International Economics II

The Real Exchange Rate and PPP

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Outline

1. The Law of One Price, PPP and Real Exchange Rate

2. Relative PPP

3. Determinants of Real Exchange Rate

Motivation

- Thus far, our small-open economy model has been a one-good model, where countries around the world produce/consume the same good and trade it at the same price. (one exception is when we studied terms-of-trade shocks.)
- This is a very stylized (and inaccurate) view of reality:
  - Households (firms) consume (produce) many different types of goods within a country.
  - Goods need not be the same price across countries, and if they are, they should be valued in a common currency.
- Need to introduce a concept to measure the relative price of goods across countries.
- How do relative prices vary across countries? How are they determined? How do they react to shocks? What are the implications for a country's external balance (i.e., the CA)?

Outline

1. The Law of One Price, PPP and Real Exchange Rate

2. Relative PPP

3. Determinants of Real Exchange Rate

The Law of One Price (LOOP)

- LOOP say that a good should cost the same abroad and at home.
- Formally, if the LOOP holds for good i, then

$$P_i = P_i^* \mathcal{E}, \tag{1}$$

where

- P_i = domestic currency price of good i.
- P_i^* = foreign currency price of good i.
- $\mathcal{E}$ = nominal exchange rate (domestic currency price for 1 unit of foreign currency).

The Law of One Price (LOOP)

- Examples of goods for which the LOOP holds:
  - Gold
  - Oil
  - Wheat (... commodities)
  - Luxury consumer goods (Ferraris, Rolex watches, etc.)
- Examples of goods for which the LOOP fails:
  - Big Mac
  - Housing
  - Transportation
  - Haircuts
  - Restaurant meals

Reasons Why the LOOP May Fail

1. A good has non-traded inputs such as: Labor, Rent, Electricity, etc.
2. Government policies/regulations (taxes)
3. Barriers to trade (tariffs, quotas)
4. Pricing to market (e.g., pharmaceuticals)

In general, when it is hard to exploit arbitrage the LOOP will fail.

The Big Mac Index

- Question: does the LOOP hold for a Big Mac?
- Interesting because: (i) Big Macs are produced more or less the same way all over the world; (ii) prices are readily available. (iii) it's a popular good.
- Construct a measure of how many U.S. Big Macs it takes to buy one Big Mac in the other country:

$$e^{\text{BigMac}} = \frac{\mathcal{E} \times P^{\text{BigMac }*}}{P^{\text{BigMac}}} \tag{2}$$

  - e^{BigMac} = Big Mac real exchange rate.
  - P^{BigMac} = dollar price of a Big Mac in the United States.
  - $P^{\text{BigMac}*}$ = foreign-currency price of a Big Mac in a foreign country.

- If $e^{\text{BigMac}} > 1$, then the Big Mac is more expensive in one country relative to the U.S.

The Big-Mac Real Exchange Rate, January 2019

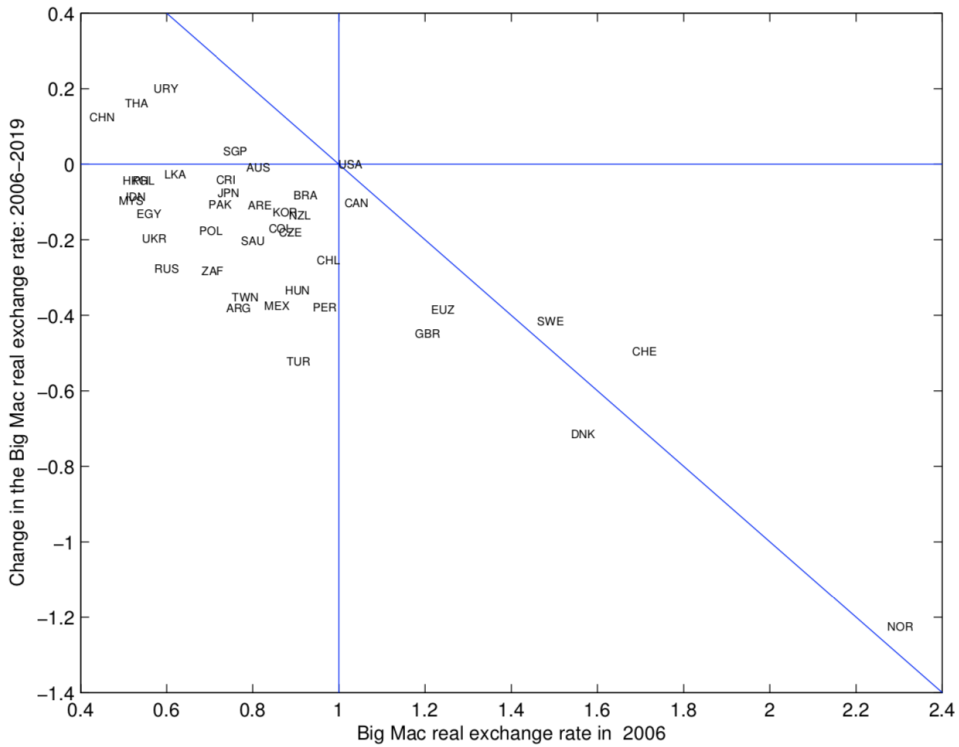
Country	$P^{\text{BigMac}*}$	$\mathcal{E}$	$\mathcal{E}P^{\text{BigMac}*}$	e^{BigMac}	$\mathcal{E}^{\text{BigMac}\,PPP}$
Switzerland	6.50	1.02	6.62	1.19	0.86
United States	5.58	1	5.58	1	1
Euro area	4.05	1.15	4.64	0.83	1.38
South Korea	4500.00	0.00	4.02	0.72	0.00
China	20.90	0.15	3.05	0.55	0.27
India	178	0.01	2.55	0.46	0.03
Russia	110.17	0.01	1.65	0.30	0.05

For updated values, check The Economist:
https://www.economist.com/news/2020/01/15/the-big-mac-index.

The Big Mac Index

- The table shows that the law of one price does not hold well for the Big Mac:
- Example: In Switzerland a Big Mac sells for the equivalent of $6.62. So one Big Mac in Switzerland buys you 1.19 Big Macs in the US. The Big Mac real exchange rate is 1.19.
- Why is the Big Mac so expensive in some countries and so cheap in others? Look at the international tradability of its components:
  - Highly Tradable: grain (wheat and sesame seeds), meat, and dairy (cheese). These components represent a small fraction of the total cost of a Big Mac.
  - Hardly Tradable: labor (compare wage per hour of a burger flipper in the US vs India), rent, electricity, and water. Large share of the cost of a Big Mac.
- We will explore in more detail later whether prices are lower in poor and emerging countries than in rich countries.

Changes in Big Mac Real Exchange Rates from 2006 to 2019



- Countries left of the vertical line were relatively cheaper than the US in 2006.
- Countries below the horizontal line became relatively cheaper than the US between 2006 and 2019.
- Most countries were cheaper than the United States in 2006 and that many of them became even cheaper by 2019.

Purchasing Power Parity

- **PPP** stands for Purchasing Power Parity.
- It generalizes the law of one price to a basket of goods.
- To move from LOOP to PPP, we need to introduce the concept of a real exchange rate.

The Real Exchange Rate

- The real exchange rate (RER) tells us how many units of the domestic basket of goods are needed to buy one unit of the foreign basket of goods. It is defined as:

$$e = \frac{\mathcal{E} P^*}{P} \tag{3}$$

where

- $P =$ domestic currency price of of a domestic basket of goods.
- $P^* =$ foreign currency price of a foreign basket of goods.
- $\mathcal{E} =$ nominal exchange rate (domestic currency price for 1 unit of foreign currency).

Different Concepts of PPP

We will study two different concepts of PPP, and look at whether they hold in the data.

