Structural Adjustments and International Trade: 
Theory and Evidence from China

Hanwei Huang¹  Jiandong Ju²  Vivian Yue ³

¹London School of Economics
²Tsinghua University and Shanghai University of Finance and Economics
³Emory University, Atlanta Fed and NBER

April 2016

¹The views expressed herein are those of the authors and should not be interpreted as reflecting the views of the Federal Reserve Bank of Atlanta.
Motivation

- China has experienced fast capital deepening and trade liberalization

- How do manufacturing production and exports adjust to trade liberalization and capital deepening in China?

- Study structural adjustment in production and trade for China in recent years
  - Reallocation across industries
  - Reallocation across firms in an industry
Motivation

- China has experienced fast capital deepening and trade liberalization

- How do manufacturing production and exports adjust to trade liberalization and capital deepening in China?

- Study structural adjustment in production and trade for China in recent years
  - Reallocation across industries
  - Reallocation across firms in an industry
This Paper

- Provide new empirical facts
  Compare production and export in China’s manufactural industries between 1999 and 2007

- Construct a theoretical model
  - Embed heterogeneous firm (Melitz 2003) into continuous Ricardian and Heckscher-Ohlin framework

- Analyze the driving forces behind these structural adjustments
  - Equilibrium properties and numerical comparative statics
  - Structural estimation and counterfactuals to isolate the driving forces of the structural adjustments
  - Welfare analysis and productivity decomposition
This Paper

- Provide new empirical facts
  Compare production and export in China’s manufactural industries between 1999 and 2007

- Construct a theoretical model
  - Embed heterogeneous firm (Melitz 2003) into continuous Ricardian and Heckscher-Ohlin framework

- Analyze the driving forces behind these structural adjustments
  - Equilibrium properties and numerical comparative statics
  - Structural estimation and counterfactuals to isolate the driving forces of the structural adjustments
  - Welfare analysis and productivity decomposition
This Paper

- Provide new empirical facts
  Compare production and export in China’s manufactural industries between 1999 and 2007

- Construct a theoretical model
  - Embed heterogeneous firm (Melitz 2003) into continuous Ricardian and Heckscher-Ohlin framework

- Analyze the driving forces behind these structural adjustments
  - Equilibrium properties and numerical comparative statics
  - Structural estimation and counterfactuals to isolate the driving forces of the structural adjustments
  - Welfare analysis and productivity decomposition
Main Findings

- Chinese manufacturing production shifts toward capital intensive industries.
- Chinese firms in labor intensive industries increase the export participation and export intensity.
- China’s TFP growth is biased toward labor intensive industry.
- Capital deepening, trade liberalization and technology progress account for structural adjustment in China.
- Endogenous firm selection contributes 12 percent of total productivity growth and affects Ricardian comparative advantage.
- China and RoW benefit from China’s structural adjustment.
Main Findings

- Chinese manufacturing production shifts toward capital intensive industries.
- Chinese firms in labor intensive industries increase the export participation and export intensity.
- China’s TFP growth is biased toward labor intensive industry.
- Capital deepening, trade liberalization and technology progress account for structural adjustment in China.
- Endogenous firm selection contributes 12 percent of total productivity growth and affects Ricardian comparative advantage.
- China and RoW benefit from China’s structural adjustment.
Main Findings

- Chinese manufacturing production shifts toward capital intensive industries.
- Chinese firms in labor intensive industries increase the export participation and export intensity.
- China’s TFP growth is biased toward labor intensive industry.
- Capital deepening, trade liberalization and technology progress account for structural adjustment in China.
- Endogenous firm selection contributes 12 percent of total productivity growth and affects Ricardian comparative advantage.
- China and RoW benefit from China’s structural adjustment.
Main Findings

- Chinese manufacturing production shifts toward capital intensive industries.
- Chinese firms in labor intensive industries increase the export participation and export intensity.
- China’s TFP growth is biased toward labor intensive industry.
- Capital deepening, trade liberalization and technology progress account for structural adjustment in China.
- Endogenous firm selection contributes 12 percent of total productivity growth and affects Ricardian comparative advantage.
- China and RoW benefit from China’s structural adjustment.
Data and Motivating Evidence

- Chinese Annual Industrial Survey
  - Manufacturing firms in year 1999 and 2007

- Changes in production and export participation
  Capital intensity \((1 - \frac{\text{labor cost}}{\text{value added}}) \in [0, 1]\)

