International Economics: Lecture 20

Exchange rates in the Long run: PPP

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The Lecture Motivation

Did Armenian goods become relatively cheaper? Would Russians have increased their spending on Armenian goods, or Armenian have decreased their spending on Russian goods?

The cost of living generally rises, but its increase isn’t equiproportional in different parts of the world.

A standardized basket of goods, which cost 100K AMD in 2000 rose in price to 190K AMD in 2016 in Armenia.

Over the same period, a basket of goods rose in price from 5.2K RUB to 27K RUB.

\[
100K \text{ AMD} = 19.2 \times 5.2K \text{ RUB} \quad \text{(in 2000)}
\]

\[
190K \text{ AMD} \times 7K \text{ RUB} \quad \text{(in 2016)}
\]

So, a basket, which cost 27K RUB in 2016, would had cost 196K AMD, mere 3.4% deviation.

2000-16. Price Increase
Armenia, 1.9 times
Russia, 5.2 times
USA, 1.4 times

Dram appreciated 3 times against rouble, & 1.1 times against dollar.

Data: UNECE

K – thousand
Consumer price index, measures the price change of a standardized basket of consumer goods.
The Lecture Motivation

Although, Russian prices rose about 2.8 times more, than Armenian prices, but over the same period dram appreciated against rouble about 3 times.

Therefore, the cost of the baskets in each country expressed in the same currency increased by about the same amount.

The relative purchasing power of each currency has remained about the same.

Is this a coincidence?

No, as in the long run, prices and exchange rates adjust to each other.

And this hypothesis is a key building block in the theory of exchange rate determination.
Interest parities, spot rate, forward rate

Uncovered interest parity provides a theory of spot exchange rate determination, given the knowledge of the:

1) Expected future exchange rate,
2) Home interest rate, and
3) Foreign interest rate.

In this lecture we look at the long run to see how the expected future exchange rate is determined.

Spot market model: Uncovered interest parity
\[ S = S^e \frac{(1+r^*)}{(1+r)} \]

Forward market model: Covered interest parity
\[ F = S \frac{(1+r)}{(1+r^*)} \]
The law of one price

Due to **goods market arbitrage** goods prices in different countries expressed in a common currency must tend to be equalized.

*Applied to a single good, this idea is referred to as the LOOP.*

*......................... basket of goods, ........................................ PPP.*

This ‘law’ should hold, as otherwise buyers would rush to buy at a cheap location (forcing prices up there) and would avoid from the expensive location (forcing priced down there).

Trade frictions (transport cost, tariffs) will hinder the process, but will not stop it.

Therefore, LOOP holds in the idealized world of

- no market frictions, and of
- perfect competition and complete price flexibility
The law of one price

LOOP - identical goods sold in different locations must sell for the same price when expressed in a common currency.

Suppose a car is priced at 400K RUB in Moscow.

AMD/RUB exchange rate is 8.5.

So, if the LOOP holds, the same car should sell in Yerevan for 3.4M AMD. Otherwise, a profitable arbitrage opportunity will arise, which will equalize the prices.

\[
\text{Relative price of car in Russia versus Armenia (q)} = \frac{S_{\text{AMD/RUB}} \times P_{\text{RUS}}}{P_{\text{ARM}}}
\]

If q=2, then two units of Armenian car are needed to purchase one unit of Russian car.

If q>1, then Russian cars are costlier. If q<1, then Russian cars are cheaper.

Only when q=1, then the price is the same in both locations, there is no arbitrage opportunity, and LOOP holds.
The law of one price

Relative price of car in Russia versus Armenia (q)

\[ q = \frac{S_{\text{AMD/RUB}} \times P_{\text{RUS.car}}}{P_{\text{ARM.car}}} \]

Only when \( q = 1 \), then the price is the same in both locations, there is no arbitrage opportunity, and LOOP holds.
Purchasing power parity

PPP is the macroeconomic counterpart to the microeconomic ‘law’ of one price (LOOP).

LOOP relates exchange rate to the relative price of an individual good.

PPP relates exchange rate to the relative price of a basket of goods.

**Price level** \((P)\) is a weighted average of the prices of all goods in a consumer basket, using the same goods and weights in both locations.

\[ P_{\text{ARM}} \text{ - price level in Armenia} \]
\[ P_{\text{RUS}} \text{ - price level in Russia} \]

*If the law of one price holds for each good in the basket, it will also hold for the price of the basket as a whole.*
Purchasing power parity

\[ \frac{S_{\text{AMD}}/RUB \times P_{\text{RUS}}}{P_{\text{ARM}}} = \text{Relative price of a basket in Russia versus Armenia (q)} \]

PPP holds when relative price of the basket is equal to 1. This statement is called **absolute PPP**.
The real exchange rate

\[
\text{Relative price of a basket in Russia versus Armenia (q)} = \frac{S_{\text{AMD/RUB}} \times P_{\text{RUS}}}{P_{\text{ARM}}}
\]

The relative price of the baskets is so important, that it has a special name, *real exchange rate*. It tells how many Armenian baskets of goods can be exchanged for one Russian basket.

