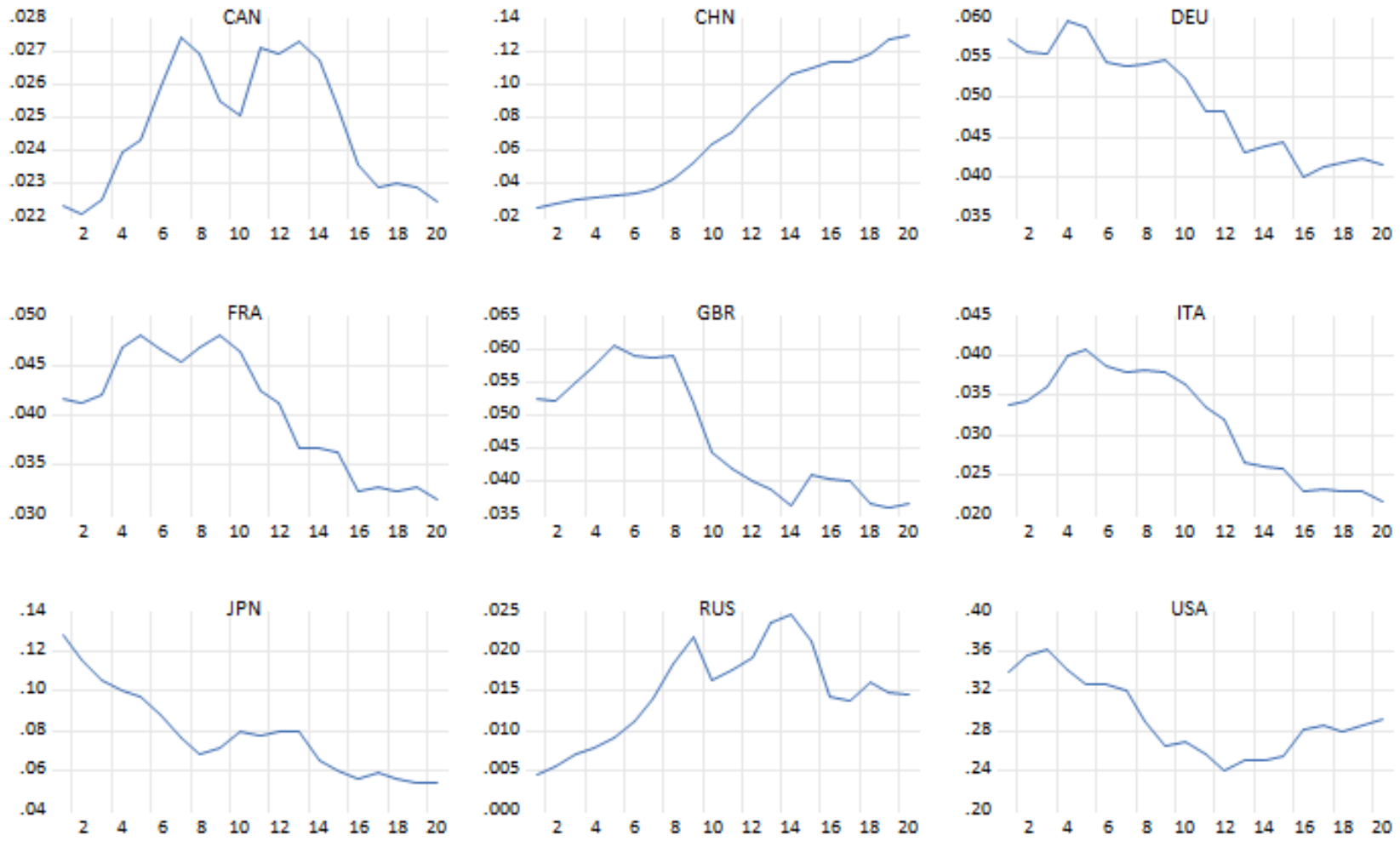
$1,000 \times \frac{\mathrm{d}\log \pi_i}{\mathrm{d}\log P_{ji}}$ for years 2000 and 2017*