1. Absolute PPP: We say that absolute PPP holds when

$$e = 1 \tag{4}$$

2. Relative PPP: We say that relative PPP holds when

$$\Delta e = 0 \tag{5}$$

Absolute PPP

- Absolute PPP holds if $e_t = 1$, that is if the purchasing power of 1 euro is the same in Spain and abroad.
- To test for absolute PPP we do need to observe the level of P_t and P_t^* and not just an index.
- It is very hard to get data for the level of P_t, because statistical agencies that produce the CPI typically publish an index and not the actual price level of a typical basket.
- Also, the basket of goods has to be comparable across countries.

Deviations From Absolute PPP in Selected Countries

Country	e	$\mathcal{E}$	$\mathcal{E}^{PPP}$
Switzerland	1.63	1.13	0.69
Australia	1.56	1.03	0.66
Japan	1.35	0.0125	0.00931
United Kingdom	1.12	1.60	1.43
Germany	1.08	1.39	1.28
United States	1	1	1
South Korea	0.7711	0.0009023	0.00117
China	0.54	0.15	0.29
India	0.32	0.02	0.07
Vietnam	0.33	4.88e-05	0.000149
India	0.32	0.02	0.07
Bangladesh	0.31	0.01	0.04
Pakistan	0.28	0.01	0.04
Egypt	0.27	0.17	0.62

$e = \mathcal{E}P^*/P$: RER; $\mathcal{E}$: nominal exchange rate; $\mathcal{E}^{PPP} = P/P^*$: PPP exchange rate.

Deviations From Absolute PPP in Selected Countries

- The table plots multiple exchange rates in 2011: the variable P^* denotes the foreign-currency price of a basket in the foreign country, and P denotes the dollar price of a basket in the United States.
- How To Interpret It? If absolute PPP held, then a basket of goods that costs 100 dollars in the United States should also cost 100 dollars in every country.
- The table suggests that there are large deviations from absolute PPP. For example, a basket that in 2011 cost 100 dollars in the United States cost 163 dollars in Switzerland and only 27 dollars in Egypt.

$\Rightarrow$ Absolute PPP fails!

The International Comparison Program (ICP)

- There is one source on actual price levels: The International Comparison Program (ICP). It represents the most extensive and thorough effort to measure absolute PPP rates across countries.
- The ICP was established in the late 1960s on the recommendation of the United Nations Statistical Commission (UNSC).
- The first comparison, conducted in 1970, covered 10 economies. Now, 40 years later, the ICP is a worldwide statistical operation whose latest comparison – ICP 2011 – involved 199 economies. The program is led and coordinated by the ICP Global Office hosted by the World Bank.
- The 2011 ICP round collected over 7 million prices from 199 economies in eight regions, with the help of 15 regional and international partners. It is the most extensive effort to measure PPPs ever undertaken.

The International Comparison Program (ICP)

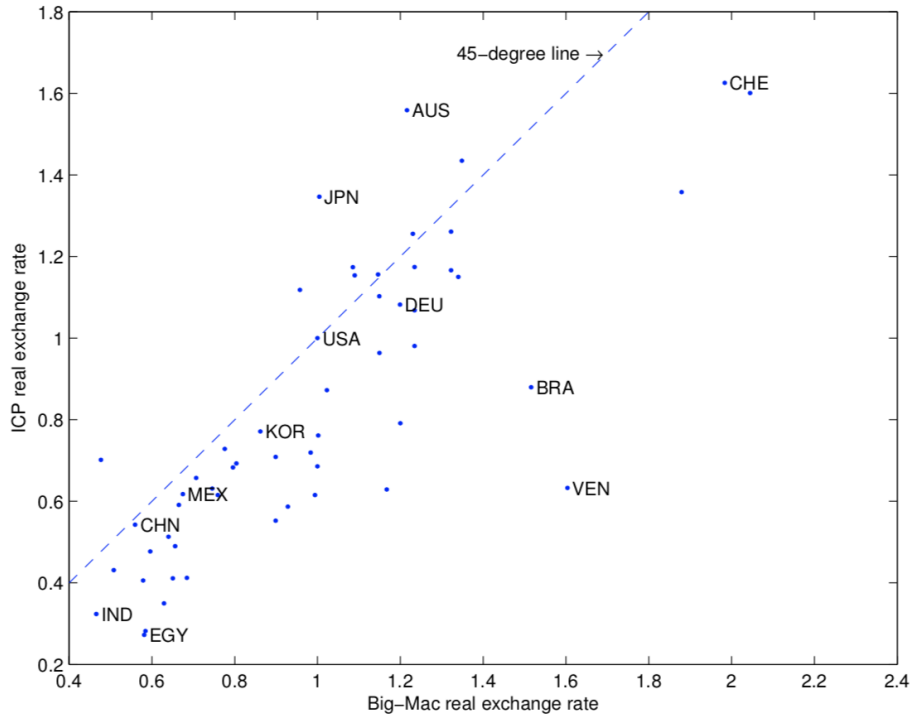
- The ICP reports the real exchange rate, which is referred to as the "Price Level Index":

$$e = PLI = \frac{\mathcal{E}P^*}{P}, \tag{6}$$

- where now P and P^* are actual price levels (and not indices!). Here is what they find for the year 2011 (most recent available):

Country	$100e = 100\frac{SP^*}{P^{US}}$
United States	100
Ethiopia	26
Bangladesh	35
India	33
Pakistan	32
China	42
Germany	111
Sweden	124
Switzerland	140
Japan	118

Comparing the ICP and Big-Mac Real Exchange Rates



- Takeaway: the Big Mac real exchange rate is a good measure of how expensive different countries are relative to one another.
- Why is this Relevant: The ICP RER is difficult to construct and is produced every 6 years. The Big Mac RER is easy to construct and is produced at high frequency

The PPP Exchange Rate

- The PPP exchange rate is the nominal exchange rate that would make the consumption basket in two countries equally expensive.
- Denote the PPP exchange rate, $\mathcal{E}^{PPP}$, as:

$$\mathcal{E}^{PPP} = P/P^* \tag{7}$$

- This is the nominal exchange rate that would make the real exchange rate equal to one.
- If $\mathcal{E}^{PPP} > \mathcal{E} \Rightarrow$ the domestic country is more expensive than the foreign country $(P > \mathcal{E}P^*)$ and we say that the domestic currency is overvalued.
- If $\mathcal{E}^{PPP} < \mathcal{E} \Rightarrow$ the domestic country is cheaper than the foreign country $(P < \mathcal{E}P^*)$ and we say that the domestic currency is undervalued.

