China’s Imbalances: Trade Integration in a DSGE Model

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Introduction

- China’s growth & integration definitive economic event of last twenty-five years

- Uneven process - characterized by swings in real exchange rate, trade balance, and accumulation of substantial foreign assets and trade integration.
  - Additionally, pace of trade integration has slowed.
Introduction

- China’s growth & integration definitive economic event of last twenty-five years

- Uneven process - characterized by swings in real exchange rate, trade balance, and accumulation of substantial foreign assets and trade integration.
  - Additionally, pace of trade integration has slowed.

- Build unified model to account for borrowing/lending, trade integration, and growth.
  - Emphasize the role of changes in various trade barriers in the accumulation of assets.
Preview of Main Findings

- Persistent trade cost "shocks" key to China’s foreign assets
  - Symmetric $\Delta$ in trade barriers lead to lending
  - Asymmetric $\Delta$ in trade barriers lead to lending

- Trade integration (% of GDP): fall common barriers (49%), Chinese export barriers (19%), and China growth (18%)

- Trade slowdown primarily reflects lack of additional integration shocks rather than reversals
  - Current expectations about future trade cost path similar to when China joined WTO.
Outline

- Model
- Estimation
- Results - decomposition of
  - Net Foreign Assets
  - Trade Integration
  - Trade Slowdown
Model

- Two countries, final NT consumption good, non-contingent bond

- Heterogeneous producers with dynamic exporting decision (sunk cost)
  - SR/LR trade adjustment (Alessandria/Choi 07, 15)

- Pricing-to-market: exporter’s demand elasticity depends on RER and relative income.

- Aggregate shocks: productivity, trade costs, and discount factor (China-specific & global)
Consumers

\[
\max E_0 \sum_{t=0}^{\infty} \Theta_t \frac{[C^\gamma (1 - L)^{1-\gamma}]^{1-\sigma}}{1 - \sigma},
\]

subject to

\[
P_t C_t + P_t Q_t B_t = W_t P_t L_t + P_t B_{t-1} + \Pi_t,
\]

\[
\ln \left( \frac{\Theta_{t+1}}{\Theta_t} \right) = \ln \beta_t = (1 - \rho_b) \ln \bar{\beta} + \rho_b \ln \beta_{t-1} + \varepsilon_\beta,
\]

Discount factor shocks capture "savings glut" story
Aggregators and Prices

Final good produced by competitive retail sector/ aggregator

\[ C_t = \left( Y_H^\frac{\theta-1}{\theta} + a^\frac{1}{\theta} Y_F^\frac{\theta-1}{\theta} \right)^\frac{\theta}{\theta-1} , \]

\[ Y_{Ht} = \left( \int_0^1 Y_{hit}^\frac{\theta-1}{\theta} di \right)^\frac{\theta}{\theta-1} , \]

\[ Y_{Ft} = \left( \int_{i \in \mathcal{E}_t^*} Y_{fit}^\frac{\theta_t-1}{\theta_t} di \right)^\frac{\theta_t}{\theta_t-1} . \]

\[ \theta_t = \theta \left( q, \frac{y}{y^*} \right) \text{ captures pricing-to-market} \]
Producers - standard sunk cost model (Dixit, 89)

\[ V_t(\eta, m) = \max_{m', p, p^*} pc_t(p) + m' p^* c_t(\bar{\zeta}^* p^*) - W_l \]

\[ -m' W_{f_{m,t}} + Q_t EV_{t+1}(\eta', m') \]

- \( m_{it} \): exporting status
- \( y_{it} = e^{z_t + \eta_{it} l_{it}}, \ \eta_{it} \sim iid \ N(0, \sigma_{\eta}^2) \)
- \( \bar{\zeta}^* > 1 \): variable trade costs for home exporters
- \( W_{t f_{0,t}} \): sunk cost to start
- \( W_{t f_{1,t}} \): sunk cost to continue.
Export Entry and Exit Thresholds

\[ W_{t} f_{0,t} - \pi_{t}^{*}(\eta_{0t}) = Q_{t} E_{t} \Delta V_{t+1}(\eta') \]

\[ W_{t} f_{1,t} - \pi_{t}^{*}(\eta_{1t}) = Q_{t} E_{t} \Delta V_{t+1}(\eta') \]

\[ \Delta V_{t}(\eta) = V_{t}(\eta, 1) - V_{t}(\eta, 0) \]

