International Monetary Economics

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Chapter 16

Price levels and the exchange rate in the long run

Outline

Introduction

- PPP is the oldest exchange rate theory,
- developed by Gustav Cassel.

Objective: Explaining

- the exchange rate level or
- changes in the exchange rate

in the long run on the basis of

- the domestic and foreign goods price or
- the inflation differential.

Law of One Price (LOP)

If we assume

- free trade,
- no transaction costs,
- complete transparency for all agents,
- goods are homogeneous
  - geographical preferences
  - preferences in time,
  - personal preferences, and
  - goods are the same / have the same characteristics
- then price in all markets have to be the same (LOP).
- Good price in the home market (P) has to be the same as the good price in the foreign market (P^*) after consideration of the exchange rate (E).

$$(1) \quad P = E \cdot P^*$$

Law of one price

- In case that

(1) $$P > EP^* \text{ or } P < EP^*$$

arbitrageurs will enter the market.

Numerical example: $E = 0.8\,€/\$ \quad P = 5\,€ \quad P^* = 10\$$

(2) $$5€ < 0.8€/\$ \cdot 10\$$$

- German product cost $5\,€$ while American product cost $8\,€$.

Arbitrage: Buy low sell high!

$$5\,€ < 0.8\,€/\$ \cdot 10\$$$

- Arbitrageurs sell Dollars and buy Euros
- They buy the cheap German product
- and sell it in the US at a higher price $\Rightarrow$ Profit per deal: $3\,€$

- Supply of Dollars increases $\Rightarrow E = 0.8\,€/\$ \downarrow$
- Demand for German products increases $\Rightarrow P = 5\,€ \uparrow$
- Supply of American products increases $\Rightarrow P^* = 10\$ \downarrow$

$$6.3\,€ = 0.7\,€/\$ \cdot 9\$$$

Law of one price and transaction costs

- Suppose that transaction cost amounts to $t = 1 €$ for shipping etc.
- Hence, arbitrage will *only* take place when the price differential is larger than transaction cost:

$$P - EP^* > t \text{ or } t < EP^* - P \tag{3}$$

- In our example, prices will not adjust completely until LoP holds!

$$5.9 € < 6.9 € = 0.75 €/\$ \cdot 9.2\$$$

Outline

Absolute purchasing power parity (APPP)

- Due to different tastes and preferences LoP does not hold for a single item.
- Idea: Purchasing power is not the same for a single item but for an identical basket of goods.

	German Shopping cart		American Shopping cart	
Good 1 = Milk	3 Bottles á 5 €	15 €	3 Bottles á 6 $	18 $
Good 2 = Sausage	4 Units á 2.5 €	10 €	4 Units á 2.5 $	10 $
Good 3 = Cheese	5 Pieces á 1 €	5 €	5 Pieces á 1 $	5 $
Good 4 = Beer	10 Cans á 4 €	40 €	10 Cans á 5 $	50 $
Good n = Jägermeister	2 Pülleken á 15 €	30 €	2 Pülleken á 21 $	42 $
	Total	100 €	Total	125 $

- Equilibrium exchange rate according to absolute purchasing power parity

$$\frac{100\,€}{125\$} = 0.8\,€/\$$$

Absolute purchasing power parity (APPP)

Equilibrium exchange rate according to absolute purchasing power parity

$$\frac{100\,€}{125\$} = 0.8\,€/\$$$

Lets assume that the actual exchange rate is indeed $E = 0.8\,€/\$$.

- Law of one price only holds for product 4 (beer).
- Law of one price does not hold for all other items.
- BUT: Absolute purchasing power parity holds, since both carts have identical prices after consideration of the exchange rate.

Implications for the real exchange rate

If APPP holds:

$$\varepsilon = \frac{EP^*}{P} = \frac{0.8\,€/\$ \cdot 125\$/\text{americ. Basket}}{100\,€/\text{europ. Basket}} = 1 \text{ europ. Basket}/\text{americ. Basket}$$

- Real exchange rate takes the value of one!

Outline

Causes for deviations from APPP

Temporary causes

- incomplete information
- adjustment of prices takes time
- goods prices are sticky, due to long term contracts while exchange rate can jump instantaneously due to new information

Permanent causes

- trade barriers
- taxes and tariffs
- Quotas
- Transportation cost
- active price differentiation of the suppliers
- (perceived) differences in the quality

Relative Purchasing Power Parity (RPPP)

- If permanent causes exist, this will hinder a complete price adjustment even in the long run.
- Absolute purchasing power parity $P = EP^*$ will not hold.
- Hence, we get for the relationship between the domestic and foreign basket of goods prices

$$(3) \quad P = \frac{1}{\varepsilon} EP^*$$

- The parameter $1/\varepsilon$ considers all permanent causes that lead to a deviation of APPP.