The PPP Exchange Rate

Country	$P^{\text{BigMac}*}$	$\mathcal{E}$	$\mathcal{E}P^{\text{BigMac}*}$	e^{BigMac}	$\mathcal{E}^{\text{BigMac}\,PPP}$
Switzerland	6.50	1.02	6.62	1.19	0.86
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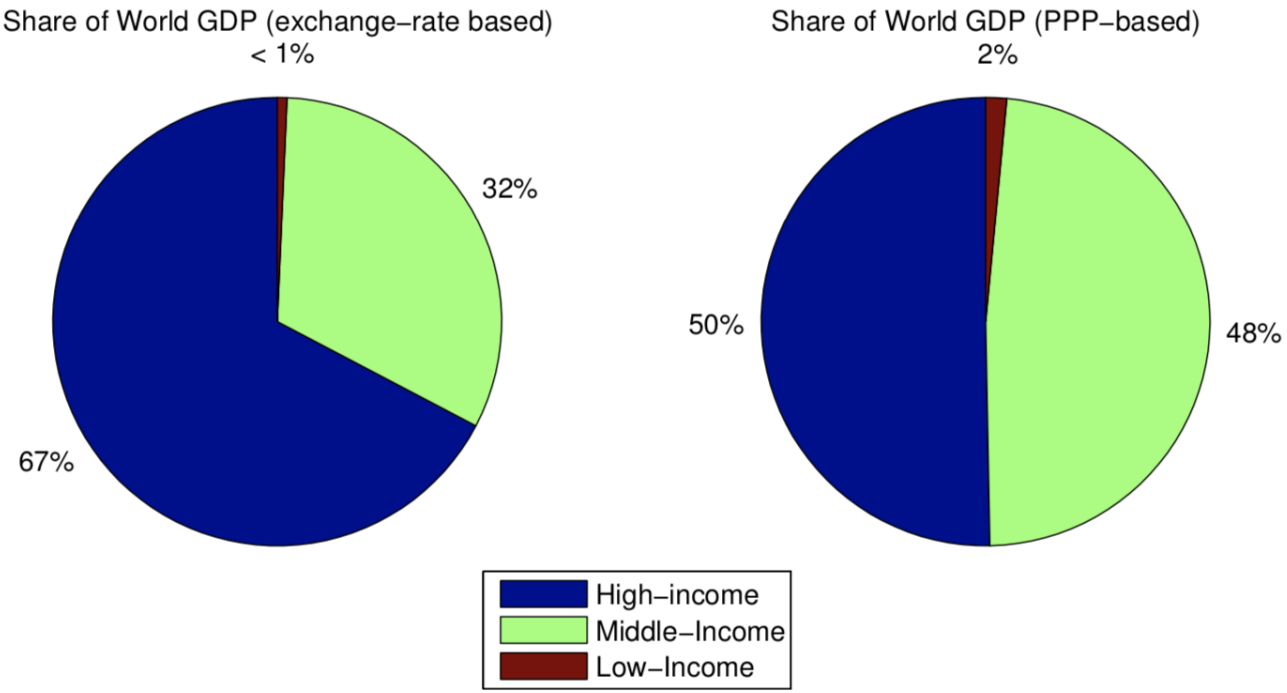
- $\mathcal{E}^{BigMac,PPP} < \mathcal{E} \Rightarrow$ Switzerland is more expensive than the US, and the dollar is undervalued relative to the Swiss franc.
- $\mathcal{E}^{BigMac,PPP} > \mathcal{E} \Rightarrow$ India is cheaper than the US, and the US dollar is overvalued relative to the Indian rupee.

PPP Exchange Rates and World Shares in GDP

- One application of PPP exchange rates is to compare economic size across countries.
- Comparisons of the size of economies (in \$) tend to overstate the size of rich countries and understate the size of poor countries since prices tend to be higher in richer countries.
- The next chart shows that in 2011, middle-income countries produced 32 percent of world GDP at market exchange rates but 48.2 of world GDP at PPP exchange rates.
- The flip-side of this is that GDP of high-income economies becomes significantly smaller when PPP-based GDPs are used, their share in world GDP falls from 67.3 percent to 50.3 percent.
- The largest relative difference obtains for low-income countries whose share in world GDP doubles from 0.7 percent when measured at market exchange rates to 1.5 percent when measured at PPP exchange rates.

World Shares in GDP



Notes: The income categories are as follows: low income – per capita gross national income (GNI) less than $1,025 (32 countries); middle income – per capita GNI from 28 $1,026 to $12,475 (84 countries); and high income – per capita GNI greater than $12,475 (56 countries).

PPP Exchange Rates and Standard of Living Comparisons

- Another application of PPP rates is in standard of living comparisons, because such comparisons are tricky given relative price differences.
- Example: in 2011 GDP per capita was 49,782 USD in the United States but only 1,533 USD in India. Can we conclude that the average American is 32 times richer than the average Indian?
- What if a given amount of dollars buys more goods and services in India than in the United States?
- Let's calculate how many burgers one can buy with each per capita GDP:
  - A Big Mac costs 5.58 dollars in the United States but only 2.55 dollars in India. So one U.S. per capita GDP buys 8,922 Big Macs and one Indian per capita GDP buys 601 Big Macs.
  - Thus, in terms of Big Macs, Americans are 15 times richer than Indians.
- Still a big income gap, but not as large as the one suggested by the simple ratio of dollar GDPs.

PPP and Standard of Living Comparisons

- Now compare GDPs per capita measured in units of baskets of goods.
  - Let GDP^I = GDP per capita in India and P^I = the price of one basket of goods in India, both in Indian rupees.
  - Let GDP^{US} and P^{US} be GDP in the US and the price of one basket of goods in the US, both in dollars.
- GDP^I/P^I = per capita GDP in India in units of baskets of goods and GDP^{US}/P^{US} per capita GDP in the US measured in units of baskets of goods.

$$\text{Ratio of Incomes in Baskets of Good } = \frac{GDP^{US}/P^{US}}{GDP^I/P^I}$$

$$= \frac{1}{P^{US}/P^I}\frac{GDP^{US}}{GDP^I} = \frac{GDP^{US}}{\mathcal{E}^{PPP,I}GDP^I} \tag{8}$$

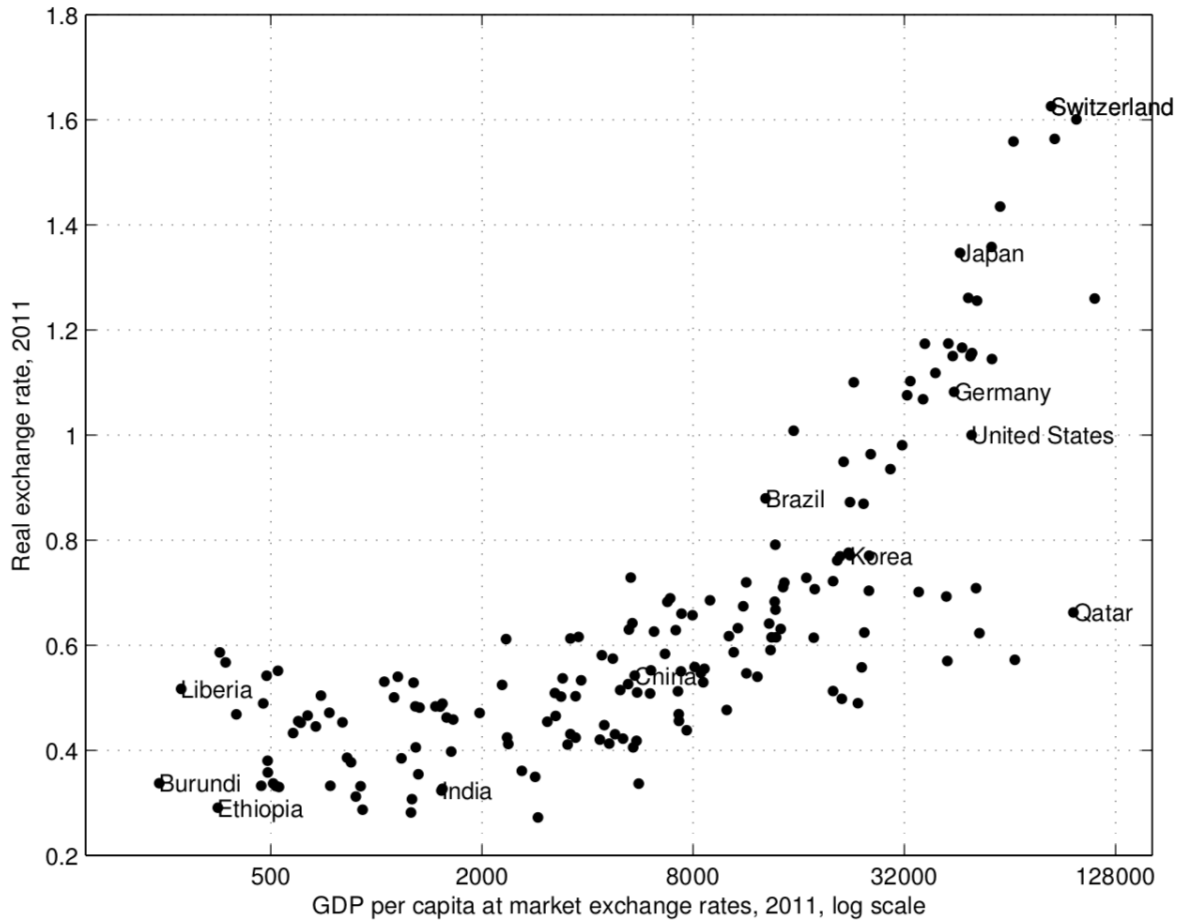
- $\mathcal{E}^{PPP,I}GDP^I = GDP^{PPP,I}$ is the GDP per-capita at PPP exchange rate, it is the GDP per capita when baskets of goods are priced in dollar prices of the United States.

