International Friends and Enemies

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Motivation

- Rapid economic growth in China and other emerging countries has seen a dramatic change in relative economic size of nations
  - Classic question in international trade is the effect of such economic growth on income and welfare in trade partners
  - Related question in political economy is whether such changes in relative economic size heighten political tension (*Thucydides Trap*)

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  - Classic question in international trade is the effect of such economic growth on income and welfare in trade partners
  - Related question in political economy is whether such changes in relative economic size heighten political tension (*Thucydides Trap*)

- We provide new theory and evidence on both of these questions
  - Develop bilateral "friends" and "enemies" measures of countries' income and welfare exposure to foreign productivity shocks
  - Can be computed using only observed trade data
  - Exact for small productivity shocks in the class of international trade models characterized by a constant trade elasticity
  - For large shocks, we characterize the quality of the approximation in terms of observed trade matrices, and show in practice almost exact
  - Computationally fast ($>$ 1 million comparative statics in seconds)
  - Reveal economic mechanisms underlying quantitative results
  - Easy to examine sensitivity of quantitative results across alternative models (e.g. many sectors, input-output linkages, economic geography)

This Paper

- First-order effect of a productivity shock in a given country on welfare in each country depends on three matrices of observed trade shares
  - Expenditure shares ($\boldsymbol{S}$): expenditure share importer on exporter
  - Income share ($\boldsymbol{T}$): share exporter value added from each importer
  - Cross-substitution matrix ($\boldsymbol{M}$): how $\uparrow$ competitiveness of one country $\rightarrow$ consumers substitute away all other countries in each market

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- Use this matrix representation to reveal economic mechanisms
  - Income exposure: market-size and cross-substitution effect
  - Welfare exposure: income exposure and cost-of-living effect
  - Partial and general equilibrium effects
  - Evaluate contribution of individual sectors
  - Evaluate contribution of importer, exporter and third markets

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  - Evaluate contribution of individual sectors
  - Evaluate contribution of importer, exporter and third markets
- Empirical application using NBER world trade data from 1970-2012
  - Impact of productivity shocks on global income and welfare
  - Almost exact approximation to exact-hat algebra for magnitude of productivity shocks implied by the observed data ($R^2 > 0.999$)
  - As countries become greater economic friends, they also become greater political friends, as measured by UN voting and strategic rivalries

Related Literature

- Theoretical work on the incidence of trade and productivity shocks
  - Hicks (1953), Johnson (1955), Bhagwati (1958)
- Quantitative trade models
  - Eaton and Kortum (2002), Costinot, Donaldson & Komunjer (2012), Caliendo & Parro (2015), Hsieh & Ossa (2016), Caliendo, Parro, Rossi-Hansberg & Sarte (2018), Monte, Redding & Rossi-Hansberg (2018), Dvorkin, Caliendo & Parro (2019)
- Research on sufficient statistics for welfare in international trade
  - Arkolakis, Costinot & Rodriguez-Clare (2012), Adão, Costinot & Donaldson (2017), Adão, Arkolakis and Esposito (2019), Baqaee & Farhi (2019), Galle, Rodriguez-Clare & Yi (2019), Huo, Levchenko & Pandalai-Nayar (2019), Barthelme, Lan & Levchenko (2019), Adão, Arkolakis & Ganapati (2020)
- Empirical evidence on trade and productivity shocks including China
  - Topolova (2010), Kovak (2013), Autor, Dorn & Hanson (2013, 2014), Hsieh & Ossa (2016), Dix-Carneiro & Kovak (2017), Amiti, Dai, Feenstra & Romalis (2019), Pierce & Schott (2019), Borusyak & Jaravel (2019), Sager & Jaravel (2019).
- Empirical research using bilateral country attitudes and UN voting
  - Scott (1955), Cohen (1960), Signorio & Ritter (1999), Kuziemko & Werker (2006), Bao, Liu, Qiu & Zhu (2019), Häge (2011), Guiso, Sapienza & Zingales (2009)

Outline

- General Armington
- Constant Elasticity Armington
- Extensions
- Data
- Empirical Results
- Conclusions

General Armington

- Goods differentiated by country of origin with homothetic preferences

$$u_n = \frac{w_n}{\mathcal{P}\left(\boldsymbol{p}_n\right)}$$

- Goods produced with labor and subject to iceberg trade costs

$$p_{ni} \equiv \frac{\tau_{ni} w_i}{z_i}$$

- Share of expenditure of country n on the goods of country i

$$s_{ni} = \frac{e_{ni}\left(\boldsymbol{p}_n\right)}{\sum_{\ell=1}^{N} e_{n\ell}\left(\boldsymbol{p}_n\right)}$$

Comparative Statics

- Market clearing

$$w_i \ell_i = \sum_{n=1}^{N} s_{ni} w_n \ell_n$$

- Totally differentiate market clearing, holding constant trade costs (τ_{ni}) and endowments (ℓ_i)

$$\mathrm{d} \ln w_i = \sum_{n=1}^{N} t_{in} \left(\mathrm{d} \ln w_n + \left[\sum_{h=1}^{N} \left[\theta_{nih} - \sum_{k=1}^{N} s_{nk} \theta_{nkh} \right] \left[\mathrm{d} \ln w_h - \mathrm{d} \ln z_h \right] \right] \right)$$

$$t_{in} \equiv \frac{s_{ni} w_n \ell_n}{w_i \ell_i}, \qquad \theta_{nih} \equiv \left(\frac{\partial e_{ni}\left(\boldsymbol{p}_n\right)}{\partial p_{nh}} \frac{p_{nh}}{e_{ni}} \right)$$

- Totally differentiate welfare, holding constant trade costs (τ_{ni}) and endowments (ℓ_i)

$$\mathrm{d} \ln u_n = \mathrm{d} \ln w_n - \sum_{i=1}^{N} s_{ni} \left[\mathrm{d} \ln w_i - \mathrm{d} \ln z_i \right]$$

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Constant Elasticity Armington

- Consider ACR class of models with constant trade elasticity θ

$$\text{(income exposure)} \qquad \mathrm{d}\ln w_i = \sum_{n=1}^{N} t_{in} \left(\mathrm{d}\ln w_n + \theta \left(\sum_{h=1}^{N} s_{nh} \left[\mathrm{d}\ln w_h - \mathrm{d}\ln z_h \right] - \left[\mathrm{d}\ln w_i - \mathrm{d}\ln z_i \right] \right) \right)$$

$$\text{(welfare exposure)} \qquad \mathrm{d}\ln u_n = \mathrm{d}\ln w_n - \sum_{i=1}^{N} s_{ni} \left[\mathrm{d}\ln w_i - \mathrm{d}\ln z_i \right]$$

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$$\text{(welfare exposure)} \qquad \mathrm{d}\ln u_n = \mathrm{d}\ln w_n - \sum_{i=1}^{N} s_{ni}\left[\mathrm{d}\ln w_i - \mathrm{d}\ln z_i\right]$$

- which has the following bilateral friend-enemy matrix representation (row i, column n) ▸ more ▸ T ▸ M ▸ S ▸ acr

$$\underbrace{\mathrm{d}\ln \boldsymbol{w}}_{\text{income effect}} = \underbrace{\boldsymbol{T}\,\mathrm{d}\ln \boldsymbol{w}}_{\text{market-size effect}} + \underbrace{\theta \boldsymbol{M} \times \left(\mathrm{d}\ln \boldsymbol{w} - \mathrm{d}\ln \boldsymbol{z}\right)}_{\text{cross-substitution effect}}$$

$$\underbrace{\mathrm{d}\ln \boldsymbol{u}}_{\text{welfare effect}} = \underbrace{\mathrm{d}\ln \boldsymbol{w}}_{\text{income effect}} - \underbrace{\boldsymbol{S}\left(\mathrm{d}\ln \boldsymbol{w} - \mathrm{d}\ln \boldsymbol{z}\right)}_{\text{price index effect}}$$

$$\boldsymbol{T}_{in} = t_{in} \equiv \frac{s_{ni} w_n \ell_n}{w_i \ell_i}, \qquad \boldsymbol{M}_{in} = \left[\boldsymbol{T}\boldsymbol{S} - \boldsymbol{I}\right]_{in} = \sum_{h=1}^{N} t_{ih} s_{hn} - 1_{n=i}, \qquad \boldsymbol{S}_{ni} = s_{ni}$$