<table>
<thead>
<tr>
<th>Variables</th>
<th>mean in 1999</th>
<th>mean in 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>capital income share</td>
<td>0.669</td>
<td>0.707</td>
</tr>
<tr>
<td>proportion of exporters</td>
<td>0.252</td>
<td>0.248</td>
</tr>
<tr>
<td>exports/gross sales</td>
<td>0.181</td>
<td>0.207</td>
</tr>
<tr>
<td>capital income share for exporters</td>
<td>0.624</td>
<td>0.619</td>
</tr>
</tbody>
</table>
Industry and Capital Intensity

Capital Intensity by Industries according to China Industry Code

<table>
<thead>
<tr>
<th>industry code</th>
<th>description</th>
<th>mean</th>
<th>std</th>
<th>non-exporters</th>
<th>exporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Manufacture of Apparel, Footwear &amp; Caps</td>
<td>0.51</td>
<td>0.24</td>
<td>0.60</td>
<td>0.24</td>
</tr>
<tr>
<td>25</td>
<td>Processing of Petroleum, Coking, &amp; Fuel</td>
<td>0.78</td>
<td>0.20</td>
<td>0.85</td>
<td>0.16</td>
</tr>
<tr>
<td>37</td>
<td>Manufacture of Transport Equipment</td>
<td>0.65</td>
<td>0.21</td>
<td>0.70</td>
<td>0.21</td>
</tr>
<tr>
<td>39</td>
<td>Electrical Machinery &amp; Equipment</td>
<td>0.61</td>
<td>0.23</td>
<td>0.73</td>
<td>0.21</td>
</tr>
<tr>
<td>40</td>
<td>Computers &amp; Other Electronic Equipment</td>
<td>0.58</td>
<td>0.25</td>
<td>0.65</td>
<td>0.23</td>
</tr>
</tbody>
</table>

"Heckscher-Ohlin Aggregates" (Schott (2003), Ju, Lin and Wang (2015))

Regroup Firms into 100 bins according to their capital intensity
Industry and Capital Intensity

Capital Intensity by Industries according to China Industry Code

<table>
<thead>
<tr>
<th>industry code</th>
<th>description</th>
<th>mean</th>
<th>std</th>
<th>non-exporters</th>
<th>exporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Manufacture of Apparel, Footwear &amp; Caps</td>
<td>0.51</td>
<td>0.24</td>
<td>0.60</td>
<td>0.24</td>
</tr>
<tr>
<td>25</td>
<td>Processing of Petroleum, Coking, &amp; Fuel</td>
<td>0.78</td>
<td>0.20</td>
<td>0.85</td>
<td>0.16</td>
</tr>
<tr>
<td>37</td>
<td>Manufacture of Transport Equipment</td>
<td>0.65</td>
<td>0.21</td>
<td>0.70</td>
<td>0.21</td>
</tr>
<tr>
<td>39</td>
<td>Electrical Machinery &amp; Equipment</td>
<td>0.61</td>
<td>0.23</td>
<td>0.73</td>
<td>0.21</td>
</tr>
<tr>
<td>40</td>
<td>Computers &amp; Other Electronic Equipment</td>
<td>0.58</td>
<td>0.25</td>
<td>0.65</td>
<td>0.23</td>
</tr>
</tbody>
</table>

- "Heckscher-Ohlin Aggregates" (Schott (2003), Ju, Lin and Wang (2015))
- Regroup Firms into 100 bins according to their capital intensity
Motivating Evidence: Production Pattern

Distribution of Firms across Industries

- Share of industry firm number in total firm number
- Industry
- 1999 and 2007

![Graph of distribution of firms across industries with data for 1999 and 2007]
Motivating Evidence: Production Pattern

Distribution of Value Added across Industries

share of industry value added in total value added

Industry

0 20 40 60 80 100

1999 2007
Motivating Evidence: Trade Pattern

Exporter Share by Industry

Industry

1999 2007
Motivating Evidence: Trade Pattern

Export Intensity by Industry

Industry

1999 2007
Motivating Evidence: Productivity Growth

Average TFP by Industry

value in log, weighted average of firm TFP estimated by LP

- TFP calculated using Levinsohn and Petrin (2003) method
- TFP growth drives China’s growth Zhu (2012)
Motivating Evidence: Productivity Growth