GDP Per Capita at Market and PPP Exchange Rates in 2011

Country	GDP	GDP^{PPP}	$\frac{GDP^{US}}{GDP}$	$\frac{GDP^{US}}{GDP^{PPP}}$
Norway	99035	61879	0.50	0.80
Switzerland	83854	51582	0.59	0.97
Australia	65464	42000	0.76	1.19
United States	49782	49782	1	1
Japan	46131	34262	1.08	1.45
Germany	44365	40990	1.12	1.21
United Kingdom	39241	35091	1.27	1.42
South Korea	22388	29035	2.22	1.71
China	5456	10057	9.12	4.95
Egypt	2888	10599	17.24	4.70
Vietnam	1543	4717	32.26	10.55
India	1533	4735	32.47	10.51
Pakistan	1255	4450	39.68	11.19
Bangladesh	874	2800	56.95	17.78

Here you have more recent data:
`https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD`

Rich Countries are More Expensive than Poor Countries



Plot: the dollar real exchange rate, $e = \mathcal{E}P^*/P^{US}$, against per capita GDP at market exchange rates in 2011 for 177 countries.

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Relative PPP

- Recall Relative PPP : $\Delta e = 0$.
- It is usually much easier to test for relative PPP since one can use Consumer Price Index, which are readily available for many countries at a relatively high frequency.
- How to test relative PPP? Take logs of e_t for any given time period t:

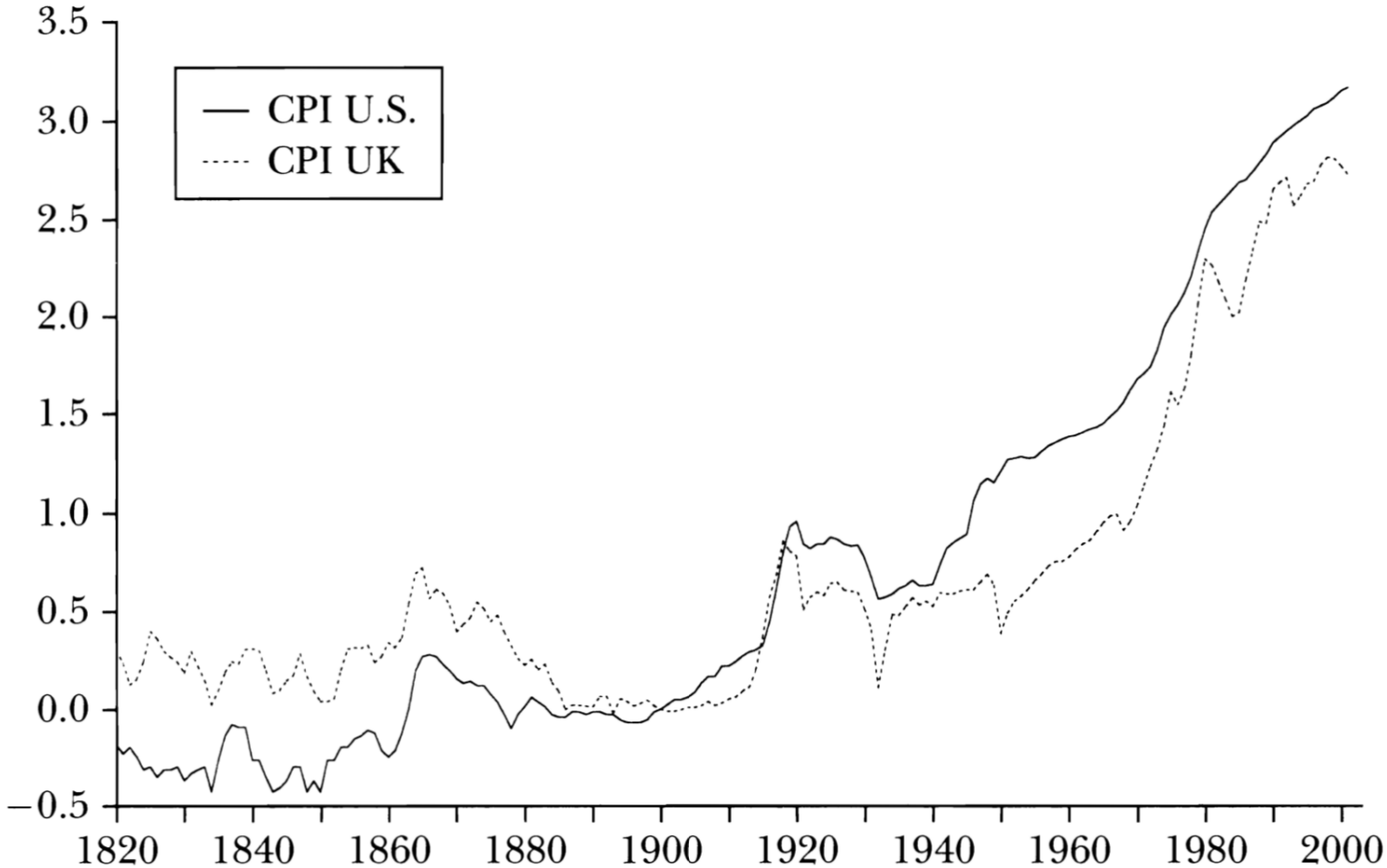
$$\ln e_t = \ln(\mathcal{E}_t P_t^*) - \ln(P_t) \tag{9}$$

- If relative PPP holds, then $\Delta \ln(e_t) = 0$ and thus $\Delta \ln(\mathcal{E}_t P_t^*)$ should be moving over time in tandem with $\Delta \ln(P_t)$.
  - Note: when $\Delta \ln(e_t) < 0$ we say that the real exchange appreciates. The domestic country becomes more expensive.
  - Note: when $\Delta \ln(e_t) > 0$ we say that the real exchange depreciates. The domestic country becomes less expensive.

Test: Relative PPP in the Long Run

- The next graph tests relative PPP by plotting $\ln(\mathcal{E}_t P_t^*)$ and $\ln(P_t)$ for the dollar pound real exchange rate over the period 1820 to 2001.
- Recall that the level of the price index in a particular year is meaningless; only its change provides information.
- So, without loss of information, the figure normalizes P_t^{US} and $\mathcal{E}_t P_1^{UK}$ to 1 (or their logs to 0) in 1900.
- The vertical difference between the broken and the solid line is e_t, the dollar-pound real exchange rate.
- The figure shows that over the past 200 years the United States did not become systematically cheaper or more expensive than the United Kingdom
- $\Rightarrow$ The relative PPP holds in the long run between these two countries.

Dollar-Pound PPP Over Two Centuries



Source: Taylor and Taylor (2004).