- If the real exchange rate *rises* (*more Armenian goods* are needed in exchange for Russian goods), we say Armenia has experienced a **real depreciation**.
- If the real exchange rate *falls* (*fewer Armenian goods* are needed in exchange for Russian goods), we say Armenia has experienced a **real appreciation**.
Absolute PPP and the real exchange rate

\[
\frac{S_{\text{AMD/RUB}} \times P_{\text{RUS}}}{P_{\text{ARM}}} = q
\]

*Absolute PPP states that the real exchange rate is equal to 1*

- If the real exchange rate is below 1 by \(x\)%, then Russian goods are \(x\)% cheaper than Armenian goods. The dram is said to be strong, the rouble is *undervalued* by \(x\)%.
- If the real exchange rate is above 1 by \(x\)%, then Russian goods are \(x\)% more expensive than Armenian goods. Dram is weak, the rouble is overvalued by \(x\)%.

For example, if a Russian basket costs 100,000 drams, and an Armenian basket costs only 80,000 drams, then \(q_{\text{RUS/ARM}} = 1.25\). The rouble is strong, and is 25% overvalued against the dram.
Big Mac Index

PPP predicts that in the long-run exchange rates should move towards the rate that would equalize the prices of an identical basket of goods and services in any two countries.

Big Mac price in January 2017
USA - $5.06
Russia - $2.15 (130 Roubles; Actual spot: 60.44; Implied exchange rate: 25.69) thus, the Rouble was undervalued by 58%.

Highest prices: Switzerland: $6.35, overvalued by 26%
Norway: $5.67, overvalues by 12%

Lowest prices: Egypt: $1.46, undervalued by 71%
Ukraine: $1.54, undervalued by 70%.
PPP is the heart and soul of

*International Macroeconomics*

Under the skin of any international economist lies a deep-seated belief in some variant of the PPP theory of the exchange rate.

Dornbusch R., Krugman P.

Absolute PPP

$$S_{\text{AMD/RUB}} \times P_{\text{RUS}} = \frac{S_{\text{AMD/RUB}}}{P_{\text{ARM}}}$$

Absolute PPP implies:

$$\text{Exchange rate} = \frac{P_{\text{ARM}}}{P_{\text{RUS}}}$$

For example, if the same basket of goods costs
- 80K drams in Armenia and
- 10K roubles in Russia, then absolute PPP predicts
- an exchange rate of 80K/10K = 8 drams per rouble.
Absolute PPP

prices, and nominal exchange rate

Thus, if we **know the price levels** in different locations, we can **use PPP** to determine an **implied exchange rate**, subject to the assumptions about

- frictionless trade,
- flexible prices,
- free competition, and
- identical goods.

**Moreover**, we can use PPP to **forecast the expected future exchange rate** implied by **forecasted future price levels**.
The big picture

Connections

Future price levels, $P, P^*$

Expected future spot rate $S_e$

Interest rates $r, r^*$

Purchasing power parity

Spot market model: Uncovered interest parity

$S = S_e(1+r^*)/(1+r)$

Forward market model: Covered interest parity

$F = S(1+r)/(1+r^*)$
Relative PPP

inflation, and exchange rate depreciation

Relative PPP implies:

\[ \% \Delta S_{\text{AMD/RUB}} = \pi_{\text{ARM}} - \pi_{\text{RUS}} \]

Exchange rate depreciation

Inflation differential

For example, if Russian inflation is 7%, and Armenian inflation is 2%, then we expect a 5% depreciation of the rouble against dram.

Actually, during the 2000-2016, Russian prices rose 176% more, than Armenian prices, and the rouble depreciated 167% against dram.
Relative PPP

\[ \% \Delta S_{\text{AMD/RUB}} = \pi_{\text{ARM}} - \pi_{\text{RUS}} \]

Exchange rate depreciation
Inflation differential

Absolute PPP: \[ S = \frac{P}{P^*} \]

The rate of change of the exchange rate is the exchange rate depreciation

\[ \text{Depreciation: } \frac{(S_1 - S_0)}{S_0} \]

The rate of change of the relative prices is APPROXIMATELY equal to the
- the rate of change of numerator MINUS
- the rate of change of denominator.

\[ \text{Inflation differential: } \frac{(P_1 - P_0)}{P_0} - \frac{(P_1^* - P_0^*)}{P_0^*} \]
Absolute PPP relates
prices to nominal exchange rate

\[
S_{\text{AMD/RUB}} = \frac{P_{\text{ARM}}}{P_{\text{RUS}}}
\]

Exchange rate
Ratio of price levels

Relative PPP relates
inflation to exchange rate depreciation

\[
\%\Delta S_{\text{AMD/RUB}} = \pi_{\text{ARM}} - \pi_{\text{RUS}}
\]

Exchange rate depreciation
Inflation differential
PPP GDP

PPP GDP is GDP converted to international dollars using PPP rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the U.S.

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP per capita, PPP (current international $), 2015</th>
<th>Implied PPP rate</th>
<th>Exchange rate</th>
</tr>
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<tbody>
<tr>
<td>Armenia</td>
<td>8,419</td>
<td>198.1</td>
<td>2.4</td>
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<td></td>
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<td>477.9</td>
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<td></td>
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<td>56,116</td>
</tr>
</tbody>
</table>

Nominal /Implied

PPP implied by Big Mac index: 18.58

Source: WB WDI database
Factors behind PPP deviations

1. Transaction costs (transportation costs, tariffs, taxes).
3. Different labor costs.
4. Imperfect competition (market power).
5. Price stickiness in the short run.

Despite all these problems, PPP is a useful approach as a long-run theory of exchange rate determination.

Big Mac price in January 2017
USA - $5.06
Russia - $2.15
(130 roubles; Actual spot: 60.44; Implied exchange rate: 25.69)

thus, the rouble was undervalued by 58%.
Thank you and take care,

but remember

Education is the path from arrogant ignorance to miserable uncertainty.

Mark Twain