Average TFP by Industry

value in log, weighted average of firm TFP estimated by LP

- TFP calculated using Levinsohn and Petrin (2003) method
- TFP growth drives China’s growth Zhu (2012)
Empirical Findings

- Chinese manufacturing production shifts toward capital intensive industries.
- Chinese firms in labor intensive industries increase the export participation and export intensity.
- China’s TFP growth is biased toward labor-intensive industry.
Model Overview

- DFS Heckscher-Ohlin and Ricardian
  - 2 countries, 2 factors, continuum of industries, continuum of firms
  - Country H is more labor-abundant than Country F
  - Industries differ in factor intensity

- Melitz
  - Sunk cost of entry (uses both factors)
  - After entry, firms observe their productivity, $\phi$, drawn from $G(\phi)$
  - Constant (exogenous) probability of firm death
  - Fixed costs of production and export (common skill intensity)
  - Decide whether to produce (export) or to exit the industry
Model Overview

- DFS Heckscher-Ohlin and Ricardian
  - 2 countries, 2 factors, continuum of industries, continuum of firms
  - Country H is more labor-abundant than Country F
  - Industries differ in factor intensity

- Melitz
  - Sunk cost of entry (uses both factors)
  - After entry, firms observe their productivity, $\phi$, drawn from $G(\phi)$
  - Constant (exogenous) probability of firm death
  - Fixed costs of production and export (common skill intensity)
  - Decide whether to produce (export) or to exit the industry
The Model:

- Factor endowment: \( \frac{L}{K} > \frac{L^*}{K^*} \)
- Consumption

\[
U = \int_0^1 b(z) \ln Q(z) \, dz, \quad \int_0^1 b(z) \, dz = 1
\]

\[
Q(z) = \left( \int_{\omega \in \Omega_z} q_z(\omega)^p \, d\omega + \int_{\omega \in \Omega_z^*} q_z(\omega)^p \, d\omega \right)^{1/p}
\]

- Production (cost) for industry \( z \) with idiosyncratic shock \( \varphi \)

\[
\Gamma(z, \varphi) = \left( f_z + \frac{q(z, \varphi)}{A(z)\varphi} \right) r^z w^{1-z}
\]

- \( A(z) \) is industry specific productivity, where \( \frac{A(z)}{A^*(z)} = \lambda A^z \),
The Model:

- **Factor endowment:** \( \frac{L}{K} > \frac{L^*}{K^*} \)
- **Consumption**

\[
U = \frac{1}{0} \int b(z) \ln Q(z) dz, \quad \frac{1}{0} \int b(z) dz = 1
\]

\[
Q(z) = \left( \int_{\omega \in \Omega_z} q_z(\omega)^p d\omega + \int_{\omega \in \Omega_z^*} q_z(\omega)^p d\omega \right)^{1/p}
\]

- **Production (cost) for industry** \( z \) **with idiosyncratic shock** \( \varphi \)

\[
\Gamma(z, \varphi) = \left( f_z + \frac{q(z, \varphi)}{A(z)\varphi} \right) r^z w^{1-z}
\]

- \( A(z) \) **is industry specific productivity**, where \( \frac{A(z)}{A^*(z)} = \lambda A^z \),
The Model:

- Factor endowment: \( \frac{L}{K} > \frac{L^*}{K^*} \)
- Consumption

\[
U = \frac{1}{0} \int b(z) \ln Q(z) \, dz, \quad \frac{1}{0} \int b(z) \, dz = 1
\]

\[
Q(z) = \left( \int_{\omega \in \Omega_z} q_z(\omega)^\rho \, d\omega + \int_{\omega \in \Omega_z^*} q_z(\omega)^\rho \, d\omega \right)^{1/\rho}
\]

- Production (cost) for industry \( z \) with idiosyncratic shock \( \varphi \)

\[
\Gamma(z, \varphi) = \left( f_z + \frac{q(z, \varphi)}{A(z)\varphi} \right) r^z w^{1-z}
\]

- \( A(z) \) is industry specific productivity, where \( \frac{A(z)}{A^*(z)} = \lambda A^z \),
The Model:

- The decision of firms:

  \[
  \begin{array}{c|c|c}
  \text{Exit} & \text{Home market only} & \text{Export} \\
  \overline{\varphi}_z & \overline{\varphi}_{zx} & \varphi
  \end{array}
  \]

- The conditional probability of export is:

  \[
  \chi_z \equiv \frac{1 - G(\overline{\varphi}_{zx})}{1 - G(\overline{\varphi}_z)}
  \]
Production and International Trade Patterns

- There exist two factor intensity cut-offs $0 \leq z < \bar{z} \leq 1$ s.t. country H specializes in the industries within $[0, z]$ and country F specializes in the industries within $[z, 1]$.

