Trapped Factors and China’s Impact on Global Growth

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*NYU Stern*

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*BU*

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*LSE*
Low-Cost Imports are Trending Upwards Dramatically

Note: Non-OECD and Chinese imports into OECD countries are from the OECD-STAN database as available in April 2013. The normalizing GDP measure for the OECD is computed from the Penn World Tables version 7.1 and equals the sum of GDP for all OECD members in a given year.
More R&D in Terrible, Horrible, No Good, Very Bad Times

European Firms
Firms more exposed to Chinese import competition have more R&D, IT, patenting (BDVR 2015)

Innovation & Growth
Quantitatively powerful source of gains from trade relative to traditional static mechanisms

Two Questions

#1: How do we understand link between low-cost imports and innovation in the cross-section?

#2: How big are the dynamic gains from trade?
WHAT WE DO IN THIS PAPER

European Microdata: Firms with higher Chinese import competition do more patenting. Stronger pattern for industries and firms with proxies for “trapped factors”

A Model of Low-Cost Trade & Growth
GE growth model with product-cycle trade and R&D

A Calibrated Trade Shock
Match recent growth in low-wage imports into OECD economies. Sizable increase in growth & welfare.

Trapped Factors: Adj. costs → lower opportunity costs
Micro: higher R&D, patenting for exposed firms
Macro: higher growth, welfare gains overall

China’s Role
Chinese imports produce half of gains from liberalization.
**Related Work**

**Endogenous Growth and Trade**

**Product-Cycle Trade**
Vernon (1966), Antràs (2005), Krugman (1979)

**Opportunity Costs and R&D**

**Quantitative Gains from Trade**
Melitz and Redding (2013), Costinot and Rodríguez-Clare (2013)
Roadmap

European microdata

A model of growth and trade

A calibrated trade shock

Trapped factors

The role of China
Trade & Patenting Data

Same empirical framework as BDVR (2015)

**UN Comtrade**: Chinese import penetration by four-digit industry + country

**European Patent Office**: Firm-level patenting rates

**Bureau van Dijk Amadeus**: European firm-level accounting information, linking dataset which allows for firm TFP and industry wage premia measures

**Merged Sample**
Panel of about 10K firms, 12 countries, 1996-2005, with 30K firm-years overall
## Table 1: Innovation, Chinese Import Growth, and Trapped Factors

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δln(PATENTS)\textsubscript{ijkt}</td>
<td>Δln(PATENTS)\textsubscript{ijkt}</td>
<td>Δln(PATENTS)\textsubscript{ijkt}</td>
<td>Δln(PATENTS)\textsubscript{ijkt}</td>
<td></td>
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<tr>
<td>Estimation Method</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
</tr>
<tr>
<td>Change in Chinese Imports, ΔIMP\textsubscript{CH} \textsubscript{ijkt}</td>
<td>0.321***</td>
<td>0.248***</td>
<td>0.287*</td>
<td>-2.479***</td>
</tr>
<tr>
<td></td>
<td>(0.102)</td>
<td>(0.096)</td>
<td>(0.158)</td>
<td>(0.849)</td>
</tr>
<tr>
<td>Industry Wage Premium</td>
<td>-0.394***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.068)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Chinese Imports</td>
<td>2.808***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Industry Wage Premium</td>
<td></td>
<td>(0.959)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm TFP\textsubscript{it-5}</td>
<td></td>
<td></td>
<td>-0.287***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.051)</td>
<td></td>
</tr>
<tr>
<td>Change in Chinese Imports</td>
<td></td>
<td></td>
<td>1.473***</td>
<td></td>
</tr>
<tr>
<td>* Firm TFP\textsubscript{it-5}</td>
<td></td>
<td></td>
<td>(0.463)</td>
<td></td>
</tr>
<tr>
<td>Firms</td>
<td>8,480</td>
<td>8,480</td>
<td>5,015</td>
<td>5,015</td>
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<tr>
<td>Industry-Country Clusters</td>
<td>1,578</td>
<td>1,578</td>
<td>1,147</td>
<td>1,147</td>
</tr>
<tr>
<td>Firm-Year Observations</td>
<td>30,277</td>
<td>30,277</td>
<td>14,497</td>
<td>14,497</td>
</tr>
</tbody>
</table>

