Product Introductions, Currency Unions, and the Real Exchange Rate

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Motivation

• Classic theories of the real exchange rate (RER) assume traded goods adhere to the “Law of One Price” (LOP)

• Big literature shows LOP fails among traded goods (Engel 1999; Crucini et al. 2005; Gopinath et al. AER 2011)

• Understanding international relative prices matters for behavior of RER shocks
What We Do

1. Introduce large dataset of identical tradeable goods, sold by global retailers in three industries and dozens of countries.

2. LOP generally holds within Currency Unions, fails otherwise (including pegged regimes).

3. New decomposition shows RER at time of introduction is most important component of RER and moves closely with NER.
Price Data from Four Global Retailers

- Apple, IKEA, Zara, and H&M
- Among the largest global retailers (by sales) in technology, furniture, and apparel industries
- Headquartered in different countries, not jointly owned
- Prices “scraped” off the retailer websites (eg. http://store.apple.com/us/shop_ipad/accessories/cases)
How Does “Scraping” Work?

<html>
<!-- START product -->
<a href="productId=MD963LL"></a>
<p class="productname">Ipad Mini Smart Cover – Dark Grey</p>
<td class="Price">$39.00</td>
<!-- END product -->

.....
Online Prices

- Daily prices for \(~ 120\)K goods, aggregated to weeks. 85 countries from 2008-2013. Coverages varies by retailer.

- Match identical products using retailer-specific id codes (larger overlap and coverage than region-specific UPCs)

- Prices include VAT taxes (US/Can are exceptions). Not within-country shipping costs. No info on quantities.

- Online and offline prices generally identical. Confirmed with customer service as well as our own physical checks.

- One price per country (true for most non-grocery items of largest U.S. retailers, like Walmart, Walgreens, Costco, etc.)
Online Prices Equal Offline Prices

(a) IKEA Online

(b) IKEA in Store
Good-level RER Definition

- $p_i(z, t)$ is log price of $z$ in country $i$ in week $t$
- $e_{ij}(t)$ is log exchange rate (units of currency $i$ per unit of $j$’s)
- $q_{ij}(z, t)$ is the log of the good-level RER:
  \[ q_{ij}(z, t) = p_i(z, t) - e_{ij}(t) - p_j(z, t) \]
- $q_{ij}(z, t) = 0$ when the LOP holds
Good-level RERs $q_{ij}$ for $j = \text{United States}$
Good-level RERs $q_{ij}$ for $j = \text{United States}$, by Store

(a) Apple  
(b) IKEA  
(c) H&M  
(d) Zara
Good-level RERs $q_{ij}$ for $j = \text{Spain}$
Good-level RERs $q_{ij}$ for $j = \text{Spain}$, by Store

(a) Apple
(b) IKEA
(c) H&M
(d) Zara
Currency Unions or the Euro Zone?

- Bahrain: Pegged to Dollar
- Ecuador: Dollarized
- Hong Kong: Pegged to Dollar
- Jordan: Pegged to Dollar
- Kazakhstan: Pegged to Dollar
- Lebanon: Pegged to Dollar
- Oman: Pegged to Dollar
- Panama: Dollarized (Weaker Form)
- Qatar: Pegged to Dollar
- El Salvador: Dollarized
- Saudi Arabia: Pegged to Dollar
- United Arab Emirates: Pegged to Dollar
## Unconditional Averages

### Panel A: Average Absolute Values of Log Good-level RERs

<table>
<thead>
<tr>
<th></th>
<th>All Stores</th>
<th>Apple</th>
<th>IKEA</th>
<th>H&amp;M</th>
<th>Zara</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currency Unions</td>
<td>0.076</td>
<td>0.023</td>
<td>0.129</td>
<td>0.020</td>
<td>0.102</td>
</tr>
<tr>
<td>NER Pegs</td>
<td>0.116</td>
<td>0.085</td>
<td>0.145</td>
<td>0.119</td>
<td>0.115</td>
</tr>
<tr>
<td>Floats</td>
<td>0.187</td>
<td>0.143</td>
<td>0.216</td>
<td>0.145</td>
<td>0.207</td>
</tr>
</tbody>
</table>