Matrix Inversion

- Re-arranging and using world GDP as numeraire ($\boldsymbol{Q}\,\mathrm{d}\ln \boldsymbol{w} = 0$)

$$(\boldsymbol{I} - \boldsymbol{V})\,\mathrm{d}\ln \boldsymbol{w} = -\frac{\theta}{\theta+1}\boldsymbol{M}\,\mathrm{d}\ln \boldsymbol{z}, \qquad \boldsymbol{V} \equiv \frac{\boldsymbol{T} + \theta \boldsymbol{T}\boldsymbol{S}}{\theta+1} - \boldsymbol{Q}$$

- Inverting $(\boldsymbol{I} - \boldsymbol{V})$, we obtain friend-enemy income exposure

$$\mathrm{d}\ln \boldsymbol{w} = \boldsymbol{W}\,\mathrm{d}\ln \boldsymbol{z}, \qquad \boldsymbol{W} \equiv -\frac{\theta}{\theta+1}\left(\boldsymbol{I} - \boldsymbol{V}\right)^{-1}\boldsymbol{M}$$

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- Using in welfare, we obtain friend-enemy welfare exposure

$$\mathrm{d}\ln \boldsymbol{u} = \boldsymbol{U}\,\mathrm{d}\ln \boldsymbol{z}, \qquad \boldsymbol{U} \equiv \left(\boldsymbol{I} - \boldsymbol{S}\right)\boldsymbol{W} + \boldsymbol{S}$$

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- Partial and general equilibrium effects

$$\boldsymbol{W} = -\frac{\theta}{\theta+1}\sum_{k=0}^{\infty}\boldsymbol{V}^k\boldsymbol{M} = -\underbrace{\frac{\theta}{\theta+1}\boldsymbol{M}}_{\text{partial equilibrium}} \underbrace{-\frac{\theta}{\theta+1}\left(\boldsymbol{V} + \boldsymbol{V}^2 + \ldots\right)\boldsymbol{M}}_{\text{general equilibrium}}$$

Comparison with Exact-Hat Algebra

- Compare Dekle, Eaton and Kortum (2007) exact-hat algebra to our friend-enemy (first-order) linearization for productivity shocks:

$$\ln \hat{w}_i = \left(\frac{\theta}{\theta+1}\right) \ln \hat{z}_i + \frac{1}{\theta+1} \ln \left[\sum_{n=1}^{N} t_{in} \frac{\hat{w}_n}{\sum_{\ell=1}^{N} s_{n\ell} \hat{w}_\ell^{-\theta} \hat{z}_\ell^{\theta}} \right]$$

$$\ln \hat{w}_i = \left(\frac{\theta}{\theta+1}\right) \ln \hat{z}_i + \frac{1}{\theta+1} \sum_{n=1}^{N} t_{in} \left[\begin{array}{c} \ln\left(\hat{w}_n\right) \\ +\theta \sum_{\ell=1}^{N} s_{n\ell} \left[\ln\left(\hat{w}_\ell\right) + \ln\left(\hat{z}_\ell\right)\right] \end{array} \right]$$

- Log of a weighted mean versus a weighted mean of logs
- These expressions are equal to one another: (i) no trade $t_{nn} \to 1$, $s_{nn} \to 1$; (ii) symmetry $t_{in} = \bar{t}$, $s_{ni} = \bar{s}$; (iii) free trade
- We characterize the quality of the approximation analytically as a function of the properties of observed trade matrices $\boldsymbol{S}$, $\boldsymbol{T}$, $\boldsymbol{M}$ ▸ more
- In practice, we find the approximation to be almost exact, even for large productivity shocks, given the observed trade matrices ▸ more

Outline

- General Armington
- Constant Elasticity Armington
- Extensions
  - Trade Imbalance more
  - Productivity and trade cost changes more
  - Small departures from constant trade elasticity more
  - Multiple industries (CDK) back
  - Multiple industries and input-output linkages (CP) more
  - Economic geography (Helpman model) more
- Data
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Data

- International trade data
  - United Nations COMTRADE data
  - NBER World Trade Database 1970-2012
- Income, population and distance data
  - CEPII Gravity Database 1970-2012

Outline

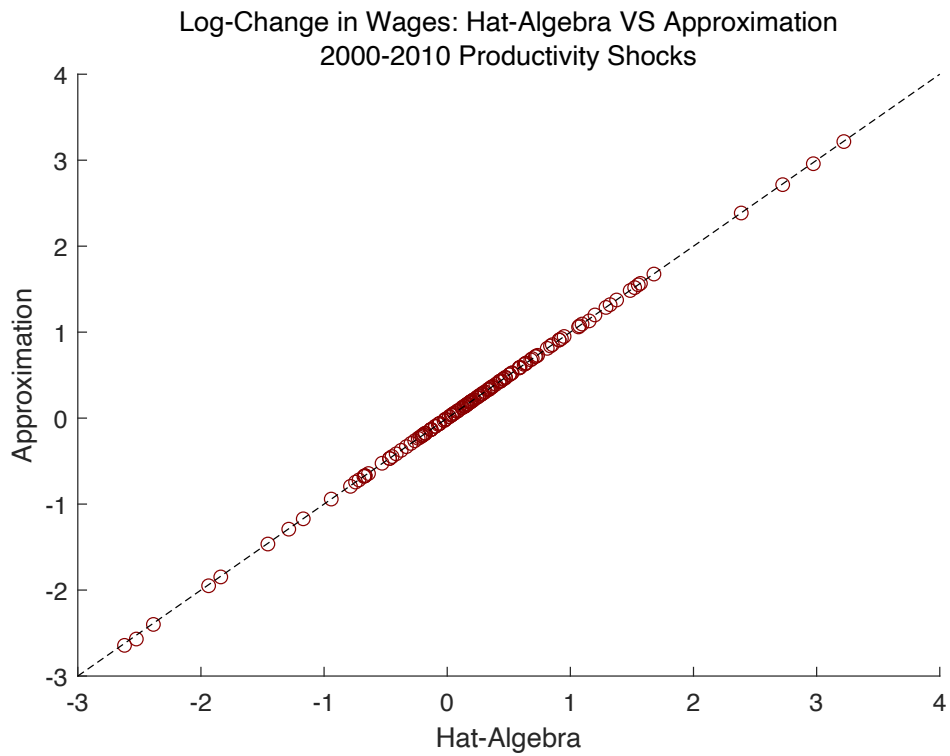
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Quality of Approximation for Productivity Shocks