Test: Relative PPP in the Long Run

- Does Relative PPP hold in the long run for other countries?
- Let P_t: U.S. price level in dollars and P_t^*: foreign price level in foreign currency.
- Take the k-period log difference of (9) at time t:

$$\ln(e_t) - \ln(e_{t-k}) = \ln\left(\frac{P_t^*}{P_{t-k}^*}\right) - \ln\left(\frac{P_t}{P_{t-k}}\right) + \ln\left(\frac{\mathcal{E}_t}{\mathcal{E}_{t-k}}\right) \quad (10)$$

- Note that $\ln\left(\frac{P_t}{P_{t-k}}\right) = \pi_{t,k}$ is the inflation rate between period t and $t-k$ of a given country!

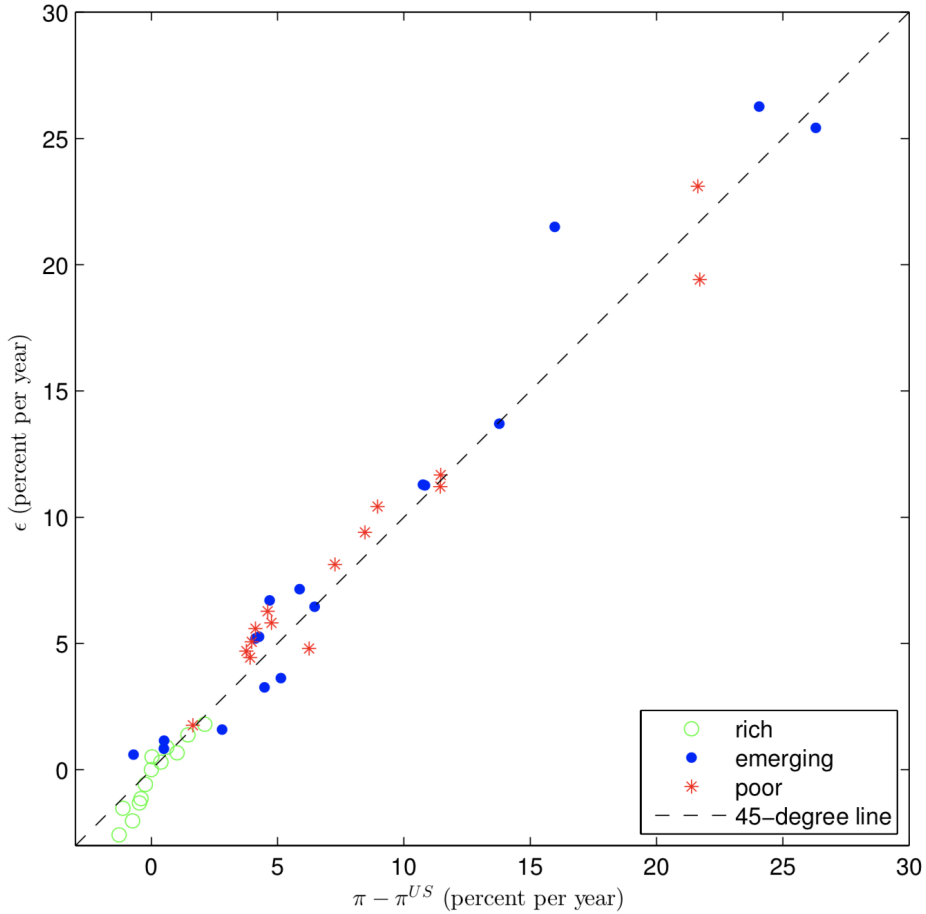
Test: Relative PPP in the Long Run

- If the Relative PPP holds in the long run: $\ln(e_t) - \ln(e_{t-k}) = 0$.
- This implies:

$$\ln\left(\frac{P_t^*}{P_{t-k}^*}\right) - \ln\left(\frac{P_t}{P_{t-k}}\right) = -\ln\left(\frac{\mathcal{E}_t}{\mathcal{E}_{t-k}}\right) \tag{11}$$

- In other words, the difference between foreign and U.S. (domestic) long-run inflation rates should equal the rate of depreciation of the foreign currency against the dollar.
- This is intuitive, since the currency with a higher rate of inflation than the United States should depreciate against the dollar.
- Also, if (11) holds in a large period k, then the Relative PPP holds as well!

Average Inflation Differentials and Depreciation Rates 1960-2017

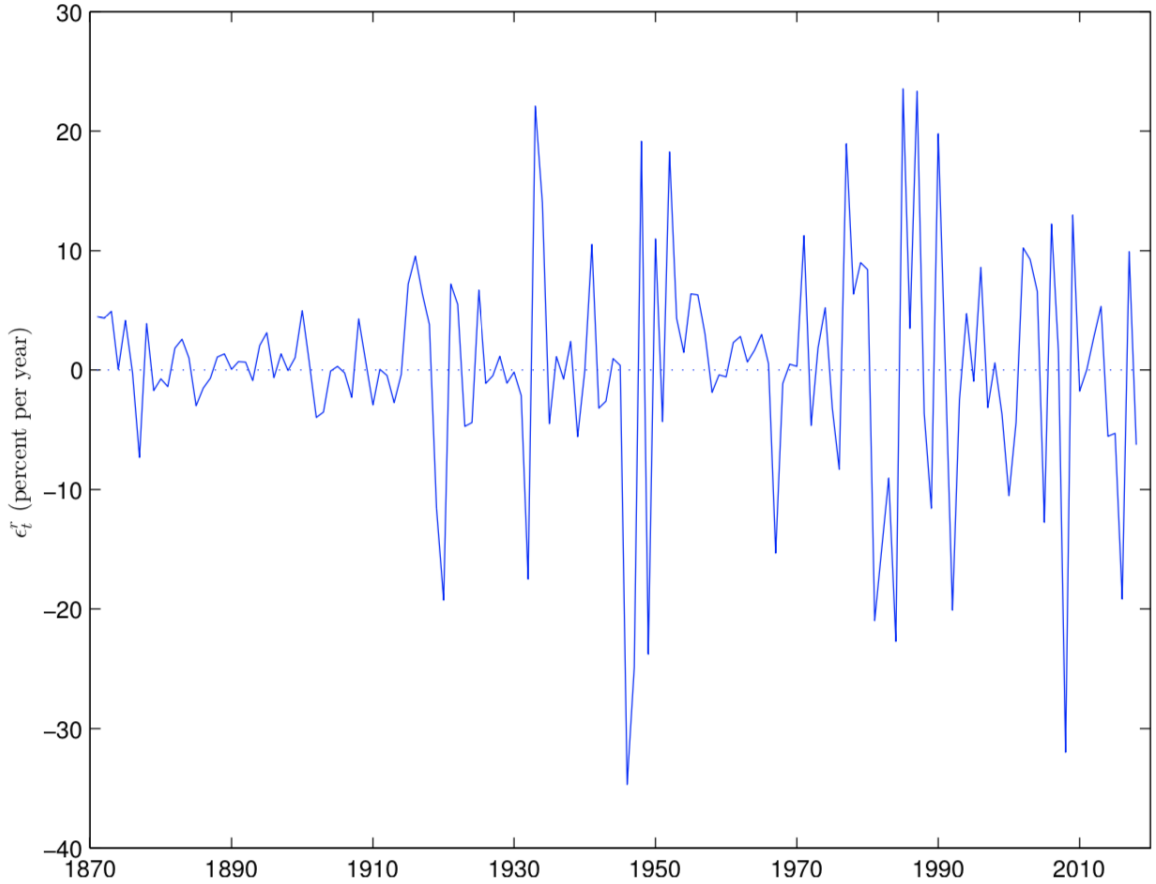


Each marker represents a country. There are 45 countries: 13 rich, 17 emerging, and 15 poor. Most countries line up close to the 45-degree line, indicating that relative PPP holds well in the long run.

