International Friends and Enemies

Benny Kleinman  
*Princeton University*

Ernest Liu  
*Princeton University*

Stephen J. Redding  
*Princeton University, NBER and CEPR*
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*)
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)

• 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 \((S)\): expenditure share importer on exporter
  - Income share \((T)\): share exporter value added from each importer
  - Cross-substitution matrix \((M)\): how ↑ competitiveness of one country → consumers substitute away all other countries in each market
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 \( (S) \): expenditure share importer on exporter
  – Income share \( (T) \): share exporter value added from each importer
  – Cross-substitution matrix \( (M) \): how ↑ competitiveness of one country → consumers substitute away all other countries in each market

• 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

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
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** ($S$): expenditure share importer on exporter
  - **Income share** ($T$): share exporter value added from each importer
  - **Cross-substitution matrix** ($M$): how ↑ competitiveness of one country → consumers substitute away all other countries in each market

• 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

• 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**

- **Research on sufficient statistics for welfare in international trade**

- **Empirical evidence on trade and productivity shocks including China**

- **Empirical research using bilateral country attitudes and UN voting**
Outline

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

- Goods differentiated by country of origin with homothetic preferences

\[ u_n = \frac{w_n}{\mathcal{P}(p_n)}, \quad p_{ni} \equiv \frac{\tau_{ni} w_i}{z_i} \]

- Market clearing

\[ w_i \ell_i = \sum_{n=1}^{N} s_{ni} w_n \ell_n, \quad s_{ni} = \frac{e_{ni}(p_n)}{\sum_{\ell=1}^{N} e_{n\ell}(p_n)} \]

- Totally differentiate market clearing and welfare, holding constant trade costs (\(\tau_{ni}\)) and endowments (\(\ell_i\))

\[
\begin{align*}
\frac{d \ln w_i}{dt} &= \sum_{n=1}^{N} t_{in} \left( \frac{d \ln w_n}{dt} + \sum_{h=1}^{N} \left[ \theta_{nhi} - \sum_{k=1}^{N} s_{nk} \theta_{nkh} \right] \left( \frac{d \ln w_h}{dt} - \frac{d \ln z_h}{dt} \right) \right) \\
\frac{t_{in}}{w_i \ell_i} &= \frac{s_{ni} w_n \ell_n}{w_i \ell_i}, \quad \theta_{nhi} \equiv \left( \frac{\partial e_{ni}(p_n)}{\partial p_{nh}} \frac{p_{nh}}{e_{ni}} \right) \\
\frac{d \ln u_n}{dt} &= \frac{d \ln w_n}{dt} - \sum_{i=1}^{N} s_{ni} \left( \frac{d \ln w_i}{dt} - \frac{d \ln z_i}{dt} \right)
\end{align*}
\]
Outline

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

- Consider ACR class of models with constant trade elasticity $\theta$

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

\[
\text{(welfare exposure)} \quad d \ln u_n = d \ln w_n - \sum_{i=1}^{N} s_{ni} \left[ d \ln w_i - d \ln z_i \right]
\]
Constant Elasticity Armington

- Consider ACR class of models with constant trade elasticity $\theta$

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

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

- Bilateral friend-enemy income and welfare exposures obtained from matrix inversion (row $i$, column $n$)

\[
\begin{align*}
\frac{d \ln w}{d t} & = T \frac{d \ln w}{d t} + \theta M \times \left( \frac{d \ln w}{d t} - \frac{d \ln z}{d t} \right) \\
\frac{d \ln u}{d t} & = \frac{d \ln w}{d t} - S \left( \frac{d \ln w}{d t} - \frac{d \ln z}{d t} \right)
\end{align*}
\]

\[
T_{in} = t_{in} \equiv \frac{s_{ni} w_n \ell_n}{w_i \ell_i}, \quad M_{in} = [TS - I]_{in} = \sum_{h=1}^{N} t_{ih} s_{hn} - 1_{n=i}, \quad S_{ni} = s_{ni}
\]
Comparison with Exact-Hat Algebra

