Trade Integration, Competition, and the Decline in Exchange-Rate Pass-Through

Chris Gust, Sylvain Leduc, and Rob Vigfusson
Federal Reserve Board

Motivation

- Incomplete exchange-rate pass-through (ERPT): According to micro studies, U.S. import prices respond less than one for one to a change in the exchange rate:
  - Goldberg and Knetter (JEL, 1997).

- ERPT important for trade balance dynamics and business cycle transmission across countries.

- ERPT is important for policymakers.
What we do

- We document an increasing disconnect between exchange rate and aggregate U.S. import prices:

- Using DSGE model, we relate this growing disconnect to:
  - Trade liberalization – lower tariff and transport costs;
  - foreign exporter’s relative productivity.

- Key features
  - Pricing-to-market with variable demand elasticity that implies firm’s pricing decision depends on prices of competitors:
    - In closed economy: Kimball (JMCB, 1995), Dotsey and King (JME, 2005);
    - In international context: Bergin and Feenstra (JEL, 2001).
  - Endogenous exporters entry/exit decisions:
    - Melitz (2003), Bergin and Glick (2005).
Findings

- **Factors leading to a greater trade integration account for a significant part of the increasing disconnect:**
  - Faster productivity growth abroad and reductions in trade costs have reduced MC of foreign exporters;
  - Our framework implies that low-cost exporters will choose a higher and more variable markup.

- **Entry of firms tends to erode markups and lead to greater co-movement of exchange rate and import prices.**

- **Variations in exporters’ markups along the intensive margin dominates the effect of entry.**

- **Approach is consistent with the view that trade integration induces an economy to become more competitive:**
  - Markups of domestic producers decline.
Data

- **We focus on a price index for imported finished goods:**
  - An aggregation over end use categories of automotive products, consumer goods, and capital goods;
  - Excludes services, computers, commodities.

- **Report an index of the price of imported finished goods relative to domestic consumer goods (durables and nondurables).**

- **Exchange rate:**
  - a 39 country trade weighted exchange rate with weights based on all non-oil imports.
Share of finished goods in total imports

Import Share of Finished Goods

Share of Total Imports
Share of Non–oil Goods

Percent

RER and import prices

Exchange Rates and Price Index in Levels

Real Exchange Rate
Relative Price of Imports to Consumer Goods

Exchange Rates and Price Index in Logged First Differences

Percent

A naïve estimate of ERPT
Other estimates of ERPT

\[
\log P_m = \log(\mu^*) + \log(\epsilon) + \log(mc^*)
\]
Summary statistics

\[ \beta_{p_m,q} = \frac{\text{cov}(\Delta p_{mt}, \Delta q_t)}{\text{var}(\Delta q_t)} = \frac{\text{corr}(\Delta p_{mt}, \Delta q_t) \frac{\text{std}(\Delta p_{mt})}{\text{std}(\Delta q_t)}}{\text{var}(\Delta q_t)} \]

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<thead>
<tr>
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<tbody>
<tr>
<td>a. ( \beta_{p,q} )</td>
<td>0.35</td>
<td>0.55</td>
<td>0.13</td>
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<tr>
<td>(a = b^c)</td>
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<tr>
<td>b. ( \sigma_{p,q}/\sigma_q )</td>
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<td>b. ( \sigma_{p,q}/\sigma_q )</td>
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<td>0.85</td>
<td>0.95</td>
<td>0.60</td>
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</table>
ERPT for subgroups of imports

![Graph showing ERPT for subgroups of imports]

- Imports
- Non-oil Imports
- Non-oil Imports Ex Services Comp, Food
- Finished Goods
Fall in ERPT using disaggregated data

- We look at 40 finished goods industries pre- and post-1990
Measuring trade costs

- Following Bernard, Jensen, and Schott (2005), we measure trade costs for each of our finished-goods industry as:
  \[ d_{it} = \frac{T_{it} + F_{it}}{V_{it}} \]

- We then compute an average trade-cost measure as:
  \[ d_t = \frac{\sum_{i=1}^{N} \left( \frac{V_{it}}{\sum_{j=1}^{N} V_{jt}} \right) d_{it}}{N} \]
Measuring trade costs