### Panel B: Share of Abs. Val. of Log Good-level RERs < 0.01

<table>
<thead>
<tr>
<th></th>
<th>All Stores</th>
<th>Apple</th>
<th>IKEA</th>
<th>H&amp;M</th>
<th>Zara</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currency Unions</td>
<td>0.610</td>
<td>0.681</td>
<td>0.307</td>
<td>0.911</td>
<td>0.548</td>
</tr>
<tr>
<td>NER Pegs</td>
<td>0.069</td>
<td>0.140</td>
<td>0.081</td>
<td>0.069</td>
<td>0.064</td>
</tr>
<tr>
<td>Floats</td>
<td>0.045</td>
<td>0.049</td>
<td>0.033</td>
<td>0.062</td>
<td>0.040</td>
</tr>
</tbody>
</table>
## Conditional Results

<table>
<thead>
<tr>
<th></th>
<th>All Stores</th>
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<th>H&amp;M</th>
<th>Zara</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside of CUs.</td>
<td>0.123</td>
<td>0.054</td>
<td>0.034</td>
<td>0.091</td>
<td>0.162</td>
</tr>
<tr>
<td>Pegged NER</td>
<td>-0.037</td>
<td>-0.040</td>
<td>-0.018</td>
<td>0.003</td>
<td>-0.053</td>
</tr>
<tr>
<td>Log NER Vol.</td>
<td>-0.034</td>
<td>-0.017</td>
<td>-0.029</td>
<td>0.001</td>
<td>-0.027</td>
</tr>
<tr>
<td>Log Bilateral Dist.</td>
<td>0.013</td>
<td>0.012</td>
<td>0.015</td>
<td>0.007</td>
<td>0.016</td>
</tr>
<tr>
<td>Abs. Relative Inc.</td>
<td>0.002</td>
<td>-0.001</td>
<td>0.023</td>
<td>0.003</td>
<td>0.000</td>
</tr>
<tr>
<td>Abs. Relative Taxes</td>
<td>0.074</td>
<td>0.477</td>
<td>0.072</td>
<td>0.049</td>
<td>0.015</td>
</tr>
<tr>
<td>Cty. Dumies:</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
### Are Results Representative? Just Small-Ticket Items?

#### Panel A: Average Absolute Values of Log Good-level RERs

<table>
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<tr>
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<th>IKEA</th>
<th>H&amp;M</th>
<th>Zara</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currency Unions</td>
<td>0.076</td>
<td>0.023</td>
<td>0.129</td>
<td>0.020</td>
<td>0.102</td>
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<td>0.187</td>
<td>0.143</td>
<td>0.216</td>
<td>0.145</td>
<td>0.207</td>
</tr>
<tr>
<td>$(p_i + p_j) &gt;$100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currency Unions</td>
<td>0.065</td>
<td>0.023</td>
<td>0.096</td>
<td>0.005</td>
<td>0.086</td>
</tr>
<tr>
<td>NER Pegs</td>
<td>0.109</td>
<td>0.081</td>
<td>0.107</td>
<td>0.113</td>
<td>0.111</td>
</tr>
<tr>
<td>Floats</td>
<td>0.189</td>
<td>0.144</td>
<td>0.178</td>
<td>0.152</td>
<td>0.205</td>
</tr>
<tr>
<td>$(p_i + p_j) &gt;$400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currency Unions</td>
<td>0.043</td>
<td>0.022</td>
<td>0.086</td>
<td>0.013</td>
<td>0.097</td>
</tr>
<tr>
<td>NER Pegs</td>
<td>0.096</td>
<td>0.078</td>
<td>0.094</td>
<td>0.125</td>
<td>0.118</td>
</tr>
<tr>
<td>Floats</td>
<td>0.171</td>
<td>0.151</td>
<td>0.170</td>
<td>0.141</td>
<td>0.270</td>
</tr>
</tbody>
</table>
Are Results Representative? Additional Stores...

<table>
<thead>
<tr>
<th></th>
<th>All Additional Stores</th>
<th>Adidas</th>
<th>Dell</th>
<th>Mango</th>
<th>Nike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: Average Absolute Values of Log Good-Level RERs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Currency Unions</td>
<td>0.086</td>
<td>0.087</td>
<td>0.054</td>
<td>0.112</td>
<td>0.053</td>
</tr>
<tr>
<td>(ii) NER Pegs</td>
<td>0.154</td>
<td>0.172</td>
<td>0.130</td>
<td>0.158</td>
<td>0.103</td>
</tr>
<tr>
<td>(iii) Floats</td>
<td>0.201</td>
<td>0.207</td>
<td>0.139</td>
<td>0.203</td>
<td>0.210</td>
</tr>
</tbody>
</table>