- Endogenous entry/exit & hysteresis \((\eta_{1t} < \eta_{0t} \text{ when } f_{1} < f_{0})\)
- Distribution of exporters is state variable & gradual entry
- With iid shocks,

\[ N_{t+1} = \Pr(\eta \geq \eta_{1t}) N_{t} + \Pr(\eta \geq \eta_{0t}) (1 - N_{t}) \]
Aggregate Shocks - Productivity

\[
\ln z_t^* = \rho_z^* \ln z_{t-1}^* + \varepsilon_{zt}, \quad \varepsilon_{zt} \sim iid \ N(0, \sigma_{z}^*)
\]

\[
\ln z_{dt} = \rho_d^z \ln z_{dt-1} + \varepsilon_{dzt}, \quad \varepsilon_{dzt} \sim iid \ N(0, \sigma_{d}^z)
\]

\[
\ln z_t = \ln z_t^* + \ln z_{d,t} - \bar{z}
\]

- \(z_t^*\): Global productivity
- \(z_{d,t}\): China-specific productivity
- \(\bar{z}\): China’s productivity disadvantage.
Aggregate Shocks - Variable Trade Costs

\[
\ln \zeta_t = \ln \zeta_{ct} + \frac{1}{2} \ln \zeta_{dt},
\]

\[
\ln \zeta^* = \ln \zeta_{ct} - \frac{1}{2} \ln \zeta_{dt}.
\]

\[
\ln \zeta_{ct} = \left(1 - \rho_{\zeta_c}\right) \ln \bar{\zeta}_c + \rho_{\zeta_c} \ln \zeta_{ct-1} + \ln \zeta_{gt-1} + \varepsilon_{\zeta_c t},
\]

\[
\ln \zeta_{gt} = \rho_{\zeta_g} \ln \zeta_{gt-1} + \varepsilon_{\zeta_g t},
\]

\[
\ln \zeta_{dt} = \left(1 - \rho_{\zeta_d}\right) \ln \bar{\zeta}_d + \rho_{\zeta_d} \ln \zeta_{dt-1} + \varepsilon_{\zeta_d t}.
\]

- \( \zeta_{ct} \): common shock
- Transitory and trend shocks. Trend shocks have news aspect
- \( \zeta_{dt} \): differential shocks
Aggregate Shocks - Fixed Trade Costs

\[
\ln f_{0t} = (1 - \rho_{f0}) \ln f_0 + \rho_{f0} \ln f_{0t-1} + \varepsilon_{f0,t},
\]

\[
\ln f_{1t} = (1 - \rho_{f1}) \ln f_1 + \rho_{f1} \ln f_{1t-1} + \varepsilon_{f1,t}.
\]
## Calibration/Estimation

### Fixed Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.96</td>
</tr>
<tr>
<td>$\zeta_b$</td>
<td>0.0001</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.30</td>
</tr>
<tr>
<td>$a_1$</td>
<td>0.16</td>
</tr>
<tr>
<td>$\theta$</td>
<td>5</td>
</tr>
</tbody>
</table>

### Estimate

- Shock process: $z_c, z_d, \bar{\zeta}_c, \bar{\zeta}_g, \bar{\zeta}_d, f_0, f_1, b$
- Level of trade costs $(\bar{\zeta}_c, \bar{\zeta}_d, f_0, f_1)$ and technology $(\bar{z}, \sigma_\eta)$
- Preferences $(\sigma, \rho, \zeta_q, \zeta_y)$
Estimation - Data

1. Ratio of China-ROW real income
2. Nominal export/import ratio
3. Real trade share in China
4. Real exchange rate
5. Real world output - detrended
6. Chinese exporters participation
Figure: Historical and Smoothed Series

- $Y_{china}/Y_{row}$ (%)
- China Export-Import Ratio (Nominal)
- Real Trade share China - (X+M)/Y
- Real Exchange Rate (log)
- World Output
- Chinese Exporters (%)
Figure: Deviations from Steady State of State Variables

- **Z (China)**: The graph shows the deviation of a variable named Z from its steady state for China. The y-axis ranges from -1 to 1, and the x-axis represents the years from 1990 to 2010.

- **Z (ROW)**: The graph represents the deviation of variable Z for the Rest of the World (ROW). The y-axis ranges from -0.1 to 0.2, and the x-axis represents the years from 1990 to 2010.

- **Beta (China)**: This graph plots the beta variable for China, with the y-axis ranging from 0.01 to 0.02, and the x-axis representing the years from 1990 to 2010.

- **Iceberg**: The graph of the iceberg variable, showing deviations with negative values ranging from -4 to -2. The x-axis represents the years from 1990 to 2010, and there are two lines indicating 'To China' and 'From China'.

- **Entry**: This represents the entry variable, with the y-axis ranging from 0.04 to 0.02, and the x-axis representing the years from 1990 to 2010.