Baier and Bergstrand (JIE, 2001)
Labor productivity

Growth in GDP per Employee for Selected Regions

GDP per Employee in the United States and ROW (1980 = 100)
DGE model

- DGE model in which 2 countries have similar structure.
- HH demand variety of domestic and foreign goods. Demand aggregator has non-constant elasticity of substitution (NCES).
- Firms are monopolistic competitors.
- Production is linear in labor: \( Y=Z*L \).
- Trade costs allow firms to price-to-market.
- Endogenous export decision.
- Complete domestic and int’l financial markets.
Household demand aggregator

• HH minimize total expenditures:

\[
\min \left( \int_0^1 p_d(i)c_d(i)di + \int_0^{\omega^*} p_m(i)c_m(i)di \right)
\]

\[s.t. \quad D(c_d(i), c_m(i)) = 1\]

• \(D(.,.)\) allows for NCES across goods.

• \(C_{mt}(i)\) indexed over \(i \in [0, \omega_t^*]\), where \(\omega_t^*\) endogenously determined fraction of foreign goods.
Household demand

- **Demand curve for import good i:**

\[ c_{mt}(i) = \frac{1}{1 + \omega_t^*} \left[ \frac{1}{1 + \eta} \left( \frac{p_{mt}(i)}{p_{mt}} \right)^{1 - \frac{1}{\gamma}} \left( \frac{p_{mt}}{\Gamma_t} \right)^{\frac{\rho}{\rho - \gamma}} + \frac{\eta}{1 + \eta} \right] C_t \]

- **\( \Gamma \) is a price index for all of a firm’s competitors:**

\[ \Gamma = \left[ \left( \frac{1}{1 + \omega_t^*} \right) p_{d^{\gamma - \rho}} + \left( \frac{\omega_t^*}{1 + \omega_t^*} \right) p_{mt^{\gamma - \rho}} \right]^{\frac{\gamma - \rho}{\gamma}} \]
Firm’s pricing decision in domestic market

• Firms set prices at home and abroad. Problem for setting domestic price:

\[
\max(p_{dt}(i) - \frac{W_t}{Z_t})c_{dt}(i) \quad \quad p_{dt}(i) = \mu_{dt}(i) \frac{W_t}{Z_t}
\]

• In a symmetric equilibrium, the markup is given by:

\[
\mu_{dt} = \left[1 - \frac{1}{\epsilon_{dt}}\right]^{-1} = \left[\gamma + \eta(\gamma - 1)\left(\frac{p_{dt}}{\Gamma_t}\right)^\rho\right]^{-1}
\]

• If \( \eta < 0 \):

\[
\downarrow \left(\frac{p_{dt}}{\Gamma_t}\right) \implies \uparrow \mu_{dt}
\]
Export entry/exit decision of a domestic firm

• Each period, a firm faces a fixed cost of exporting, which varies with a good’s type and is paid in units of labor:

\[ f_x(i) = \frac{f}{1 - \alpha_i}, \quad \alpha_x \geq 0 \]

• The entry decision is made before the realization of the shocks. Firms will decide to export if:

\[ E_{t-1} \left[ \lambda_{t-1,t} \left( \pi_{xt}(i) - f_x(i)w_t \right) \right] > 0 \]

• Where profits in the foreign market are:

\[ \pi_{xt}(i) = \left( q_t p_{mt}^*(i) - \frac{D_t w_t}{Z_t} \right) c_{mt}^*(i) \]
Calibration

- Z and D are assumed to be iid.

- Set \( \eta, \sigma_z, \) and \( \sigma_d \) so that, for 1980-89, we match \( \sigma_y, \sigma_{pm}/\sigma_{RER} \) and \( \rho(P_m,RER) \):
  \[ \Rightarrow \beta_{p_m,q} \] is pinned down on pre-1990 data.

- Set \( \gamma \) so that exporters’ markup at home is about 20%.

- Set \( \rho \) so that the trade elasticity is 2.

- Set \( f \) so that the import share is 10% in the initial SS.