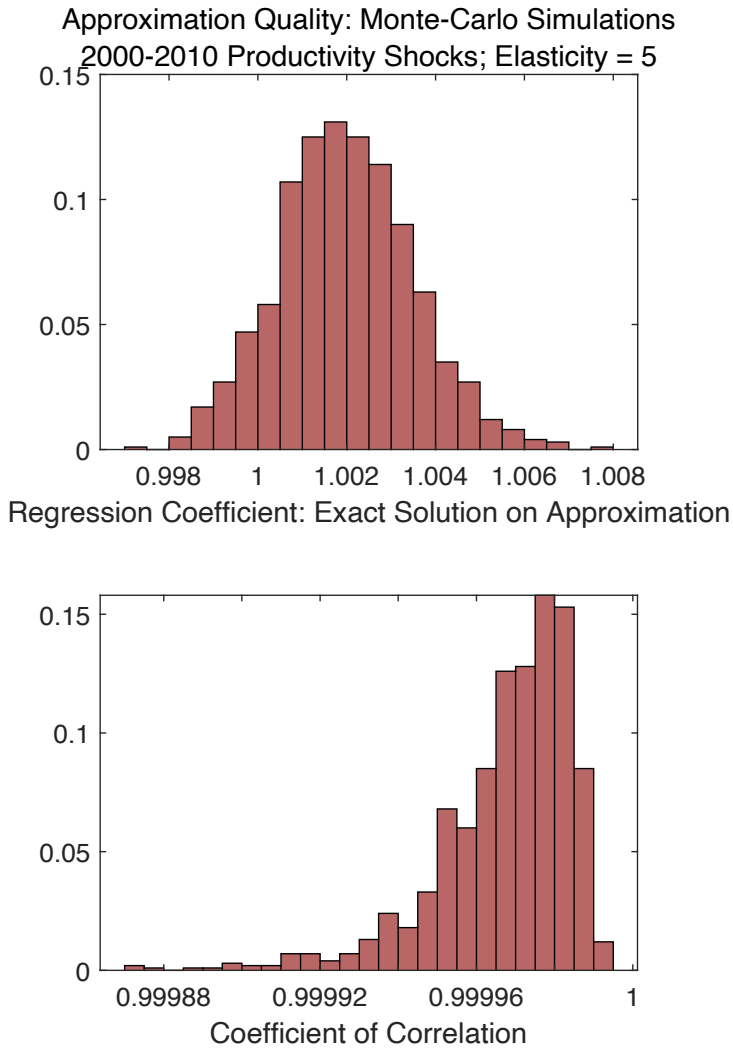
- Use exact-hat algebra to recover (up to normalization) changes in trade costs ($\hat{\tau}_{ni}^{-\theta}$) and productivity ($\hat{z}_n$) that exactly rationalize observed trade data more
- Undertake exact-hat algebra counterfactual for a change in productivity ($\hat{z}_n$)
- Compare the exact-hat algebra counterfactuals for bilateral income responses ($\ln \hat{w}_i$) to the predictions of our linearization ($\boldsymbol{W} d \log \boldsymbol{z}$)

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Monte Carlo Simulation

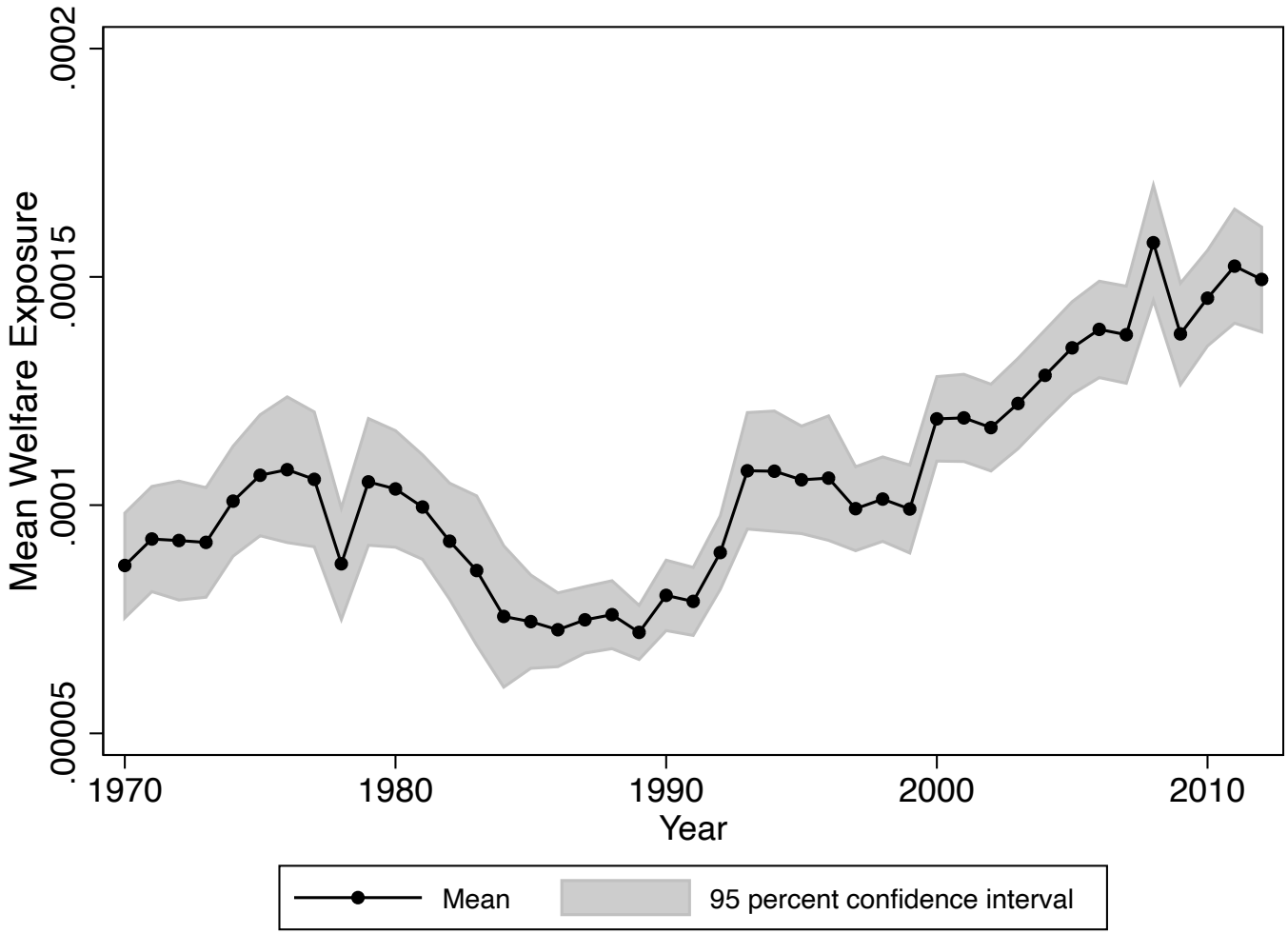


- 1,000 simulations from empirical distribution productivity shocks ▸ th2 ▸ th20
- Better approximation for productivity shocks than trade cost shocks ▸ tau

