The Global Welfare Impact of China: Trade Integration and Technological Change

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Motivation

• Trade integration of China
  • 1.3 billion people
  • 12-fold growth in exports since 1990
  • 10% of global imports now come from China
China’s Exports
1990=100

![Graph showing China's exports from 1960 to 2010 compared to the world's exports. The graph displays a significant increase in China's exports after 1990, while the world's exports show a more gradual increase.](image)
Share of China in Global Imports

OECD

East and South Asia

Latin America and Caribbean

East. Europe and Cent. Asia

Middle East and North Africa

Sub-Saharan Africa

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Concerns

- **Among developing countries:** China’s integration might lower welfare due to similar comparative advantage
  Devlin, Estevaeordal and Rodriguez-Clare, eds (2005), Gallagher, Moreno-Brid and Porzecanski (2008)

- **Among advanced countries:** China catching up in its comparative disadvantage sectors might reduce welfare

- Evaluating these concerns is challenging: a rich/tractable model with multilateral trading relations, reliable measures of sectoral comparative advantage across countries
This Paper

- Assess the welfare impact of
  - China’s trade integration to date
  - Balanced and unbalanced productivity growth in China
- Construct a Ricardian-HO model of 75 countries 20 sectors
  - Multiple factors of production; fully fledged input-output linkages; a non-tradeable sector; inter- and intra-sectoral trade
  - Analytical results on the “Samuelson conjecture” when there are more than 2 countries
- Measure comparative advantage following EK
  - Trade data reveal CA after netting out differences in factor costs and trade costs
Quantitative Results

- Welfare gains in two counterfactual growth scenarios:
  - World: balanced (0.01%) $<<$ unbalanced (0.42%)
  - Diametrically opposite to the Samuelson conjecture
- Welfare gains from China's trade integration today
  - China: 3.72%; the world: 0.13%; Asia: 0.23%
  - 9 countries lose (mostly textile and apparel producers): Honduras ($-0.27\%$), El Salvador ($-0.21\%$)
Analytical Results

- In a simplified 2-sector model, vary country 1’s *relative* productivity, keeping its *average* productivity constant.

- Which level of relative productivity minimizes welfare?
  - With only 2 countries, welfare in country 2 is lowest when relative productivity is identical across countries.
  - With more than 2 countries, welfare in country 2 is lowest when relative productivity is identical to the relative average productivity *of all other countries serving country 2*, weighted by unit and trade costs.

- Intuition: China’s pattern of comparative advantage is “common” in the world. Unbalanced growth actually makes China *more* different from the average country.
Preferences

• Countries $n, i = 1, \ldots, N$; sectors $j, k = 1, \ldots, J + 1$; sector $J + 1$ nontradeable

• Consumption of the final good:

$$Y_n = \left( \sum_{j=1}^{J} \omega_j^\frac{1}{\eta} (Y_j^\frac{1}{\eta-1}) \right)^{\frac{\eta}{\eta-1} \xi_n} \left( Y_{J+1} \right)^{1-\xi_n},$$

where $Y_{J+1}^n$ is the nontradable-sector composite good, and $Y_j^n$ is the composite good in tradable sector $j = 1, \ldots, J$.

• Budget constraint/trade balance in country $N$:

$$P_n Y_n = w_n L_n + r_n K_n,$$

where $P_n = B_n \left( \sum_{j=1}^{J} \omega_j (p_n^j)^{1-\eta} \right)^{\frac{1}{1-\eta} \xi_n} (p_n^{J+1})^{1-\xi_n}$
Technology

- Each sector’s output $Q^j_n$ aggregates a continuum of varieties $q \in [0, 1]$ unique to each sector:

$$Q^j_n = \left[ \int_0^1 Q^j_n(q) \frac{\varepsilon-1}{\varepsilon} dq \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

- Producing one unit of good $q$ in sector $j$ in country $n$ requires $\frac{1}{z^j_n(q)}$ input bundles.