- **Continuation**: The graph for continuation shows the deviations, with the y-axis ranging from -0.02 to 0, and the x-axis representing the years from 1990 to 2010.
### Estimated Persistence of Shocks

<table>
<thead>
<tr>
<th></th>
<th>prior mean</th>
<th>posterior mean</th>
<th>posterior mode</th>
<th>90% HPD - interval</th>
<th>prior std.dev.</th>
<th>prior</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho_{zd}$</td>
<td>0.95</td>
<td>0.996</td>
<td>0.999</td>
<td>0.9905 - 1</td>
<td>unif</td>
<td>0.5</td>
</tr>
<tr>
<td>$\rho_{zc}$</td>
<td>0.7</td>
<td>0.747</td>
<td>0.731</td>
<td>0.5586 - 0.954</td>
<td>unif</td>
<td>0.5</td>
</tr>
<tr>
<td>$\rho_{\zeta c}$</td>
<td>0.79</td>
<td>0.917</td>
<td>0.962</td>
<td>0.8099 - 0.9981</td>
<td>unif</td>
<td>0.5</td>
</tr>
<tr>
<td>$\rho_{\zeta d}$</td>
<td>0.95</td>
<td>0.978</td>
<td>0.992</td>
<td>0.9578 - 0.9998</td>
<td>unif</td>
<td>0.5</td>
</tr>
<tr>
<td>$\rho_b$</td>
<td>0.945</td>
<td>0.948</td>
<td>0.953</td>
<td>0.9158 - 0.98</td>
<td>norm</td>
<td>0.025</td>
</tr>
<tr>
<td>$\rho_{\zeta g}$</td>
<td>0.8</td>
<td>0.895</td>
<td>0.975</td>
<td>0.7423 - 0.9978</td>
<td>unif</td>
<td>0.5</td>
</tr>
<tr>
<td>$\rho_f$</td>
<td>0.9</td>
<td>0.820</td>
<td>0.853</td>
<td>0.666 - 0.9939</td>
<td>unif</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Notes: Based on annual data from 1990 to 2014.

Shocks are persistent but not permanent - rationale for borrowing/lending
Figure 7: Decomposition of China Net Foreign Assets (Model)

China NFA % of GDP (Change from 1990)

- Model
- Data (L-M 2007)
Assets-GDP Ratio and Shocks

Consider 1 standard deviation shock

- Productivity shocks ($\approx$ unit root): minor impact on assets
- Discount factor: increase assets
Impulse Response of NFA-GDP Ratio to 1 std deviation shock

- eb
- zd
Assets-GDP Ratio and Trade cost shocks

Consider 1 standard deviation shock

- **Persistent trade cost shocks** $\Delta$ assets.

- **Common shocks to trade costs** affect China more since it is more open.
  - $+$ transitory $\rightarrow$ borrowing
  - $+$ trend shock $\rightarrow$ savings

- **Differential shocks**, temporarily cheaper for ROW to consume $\rightarrow$ savings
Response of NFA/GDP

- **common**
- **trend**
Growth in Trade between China and ROW

- Focus on nominal trade share

\[ tr = \frac{P_x X + P_m M}{P_y Y} \]

- Consider contribution of shocks to change
  - over whole period (90 to 14)
  - slow-down - compare 11-14 to 97-07
<table>
<thead>
<tr>
<th>Source of Change in ROW Trade-GDP (1990 to 2014)</th>
<th>ROW</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>15.0%</td>
<td>38.7%</td>
</tr>
<tr>
<td>Productivity</td>
<td>18.1%</td>
<td>-45.0%</td>
</tr>
<tr>
<td>Trade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common</td>
<td>23.3%</td>
<td>70.1%</td>
</tr>
<tr>
<td>Difference</td>
<td>19.0%</td>
<td>-38.5%</td>
</tr>
<tr>
<td>Trend</td>
<td>25.7%</td>
<td>77.0%</td>
</tr>
<tr>
<td>Fixed</td>
<td>-1.2%</td>
<td>-2.1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22.8%</strong></td>
<td><strong>23.8%</strong></td>
</tr>
</tbody>
</table>

Each entry measures the share of the total change in nominal trade to GDP from 1990 to 2014 from that shock alone.
<table>
<thead>
<tr>
<th>Source of the slow-down in 11-14 (comparing to 97-07)</th>
<th>ROW</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial</strong></td>
<td>6.4%</td>
<td>6.6%</td>
</tr>
<tr>
<td><strong>Productivity</strong></td>
<td>-10.6%</td>
<td>10.3%</td>
</tr>
<tr>
<td><strong>Trade</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Common</strong></td>
<td>80.9%</td>
<td>98.4%</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>14.9%</td>
<td>-14.0%</td>
</tr>
<tr>
<td><strong>Trend</strong></td>
<td>7.5%</td>
<td>-3.7%</td>
</tr>
<tr>
<td><strong>Fixed</strong></td>
<td>7.5%</td>
<td>6.6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>-0.94%</strong></td>
<td><strong>-2.43%</strong></td>
</tr>
</tbody>
</table>