Relative Purchasing Power Parity (RPPP)

$$(3) \quad P = \frac{1}{\varepsilon} EP^*$$

$$(4) \quad \varepsilon = \frac{EP^*}{P}$$

- Parameter ε is labeled as the real exchange rate
- If APPP holds, the real exchange rate will take the value of one.
- Deviations from APPP can lead to a situation where the real exchange rate is smaller or larger than 1!

Relative PPP

$$(4) \quad \varepsilon = \frac{E \cdot P^*}{P}$$

- From equation (4) we get for the change of the real exchange rate:

$$(5) \quad \widehat{\varepsilon} = \widehat{E} + \widehat{P^*} - \widehat{P}$$

How do we get from (4) to (5)???

$$(4') \quad \varepsilon_t = \frac{E_t P_t^*}{P_t} \qquad (4'') \quad \varepsilon_{t+1} = \frac{E_{t+1} P_{t+1}^*}{P_{t+1}}$$

- Taking the natural logs of (4') and (4'') one gets:

$$(5') \quad \ln \varepsilon_t = \ln E_t + \ln P_t^* - \ln P_t$$

$$(5'') \quad \ln \varepsilon_{t+1} = \ln E_{t+1} + \ln P_{t+1}^* - \ln P_{t+1}$$

Relative PPP

- Subtracting (5') from (5'') one gets:

$$(5''') \quad \ln \varepsilon_{t+1} - \ln \varepsilon_t = (\ln E_{t+1} - \ln E_t) + (\ln P^*_{t+1} - \ln P^*_t) - (\ln P_{t+1} - \ln P_t)$$

- Defining $\hat{\varepsilon} = \ln \varepsilon_{t+1} - \ln \varepsilon_t$ and so on...

$$(5) \quad \hat{\varepsilon} = \widehat{E} + \widehat{P^*} - \widehat{P}$$

Relative PPP

$$(5) \quad \widehat{\varepsilon} = \widehat{E} + \widehat{P^*} - \widehat{P}$$

- If the permanent causes are constant $\Rightarrow$ the real exchange rate (ε) does not change.
- The *change* in the real exchange rate is zero ($\hat{\varepsilon} = 0$).

$$(6) \quad 0 = \widehat{E} + \widehat{P^*} - \widehat{P}$$

Solving for the change in the nominal exchange rate yields:

$$(7) \quad \widehat{E} = \widehat{P} - \widehat{P^*}$$

- Equation (7) is labeled as the relative purchasing power parity.

Implications of RPPP

$$(7) \quad \widehat{E} = \widehat{P} - \widehat{P^*}$$

$$(7') \quad \frac{E_{t+1} - E_t}{E_t} = \frac{P_{t+1} - P_t}{P_t} - \frac{P^*_{t+1} - P^*_t}{P^*_t}$$

Relative PPP implies:

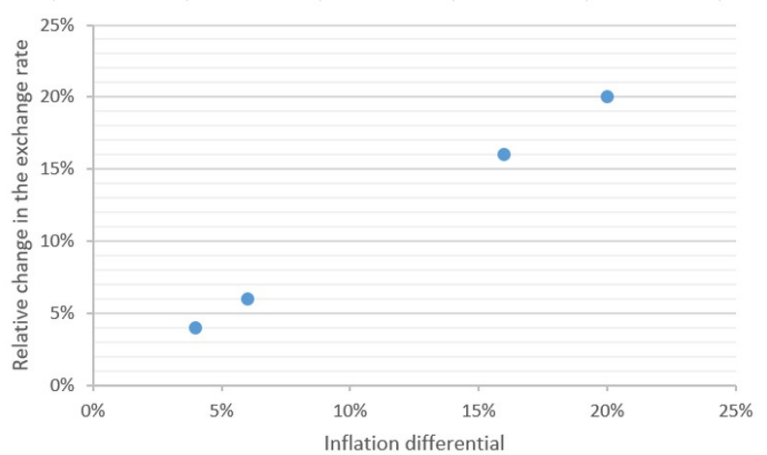
- Relative change in the nominal exchange rate is equal to the inflation differential between Euroland and the US.
- The real exchange rate is constant.
- If the domestic price level increases by 10 % while the foreign price level is constant, the nominal exchange rate increases by 10 %.
- Countries that have problems with their internal price stability,
- also have problems with their external price stability.