- Set \( \alpha_x \) so that the import share rises 4 ppt in the second SS.

- \( D=D^*=1.1 \) in initial SS. Set the decline in Ds to 5 ppt.

- Set the level of foreign productivity 30% higher than at home in the second SS.
Some properties of the model
A direct measure of ERPT

• **Foreign exporter’s pricing equations:**

\[ p_{mt} = \mu_{mt} D_t^* \frac{W_t^*}{Z_t^*} q_t \]

• **Linearized:**

\[ \hat{p}_{mt} = k_m \left( \hat{D}_t^* + \hat{w}_t^* - \hat{Z}_t^* + \hat{q}_t \right) + (1 - k_m) \hat{\Gamma}_t \]

• **The direct measure of pass-through:**

\[ k_m \equiv \frac{\partial \ln(p_m)}{\partial \ln(q)} = \frac{1}{1 - \eta \mu_m \left( \frac{\rho (\gamma - 1)}{\gamma - \rho} \right) \left( \frac{\Gamma}{p_m} \right)^{\gamma - \rho}} \]

• With \( \eta < 0 \), low-cost firms have lower relative prices, higher markups, and lower direct pass-through.
Trade integration and ERPT

\[ MR_m(j) = P_m(j) \left[ 1 - \frac{1}{|\varepsilon_m(j)|} \right] \]
**ERPT**

- **The direct measure of pass-through:**

\[
k_m \equiv \frac{\partial \ln(p_m)}{\partial \ln(q)} = \frac{1}{1 - \eta \mu_m \left(\frac{\rho (\gamma - 1)}{\gamma - \rho}\right) \left(\frac{\Gamma}{p_m}\right)^\gamma} - \frac{\rho}{\gamma - \rho}
\]

- **\(B_{pm,q}\)** is related to this direct measure of PT by:

\[
\beta_{pmq} \equiv k_m + k_m \left(\frac{\text{cov}(\Delta(\hat{D}_t + \hat{w}_t - \hat{Z}_t, \Delta\hat{q}_t))}{\text{var}(\Delta\hat{q}_t)}\right) + (1 - k_m) \frac{\text{cov}(\Delta\hat{\Gamma}_t, \Delta\hat{q}_t)}{\text{var}(\Delta\hat{q}_t)}
\]
Fall in trade costs and increase in foreign productivity

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Trade Costs (D, D*)</td>
<td>-5 ppt</td>
</tr>
<tr>
<td>Foreign Productivity (Z*)</td>
<td>35 %</td>
</tr>
<tr>
<td>Foreign Exporter’s Marginal Cost (qD<em>mc</em>)</td>
<td>-23.8 %</td>
</tr>
<tr>
<td>Home import Price (p_m)</td>
<td>-9.9 %</td>
</tr>
<tr>
<td>Foreign Exporter’s Markup (μ_m)</td>
<td>13.9 %</td>
</tr>
<tr>
<td>Direct Pass-Through (κ_m)</td>
<td>-11.6 ppt</td>
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<tr>
<td>Pass-through (β_{pm,q})</td>
<td>-14.7 ppt</td>
</tr>
<tr>
<td>Home Firm’s Markup at Home (μ_d)</td>
<td>-1.7 %</td>
</tr>
</tbody>
</table>
Entry and ERPT (1)

Foreign Export Profits

Import Share

Foreign Exporter Markup

Domestic Firm Markup

Direct Pass-Through

General Equilibrium Pass-Through

Fixed Cost
Entry and ERPT (2)
ERPT and trade costs at the industry level

- A 1 ppt decline in trade costs is associated with a 0.7 ppt decline in PT
Conclusion

- Economic forces that lower foreign exporters’ marginal costs in US dollars lead to:
  - Higher and more variable exporters’ markups
  - Lower ERPT

- Entry of firms tends to erode markups and increase ERPT

- The effect of pricing complementarity along the intensive margins dominates the effect of entry on ERPT

- Approach is consistent with the view that trade integration induces an economy to become more competitive
Entry and PT (3)
Tariffs in **developed** countries have fallen roughly 3 ppt since the late 1980s

