LECTURES 8 & 9: PURCHASING POWER PARITY (PPP)

EMPIRICAL TESTS OF PPP

Motivating questions:

How integrated are goods markets internationally?

How rapidly do prices adjust?
PPP: ALTERNATIVE DEFINITIONS

Absolute PPP:

\( P \equiv \) price of a basket of goods in domestic currency

esp. from the World Bank’s International Comparison Program.

- \( RER = 1 \), where real exchange rate \( RER \equiv E \frac{P^*}{P} \)

- \( P = E P^* \)

- \( E = \frac{P}{P^*} = \frac{1/P^*}{1/P} \)

- In logs: \( e = p - p^* \).
Relative PPP

\( CPI \equiv \) is a price index, expressed relative to an arbitrary base year e.g., “\( CPI_{2000} \equiv 100.0 \)” (from national agencies).

Define real exchange rate \( Q \equiv E \frac{CPI^*}{CPI} \).

- \( Q \) is constant (at \( \bar{Q} \)), or \( E = \bar{Q} \frac{CPI}{CPI^*} \).

- \( CPI = \frac{1}{\bar{Q}} (E)(CPI^*) \).

- In logs, \( \Delta e = \Delta cpi - \Delta cpi^* \) (relative to some base year).

- Annual depreciation = \( \pi - \pi^* \).
PPP: EMPIRICAL QUESTIONS

• Does PPP hold: in the short run? No.
   In the long run? Maybe.
   • What is the estimated speed of adjustment to the LR?
   • What is the test’s “statistical power”?

• Are PPP deviations:
   • related to variation in nominal exchange rates?
     - Can one infer causality?
   • related to geography?
     - To distance? To borders?

• Does the Law of One Price hold better in some sectors than others?
  - Commodities vs. Manufactures & Services
  - Tradables vs. Nontradables
  - Imports. (Is there full pass-through?)
PPP in a sense holds well in hyperinflations:
The cumulative change in $E$ corresponds to the cumulative change in $CPI$. 
SPECIFICATION OF PPP TEST:

the real exchange rate as an autoregressive process

\[ q_t = k + \delta q_{t-1} + u_t \]  
where \( u_t \equiv \) random disturbance with \( E(u_t) = 0. \)

\( H_0: \ \delta = 1 \)  
(random walk, or unit root)

\( H_1: \ \delta = 0 \)  
(full adjustment to PPP)

\( H_{Alt}: 0 < \delta < 1 \)  
(gradual adjustment to PPP).

Common finding in tests of 1980s: can’t reject \( H_0 \).

True problem:

**Insufficient power** in the tests, due to insufficient data.

Since 1990, studies have sought more data.
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- \( RER = 1 \), where real exchange rate \( RER \equiv E \frac{P^*}{P} \)
- \( P = E P^* \)
- \( E = \frac{P}{P^*} \Rightarrow \frac{1}{P^*} = \frac{1}{P} \)
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PPP: ALTERNATIVE DEFINITIONS (continued)

Relative PPP

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Define real exchange rate $Q \equiv E \frac{CPI^*}{CPI}$.

- $Q$ is constant (at $Q$), or $E = \bar{Q} \frac{CPI}{CPI^*}$.
- $CPI = \frac{1}{Q} (E)(CPI^*)$.
- In logs, $\Delta e = \Delta cpi - \Delta cpi^*$ (relative to some base year).
- Annual depreciation $= \pi - \pi^*$. 

Prof. Jeffrey Frankel, Harvard Kennedy School
PPP: ALTERNATIVE DEFINITIONS

**Absolute PPP :**

\[ P \equiv \text{price of a basket of goods in domestic currency} \]

esp. from the World Bank’s International Comparison Program.

- \( RER = 1 \), where real exchange rate \( RER \equiv E \frac{P^*}{P} \)
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- \( CPI = \frac{1}{\bar{Q}} (E)(CPI^*) \).

- In logs, \( \Delta e = \Delta cpi - \Delta cpi^* \) (relative to some base year).

- Annual depreciation = \( \pi - \pi^* \).
With 100 or 200 years of data it is not hard to reject a random walk, i.e., to detect regression to the mean.

## Studies with long time series:

<table>
<thead>
<tr>
<th>Study</th>
<th>Time Period</th>
<th>Estmt. $\delta$</th>
<th>Speed of Adjustment</th>
<th>Half-life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JF (1990)</td>
<td>1869-1987</td>
<td>.84</td>
<td>.16</td>
<td>4</td>
</tr>
<tr>
<td>Updated WTP (2007)</td>
<td>1791-2005</td>
<td>.88</td>
<td>.12 (s.e.=.05)</td>
<td>4</td>
</tr>
<tr>
<td>Alan Taylor (2002)</td>
<td>1870-1996</td>
<td>.79</td>
<td>.21 (s.e.=.01)</td>
<td>3.4 – 4.1</td>
</tr>
</tbody>
</table>

## Cross-country panel data studies:

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of countries</th>
<th>Country</th>
<th>Half-life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frankel &amp; Rose (1995)</td>
<td>150</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Wei &amp; Parsley (1998)</td>
<td>14</td>
<td></td>
<td>4-5</td>
</tr>
<tr>
<td>Choi, Mark &amp; Sul (2004)</td>
<td>21</td>
<td></td>
<td>5.5</td>
</tr>
</tbody>
</table>
Figure 1.—A Century of Real Exchange Rates

Taylor spliced together 100+ years of data for 20 currencies: 1870-1996

One lesson: reversion to LR

Alan M. Taylor, A Century of Purchasing-Power Parity

* 2002 by the President and Fellows of Harvard College and the Massachusetts Institute of Technology
Why does PPP fail so badly in the short run?