Outline

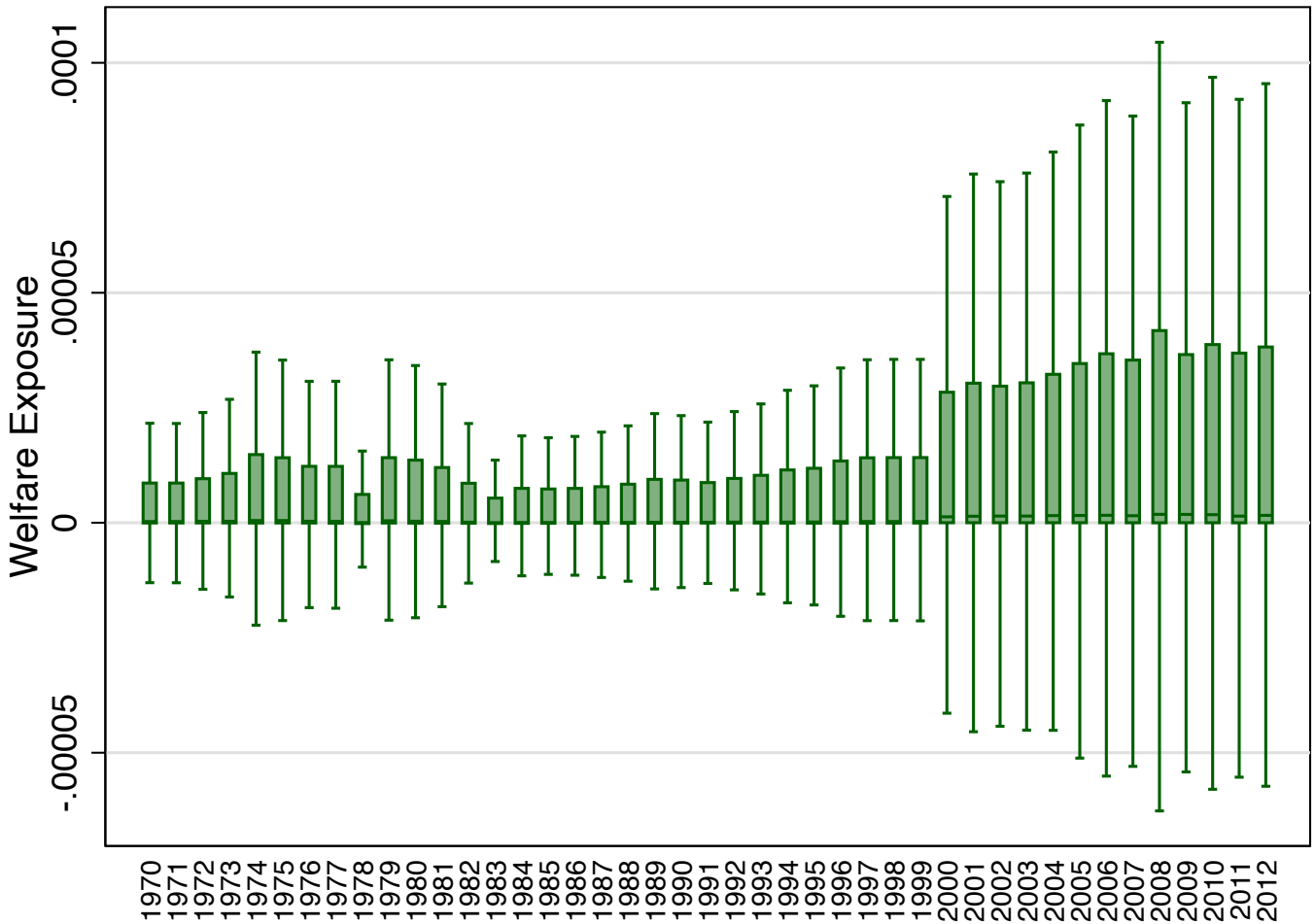
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Global Welfare Exposure



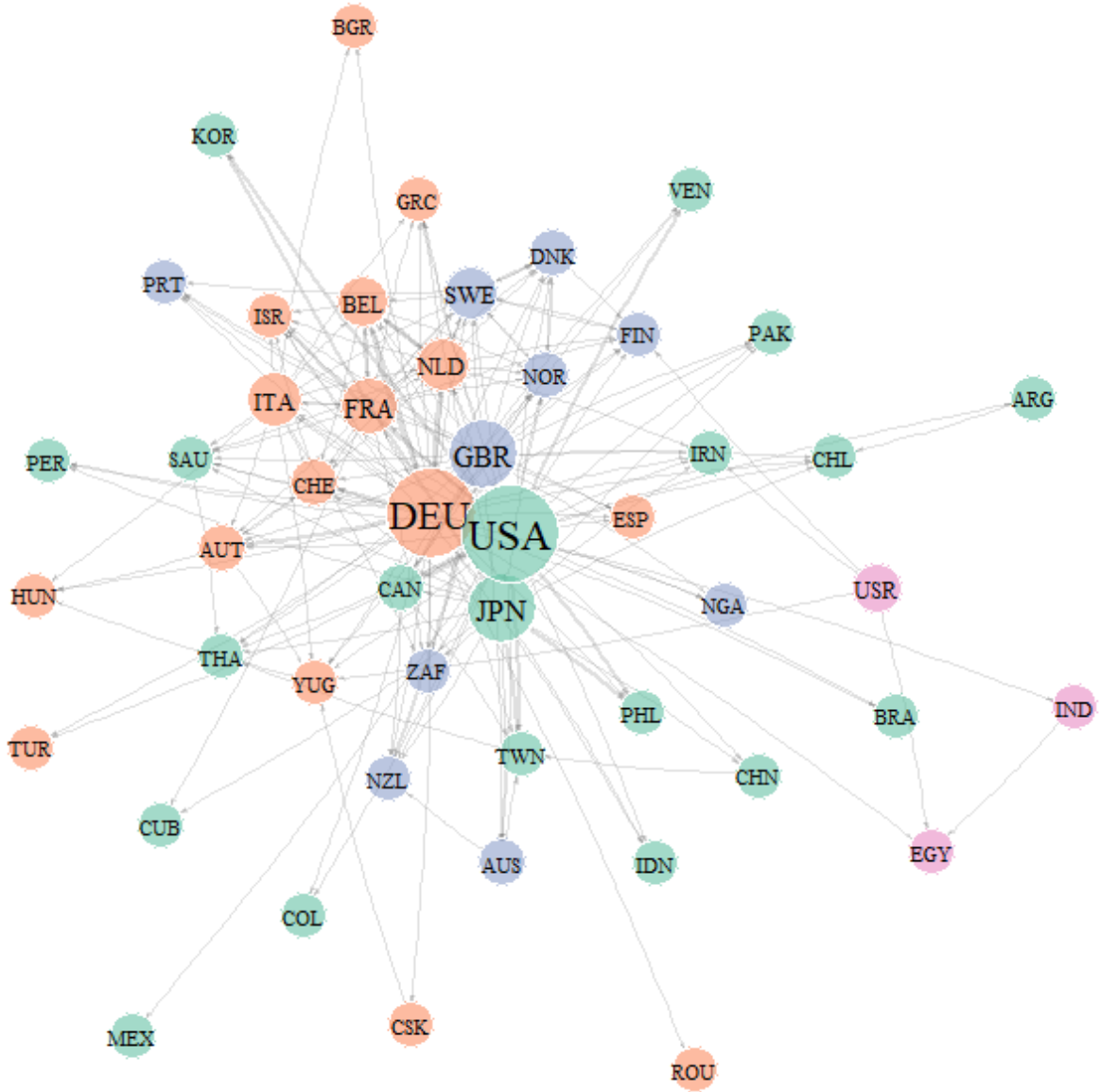
- Growing average economic interdependence, consistent with increasing globalization over our sample period