- If $\tau = 1$ and $f_{zx} = f_z, \forall z$, then $z = \bar{z}$: complete specialization.

- Generalization of Bernard, Redding and Schott (2007).
Production and International Trade Patterns

- There exist two factor intensity cut-offs $0 \leq z < \bar{z} \leq 1$ s.t. country H specializes in the industries within $[0, z]$ and country F specializes in the industries within $[z, 1]$. 

- If $\tau = 1$ and $f_{zx} = f_z, \forall z$, then $z = \bar{z}$: complete specialization.

- Generalization of Bernard, Redding and Schott (2007).
Productivity Cut-offs across Industries in Home and Foreign Countries

(a): labor abundant home

(b): capital abundant foreign
Export Probability and Export Intensity

- Assume Pareto distribution for firm specific productivity
  \[ g(\varphi) = a\theta^a\varphi^{-(a+1)}, \ a + 1 > \sigma \]

- The conditional probability of export is:
  \[
  \chi_z = \begin{cases} 
  \frac{R^*}{fR} & z \in [0, z] \\
  \frac{\tilde{\tau}^{-a} f - \varepsilon(z)^a h(z)}{\varepsilon(z)^a f h(z) - \tilde{\tau}^a} & z \in (z, \bar{z})
  \end{cases}
  \]

- How does export probability vary across industries?
  \[
  \frac{\partial \chi_z}{\partial z} = \frac{a(1 - \tilde{\tau}^{-2} f^2) \varepsilon(z)^a h(z)}{(\varepsilon(z)^a f h(z) - \tilde{\tau}^a)^2} \left[ \ln(A) - \frac{\sigma}{\sigma - 1} \ln\left(\frac{r/w}{r^*/w^*}\right) \right] \]
  \[ \text{Ricardian CA} \quad \text{HO CA} \]
Export Probability and Export Intensity

- Assume Pareto distribution for firm specific productivity
  \[ g(\varphi) = a\theta^a \varphi^{-(a+1)}, a + 1 > \sigma \]

- The conditional probability of export is:
  \[ \chi_z = \begin{cases} \frac{R^*}{fR} & z \in [0, z] \\ \frac{\tilde{\tau}^{-a}f - \varepsilon(z)^a h(z)}{\varepsilon(z)^a fh(z) - \tilde{\tau}^a} & z \in (z, \bar{z}) \end{cases} \]

- How does export probability vary across industries?
  \[ \frac{\partial \chi_z}{\partial z} = \frac{a(1 - \tilde{\tau}^{-2}f^2)\varepsilon(z)^a h(z)}{(\varepsilon(z)^a fh(z) - \tilde{\tau}^a)^2} \left[ \ln(A) - \frac{\sigma}{\sigma - 1} \ln\left(\frac{r/w}{r^*/w^*}\right) \right] \]

\[ \text{Ricardian CA} \quad \text{HO CA} \]
Export Probability and Export Intensity

- Export intensity $\gamma_z = \frac{f\chi_z}{1 + f\chi_z}$
- Export probability and export intensity in H and F

- Labor intensive sectors in labor abundant country
  - High exporter participation. Exporter export large fraction of output
Structural Estimation for Quantitative Analysis

- parameters taken as given

<table>
<thead>
<tr>
<th>parameters</th>
<th>value</th>
<th>source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma$</td>
<td>3.43</td>
<td>Broda &amp; Weinstein (2006)</td>
</tr>
<tr>
<td>$a$</td>
<td>2.76</td>
<td>Defever &amp; Riaño (2014)</td>
</tr>
<tr>
<td>$L^*/L$</td>
<td>$\text{year}_{1999}: 2.49$</td>
<td>World Bank</td>
</tr>
<tr>
<td></td>
<td>$\text{year}_{2007}: 2.22$</td>
<td></td>
</tr>
<tr>
<td>$f$</td>
<td>$\text{year}_{1999}: 1.00$</td>
<td>Industry average. Own calculation</td>
</tr>
<tr>
<td></td>
<td>$\text{year}_{2007}: 1.77$</td>
<td></td>
</tr>
<tr>
<td>$b(z)$</td>
<td>Linear interpolated from industry expenditure data. Own calculation</td>
<td></td>
</tr>
</tbody>
</table>

- Estimate $f$ as the average of $\frac{\gamma_z}{\chi_z(1-\gamma_z)}$ across all sectors.