Panel B: Share of Abs. Val. of Log Good-level RERs < 0.01

<table>
<thead>
<tr>
<th></th>
<th>All Additional Stores</th>
<th>Adidas</th>
<th>Dell</th>
<th>Mango</th>
<th>Nike</th>
</tr>
</thead>
<tbody>
<tr>
<td>(iv) Currency Unions</td>
<td>0.377</td>
<td>0.353</td>
<td>0.380</td>
<td>0.332</td>
<td>0.442</td>
</tr>
<tr>
<td>(v) NER Pegs</td>
<td>0.054</td>
<td>0.027</td>
<td>0.041</td>
<td>0.053</td>
<td>0.092</td>
</tr>
<tr>
<td>(vi) Floats</td>
<td>0.049</td>
<td>0.045</td>
<td>0.052</td>
<td>0.041</td>
<td>0.138</td>
</tr>
</tbody>
</table>
Are Results Representative? Distributer Role Only...

- Is it important that manufacturer and retailer are the same?

- IKEA, for example, makes nearly all the goods it sells, and sells nearly all the goods it makes.

- Apple, however, makes less than half of the goods that it distributes. It sells, for example:
  - Cables and adaptors by Apogee, Belkin, and Kanex
  - Canon digital cameras
  - Epson printers
  - Michael Kors travel totes

- Of the goods sold by Apple, our patterns hold equally well among Apple and non-Apple products.
### Does This Show Up in “Aggregated” Data? Eurostat...

<table>
<thead>
<tr>
<th></th>
<th>Audio Equip</th>
<th>Clothes</th>
<th>Elect Equip</th>
<th>Metal Prods</th>
<th>Shoes</th>
<th>Furniture</th>
<th>Software</th>
<th>Transp Equip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro</td>
<td>0.067</td>
<td>0.091</td>
<td>0.069</td>
<td>0.067</td>
<td>0.114</td>
<td>0.095</td>
<td>0.112</td>
<td>0.079</td>
</tr>
<tr>
<td>Pegs</td>
<td>0.103</td>
<td>0.167</td>
<td>0.082</td>
<td>0.115</td>
<td>0.174</td>
<td>0.375</td>
<td>0.109</td>
<td>0.120</td>
</tr>
<tr>
<td>Floats</td>
<td>0.123</td>
<td>0.198</td>
<td>0.091</td>
<td>0.101</td>
<td>0.200</td>
<td>0.296</td>
<td>0.133</td>
<td>0.121</td>
</tr>
</tbody>
</table>
Results

- Result 1: LOP holds well within currency unions \((q \approx 0)\)
  - Does not hold for hard pegs, so not just lack of NER volatility
  - Evidence for both euro zone and dollarized countries
  - Currency union swamps geography, tariffs, culture, etc.
  - Conveniently eliminates worry about matching errors

- Result 2: We now introduce an RER decomposition
RER Decomposition

- Let $i_i(z)$ be the $t$ at which good $z$ is first available in $i$
- Let $l_i(z, t)$ be the most recent $t$ when $z$ changed price in $i$
- Let $\bar{p}_i(z) = p_i(z, i_i(z))$ be the log price at introduction
- We can then write the price of $z$ in $i$ at $t$ as:

$$p_i(z, t) = \bar{p}_i(z) + \Delta_{i_i(z)}^{l_i(z, t)} p_i(z)$$
RER Decomposition

- Re-write this when translated into country $k$ currency units:

$$p_i(z, t) - e_{ik}(t) = \bar{p}_i(z) - e_{ik}(i_i(z)) + \Delta_{i_i(z)} p_i(z) - e_{ik} - \Delta_{l_{i(z), t}} e_{ik}$$

\[\text{Price at Introduction}\]
\[\text{Price Changes}\]
\[\text{Stickiness}\]

- Combining with equivalent expression for $p_j(z, t) - e_{jk}(t)$:

$$q_{ij}(z, t) = \bar{p}_i(z) - e_{ik}(i_i(z)) - \bar{p}_j(z) + e_{jk}(i_j(z))$$

\[\text{Good-Level RER at Introduction}\]

$$+ \Delta_{i_i(z)} p_i(z) - e_{ik} - \Delta_{l_{i(z), t}} p_j(z) - e_{jk} - \left[\Delta_{l_{i(z), t}} e_{jk} - \Delta_{l_{j(z), t}} e_{jk}\right]$$

\[\text{Changes in Demand}\]
\[\text{Stickiness}\]
• To eliminate dependence on 3rd countries we take the average of the decomposition when $k = i$ and when $k = j$.