Each entry measures the share of the difference in the average annual contribution from 2011 to 2014 minus that from 1997 to 2007.
Trend Trade Cost

-0.08
-0.07
-0.06
-0.05
-0.04
-0.03
-0.02
-0.01

Summary

- Decline in trade barriers matter for China’s savings
- Chinese trade integration attributed equally to trend, common, differential and productivity.
- Trade slow-down mostly reflects lack of barrier reductions, rather than reversal, and waning influence of past reforms.
  - Expectations for integration haven’t diminished much.
## Estimated Preferences and Technology

<table>
<thead>
<tr>
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<th>prior std.dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ρ</td>
<td>2</td>
<td>1.6964</td>
<td>1.7364</td>
<td>1.4745 - 1.9236</td>
<td>invg 1</td>
</tr>
<tr>
<td>σ</td>
<td>5</td>
<td>4.7231</td>
<td>4.3826</td>
<td>3.3182 - 5.9365</td>
<td>invg 1</td>
</tr>
<tr>
<td>z</td>
<td>2.42</td>
<td>2.3378</td>
<td>2.368</td>
<td>2.1776 - 2.4633</td>
<td>norm 0.1</td>
</tr>
<tr>
<td>ξ_c</td>
<td>0.5</td>
<td>0.4926</td>
<td>0.5026</td>
<td>0.4113 - 0.5683</td>
<td>norm 0.05</td>
</tr>
<tr>
<td>ξ_d</td>
<td>0.1</td>
<td>0.1197</td>
<td>0.1</td>
<td>-0.0286 - 0.2856</td>
<td>norm 0.1</td>
</tr>
<tr>
<td>ξ_q</td>
<td>-0.3</td>
<td>-0.3067</td>
<td>-0.2923</td>
<td>-0.5041 - -0.0797</td>
<td>norm 0.15</td>
</tr>
<tr>
<td>ξ_y</td>
<td>-0.15</td>
<td>-0.156</td>
<td>-0.1633</td>
<td>-0.2827 - -0.034</td>
<td>norm 0.15</td>
</tr>
<tr>
<td>f_0</td>
<td>0.37</td>
<td>0.387</td>
<td>0.3728</td>
<td>0.3087 - 0.473</td>
<td>invg 0.05</td>
</tr>
<tr>
<td>f_1</td>
<td>0.039</td>
<td>0.0427</td>
<td>0.0407</td>
<td>0.031 - 0.0536</td>
<td>invg 0.01</td>
</tr>
<tr>
<td>σ_η</td>
<td>0.235</td>
<td>0.1959</td>
<td>0.1824</td>
<td>0.1662 - 0.2269</td>
<td>invg 0.05</td>
</tr>
</tbody>
</table>

Notes: Based on annual data from 1990 to 2014.
## Estimated Shock Std. Deviation

<table>
<thead>
<tr>
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<th>prior std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_{zd}$</td>
<td>0.07</td>
<td>0.0699</td>
<td>0.0678</td>
<td>0.0527 - 0.0871</td>
<td>invg 0.025</td>
</tr>
<tr>
<td>$\sigma_{zc}$</td>
<td>0.033</td>
<td>0.0355</td>
<td>0.0333</td>
<td>0.0267 - 0.043</td>
<td>invg 0.025</td>
</tr>
<tr>
<td>$\sigma_{\xi_c}$</td>
<td>0.2</td>
<td>0.1602</td>
<td>0.1549</td>
<td>0.1209 - 0.1984</td>
<td>invg 0.05</td>
</tr>
<tr>
<td>$\sigma_{\xi_d}$</td>
<td>0.124</td>
<td>0.1653</td>
<td>0.1531</td>
<td>0.1276 - 0.2018</td>
<td>invg 0.05</td>
</tr>
<tr>
<td>$\sigma_{\xi_g}$</td>
<td>0.016</td>
<td>0.0339</td>
<td>0.0118</td>
<td>0.0052 - 0.0692</td>
<td>invg 0.02</td>
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<tr>
<td>$\sigma_{f_0}$</td>
<td>0.01</td>
<td>0.007</td>
<td>0.0047</td>
<td>0.0025 - 0.0119</td>
<td>invg 0.05</td>
</tr>
<tr>
<td>$\sigma_{f_1}$</td>
<td>0.22</td>
<td>0.2213</td>
<td>0.2193</td>
<td>0.2075 - 0.2378</td>
<td>invg 0.01</td>
</tr>
<tr>
<td>$\sigma_b$</td>
<td>0.005</td>
<td>0.0055</td>
<td>0.0044</td>
<td>0.0029 - 0.0082</td>
<td>invg 0.01</td>
</tr>
</tbody>
</table>

Notes: Based on annual data from 1990 to 2014.