Test: Relative PPP in the Short Run

- Question: does relative PPP hold in the short run?
- A simple way to check is to look whether $\ln(e_t) - \ln(e_{t-k}) = 0$ is true for a very small k (a short period of time).
- The next figure displays the year-to-year changes in the dollar/pound real exchange rate, between 1870 and 2018.
- The takeaway of the figure is that the real exchange rate moves around quite a bit.
- The standard deviation is 9.3 percent. This means that typically, from one year to the next, the US becomes almost 10 percent more expensive or cheaper than the UK.
- This suggests that the Relative PPP does not hold in the short run.

Year-Over-Year Percent Change in the Dollar-Pound Real Exchange Rate: 1870-2018



The figure shows that the dollar-pound real exchange rate changes significantly from one year to the next, suggesting that relative PPP does not hold in the short run.

Relative PPP in the Short Run

- The pattern of the previous graph is also true for other countries. In the short-run relative PPP does not hold.
- In fact e_t is VERY volatile in the short run.
- By exploring changes in nominal exchange rate regimes (e.g. from fixed exchange rate to floating) Mussa (1986) shows that $\mathcal{E}_t$ drives e_t in the short run (instead of prices).
- This disconnection of the real prices from the real exchange rate is known as the Mussa Puzzle.
- Some economists (Nakamura and Steinsson (2018), Itskhoki and Mukhin (2019)) argue that this is evidence for monetary non-neutrality in the short run.
- Nevertheless, there still plenty of disagreement on what generates the monetary non-neutrality.

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Why Does PPP Fail?

- Why do we see these price differentials, and thus failure of absolute PPP, across countries?
- One reason is that many goods are not traded internationally, and hence price discrepancies will not be arbitraged away via trade.
- In fact, we do observe failure in PPP even inside the same country! $\rightarrow$ Trade barriers.
- Engel and Rogers (AER, 1996) collected price data of various goods (14) in different geographical locations (cities, 23) within Canada and the US, over a long period of time (1978 to 1994).
- Their goal was to examine what explains PPP differentials. In particular they focus on:
  - distance (a common measure of trade costs);
  - international border.

How Wide is the Border

- They hypothesize that the volatility of prices of the similar goods sold in different locations is related to both the distance between the locations and the whether the location is in different countries.
- Intuition: if the LOOP held, then the volatility of relative prices across locations should be low (zero?), and in particular, unrelated to measures of trade costs, such as distance and the border.
- To be precise, let the real exchange rate between cities $c1$ and $c2$ for a basket of goods g be

$$e^g_{c1,c2,t} = \frac{\mathcal{E}_{c1,c2,t} P^g_{c2,t}}{P^g_{c1,t}}, \tag{12}$$

  where $\mathcal{E}_{c1,c2}$ is nominal exchange rate between cities $c1$ and $c2$ in period t (clearly, $\mathcal{E}_{c1,c2} = 1$ if $c1$ and $c2$ are in the same country).
- Let the $\sigma^g_{c1,c2}$ be the standard deviation of $\Delta \ln e^g_{c1,c2,t}$, where the differences are across time periods (so they are testing relative PPP).

How Wide is the Border?

- Engel and Rogers (1996) estimate the following regression:

$$\sigma^{g}_{c1,c2} = \text{ constant } + 0.00106 \ln d_{c1,c2} + 0.0119 B_{c1,c2} + \mu^{g}_{c1,c2} \tag{13}$$

  - $\ln d_{c1,c2}$ is the log distance in miles between cities $c1$ and $c2$,
  - $Bc1, c2$ a dummy variable for whether $c1$ and $c2$ are in different countries,
  - $\mu^{g}_{c1,c2}$ is a regression residual.

- They also have other specifications with city dummy pair variables.

- Takeaway: Deviations from relative PPP are increasing in distance and in the existence of a border.

How Wide is the Border?

- How larger is the effect of a border relative to distance?
- Counterfactual Experiment: If we were to remove the border, by how much should we increase the distance between $c1$ and $c2$ so that $\sigma^{g}_{c1,c2}$ remains constant?
- $0.00106 \ln d_{c1,c2} = 0.0119 \Rightarrow \ln d_{c1,c2} = 0.0119/0.00106 = 1122.6\%$!
- Since the average distance between two cities in the Engel-Rogers dataset is around 1,100 miles (≈ 1770km), a border is equivalent to add almost 20,000km $(1770 * 11.22)$ - This is more than the distance between Barcelona and Sydney!
- The mere existence of an international border separating two locations adds significantly to the amplitude of deviations from relative PPP.
- Evidence that exchange rate volatility, local price rigidities, tariffs, and cross-border regulations play an important role in determining the size of changes in real exchange rates in the short run.

Why Does PPP Fail?

- Let us formalize this argument in a very simple framework where we have tradable and nontradable goods.
- The price index is an average of all prices in the economy, traded goods prices, P_T , and nontraded goods prices, P_N:

$$P = \phi(P_T, P_N). \tag{14}$$

- To capture the right RER is really important to get the right price index. Take $0 < \alpha < 1$ as the consumption share of traded goods. Examples of P:
  - Simple weighted average: $P = \alpha P_T + (1 - \alpha) P_N$.
  - Implied by a Cobb-Douglas utility function: $P = P_T^{\alpha} P_N^{1-\alpha}$
- Notice that the price index is a function that if you increase all prices by z, the index also raise by z: $zP = \phi(zP_T, zP_N)$

Why Does PPP Fail?

- Next, suppose the LOOP holds for traded goods but not for nontraded goods:

$$P_T = \mathcal{E} P_T^*, \tag{15}$$
$$P_N \neq \mathcal{E} P_N^*. \tag{16}$$

- The real exchange rate is then:

$$\begin{aligned} e &= \frac{\mathcal{E} P^*}{P} = \frac{\mathcal{E}\phi(P_T^*, P_N^*)}{\phi(P_T, P_N)} \\ &= \frac{\mathcal{E} P_T^* \phi(1, P_N^*/P_T^*)}{P_T \phi(1, P_N/P_T)} = \frac{\phi(1, P_N^*/P_T^*)}{\phi(1, P_N/P_T)} \end{aligned}$$

- Intuition: if the relative price of nontradables is lower in the foreign country $P_N/P_T > P_N^*/P_T^*$, then the real exchange rate is lower than 1, $e < 1$.
- India would be cheaper than the US because its nontradables goods are cheaper.

Why Does PPP Fail?

- Question: What could make P_N^*/P_T^* change relative to P_N/P_T?
- Answer:
  - Short run: Factors and productivity are immobile $\Rightarrow$ Changes in demand.
  - Long/medium run: Factors and productivity are growing $\Rightarrow$ Changes in factors/productivities.
- We will focus on Long/medium run.
- Productivity growth in the traded sector relative to the non-traded sector in the foreign country being faster than in the domestic country will change the relative prices and therefore the RER.

The Balassa-Samuelson Model

- Is the tendency for countries with higher productivity growth in tradables compared to nontradables to have higher prices, and thus appreciated real exchange rates.
- Let's formalize this argument in the Balassa-Samuelson Model.
- 2 goods: Q_T and Q_N, where Q_T is traded output and Q_N is nontraded output.
- Production of tradables and nontradables will follow a linear production function:

$$Q_T = a_T L_T \qquad Q_N = a_N L_N \tag{17}$$

where:

  - L_T : labor input in the traded sector; L_N : labor input in the nontraded sector; (note $L = L_T + L_N$).
  - a_T: exogenous labor productivity in the traded sector; a_N: exogenous labor productivity in the nontraded sector.
  - W: wage rate (free labor mobility guarantees that they are the same in both sectors).