  - $z^j_n(q)$ is drawn from the Fréchet distribution with cdf

$$F^j_n(z) = e^{-T^j_n z^{-\theta}},$$

  where $T^j_n$ varies by country and sector

- Costly trade: $d^j_{ni} \geq 1$
Quantitative Model Setup

- Input bundle has a cost:

\[ c_n^j = \left( w_n^{\alpha_j} r_n^{1-\alpha_j} \right)^{\beta_j} \left( \prod_{k=1}^{J+1} \left( p_k^n \right)^{\gamma_{k,j}} \right)^{1-\beta_j} \]

- Production is Cobb-Douglas in \( L \), \( K \), and intermediate inputs coming from sectors \( 1, \ldots, J+1 \)

- Full set of I-O linkages between all sectors, including nontradeable

- Factor and intermediate input intensities differ by sector – HO feature
Prices and Trade Shares

- Multilateral resistance $\Phi_n^j$ summarizes country $n$’s access to production technology in sector $j$

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

- Price $p_n^j$ in sector $j$ and country $n$:

$$p_n^j = \Gamma \left( \Phi_n^j \right)^{-\frac{1}{\theta}}$$

- Share of sector $j$’s varieties originating in country $i$ that country $n$ consumes $\pi_{ni}^j$

$$\pi_{ni}^j = \frac{T_i^j \left( c_i d_{ni}^j \right)^{-\theta}}{\Phi_n^j}$$
Closing the Model

- Goods market clearing:

\[ p_j^i Q_n^i = p_n^j Y_n^j + \sum_{k=1}^{J} (1-\beta_k) \gamma_{j,k} \left( \sum_{i=1}^{N} \pi_{in}^k p_i^k Q_i^k \right) + (1-\beta_{J+1}) \gamma_{j,J+1} p_{n+1}^{J+1} Q_{n+1}^{J+1} \]

- Factor market clearing:

\[ \sum_{j=1}^{J+1} L_n^j = L_n \quad \text{and} \quad \sum_{j=1}^{J+1} K_n^j = K_n \]
Simplified Version

- One factor of production: labor

- Two EK sectors (A and B) and one homogeneous good \( H \)
  - \( H \) is freely traded and produced in all countries
  - Wages are pinned down by productivity of good H (Helpman, Melitz and Yeaple, 2004, Chaney, 2008)

- Utility: \( U_n = A_n^{\frac{\alpha}{2}} B_n^{\frac{\alpha}{2}} H_n^{1-\alpha} \)

- Thought experiment:
  - Vary \( \frac{T_1^A}{T_1^B} \) while keeping \( (T_1^A T_1^B)^{1/2} = c \) to examine the impact of “technological similarity” across countries
Welfare in Simplified Model

- Price in sector \( j \in \{A, B\} \) and country \( n \):

\[
p_n^j = \Gamma \left( \Phi_n^j \right)^{-\frac{1}{\theta}} = \Gamma \left( \sum_{i=1}^{N} T_{ij} \left( w_i d_{ni}^j \right)^{-\theta} \right)^{-\frac{1}{\theta}}
\]

- Aggregate price level:

\[
P_n \propto \left( p_n^A p_n^B \right)^{\frac{1}{2} \alpha} \left( p_n^H \right)^{1-\alpha}
\]

- Welfare (indirect utility):

\[
w_n/P_n = w_n \left( p_n^A p_n^B \right)^{-\frac{1}{2} \alpha} \left( p_n^H \right)^{\alpha-1}
\]
Lemma 1

The relative technology \( \left( \frac{T_A^1}{T_B^1} \right)_n \) of country 1 that minimizes welfare in country \( n \) subject to the constraint that \( \left( T_A^1 T_B^1 \right)^{1/2}_n = c \) is given by:

\[
\left( \frac{T_A^1}{T_B^1} \right)_n = \frac{\sum_{i=2}^{N} T_A^i \left( \frac{w_i d_A^{ni}}{d_A^{n1}} \right)^{-\theta}}{\sum_{i=2}^{N} T_B^i \left( \frac{w_i d_B^{ni}}{d_B^{n1}} \right)^{-\theta}}.
\]
Example: 2 vs. 3 Countries

Suppose trade is costless. Then the country 1 relative technology $T_A^1/T_B^1$ that minimizes welfare in countries 1 and 2 is: With 2 countries:

$$\left( \frac{T_A^1}{T_B^1} \right)_1 = \left( \frac{T_A^1}{T_B^1} \right)_2 = \frac{T_A^2}{T_B^2}.$$ 