Global Welfare Exposure

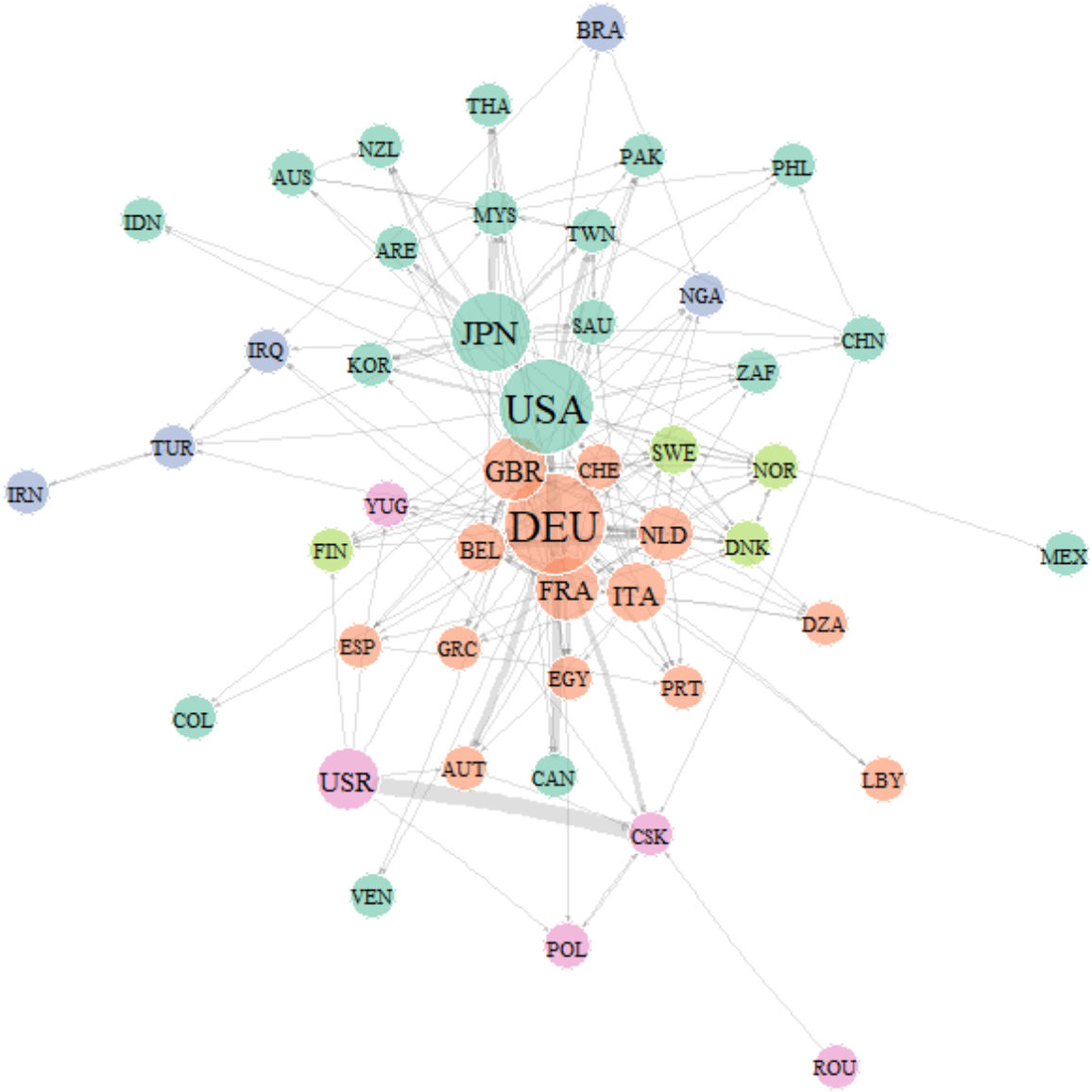


- Growing dispersion in economic interdependence, consistent with increasing globalization over our sample period