$\Delta E$ with sticky prices?
Or does the same exogenous real $\Delta Q$ show up as $\Delta E$ or $\Delta P$, depending if rate is floating vs. fixed?

Three useful kinds of evidence:

• The pattern of movement in real exchange rates:
  • band or threshold
  • Random Walk
  • trend
  • AR.

• Effects of exchange rate regime on variability in $Q$.

• Tests of Law of One Price for narrowly defined goods.
Four patterns of deviation from PPP and their likely origins:

a) Band $\leq$ barriers to trade

b) Random walk $\leq$ shifts in terms of trade

c) Trend $\leq$ Balassa-Samuelson effect

d) Autoregression $\leq$ sticky prices.
Var($e_t$) and Var ($q_t$) are correlated.

Is it coincidence? No, it can’t be: Every time a regime switch raises variability of nominal exchange rates, it also raises variability of real exchange rates.

- Pre- and post-1973 (Fig. 19.4)

- Inter-war period (Eichengreen, 1988): 1922-26 float vs. 1927-31 fix

- Post-war regimes (Mussa, 1986):
  - Canadian float in the 1950s
  - Ireland regime changes (see appendix table)

  1914-45 Interwar
  1946-71 Bretton Woods
  1971-96 Float
When nominal exchange rate variability (¥/$) went up with floating, real exchange rate variability went up in tandem.

Coincidence?

Figure 19.4
Nominal & real exchange rates both became more volatile after 1973.
The final nail in the coffin:
Exchange rate variability across a century of regimes

Each observation is a country-regime.  (Adapted from A.Taylor, 2002)

Variability of real exchange rate

Variability of nominal exchange rate

Again, each time a more flexible regime raises nominal variability, it raises real variability too.
Looking ahead -- FAILURES OF PURCHASING POWER PARITY (PPP)

Tests of the Law of One Price

1. NTGs
2. Commodities
3. Manufactures
4. Big Mac hamburgers
5. Imports

Barriers to International Integration

Transportation costs
Tariffs & non-tariff trade barriers
Border frictions
Currencies

Non-Traded Goods
-- The Balassa-Samuelson Effect
Tests of the Law of One Price (LoOP)

1. NonTraded Goods & Services, e.g., haircuts & housing have little scope for arbitrage.

2. Commodities – oil, minerals, & agriculture. -- where arbitrage can potentially work well.

3. Disaggregated manufactures

4. Retail: In reality, even TGs have a NTG component (distribution & marketing), & vice versa.
   - Some models make the TG/NTG line endogenous: Bergin (2003); Ghironi & Melitz (2004)

5. Pass-through of import prices.
Prices of nontraded services vary widely. Notice that they are lower in poorer (low-wage) countries than in high-wage countries.
Arbitrage equalizes prices for a homogenous metal such as gold => The Law of One Price holds.

### Gold Prices Around the World

<table>
<thead>
<tr>
<th>Exchange</th>
<th>Time (Eastern Standard Time)</th>
<th>USD/Troy Ounce</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>10:28</td>
<td>$625.01</td>
</tr>
<tr>
<td>Australia</td>
<td>10:28</td>
<td>$625.00</td>
</tr>
<tr>
<td>Brazil</td>
<td>9:53</td>
<td>$617.71</td>
</tr>
<tr>
<td>Switzerland</td>
<td>10:28</td>
<td>$625.51</td>
</tr>
<tr>
<td>India</td>
<td>6:07</td>
<td>$634.89</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>10:21</td>
<td>$622.75</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>5:58</td>
<td>$624.50</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>0:51</td>
<td>$623.40</td>
</tr>
</tbody>
</table>

Prices were downloaded from Bloomberg on November 3, 2006.

Note: India has tariffs & quotas on gold imports.

Even in a manufacturing sector as disaggregated and seemingly standardized as ball bearings, the relative price in Japan varies (1) widely, and (2) in correlation with the ¥/$ exchange rate.
4. Big Macs

Big Macs are partly traded (ingredients) & partly nontraded (cooking & retail).

Their price varies widely across countries.

The price tends to be higher in rich countries (e.g., Europe & Japan), than in developing countries (e.g., China) and in countries with overvalued currencies (e.g., Argentina in 2000).
5. Pass-through to import prices

- Pass-through coefficient $\equiv$ % change in local price resulting from a given % change in exchange rate.
- Pass-through is greatest for imported goods at dock, but less for prices of the same goods at retail level.
- Reason: local distribution & retail costs.
- The passthrough to prices of local substitutes is again less; and is still less to the CPI.

Exchange rate pass-through to domestic prices

- Source: Frankel, Parsley & Wei (2012)
Passthrough coefficients for less developed countries > for rich, historically.

Passthrough and Income
(Average 1990-2001)
(Country Grouping Based on World Bank Classification)

Source: Frankel, Parsley & Wei (2012)