- Expenditure function $b(z)$: infer import for each industry (industry 1 to 100) by matching the firm data with the custom data for year 2000-2006.
Structural Estimation for Quantitative Analysis

- GMM estimation to fit the distribution of output and export across industries in 1999 and 2007 respectively.
- Data: Target Moments (used in the estimation)

<table>
<thead>
<tr>
<th>year</th>
<th>1999</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing output of RoW vs China: $R^*/R$</td>
<td>16.74</td>
<td>7.47</td>
</tr>
<tr>
<td>Mean exporter share: $z \in [0, 0.5]$</td>
<td>0.313</td>
<td>0.421</td>
</tr>
<tr>
<td>Mean exporter share: $z \in [0.5, 1]$</td>
<td>0.241</td>
<td>0.234</td>
</tr>
<tr>
<td>capital intensity weighted by firm mass</td>
<td>0.668</td>
<td>0.708</td>
</tr>
<tr>
<td>capital intensity weighted by export firm mass</td>
<td>0.625</td>
<td>0.621</td>
</tr>
</tbody>
</table>

Notes: $R^*/R$ is calculated using the ratio of manufacturing output for RoW and China (World Bank)
Model Estimation Results

- Estimation results
- Estimate \( \{ \frac{K^*}{K}, K/L, A, \lambda, \tau \} \) to match the target moments

<table>
<thead>
<tr>
<th></th>
<th>( \frac{K^*}{K} )</th>
<th>K/L</th>
<th>A</th>
<th>( \lambda )</th>
<th>( \tau )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>3.45</td>
<td>0.93</td>
<td>1.25</td>
<td>0.132</td>
<td>2.95</td>
</tr>
<tr>
<td>2007</td>
<td>2.90</td>
<td>2.03</td>
<td>0.847</td>
<td>0.378</td>
<td>2.09</td>
</tr>
</tbody>
</table>

- We find that the TFP growth of China relative to RoW is labor-bias: the more labour intensive sectors growth enjoys a faster productivity growth relative to RoW.
Model Fit

Target Moments: data v.s. model

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^*/R$</td>
<td>16.74</td>
<td>7.47</td>
<td>16.74</td>
<td>7.47</td>
</tr>
<tr>
<td>Exporter share: $z \leq 0.5$</td>
<td>0.31</td>
<td>0.42</td>
<td>0.31</td>
<td>0.42</td>
</tr>
<tr>
<td>Exporter share: $z \geq 0.5$</td>
<td>0.239</td>
<td>0.233</td>
<td>0.236</td>
<td>0.228</td>
</tr>
<tr>
<td>Capital intensity for all firms</td>
<td>0.67</td>
<td>0.71</td>
<td>0.66</td>
<td>0.69</td>
</tr>
<tr>
<td>Capital intensity for exporters</td>
<td>0.62</td>
<td>0.62</td>
<td>0.63</td>
<td>0.63</td>
</tr>
</tbody>
</table>
Model Fit

- Non-targeted moments: data v.s. model

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>aggregate exporter share</td>
<td>0.252</td>
<td>0.248</td>
<td>0.240</td>
<td>0.230</td>
</tr>
<tr>
<td>aggregate export intensity</td>
<td>0.181</td>
<td>0.208</td>
<td>0.188</td>
<td>0.284</td>
</tr>
<tr>
<td>capital income share</td>
<td>0.761</td>
<td>0.830</td>
<td>0.790</td>
<td>0.768</td>
</tr>
<tr>
<td>wage RoW vs China: w*/w</td>
<td>6.43</td>
<td>2.90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Wedges to explain capital income share Karabarbounis and Neiman (2014), Chang et al (2015)

- According to ILO, the world wage grew by 60.6% and the wage in China grew by 168% during 1999-2007.
Model Fit