The Balassa-Samuelson: Production

- Firms choose Q_T and L_T to maximize profits:

$$\Pi_T = P_T Q_T - W L_T \quad \text{where} \quad Q_T = a_T L_T. \tag{18}$$

- Substituting Q_T, and taking FOC over L_T:

$$\frac{\partial \Pi_T}{\partial L_T} = P_T a_T - W = 0$$
$$\Rightarrow P_T a_T = W$$

- Using the same argument in the nontraded sector: $P_N a_N = W$.
- Combining both conditions:

$$\frac{P_N}{P_T} = \frac{a_T}{a_N} \tag{19}$$

The Balassa-Samuelson: Effect

- Hence, $P_N/P_T = a_T/a_N$ implies a tight relationship between productivities and relative prices.
- The same condition holds for the foreign country: $P_N^*/P_T^* = a_T^*/a_N^*$.
- It also connects relative productivities to the real exchange rate.
- Is this prediction of the Balassa-Samuelson model borne out in the data?

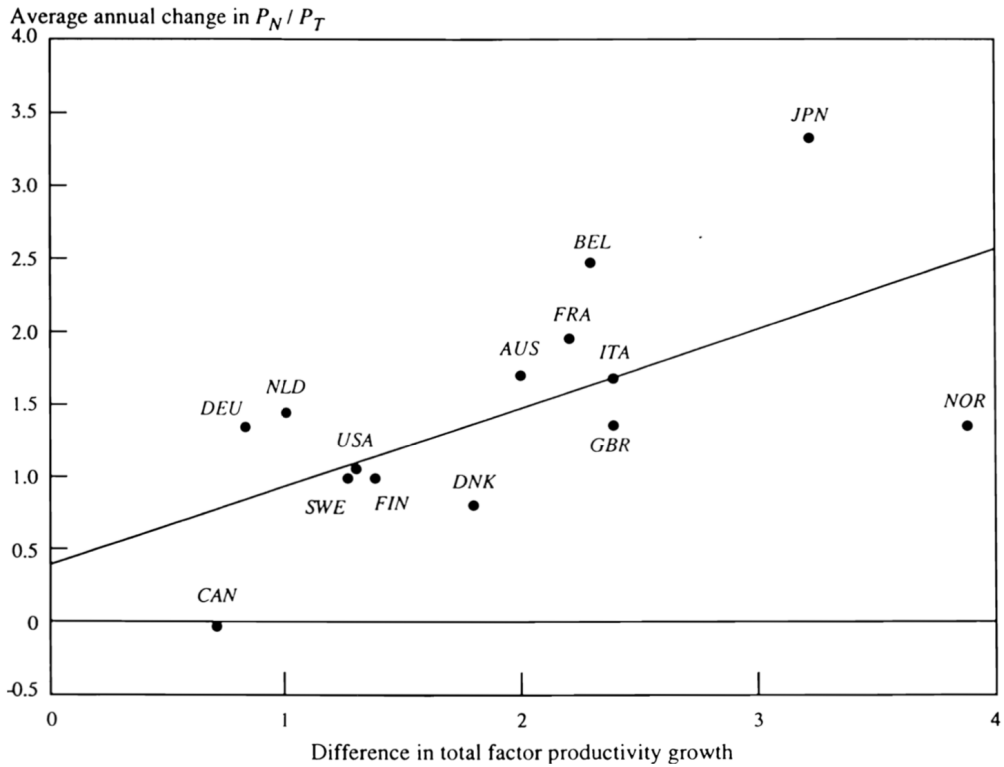
Testing the Balassa-Samuelson Model

- Let's examine how the relative price of the N and T sector relate to the two sectors relative productivities.
- Take the differences of the natural logarithm of (19) to express as percentage change over time:

$$\%\Delta(P_N/P_T) = \%\Delta a_T - \%\Delta a_N \tag{20}$$

- This expression says that the percent change in the relative price of nontradables is equal to the growth rate differential between factor productivity in the traded sector and the nontraded sector.
- De Gregorio, Giovannini, and Wolf (EER, 1994) test whether this relationship holds for 14 OECD countries over the period 1970–1985.

Differential Factor Productivity Growth and Changes in the Relative Price of Nontradables



The figure plots the average annual percentage change in the relative price of nontradables in terms of tradables (vertical axis) against the average annual growth in total factor productivity differential between the traded sector and the nontraded sector (horizontal axis) over the period 1970-1985 for 14 OECD countries (Source: De Gregorio et al. (2004)).

The Real Exchange Rate and Balassa-Samuleson

- Recall: $e = \dfrac{\phi(1, P_N^*/P_T^*)}{\phi(1, P_N/P_T)}$.
- Using the equilibrium condition (19) of the home and foreign country:

$$e = \frac{\phi(1, a_T^*/a_N^*)}{\phi(1, a_T/a_N)} \tag{21}$$

- If a_T^*/a_N^* faster than a_T/a_N, then $\uparrow e$.
- That is, the real exchange rate of the domestic country depreciates if relative productivity growth in the traded sector relative to productivity growth in the nontraded sector is faster in the foreign country than in the domestic country.

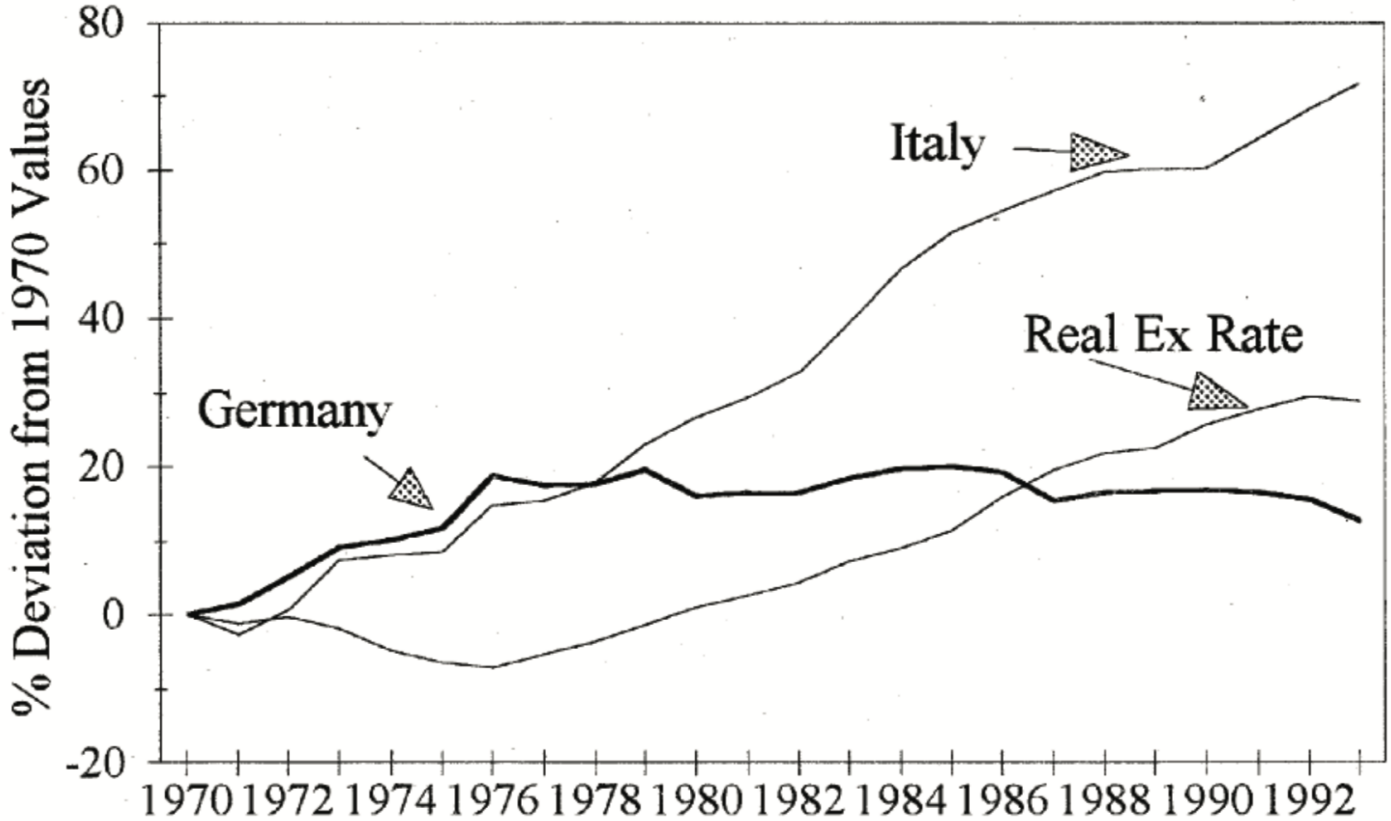
The Real Exchange Rate and Balassa-Samuleson