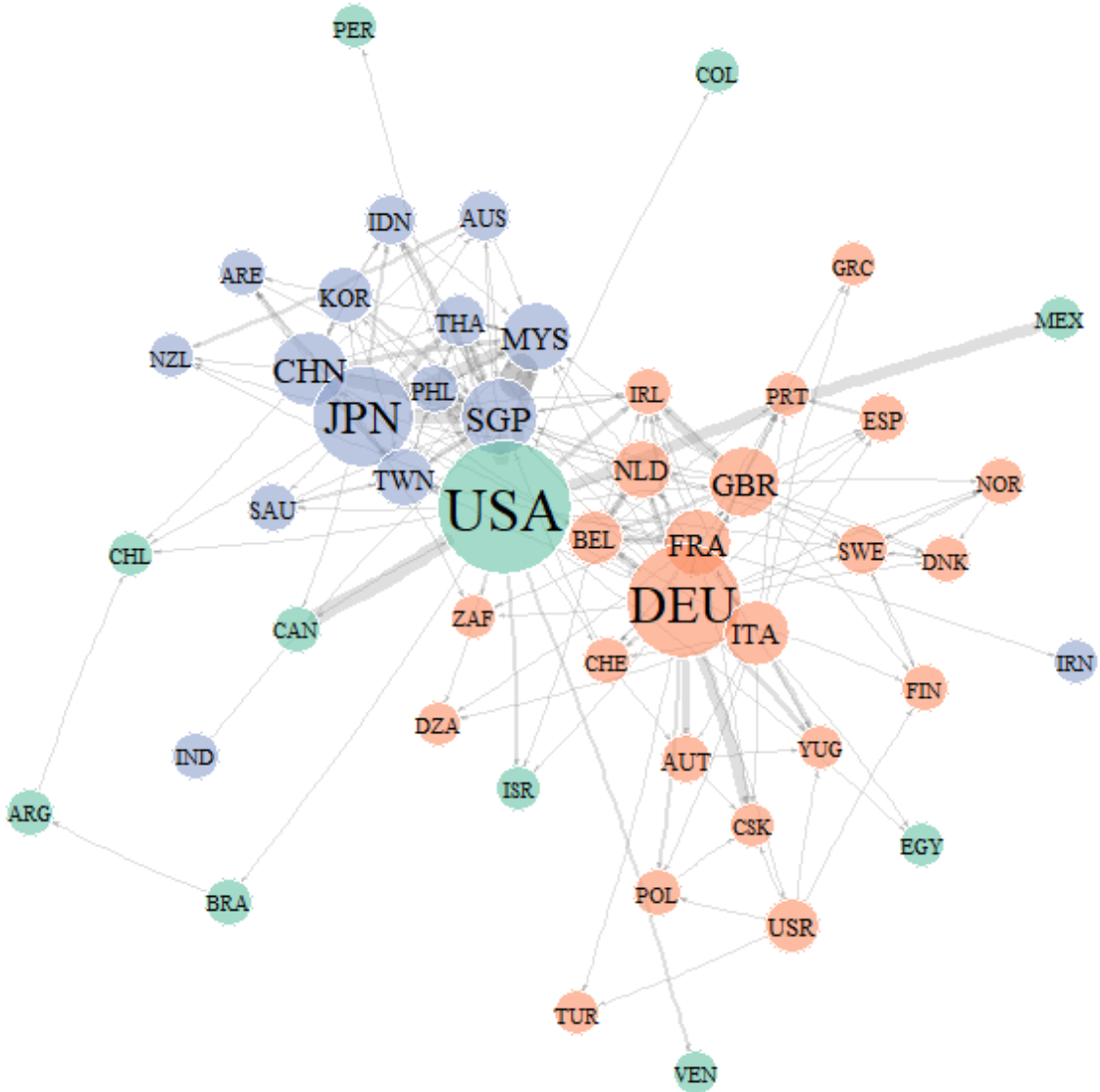
Global Network Welfare Exposure 1970



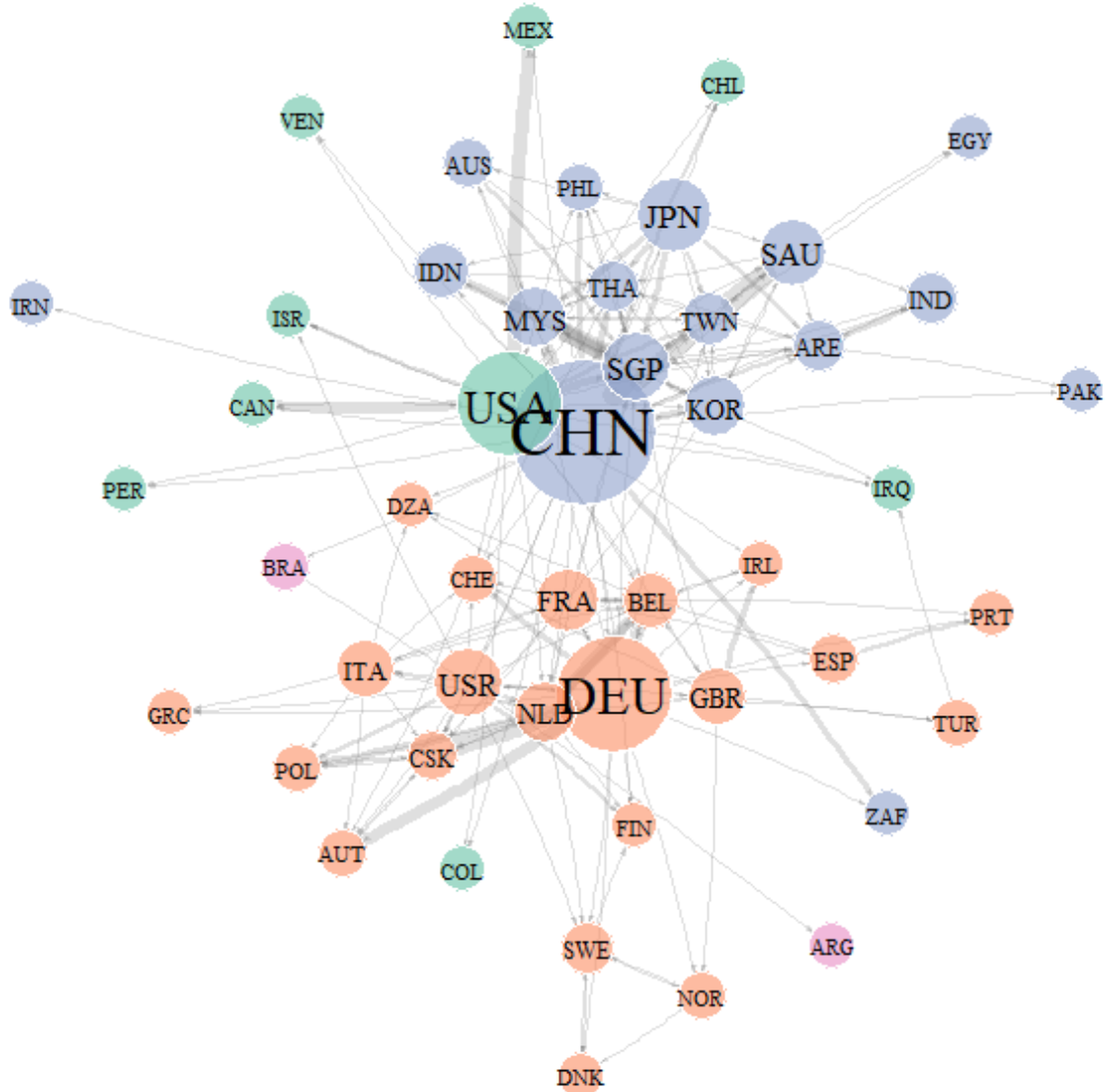
Global Network Welfare Exposure 1985



Global Network Welfare Exposure 2000

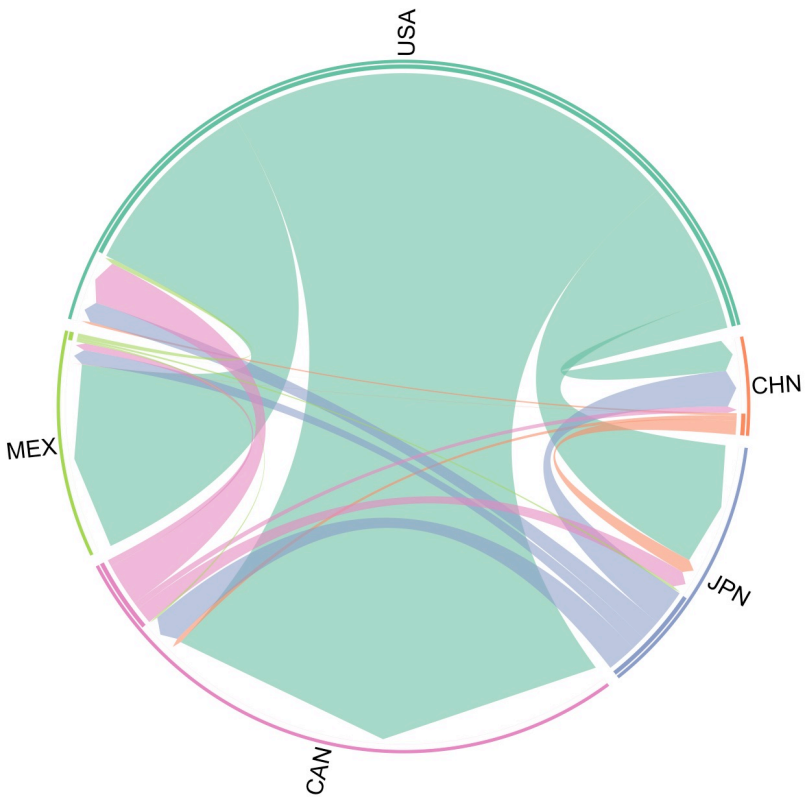