- **Non-targeted moments: data v.s. model**

<table>
<thead>
<tr>
<th>Year</th>
<th>Data 1999</th>
<th>Data 2007</th>
<th>Model 1999</th>
<th>Model 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate exporter share</td>
<td>0.252</td>
<td>0.248</td>
<td>0.240</td>
<td>0.230</td>
</tr>
<tr>
<td>Aggregate export intensity</td>
<td>0.181</td>
<td>0.208</td>
<td>0.188</td>
<td>0.284</td>
</tr>
<tr>
<td>Capital income share</td>
<td>0.761</td>
<td>0.830</td>
<td>0.790</td>
<td>0.768</td>
</tr>
<tr>
<td>Wage RoW vs China: w*/w</td>
<td>6.43</td>
<td>2.90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Wedges to explain capital income share**: Karabarbounis and Neiman (2014), Chang *et al* (2015)

- According to ILO, the world wage grew by 60.6% and the wage in China grew by 168% during 1999-2007.
Model Fit

- Non-targeted moments: data v.s. model

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>aggregate exporter share</td>
<td>0.252</td>
<td>0.248</td>
<td>0.240</td>
<td>0.230</td>
</tr>
<tr>
<td>aggregate export intensity</td>
<td>0.181</td>
<td>0.208</td>
<td>0.188</td>
<td>0.284</td>
</tr>
<tr>
<td>capital income share</td>
<td>0.761</td>
<td>0.830</td>
<td>0.790</td>
<td>0.768</td>
</tr>
<tr>
<td>wage RoW vs China: w*/w</td>
<td>6.43</td>
<td></td>
<td></td>
<td>2.90</td>
</tr>
</tbody>
</table>

- Wedges to explain capital income share Karabarbounis and Neiman (2014), Chang et al (2015)

- According to ILO, the world wage grew by 60.6% and the wage in China grew by 168% during 1999-2007.
Model Fit

Export Participation by Industries

- Model 1999
- Data 1999
- Model 2007
- Data 2007
Distributoin of Firm across Industries

- Model 1999
- Data 1999
- Model 2007
- Data 2007
Decompose Ricardian Comparative advantage

- First decomposition of Ricardian comparative advantage into exogenous and endogenous components (Bernard, Redding and Schott (2007)).

- Average TFP for each sector is
  \[
  \hat{A}(z) = E_\phi \{ A(z) \phi | \phi > \phi_z \} = A(z) \hat{\phi}_z
  \]

Thus the measured Ricardian Comparative advantage is

\[
\frac{\hat{A}(z)}{A^*(z)} = \frac{A(z)}{A^*(z)} \frac{\hat{\phi}_z}{\hat{\phi}^*_z}
\]

- Given our functional assumptions, we can prove that

\[
\frac{\hat{A}(z)}{A^*(z)} = \lambda A^z \left( \frac{1 + f \chi_z}{1 + f \chi^*_z} \right)^{1/a}
\]

\[
\text{exo.} \left( \frac{1 + f \chi_z}{1 + f \chi^*_z} \right)^{1/a} \text{ endo.}
\]
Decompose Ricardian Comparative advantage

(a)

Ricardian Decomposition 1999

(b)

Ricardian Decomposition 2007

Industry  
Total Ricardian CA  Exogeneous Ricardian CA

Industry  
Total Ricardian CA  Exogeneous Ricardian CA
Decompose Ricardian Comparative advantage

Total Ricardian comparative advantage are amplified by the endogenous firm selection mechanism.
Endogenous Selection Implied Productivity

Total Productivity Growth and Productivity Growth due to Firm Selection

- Firm selection contributes about 11.7% of the total productivity growth.
Endogenous Selection Implied Productivity

Total Productivity Growth and Productivity Growth due to Firm Selection

- Firm selection contributes about 11.7% of the total productivity growth.
Counterfactual Experiments and Welfare Analysis