- Can the Balassa Samuelson model explain the observed real depreciation of bilateral exchange rates?
- Canzoneri, Cumby, and Diba (JIE, 1999) collect data on productivity differential for the United States, Germany, Italy and Japan over the period 1970 to 1993 to study this question.
- For example, can Balassa Samuelson model explain the observed real depreciation of the German mark against the Japanese Yen and against the Italian Lira in the 1970s and 1980s?
- According to the Balassa Samuelson model the bilateral real exchange rate between the German Mark (DM) and the Italian Lira (L) should change as:

$$\%\Delta e^{DM/L} = \alpha \left[\%\Delta(a_T^I/a_N^I) - \%\Delta(a_T^G/a_N^G)\right] \tag{22}$$

where α is the share of N in the price index.

Differential Factor Productivity Growth and Changes in the Relative Price of Nontradables



Source: Canzoneri et al (1999).

The Real Exchange Rate and Balassa-Samuleson

- Over the long run, here 1970 to 1993, Balassa Samuelson explains well the observed real depreciation of the German mark against the Italian Lira.
- These authors, however, also present evidence that the Balassa-Samuelson model fails to explain the observed real appreciation of the Japanese yen against the U.S. dollar.
- What to make of this? In some episodes long-run changes in real exchange rates can be explained well by differences in relative productivity growth rates but not always.
- This is not necessarily evidence against Balassa-Samuelson because clearly there can be other explanations for real exchange rate movements.
- Furthermore, relative productivity differences might better explain long-term real exchange rate differences, such as those observed between rich and poor countries.

The Real Exchange Rate of Rich and Poor Countries, 2006

Take:

$$e^{poor/rich} = \frac{\phi(1, a_T^{rich}/a_N^{rich})}{\phi(1, a_T^{poor}/a_N^{poor})} \tag{23}$$

Expect that poor countries have larger e, since $a_T^{rich}/a_N^{rich} > a_T^{poor}/a_N^{poor}$.

Country	RER
Ethiopia	5.4
Bangladesh	5.0
India	4.7
Pakistan	3.4
Unites States	1.0
Germany	0.9
Sweden	0.8
Switzerland	0.6
Japan	0.9

Source: World Economic Outlook Database, IMF, April 2006.

Other Determinants of the RER

- Relative productivities are not the only determinant of the RER. Let's see a couple of examples.
- Home Bias: PPP can fail when the weights with which a particular good enters in the consumption basket is different across countries.
- Differences in weights may reflect differences in tastes across countries. National tastes could be acquired via resource abundance or production specialization.
- Example: Argentine might spend a larger fraction of their budgets on beef than do Germans and Germans might spend relatively more on cars than Argentines.
- Such a preference for domestically produced goods is called home bias.
- Say α is the consumption share of beef and $1-\alpha$ of car:

$$P = (P_b)^{\alpha}(P_c)^{1-\alpha}, \qquad P^* = (P_b^*)^{\alpha^*}(P_c^*)^{1-\alpha^*} \tag{24}$$

where $\alpha > \alpha^*$ (Argentina is without * and Germany is with *).

Home Bias

- Let $\mathcal{E}$ be the exchange rate (pesos per euro). Even if the LOOP holds for both good:

$$P_b = \mathcal{E} P_b^*, \quad \text{and} \quad P_c = \mathcal{E} P_c^*,$$

- the PPP may fail:

$$e = \frac{\mathcal{E} P^*}{P} = \mathcal{E} \frac{(P_b^*)^{\alpha^*}(P_c^*)^{1-\alpha^*}}{(P_b)^{\alpha}(P_c)^{1-\alpha}} = \mathcal{E} \frac{(P_b/\mathcal{E})^{\alpha^*}(P_c/\mathcal{E})^{1-\alpha^*}}{(P_b)^{\alpha}(P_c)^{1-\alpha}} = \left(\frac{P_b}{P_c}\right)^{\alpha-\alpha^*}$$

- Because $\alpha > \alpha^*$, an increase in the price of beef relative to cars causes a real appreciation of the peso (a fall in e).
- If the relative price of beef increases, then the price of the Argentine consumption basket, P, increases by more than the price of the German consumption basket, P^*.

Trade Barriers and Real Exchange Rates

- Deviations from PPP may arise because governments impose trade barriers, such as import tariffs, export subsidies, and quotas, that artificially distort relative prices across countries.
- Suppose two goods M and X. Say home export X and import M. Again, the LOOP holds for both goods:

$$P_X = \mathcal{E} P_X^*, \quad \text{and} \quad P_M = \mathcal{E} P_M^*,$$

- Using the definition of e, and the price levels of home and foreign country:

$$e = \frac{\mathcal{E} P^*}{P} = \frac{\mathcal{E}\phi(P_X^*, P_M^*)}{\phi(P_X, P_M)} = \frac{\mathcal{E}\phi(P_X^*, P_M^*)}{\phi(\mathcal{E} P_X^*, \mathcal{E} P_M^*)} = 1$$

- It is easy to show the PPP holds if all goods are tradables and there are no trade barriers in place.

Trade Barriers and Real Exchange Rates

- Suppose the domestic government imposes a tariff τ on imports:

$$P_M = (1+\tau)\mathcal{E}P_M^*. \tag{25}$$

- The real exchange rate becomes:

$$e = \frac{\mathcal{E}\phi(P_X^*, P_M^*)}{\phi(P_X, P_M)} = \frac{\mathcal{E}\phi(P_X^*, P_M^*)}{\phi(\mathcal{E}P_X^*, (1+\tau)\mathcal{E}P_M^*)} < 1 \tag{26}$$

- Import tariffs make the domestic country more expensive relative to the foreign country.

Short Run and Real Exchange Rates

- All the previous arguments are suitable for medium and long run analysis of RER.
- However, in the short run, since productivities and factors are fixed, changes in the demand would likely to drive RER.
- Intuitively, think about the case where there is tradable and nontradable goods.
- Suppose a sharply decreases the HH income of the home country:
  - bad weather that result in a poor harvest,
  - fall in a commodity price.

Short Run and Real Exchange Rates

- The price of the traded good will change very little (if it changes at all) since it depends on the demand of many countries, many of which did not have a "bad shock".
- However, the price of the nontraded good will decrease sharply since it depends only the demand of home (remember take supply as fixed!).
- This results in a real exchange-rate depreciation ($\uparrow e$) and the home country will be cheaper than the rest of the world.
- Another example is when there is a sudden stop, that is an increase in the interest rate in the home country.
- We will not go in further details, but it is possible to introduce tradables and nontradables to our intertemporal 2-period model of CA determination to evaluate what would happen to the RER.

Taking Stock

- We discuss the definition of the Law of One Price and the Real Exchange rate.
- We saw that absolute PPP does not hold in the data.
- The relative PPP, however, holds for long periods. But again, it fails in the short run.
- There were many reasons for the PPP to fail, an international border encapsulate many of them.
- Using the Balassa-Samuelson model, we analyze how different productivity growth generates changes in RER.