With 3 countries:

$$\left( \frac{T_A^1}{T_B^1} \right)_1 = \left( \frac{T_A^1}{T_B^1} \right)_2 = \left( \frac{T_A^1}{T_B^1} \right)_3 = \frac{T_A^2 w_2^{-\theta} + T_A^3 w_3^{-\theta}}{T_B^2 w_2^{-\theta} + T_B^3 w_3^{-\theta}}.$$
Estimation Strategy

- Three types of parameters:
  - Estimated by us from the data: $\alpha_j$, $\beta_j$, $\gamma_{k,j}$, $L_n$, $K_n$, $\xi_n$
  - Estimated by others/commonly used: $\theta$, $\eta$, $\varepsilon$
  - Estimated by us within the model: $T^i_n$, $d^i_{ni}$, $\omega_j$

- 2 major steps of estimation strategy:
  - Tradeable $T^i_n$ relative to U.S.: gravity-based estimation following EK and others
  - $T^i_n$ for the U.S., $T^{i+1}_n$ for $n = 1, ..., N$, $\omega_j$ for $j = 1, ..., J$
Tradeable Sectors

• Eaton-Kortum procedure:

\[ \frac{\pi^j_{ni}}{\pi^j_{nn}} = \frac{T^j_i (c^j_i d^j_{ni})^{-\theta}}{T^j_n (c^j_n)^{-\theta}} \]

in logs:

\[ \ln \left( \frac{\pi^j_{ni}}{\pi^j_{nn}} \right) = \ln \left( T^j_i (c^j_i)^{-\theta} \right) - \ln \left( T^j_n (c^j_n)^{-\theta} \right) - \theta \ln d^j_{ni} \]

• Iceberg costs:

\[ \ln d^j_{ni} = \delta^j_k + b^j_{ni} + CU^j_{ni} + RTA^j_{ni} + ex^j_i + \nu^j_{ni} \]

• \( d^j_{ni} \) will vary by \( j \); generally \( d^j_{ni} \neq d^j_{in} \); fixed effect on the exporter (Waugh 2010)
Estimating Equation

\[ \ln \left( \frac{\pi_{jn}}{\pi_{nn}} \right) = \ln \left( \frac{T_i^j(c_i^j)}{T_n^j(c_n^j)} \right)^{-\theta} - \theta\text{ex}_i^j - \ln \left( \frac{T_n^j(c_n^j)}{T_i^j(c_i^j)} \right)^{-\theta} \]

- Exporter Fixed Effect
- Importer Fixed Effect
- \(-\theta\delta_k^j - \theta b_{ni}^j - \theta CU_{ni}^j - \theta RTA_{ni}^j - \theta\nu_{ni}^j\)
  - Bilateral Observables
  - Error Term

- Importer fixed effect yields technology-cum-unit-cost term relative to a reference country—the US:

\[ s_n^j = \frac{T_n^j}{T_{us}^j} \left( \frac{c_n^j}{c_{us}^j} \right)^{-\theta} \]
Extracting $T^j_n$'s

- Cost of the input bundle relative to the U.S.:
  \[
  \frac{c^j_n}{c^j_us} = \left( \frac{w_n}{w_{us}} \right)^{\alpha_j \beta_j} \left( \frac{r_n}{r_{us}} \right)^{(1-\alpha_j)\beta_j} \left( \prod_{k=1}^{J} \left( \frac{p^k_n}{p^k_{us}} \right)^{\gamma_{k,j}} \right)^{1-\beta_j} \left( \frac{p^{J+1}_n}{p^{J+1}_{us}} \right)^{\gamma_{J+1,j}(1-\beta_j)}
  \]

- Price level in tradable sector $j$ relative to the U.S.:
  \[
  \frac{p^j_n}{p^j_{us}} = \left( \frac{\pi_{nn}^j}{\pi_{us,us}^j} \frac{1}{s^j_n} \right)^{\frac{1}{\theta}}
  \]

- Use data for the rest: $\frac{w_n}{w_{us}}$, $\frac{r_n}{r_{us}}$, $\frac{p^{J+1}_n}{p^{J+1}_{us}}$
Data