### Notes:
- *** denotes 1% significance; ** denotes 5% significance; * denotes 10% significance.
- Standard errors (in parentheses) are clustered by country and four-digit industry cell.
- Data on firm-level patenting comes from the European Patent Office linked to the Bureau Van Dijk Amadeus database of firm-level accounting information.
- Data on Chinese imports by industry-country cell is drawn from the UN Comtrade database, covering 12 nations.
- The industry wage premia are defined as the coefficients on three-digit industry dummies in a wage regression implemented using United Kingdom Labor Force Survey pooled worker cross-sections from 1996-2008, controlling for a quadratic in experience, schooling, region and gender.
- Firm level ln(TFP) is calculated using the de Loecker (2011) three-factor production function estimation method using labor, capital, and materials based on a restricted sample requiring each accounting variable, also drawn from the Amadeus database but covering 4 countries.
ROADMAP

European microdata

A model of growth and trade

A calibrated trade shock

Trapped factors

The role of China
A Model of Product-Cycle Growth and Trade

\[ \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma}}{1-\sigma}, \sum_{t=0}^{\infty} \beta^t \frac{C^*_t^{1-\sigma}}{1-\sigma} \]

\[ Y_t = H^\alpha \int_0^{A_t} x_{kt}^{1-\alpha} dk = C_t + \int_0^{A_{t+1}} x_{kt+1} dk + Z_t \]

\[ Y^*_t = H^{*\alpha} \int_0^{A_t} x^*_{kt}^{1-\alpha} dk = C^*_t + \int_0^{A_t} x^*_{kt+1} dk \]

North v. South
- Identical preferences and nontraded final goods technology
- Traded intermediates, only North innovates new varieties
Innovation Occurs in Northern Intermediate Goods Firms

Northern Intermediate Firms
Many firms $f$ each with measure $A_{ft}$ of varieties produced at unit marginal cost in final goods

Innovation
Invent a measure $M_{ft+1}$ of new varieties at R&D cost given by

$$Z_{ft} = \nu M_{ft+1}^\gamma A_t^{1-\gamma}, \gamma > 1$$

Monopoly Power
A newly innovated $M$ good is monopoly protected for 10 years

Trade Policy & Off-Patent Goods
Policy sets fraction $\phi$ of off-patent goods which can be imported ($I$ goods) or nontraded ($R$ goods). Both are sold competitively.
Evaluating the Assumption of No Southern Innovation

US Patents from Foreign Countries, 1977–2006

- Total Foreign (mean = 46.3%)
- Non–OECD (mean = 2.60%)
- China (mean = 0.06%)

Note: Patent fractions are computed from the NBER patent database, accessible via Brownyn Hall’s website. Each series is normalized by the total number of granted US Patent and Trademark Office applications in the same year. The reported means are computed over the full range 1977-2006.
Balanced Trade in Intermediate Goods between North and South

Note: The figure plots the product cycle for intermediate goods in the open-economy model. Goods trade in each period will display the above decomposition, into newly innovated $M$ goods produced solely in the North, perfectly competitive but non-traded $R$ goods produced in the North and the South, and perfectly competitive, traded $I$ goods produced solely in the South. The vertical axis plots stylized intensive margins.
Balanced Growth & Trade

Marginal cost of innovating = Monopoly profits

$$g(\phi)^{\gamma-1} = \Omega \beta \frac{1}{\alpha} (1 + g(\phi))^{-\frac{\sigma}{\alpha}} \left( H + q(\phi)^{\frac{1}{\alpha}} H^* \right)$$

$$q(\phi) = \left( \frac{\phi H}{g(\phi)H^*} \right)^{\frac{\alpha}{2-\alpha}} \Psi$$

$q(\phi)$ is the Southern terms of trade: $q(\phi) < 1$ is assumed and verified in calibration, so the South dominates the North on cost of non-restricted goods

**Theorem:** A liberalization $\phi \rightarrow \phi' > \phi$ increases the long-run balanced growth path growth rate.
Trade Liberalization Yields Higher Long-Run Growth

Note: The figure plots the equilibrium innovation optimality condition for Northern intermediate goods firms in the steady-state growth path of the open-economy model. The innovation optimality condition pins down steady-state growth path growth rates in this framework, and increases in the returns to innovation induced by increases in $\phi$ lead to strictly higher long-run growth rates.
Roadmap

European microdata

A model of growth and trade

A calibrated trade shock

Trapped factors

The role of China
A Trade Shock to Match Observed North-South Trade

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>10 yrs</td>
<td>Effective patent length</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>$\frac{2}{3}$</td>
<td>King and Rebelo (1999)</td>
</tr>
<tr>
<td>$\frac{H^*}{H}$</td>
<td>2.96</td>
<td>Barro and Lee (2010), Schoellman (2011)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.98</td>
<td>Annual interest rate $\approx 4%$</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>1.0</td>
<td>King and Rebelo (1999)</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>2.0</td>
<td>BSVR (2013), Jones and Williams (2000)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target</th>
<th>Target Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H$</td>
<td>2.0%</td>
<td>US GDP growth, 1960-2010</td>
</tr>
<tr>
<td>$\phi$</td>
<td>3.9%</td>
<td>nonOECD I/OECD Y ratio, 1997</td>
</tr>
<tr>
<td>$\phi'$</td>
<td>7.0%</td>
<td>nonOECD I/OECD Y ratio, 2006</td>
</tr>
</tbody>
</table>
Trade Liberalization Boosts Growth Substantially