Global Network Welfare Exposure 2012

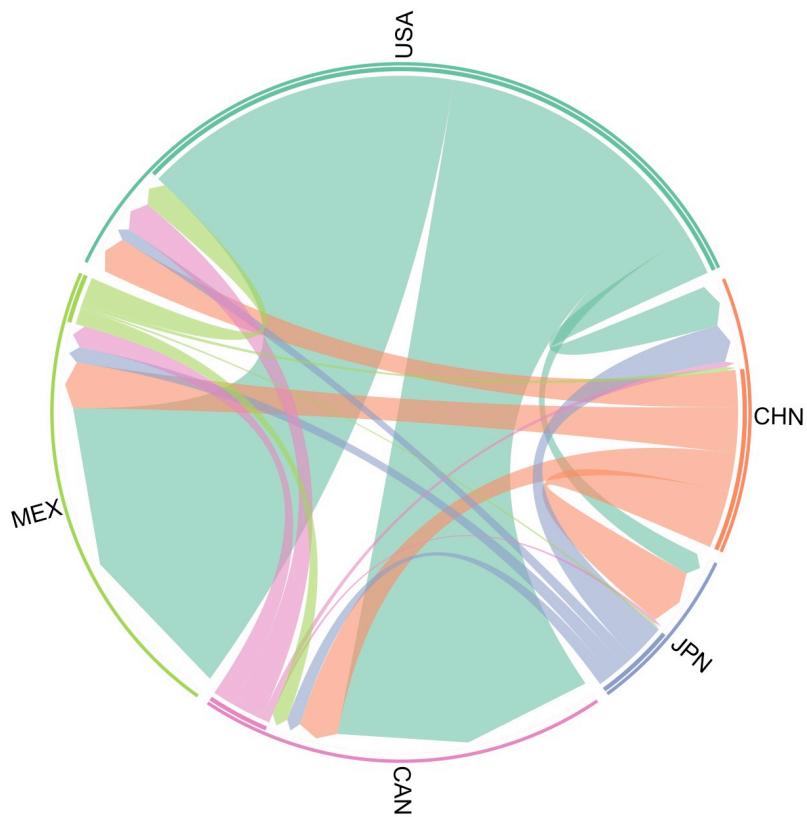


Welfare Exposure N. America

(a) 1970



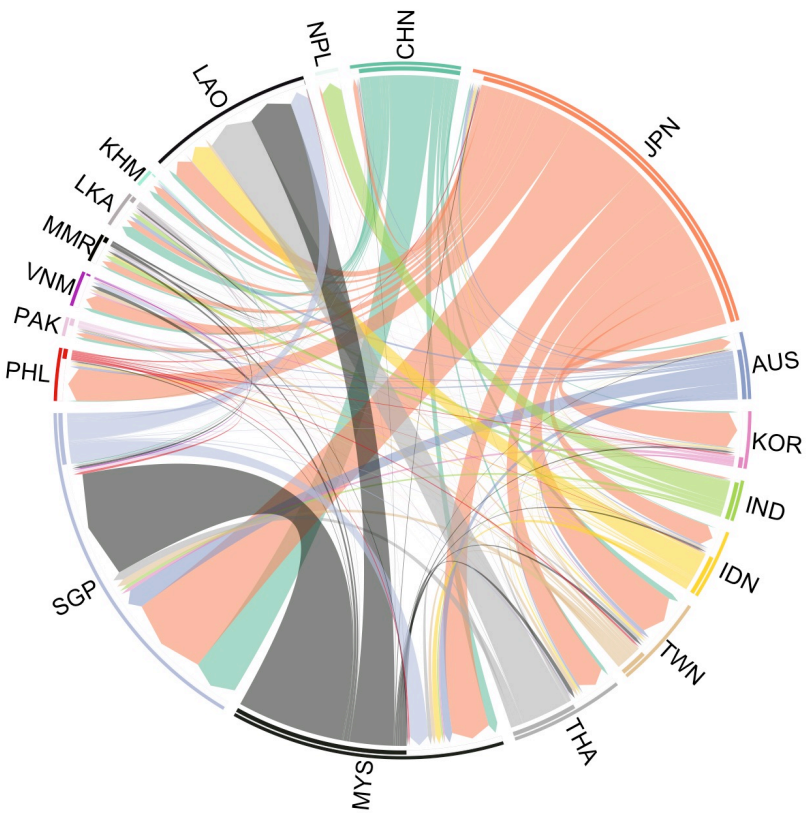
(b) 2012



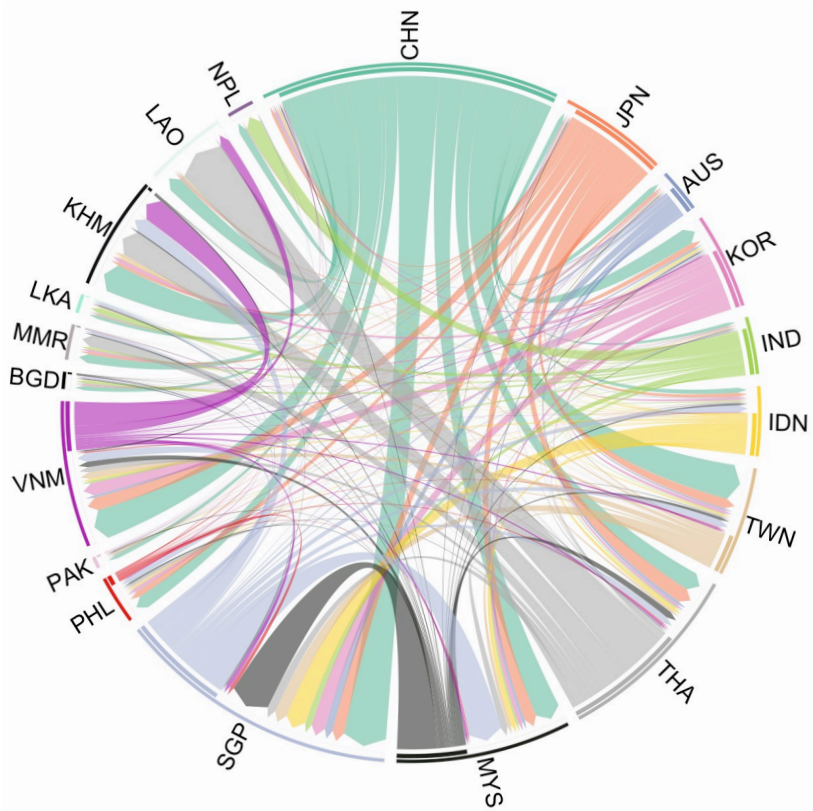
- Growing US-Mexico, Mexico-China and Mexico-US exposure