Table 3: Weighted-Average Tariffs on Products in Developed Countries$^a$

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<tr>
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<tbody>
<tr>
<td>Developing Countries</td>
<td>7.2</td>
<td>4.9</td>
<td>3.9</td>
<td>3.3</td>
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<tr>
<td>Asia$^c$</td>
<td>7.8</td>
<td>4.8</td>
<td>3.9</td>
<td>3.7</td>
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<tr>
<td>Developed Countries</td>
<td>5.1</td>
<td>3.5</td>
<td>2.5</td>
<td>2.6</td>
</tr>
<tr>
<td>World</td>
<td>5.8</td>
<td>4.0</td>
<td>3.1</td>
<td>2.7</td>
</tr>
</tbody>
</table>

$^a$Weighted-average tariffs are calculated as simple averages across non-fuel and non-agricultural products, weighting by each country’s import share. Source: Unctad (http://globstat.unctad.org/html/index.html).

$^b$Decline refers to the difference between columns 2 and 4.

$^c$Asia including Japan.
Tariffs in developing countries have fallen about 10 ppt since the mid-1980s

Table 2: Weighted-Average Tariffs on Products in Developing Countries

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</thead>
<tbody>
<tr>
<td>Developing Countries</td>
<td>22.2</td>
<td>17.9</td>
<td>11</td>
<td>11.2</td>
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<tr>
<td>Asia(^c)</td>
<td>20.9</td>
<td>17.1</td>
<td>9.7</td>
<td>11.2</td>
</tr>
<tr>
<td>South America</td>
<td>36.4</td>
<td>24.9</td>
<td>11.2</td>
<td>23.2</td>
</tr>
</tbody>
</table>

\(^a\)Weighted-average tariffs are calculated as simple averages across product categories, weighting by each country’s import share. Source: Unctad (http://globstat.unctad.org/html/index.html).

\(^b\)Decline refers to the difference between columns 2 and 4.

\(^c\)Asia including Japan.
PT in partial equilibrium (2)

\[ \hat{p}_{m_t} = k_m \left( \hat{D}_t^* + \hat{\psi}_t^* + \hat{q}_t \right) + (1 - k_m) \hat{\xi}_t \]

\[ k_m = \frac{1}{1 + \chi (\mu_m - 1)} \]
Household demand aggregator

- **Demand aggregator:**

\[
D\left(\frac{c_{dt}(i)}{C_t}, \frac{c_{mt}(i)}{C_t}\right) = \left(\frac{1}{1+\omega_t^*} V_{dt}^{\rho} + \frac{\omega_t^*}{1+\omega_t^*} V_{mt}^{\rho}\right)^\rho - \frac{1}{(1+\eta)^\gamma} + 1
\]

- **Where:**

\[
V_{dt} = \int_0^1 \frac{1}{(1+\eta)^\gamma} \left[ (1+\omega_t^*)(1+\eta) \frac{c_{dt}(i)}{C_t} - \eta \right]^\gamma di
\]

\[
V_{mt} = \frac{1}{\omega_t^*} \int_0^{\omega_t^*} \frac{1}{(1+\eta)^\gamma} \left[ (1+\omega_t^*)(1+\eta) \frac{c_{mt}(i)}{C_t} - \eta \right]^\gamma di
\]
Firm’s pricing decision in export market

- **Profit maximization implies:**

\[ q_t p_{mt}^* (i) = \mu_{mt}^* (i) \frac{D_t w_t}{Z_t} \]

- **The markup is defined by:**

\[
\mu_{mt}^* = \left[ 1 - \frac{1}{\varepsilon_{mt}^*} \right]^{-1} = \left[ \gamma + \eta(\gamma - 1) \left( \frac{p_{mt}^*}{\Gamma_t^*} \right) \frac{\rho}{\rho - \gamma} \right]^{-1}
\]
Special case of demand aggregator

- When $\eta=0$, combination of Dixit-Stiglitz and Armington aggregator:

$$c_{mt}(i) = \frac{1}{1 + \omega_t^*} \left( \frac{p_{mt}(i)}{p_{mt}} \right)^{\frac{1}{\gamma-1}} \left( \frac{p_{mt}}{\Gamma_t} \right)^{\frac{\rho}{\gamma-\rho}} C_t$$