A: Variety Growth

B: Southern Terms of Trade

C: Northern Output Growth

D: Southern Output Growth

Note: The figure displays the transition path in response to a permanent, unanticipated trade liberalization from policy parameter $\phi$ to $\phi' > \phi$, which is announced in period 0 to become effective in period 1. The plotted transition is computed in the Fully Mobile economy, in which intermediate goods firms may respond to the information about trade liberalization without short-term adjustment costs.
### The Growth and Welfare Effects of Liberalization are Large

<table>
<thead>
<tr>
<th>%</th>
<th>Pre-Shock</th>
<th>Post-Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports to GDP</td>
<td>3.9</td>
<td>7.0</td>
</tr>
<tr>
<td>Growth Rate</td>
<td>2.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Northern Welfare Gains</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>Southern Welfare Gains</td>
<td>-</td>
<td>13</td>
</tr>
</tbody>
</table>

Note: Growth rates are variety growth rates expressed in annualized terms. Welfare gains are the increase in consumption in every period required to yield indifference between the pre-liberalization BGP and the post-liberalization allocations, taking into account the full transition path.
ROADMAP

European microdata

A model of growth and trade

A calibrated trade shock

Trapped factors

The role of China
FUNDAMENTAL INPUTS
ADJUST TO SHOCK

Period t

Trade in intermediates

Final goods production

Intermediate firms make input demands

Trade policy announced (Fully Mobile)

Intermediates produced, innovated

Households consume

Period t+1
Trapped Factors Inputs
Don’t Adjust

Trade in intermediates
Intermediate firms make input demands
Households consume

Period t
Final goods production

Period t+1

Trade policy announced
(Fully Mobile)
Trade policy announced
(Trapped Factors)

Intermediates produced, innovated

TF vs. Specific Factors
Trapped Factors Generate Micro Patenting Pattern

Note: The solid black bar on the left displays the level of industry patenting in the period before a permanent and unanticipated trade liberalization from policy parameter $\phi$ to $\phi' > \phi$. Patent flows in the pre-shock period are normalized to equal 1000. The Shocked industry loses 24.2% of its previously protected $R$ goods production opportunities when these are converted to imported $I$ goods from the South, and the No Shock industry does not lose any unanticipated $R$ goods to Southern competition.
Note: The figure displays the transition path in response to a permanent, unanticipated trade liberalization from policy parameter $\phi$ to $\phi' > \phi$, which is announced in period 0 to become effective in period 1. The plotted transition is computed in the Trapped Factors economy, in which intermediate goods firms don’t respond to the information about trade liberalization because of short-term adjustment costs.
Trapped Factors Boost Short-Term Macro Benefits

<table>
<thead>
<tr>
<th>%</th>
<th>Pre-Shock</th>
<th>Shock Period</th>
<th>Post-Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growth Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully Mobile</td>
<td>2.0</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Trapped Factors</td>
<td>2.0</td>
<td>2.7</td>
<td>2.4</td>
</tr>
</tbody>
</table>

| Northern Welfare Gains |          |              |
| Fully Mobile | -         | -             | 14         |
| Trapped Factors | -         | -             | 16         |

Note: Growth rates are variety growth rates expressed in annualized terms. Welfare gains are the increase in consumption in every period required to yield indifference between the pre-liberalization BGP and the post-liberalization allocations, taking into account the full transition path.
ROADMAP

European microdata

A model of growth and trade

A calibrated trade shock

Trapped factors

The role of China
About half of rise in low-cost imports is due to China

Note: Non-OECD and Chinese imports into OECD countries are from the OECD-STAN database as available in April 2013. The normalizing GDP measure for the OECD is computed from the Penn World Tables version 7.1 and equals the sum of GDP for all OECD members in a given year.
China Boosts Macro Benefits

Note: The figure displays the transition path in response to trade liberalization in two scenarios. The “Baseline” case replicates the Trapped Factors case. A permanent and unanticipated trade liberalization from $\phi$ to $\phi' > \phi$ is announced in period 0 to become effective in period 1. The “No China” path plots the Trapped Factors case, starting with the same initial conditions as Baseline but instead considering a counterfactual increase of $\phi$ to a level between $\phi$ and $\phi'$ which matches post-liberalization imports to GDP ratios assuming no growth in Chinese imports into the OECD.
## China Boosts Macro Benefits