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

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

- 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) free trade

- We characterize the quality of the approximation analytically as a function of the properties of observed trade matrices \( S, T, M \)

- In practice, we find the approximation to be almost exact, even for large productivity shocks, given the observed trade matrices
Outline

• General Armington

• Constant Elasticity Armington

• Extensions
  – Trade Imbalance
  – Productivity and trade cost changes
  – Small departures from constant trade elasticity
  – Multiple industries (CDK)
  – Multiple industries and input-output linkages (CP)
  – Economic geography (Helpman model)

• Data

• Empirical Results

• Conclusions
Outline

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

• International trade data
  – United Nations COMTRADE data
  – NBER World Trade Database 1970-2012

• Income, population and distance data
  – CEPII Gravity Database 1970-2012
• General Armington

• Constant Elasticity Armington

• Extensions

• Data

• Empirical Results
  – Quality of the approximation for large shocks
  – Global productivity shocks, income and welfare
  – Economic and political friends and enemies

• Conclusions
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.
- Undertake exact-hat algebra counterfactual for a change in productivity ($\hat{z}_n$).
- Compare the exact-hat algebra counterfactuals for bilateral income responses ($\ln \hat{\psi}_i$) to the predictions of our linearization ($W d \log z$).
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.

• 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 ($W d \log z$).
Monte Carlo Simulation

Approximation Quality: Monte-Carlo Simulations
2000-2010 Productivity Shocks; Elasticity = 5

Regression Coefficient: Exact Solution on Approximation

Coefficient of Correlation

- 1,000 simulations from empirical distribution productivity shocks
- Better approximation for productivity shocks than trade cost shocks
Outline

• General Armington
• Constant Elasticity Armington
• Extensions
• Data
• Empirical Results
  – Quality of the approximation
  – Global productivity shocks, income and welfare
  – Economic and political friends and enemies
• Conclusions
Growing average economic interdependence, consistent with increasing globalization over our sample period.
Growing dispersion in economic interdependence, consistent with increasing globalization over our sample period
Global Network Welfare Exposure 1970
Global Network Welfare Exposure 2000
Global Network Welfare Exposure 2012
Welfare Exposure N. America

- Growing US-Mexico, Mexico-China and Mexico-US exposure
• China replaces Japan at the center of Asian trade
Summary of Other Empirical Results

• Strong *general equilibrium* effects, such that inferring welfare exposure from *partial equilibrium* terms can be misleading

• Both *market-size* and *cross-substitution* effects are substantial relative to overall income exposure

• *Cost-of-living* effect large relative to *income exposure*, such that income exposure can be a poor guide to welfare exposure

• Economically relevant *importer, exporter & third-market* effects

• Strong correlation between aggregate welfare predictions of *single-sector, multi-sector* and *input-output* models

• Multi-sector and input-output models have additional disaggregated predictions for *sector income exposure*
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.
Chinese Productivity Growth and Importer Welfare

- Strong correlation between aggregate predictions of all three models
• Largest income effects in Electrical Sector in South-East Asia and in Extractive Sectors in commodity-intensive emerging economies
Outline

• General Armington
• Constant Elasticity Armington
• Extensions
• Data

• Empirical Results
  – Quality of the approximation
  – Global productivity shocks, income and welfare
  – Economic and political friends and enemies

• Conclusions
Conclusions

- We examine the classic economic question of the impact of foreign economic growth on domestic income and welfare

- Develop new 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 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)

- Empirical application using NBER world trade data from 1970-2012
  - 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
Conclusions

• We examine the classic economic question of the impact of foreign economic growth on domestic income and welfare

• Develop new 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 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)

• Empirical application using NBER world trade data from 1970-2012
  – 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
Conclusions

• We examine the classic economic question of the impact of foreign economic growth on domestic income and welfare

• Develop new 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 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)

• Empirical application using NBER world trade data from 1970-2012
  − 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
Thank You