i \ j	CAN	CHN	DEU	FRA	GBR	ITA	JPN	RUS	USA
CAN		−25.78 −5.79	−5.48 −.37	−1.47 .29	−.72 2.08	−2.35 −.16	−4.88 −5.41	−.62 −.53	15.90 64.43
CHN	6.69 6.95		7.38 16.67	5.38 7.79	6.09 8.50	2.14 5.28	11.70 31.77	.89 −2.48	46.43 66.17
DEU	1.20 .14	−7.79 −6.10		6.54 3.45	10.18 5.34	1.30 0.18	.10 −5.26	−1.86 −4.56	24.17 15.42
FRA	1.00 −.19	−8.55 −5.20	−13.75 −6.40		5.57 2.69	−4.21 −2.59	−.91 −3.74	−2.09 −3.10	13.12 9.89
GBR	.73 −.97	−16.48 −7.69	−18.05 −7.00	−5.31 −2.28		−4.63 −2.59	−3.41 −7.78	−2.38 −1.97	8.38 10.99
ITA	1.02 .14	−8.34 −5.82	−3.67 −.48	6.14 3.67	7.22 4.43		−.21 −3.01	−2.65 −6.83	12.68 12.13
JPN	4.35 3.51	−26.34 −14.15	−.28 4.71	2.02 3.69	4.35 6.62	.35 2.26		−1.77 −2.05	31.29 70.09
RUS	1.54 4.52	−5.99 3.51	8.97 56.53	9.92 24.30	9.12 26.59	5.14 25.75	2.81 6.42		24.53 56.82
USA	−1.69 −5.06	−46.53 −16.15	−11.87 −6.17	−3.92 −2.77	−2.89 −2.65	−4.06 −2.83	−9.84 −23.64	−2.07 −1.72	

* The numerators are for 2017 and the denominators for 2000.

- USA's top target for conflict was CHN in 2017 & JPN in 2000.
- Any country would benefit from further collaboration with USA.

Normalized global bargaining powers (2000-2019)



$1,000 \times \frac{\mathrm{d}\log \pi_j}{\mathrm{d}\log P_{ii}}$ for years 2000 and 2017*

i \ j	CAN	CHN	DEU	FRA	GBR	ITA	JPN	RUS	USA
CAN	9.78 −6.14	5.86 3.48	9.65 10.07	9.13 9.83	−1.66 6.94	11.18 9.66	7.39 8.39	12.19 3.71	−17.81 −13.53
CHN	−16.04 4.14	−427.81 −539.55	47.37 17.38	90.31 18.44	68.51 21.72	78.00 16.12	−14.27 −14.48	−16.67 3.63	7.51 5.66
DEU	12.28 21.45	7.20 −2.67	−103.54 −76.41	−25.87 −44.49	−8.36 −8.97	−18.20 −29.07	14.56 25.36	−.68 −131.24	13.68 25.65
FRA	12.86 13.68	9.23 7.19	−49.72 −48.77	−60.84 −35.22	−20.33 −25.60	−40.20 −35.32	12.70 19.50	−8.71 −68.17	14.02 18.12
GBR	8.08 −15.25	12.39 15.73	−41.21 −35.97	−24.74 −34.16	39.54 9.38	−10.57 −6.50	12.97 22.15	2.69 −84.74	11.26 21.10
ITA	5.47 9.64	8.33 5.70	−34.34 −41.02	−29.35 −39.73	−4.87 −7.24	−92.89 −75.83	8.21 13.64	−8.01 −103.64	8.87 14.43
JPN	7.44 37.22	−63.87 −237.22	26.60 104.65	41.44 147.01	27.42 120.66	40.95 143.62	−195.01 −545.22	15.31 90.96	18.70 61.01
RUS	8.49 4.01	−5.95 −17.70	−11.52 5.67	4.25 6.03	6.35 7.11	−2.16 −.05	.05 −1.58	−383.08 −2529.9	8.00 4.05
USA	−428.72 −689.47	99.20 127.87	−110.9 123.76	33.60 171.56	−49.71 25.21	117.54 222.24	141.89 164.12	107.96 −290.62	32.48 −62.85

* The numerators are for 2017 and the denominators are for 2000.

- UK & USA advocated antiglobalization most in 2017.
- Japan would benefit most if USA went to antiglobalization in 2017. Canada would hurt most.

China-USA trade war since 2018

Table: Effects measured by $\frac{\mathrm{d}\log \pi_k}{\mathrm{d}\log P_{ji}}$

yr / k	CAN	DEU	FRA	GBR	ITA	JPN	RUS	CHN	USA
2018	-.023	.010	.006	.003	.009	.016	.018	.109	-.051
2019	-.020	.005	.004	.002	.008	.015	.017	.096	-.044

* Country i is for the USA and j for China.

- The war did hurt China's π_j; but the harm decreased from 2018 to 2019.
- It increased USA's π_i with a diminishing magnitude.
- Except for Canada, no third countries in the table benefited from the war. Japan and Russia suffered most.

questions?

Trade counterbalances cooperation and competition.