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>Pre-Shock</th>
<th>Shock Period</th>
<th>Post-Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Growth Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully Mobile</td>
<td>2.0</td>
<td>2.4</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Trapped Factors</td>
<td>2.0</td>
<td>2.7</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>No China</td>
<td>2.0</td>
<td>2.4</td>
<td>2.2</td>
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### Northern Welfare Gains

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Fully Mobile</td>
<td>-</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>Trapped Factors</td>
<td>-</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>No China</td>
<td>-</td>
<td>-</td>
<td>7</td>
</tr>
</tbody>
</table>

Note: Growth rates are variety growth rates expressed in annualized terms. Welfare gains are the increase in consumption in every period required to yield indifference between the pre-liberalization BGP and the post-liberalization allocations, taking into account the full transition path.
Wrapping Up

**European Microdata:** Firms with higher Chinese import competition do more patenting. Stronger pattern for industries and firms with proxies for “trapped factors”

**A Model of Low-Cost Trade & Growth**
GE growth model with product-cycle trade and R&D

**A Calibrated Trade Shock**
Match recent growth in low-wage imports into OECD economies. Sizable increase in growth & welfare.

**Trapped Factors:** Adj. costs → lower opportunity costs
*Micro:* higher R&D, patenting for exposed firms
*Macro:* higher growth, welfare gains overall

**China’s Role**
Chinese imports produce half of gains from liberalization.
Donald Trump Doesn’t Know What He’s Talking About!
Backup Slides
Baseline Results are Qualitatively Robust

Note: The figure displays various robustness checks to the baseline Trapped Factors transition path. All plotted parameterizations of the model vary only the parameter indicated in the legend, starting from the baseline Trapped Factors results.
**Semiendogenous Growth Changes**

**Little Quantitatively**

Note: The figure displays the Fully Mobile transition path in the semi-endogenous growth model in response to a permanent, unanticipated trade liberalization from policy parameter $\phi$ to $\phi' > \phi$, which is announced in period 0 to become effective in period 1. The semi-endogenous growth model’s value for variety growth and output growth in the long run does not vary with trade policy, so there is only one steady-state growth marker for these series.
An Extension with Southern Innovation Changes Little

Note: The figure displays the Fully Mobile transition path in the growth model with Southern innovation in response to a permanent, unanticipated trade liberalization from policy parameter $\phi$ to $\phi' > \phi$, which is announced in period 0 to become effective in period 1. Intermediate goods firms may respond to the information about trade liberalization without short-term adjustment costs.
A Counterfactual Experiment with No Chinese Import Growth

<table>
<thead>
<tr>
<th>Imports to GDP %</th>
<th>1997</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Non-OECD</td>
<td>3.9</td>
<td>7.0</td>
</tr>
<tr>
<td>No China Case</td>
<td>3.9</td>
<td>5.37</td>
</tr>
</tbody>
</table>

**First Row:** Observed import ratios for the model’s baseline calibration presented in the quantitative experiment

**Second Row:** Counterfactual with no growth in Chinese import shares as a proportion of OECD GDP

**China’s Contribution:** The difference between the first and second row transition paths
Trapped vs. Specific Factors

Specific factors models as in Jones (1971) or Mussa (1974) are superficially similar to our framework

Similarities
- Both feature immobility of inputs
- Both distinguish between the long run and the short run

Differences
- Trapped factors allows for an alternative use for immobile inputs in the face of import competition: innovation
- All inputs, not just one, are trapped within firms in the trapped-factors environment
**Shadow Values Drop Moderately**

Note: The figure displays the transition path in response to a permanent, unanticipated trade liberalization from policy parameter $\phi$ to $\phi' > \phi$, which is announced in period 0 to become effective in period 1. The plotted transition is computed in the Trapped Factors economy, in which intermediate goods firms don’t respond to the information about trade liberalization because of short-term adjustment costs. For the two shadow value figures, shadow values are normalized to equal 100% in non-shock periods.
Half-China Case

Note: The figure displays the transition path in response to trade liberalization in two scenarios. The “Baseline” case replicates the Trapped Factors case. A permanent and unanticipated trade liberalization from $\phi$ to $\phi' > \phi$ is announced in period 0 to become effective in period 1. The “Half China” path plots the Trapped Factors case, starting with the same initial conditions as Baseline but instead considering a counterfactual increase of $\phi$ to a level between $\phi$ and $\phi'$ which matches post-liberalization imports to GDP ratios assuming that half the growth in Chinese imports into the OECD occurs through policy substitution to non-China, non-OECD countries.