- When $\rho=1$ and $\omega_t^* = 0$, then aggregator of Dotsey and King (2005):

$$c_{mt}(i) = \left[ \frac{1}{1+\eta} \left( \frac{p_{mt}(i)}{\Gamma_t} \right)^{\frac{1}{\gamma-1}} + \frac{\eta}{1+\eta} \right] C_t$$
Households

- Households have per-period utility given by:

\[
\log(C_t) - \frac{\chi_0 L_t^{1+\chi}}{1 + \chi}
\]

- With the following budget constraint (in real terms):

\[
C_t + \int_{s} p_{bt,t+1} b_{t+1} = w_t L_t + \Omega_t + b_t
\]
Price convergence

- Our 5 ppt decline in trade costs leads to only 2 ppt convergence in prices
- This is due to markup adjustments:
  - Firms set a higher markup abroad and a lower one at home
- Engel and Rogers (2004) and Bergin and Glick (2005)
Selected finished goods industries

<table>
<thead>
<tr>
<th>SITC</th>
<th>Descriptions</th>
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<tbody>
<tr>
<td>54</td>
<td>Medicinal and pharmaceutical products</td>
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<tr>
<td>55</td>
<td>Essential oils; polishing and cleansing preps</td>
</tr>
<tr>
<td>66</td>
<td>Glassware, Pottery, and Precious Stones</td>
</tr>
<tr>
<td>72</td>
<td>Agricultural, Textile, and Civil Engineering Machinery</td>
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<tr>
<td>73</td>
<td>Metalworking machinery</td>
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<tr>
<td>74</td>
<td>Pumps, Heating and Cooling Equipment And Nonelectrical Machinery</td>
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<td>751</td>
<td>Office Machines</td>
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<td>76</td>
<td>Television and Radio Receivers, Telecommunication Equipment</td>
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<td>Electrical Machinery</td>
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<td>78</td>
<td>Motor Cars And Parts</td>
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<tr>
<td>81</td>
<td>Prefabricated buildings; plumbing, heat and lighting fixtures</td>
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<tr>
<td>84</td>
<td>Articles of apparel and clothing accessories</td>
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<td>85</td>
<td>Footwear</td>
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<td>885</td>
<td>Watches And Clocks</td>
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<tr>
<td>894</td>
<td>Baby Carriages, Toys, Games And Sporting Goods</td>
</tr>
<tr>
<td>898</td>
<td>Musical Instruments, Parts And Accessories Thereof; Records Tapes</td>
</tr>
</tbody>
</table>
Outline of the talk

- Document the increasing disconnect between U.S. import prices and exchange rates.
- Provide evidence on falling tariffs and transport costs and changes in relative productivity across countries.
- Describe the DGE model.
- Present the results.
ERPT in partial equilibrium

\[
MR_m(j) = P_m(j) \left[ 1 - \frac{1}{|\varepsilon_m(j)|} \right]
\]
## Lower trade costs on domestic exporters and ERPT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Domestic Exporter’s Trade Cost (D)</td>
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<tr>
<td>Real Exchange Rate (q)</td>
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<tr>
<td>Foreign Exporter’s Marginal Cost (qD<em>mc</em>)</td>
<td>-0.7 %</td>
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<tr>
<td>Home import Price (p_m)</td>
<td>-0.3 %</td>
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<td>Direct Pass-Through (κ_m)</td>
<td>-0.4 ppt</td>
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<td>-0.6 ppt</td>
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<tr>
<td>Home Firm’s Markup at Home (μ_d)</td>
<td>-0.1 %</td>
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</tbody>
</table>
Evidence on trade costs and productivity

- We use our DGE model to link the fall in ERPT to:
  - Global reduction in trade costs;
  - Emergence of low-cost production centers abroad, particularly in Developing Asia and China.

- We measure trade costs using evidence on transport costs and tariffs.

Lower trade costs on foreign exporters and ERPT

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<td>(D*)</td>
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<td>(β_{p_m,q})</td>
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