- Counterfactual experiments to change one channel of structural adjustment
  - Technology
  - Trade cost
  - Endowment
- Welfare analysis
<table>
<thead>
<tr>
<th>year</th>
<th>model 1999</th>
<th>$A$ and $\lambda$ 2007</th>
<th>$f$ and $\tau$ 2007</th>
<th>endm’t 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^*/R$</td>
<td>16.74</td>
<td>9.17</td>
<td>16.09</td>
<td>13.98</td>
</tr>
<tr>
<td>exporter share: $z \leq 0.5$</td>
<td>0.314</td>
<td>0.402</td>
<td>0.440</td>
<td>0.261</td>
</tr>
<tr>
<td>exporter share: $z \geq 0.5$</td>
<td>0.236</td>
<td>0.177</td>
<td>0.350</td>
<td>0.212</td>
</tr>
<tr>
<td>capital intensity for all firms</td>
<td>0.659</td>
<td>0.658</td>
<td>0.655</td>
<td>0.694</td>
</tr>
<tr>
<td>capital intensity for exporters</td>
<td>0.631</td>
<td>0.567</td>
<td>0.633</td>
<td>0.678</td>
</tr>
<tr>
<td>aggregate exporter share</td>
<td>0.240</td>
<td>0.193</td>
<td>0.355</td>
<td>0.211</td>
</tr>
<tr>
<td>aggregate export intensity</td>
<td>0.189</td>
<td>0.147</td>
<td>0.379</td>
<td>0.173</td>
</tr>
</tbody>
</table>
Structural Adjustment under Counterfactuals

Counterfactual on Exporter Share

- Model 1999
- Countefactual: technology
- Countefactual: trade cost
- Countefactual: endowment
- Model 2007
Structural Adjustment under Counterfactuals

Endowment Driven Ricardian CA

- Total Implied Ricardian CA 1999
- Counterfactual Ricardian CA: 2007 endowments
Welfare Analysis

- Compute welfare for China and RoW using the estimated $A(z)$ and $A(z)^*$
- Welfare depends on Ricardian comparative advantage, H-O comparative advantage, Krugman love of varieties, and Melitz endogenous productivity.
- Estimate the welfare change overtime in baseline model

$$\frac{\exp(U_{2007})}{\exp(U_{1999})} = 4.78$$

$$\frac{\exp(U^*_{2007})}{\exp(U^*_{1999})} = 1.98$$

- Implied real consumption grows at 19.3% for China and 1.13% for RoW.
- In the data real GDP per capita grows at 12.5% for China and 4.9% for RoW.
- Costinot et. al (2015) and Levchenko and Zhang (2016) study the welfare implication of evolving comparative advantages.
Welfare Analysis

- Compute welfare for China and RoW using the estimated $A(z)$ and $A(z)^*$
- Welfare depends on Ricardian comparative advantage, H-O comparative advantage, Krugman love of varieties, and Melitz endogenous productivity.
- Estimate the welfare change overtime in baseline model

$$\frac{\exp(U_{2007})}{\exp(U_{1999})} = 4.78$$
$$\frac{\exp(U^*_{2007})}{\exp(U^*_{1999})} = 1.98$$

- Implied real consumption grows at 19.3% for China and 1.13% for RoW.
- In the data real GDP per capita grows at 12.5% for China and 4.9% for RoW.
- Costinot et. al (2015) and Levchenko and Zhang (2016) study the welfare implication of evolving comparative advantages.
Welfare Analysis

- Compute welfare for China and RoW using the estimated $A(z)$ and $A(z)^*$
- Welfare depends on Ricardian comparative advantage, H-O comparative advantage, Krugman love of varieties, and Melitz endogenous productivity.
- Estimate the welfare change overtime in baseline model

\[
\frac{\exp(U_{2007})}{\exp(U_{1999})} = 4.78
\]
\[
\frac{\exp(U^*_{2007})}{\exp(U^*_{1999})} = 1.98
\]

- Implied real consumption grows at 19.3% for China and 1.13% for RoW.
- In the data real GDP per capita grows at 12.5% for China and 4.9% for RoW.
- Costinot et. al (2015) and Levchenko and Zhang (2016) study the welfare implication of evolving comparative advantages.
Calculate the welfare changes from the baseline case for 1999 and the counterfactuals. Compute \( \frac{\exp(U^{CF}_{1999})}{\exp(U_{1999})} \) for China and RoW.

<table>
<thead>
<tr>
<th></th>
<th>A and ( \lambda )</th>
<th>( f ) and ( \tau )</th>
<th>endm’t</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>2.29</td>
<td>1.026</td>
<td>2.386</td>
</tr>
<tr>
<td>RoW</td>
<td>1.119</td>
<td>1.008</td>
<td>2.156</td>
</tr>
</tbody>
</table>
Conclusion

- Document puzzling structural adjustments of Chinese production and export

- Provide a unifying framework of international trade that generate a rich set of predictions

- No single driving force behind the observed adjustments

- Endogenous firm selection contributes 12 percent of total productivity growth and affects Ricardian comparative advantage.

- China and RoW benefit from China’s structural adjustment.