• From now on, we write these terms as:

$$q_{ij} (z, t) = q^L_{ij} (z, t) + q^D_{ij} (z, t) + q^S_{ij} (z, t)$$

• Results are robust to obvious alternatives
Decomposition $q_{ij} = q_{ij}^l + q_{ij}^D + q_{ij}^S$ for $j = \text{United States}$

(a) Good-level RER ($q_{ij}$)  
(b) RER At Intro ($q_{ij}^l$)  
(c) Changes in Demand ($q_{ij}^D$)  
(d) Stickiness ($q_{ij}^S$)
Decomposition \( q_{ij} = q^l_{ij} + q^D_{ij} + q^S_{ij} \) for \( j = \text{Spain} \)
Decomposing Cross-Sectional Variation in $q_{ij}$

- **Canada and USA**
  - Full Sample

- **Japan and USA**
  - Full Sample

- **Mexico and USA**
  - Full Sample

- **Denmark and Spain**
  - Full Sample

- **France and Spain**
  - Full Sample

- **Norway and Spain**
  - Full Sample
Decomposing Cross-Sectional Variation in $q_{ij}$

Graphs showing the distribution of Intro, Demand, and Stickiness for different countries and samples.
Importance of $q^I$ for RER measurement and PPP Puzzle

- Price indices use *changes*, not *levels*, so omit info in $q^I$.
- Won’t distinguish RER behavior for CU vs. Peg
- Plausible Explanation for PPP Persistence Puzzle?
  - Imagine prices never change. RER=NER for existing goods.
  - Goods frequently enter/exit with $q^I$ i.i.d. with mean $\bar{q}$
  - True $q$ can’t wander too far from $\bar{q}$, mean-reverts with intros
  - If price indices ignore intros, measured $q$ can wander from $\bar{q}$
- Puzzle solved? Nope. $q^I$ moves closely with NER in our data.
Good-level RERs at Introduction vs. NER, Raw Data

Austria and USA

Canada and USA

China and USA

Spain and USA

Germany and USA

Finland and USA

France and USA

Italy and USA

Japan and USA

Mexico and USA

Sweden and USA

United Kingdom and USA

Apple □ □ □ □
Ikea ▲ ▲ ▲ ▲
H & M □ □ □ □
Zara □ □ □ □
Good-level RERs at Introduction vs. NER, Lowess

- Austria and USA
- Canada and USA
- China and USA
- Spain and USA
- Germany and USA
- Finland and USA
- France and USA
- Italy and USA
- Japan and USA
- Mexico and USA
- Sweden and USA
- United Kingdom and USA

RER at Introduction

Log Exchange Rate
Good-level RERs at Introduction vs. NER, Regression

<table>
<thead>
<tr>
<th>All Stores (Wtd.)</th>
<th>All Stores (Unwtd.)</th>
<th>Apple</th>
<th>IKEA</th>
<th>H&amp;M</th>
<th>Zara</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) All Bilats.</td>
<td>0.826 (0.006)</td>
<td>0.686 (0.007)</td>
<td>0.414 (0.010)</td>
<td>0.819 (0.031)</td>
<td>0.985 (0.004)</td>
</tr>
<tr>
<td>(ii) U.S. Bilats.</td>
<td>0.868 (0.022)</td>
<td>0.680 (0.025)</td>
<td>0.493 (0.030)</td>
<td>0.848 (0.048)</td>
<td>1.021 (0.027)</td>
</tr>
</tbody>
</table>

**Dependent Variable:** Good-Level Log RER at Introduction $q_{ij}^l$

**Independent Variable:** Log NER

**Fixed Effects:** Country Pair Effects
Conclusions and Implications

- What determines market segmentation? Being in a currency union appears to be far more important than:
  - Distance
  - Culture
  - Taxes or tariffs
  - NER volatility

- Macro implications
  - Optimal currency areas
  - Cost of "internal devaluations"

- Modeling and measurement of RER
  - PCP vs. LCP modeling
  - RER at Intro tracking NER suggests important role for variable markups and real rigidities.
  - Standard measures of RER may omit critical information