Welfare Exposure Asia

(a) 1970



(b) 2012

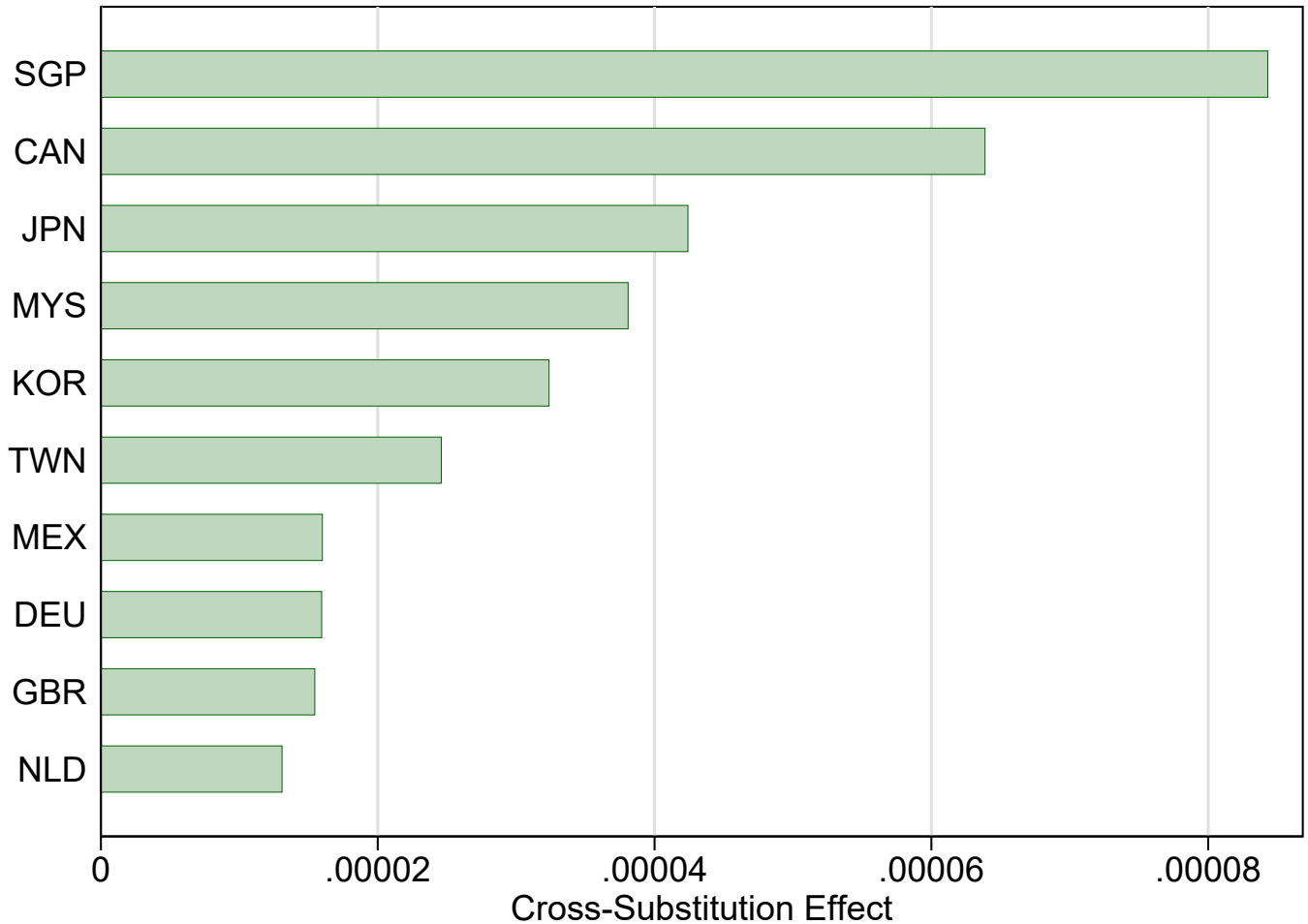


- China replaces Japan at the center of Asian trade ▸ CentralEurope

Summary of Other Empirical Results

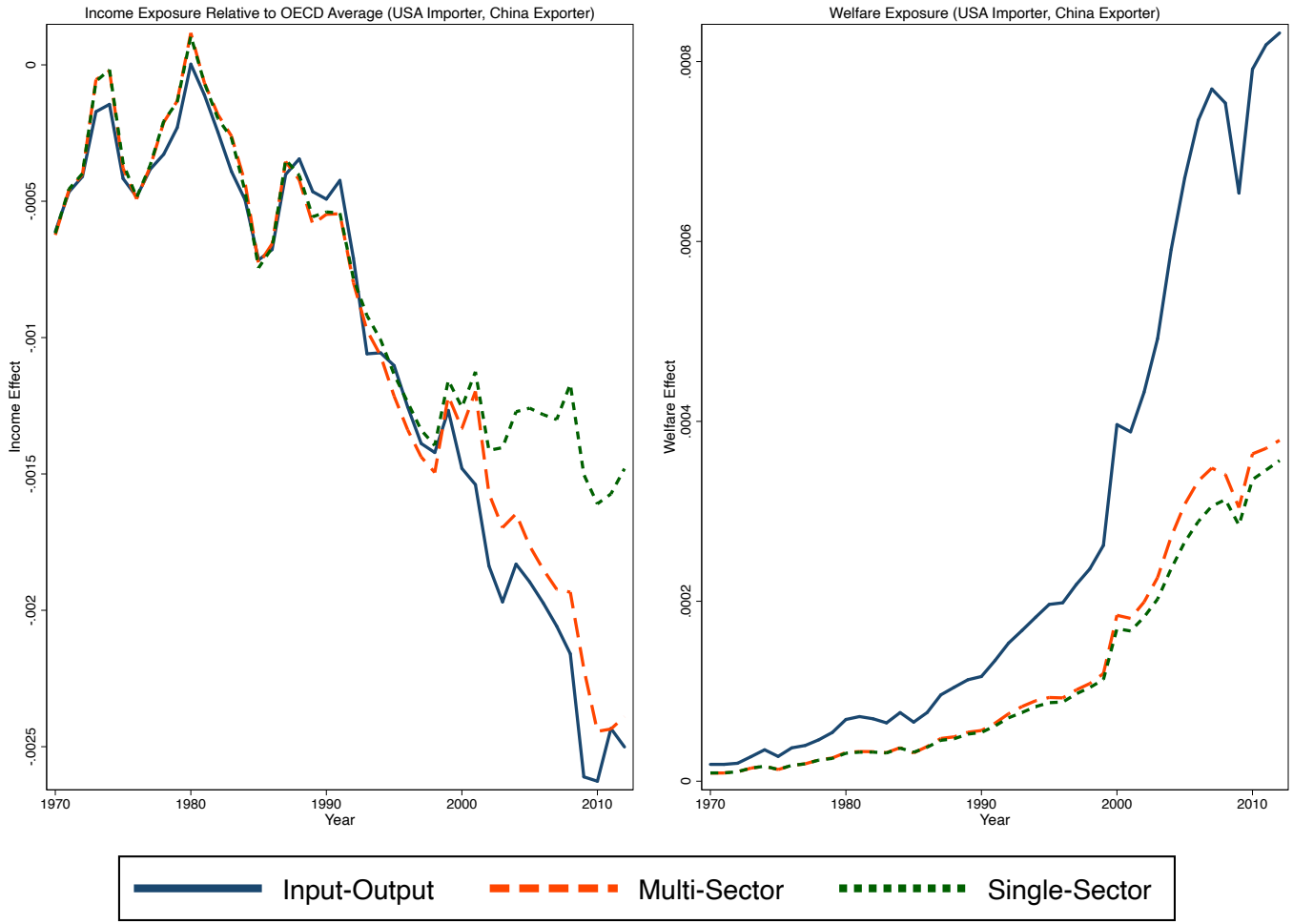
- Strong general equilibrium effects, such that inferring welfare exposure from partial equilibrium terms can be misleading ▸ more
- Both market-size and cross-substitution effects are substantial relative to overall income exposure ▸ more
- Cost-of-living effect large relative to income exposure, such that income exposure can be poor guide to welfare exposure ▸ more
- Economically relevant importer, exporter & third-market effects ▸ more
- Strong correlation between aggregate welfare predictions of single-sector, multi-sector and input-output models ▸ more
- Multi-sector and input-output models have additional disaggregated predictions for sector income exposure ▸ more

3rd Market Effects: US Exposure to China



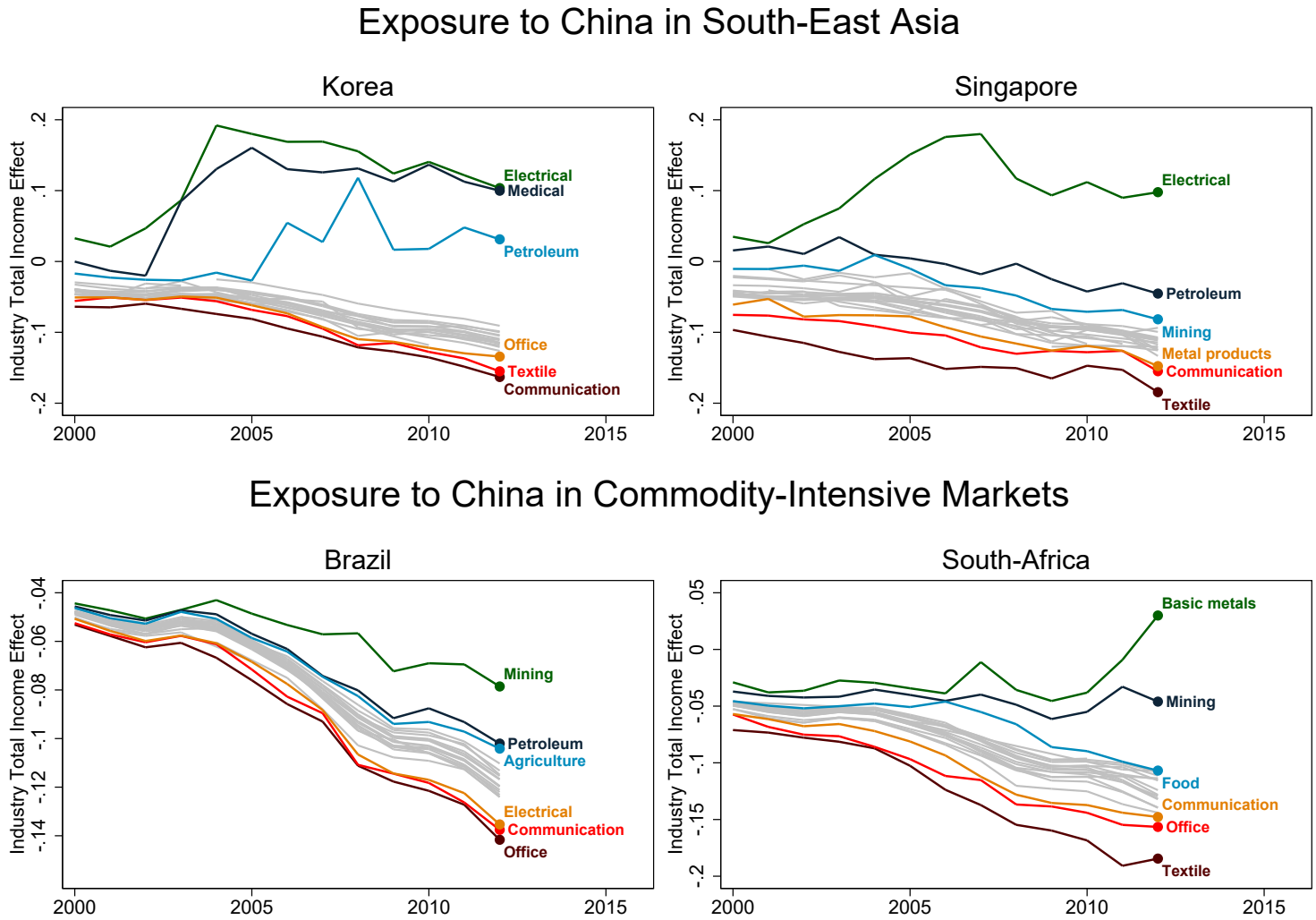
- Third market effects depend on the share of US income derived from a market times the share of that market's expenditure on China more

Chinese Productivity Growth and Importer Welfare



- Strong correlation between aggregate predictions of all three models

Industry Income Exposure



- Largest income effects in Electrical Sector in South-East Asia and in Extractive Sectors in commodity-intensive emerging economies

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  - Computationally fast ($>$ 1 million comparative statics in seconds)
  - Reveal economic mechanisms of market-size, cross-substitution and cost-of-living effects underlying quantitative results
  - Quantify the role of partial and general equilibrium effects
  - Easy to examine sensitivity of quantitative results across alternative models (e.g. many sectors, input-output linkages, economic geography)

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  - Almost exact approximation to exact-hat algebra for magnitude of productivity shocks implied by the observed data ($R^2 > 0.999$)
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Thank You