- 19 tradable sectors; 75 countries; 2000-2007
- Output, wages, value added, $\alpha_j$, $\beta_j$: UNIDO
- Bilateral, sector-level trade: COMTRADE
- Distance, RTA, currency Union: CEPII, WTO, Rose (2004)
- $\gamma_{k,j}$, $\alpha_{J+1}$, $\beta_{J+1}$, $\omega_j$: U.S. 1997 Detailed Make and Use tables
- $L_n$, $K_n$, per capita income: Penn World Tables
- $p_{n}^{J+1}/p_{us}^{J+1}$, $p_{n}^{J+1}/p_{T}^{J+1}$: ICP Program
- $\xi_n$: Yi and Zhang (2010)
- $\theta = 8.28$ (EK preferred value); $\eta = 2$; $\varepsilon = 4$
<table>
<thead>
<tr>
<th>ISIC code</th>
<th>Sector Name</th>
<th>$\alpha_j$</th>
<th>$\beta_j$</th>
<th>$\gamma_{j+1,j}$</th>
<th>$\omega_j$</th>
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Mean    0.414  0.393  0.399  0.053
Min     0.244  0.243  0.246  0.002
Max     0.561  0.651  0.788  0.209
## Model Fit

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<th>Model</th>
<th>Data</th>
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Model Fit

![Model Fit Diagram](image)

- **China Pairs**: Red circles
- **Non-China Pairs**: Blue circles

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di Giovanni, Levchenko, and Zhang

The Global Welfare Impact of China

05/2012
Welfare Impact of Balanced vs. Unbalanced Growth

![Graph showing the ratio of world frontier to actual and counterfactual growth rates, with markers for actual, unbalanced, and balanced counterfactual scenarios.](image-url)
## Welfare Impact of Balanced vs. Unbalanced Growth

<table>
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<tr>
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<th>Min</th>
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<td>China</td>
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Balanced vs. Unbalanced Growth
Intermediate Step: Fixed \( w \) and \( r \)

- True change in welfare between baseline and counterfactual:

\[
\Delta \left( \frac{w_n(T) + r_n(T)k_n}{P_n(T, w, r)} \right)
\]

- “Intermediate” Change in Welfare: hold \( w, r \) at their baseline values:

\[
\Delta \left( \frac{\overline{w}_n + \overline{r}_n k_n}{P_n(T, \overline{w}, \overline{r})} \right)
\]

- Isolate the multilateral similarity effect operating through the price levels – counterpart to the analytical results with fixed factor prices
Intermediate Step: Fixed $w$ and $r$
China’s Comparative Advantage and the World Average
Unbalanced Gains and Technological Similarity
Robustness


  - $D_n$ is a transfer; taken directly from the data

\[
\sum_{j=1}^{J+1} p^n_j Y^n_j = w_n L_n + r_n K_n - D_n.
\]

- Adding Agriculture and Mining sectors (14% of world trade)
- Directly estimated sectoral productivity for those countries where data are available (STAN: Austria, Belgium, Czech Republic, Denmark, Finland, France, Greece, Italy, Norway, Slovenia, and Sweden)
- Alternative unbalanced counterfactuals: no absolute productivity loss, exactly the same as the US.
Alternative Unbalanced Counterfactuals

The graph shows the ratio to the world frontier for various models and counterfactuals. The x-axis represents different values, while the y-axis shows the ratio to the world frontier. The graph includes markers for:

- **Actual T**: Represents the actual scenario.
- **Counterfactual T, Linear**: Linear counterfactual scenario.
- **Counterfactual T, No Tech. Regress**: Counterfactual without technical regress.
- **Counterfactual T, Same as US**: Counterfactual scenario similar to the US.

The markers are color-coded and labeled with numbers for identification.
China’s entry into world trade has been dramatic. Concerns: for developing countries with respect to trade integration; for developed countries with respect to technological change. This paper: analytical exploration and quantitative assessment of the global welfare impact of China’s integration and sectoral growth.

- Trade integration: global impact $\sim 0.13\%$, $\sim 0.23\%$ in Asia; winners (Malaysia, Kazakhstan, Japan, Australia/NZ) and losers (Textile and Apparel producers).
- Technological change: world is 40 times (!) better off with unbalanced productivity growth in China.