Testing RPPP

Time	$\pi_{ITA} - \pi^*_{BRD}$	$\frac{E_{t+1}-E_t}{E_t}$
1973	$12\% - 8\%$	4 %
1974	$25\% - 5\%$	20 %
1975	$11\% - 5\%$	6 %
1976	$20\% - 4\%$	16 %

Testing RPPP: Scatter diagram

pi_ITA	pi_BRD	pi_ITA - pi_BRD	(E_t+1 - E_t) / E_t
12.0%	8.0%	4%	4%
25.0%	5.0%	20%	20%
11.0%	5.0%	6%	6%
20.0%	4.0%	16%	16%



Testing RPPP

$$\frac{E_{t+1} - E_t}{E_t} = \alpha + \beta \cdot (\pi_t^{ITA} - \pi_t^{BRD}) + u_{t+1} \tag{4}$$

2 pairs of Hypotheses:

- H_0: $\alpha = 0$ and H_a: $\alpha \neq 0$
- H_0: $\beta = 1$ and H_a: $\beta \neq 1$
- Hence, we want to perform a two sided test!

We want to test on a 95 % confidence level and assume that we have enough observations so that the normal distribution is the appropriate choice!

- $t_{critical} \approx 2$ (in case you want to be precise: 1.96)

Testing RPPP Results for 1973 – 1995

	Coeff.	SE	t-Stat	P-val.	Low95	Up95
Intercept	4.91	2.12	2.32	0.03	0.50	9.31
$\pi_t^{ITA} - \pi_t^{BRD}$	0.42	0.24	1.76	0.09	−0.08	0.91

Interpretation confidence intervals

- Claimed value of $\alpha = 0$ is NOT included in the 95 % confidence interval. We reject H_0.
- Claimed value of $\beta = +1$ is NOT included in the 95 % confidence interval. We reject H_0.

Conclusions

- Empirical evidence is not in line with RPPP. Beta is estimated to be $+0.4$, but should be equal to $+1$!
- Both coefficients are significantly different from claimed values on a 95 % confidence level.
- RPPP does NOT hold.

How to compute an estimated t-value (t_{est})

$$t_{est} = \frac{\text{estimated coefficient} - \text{claimed value}}{\text{standard error (SE)}} \tag{5}$$

- We claimed (in the hypotheses) that alpha should be zero:

$$t_{est} = \frac{4.91 - 0}{2.12} = 2.32 \tag{6}$$

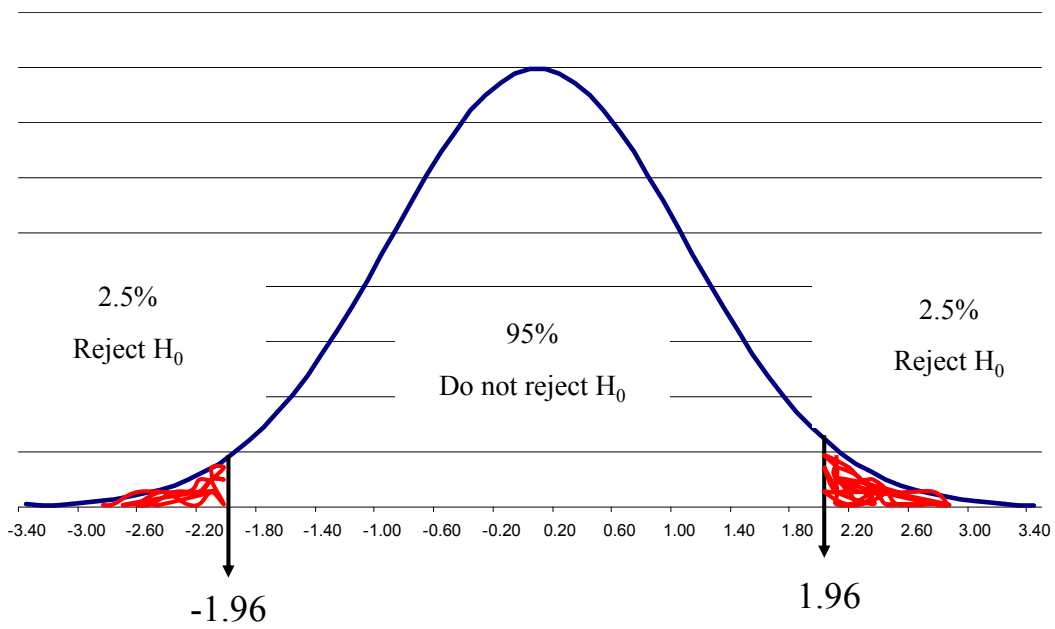
- We claimed (in the hypotheses) that beta should be one:

$$t_{est} = \frac{0.42 - 1}{0.2} = -2.46 \tag{7}$$

NEW

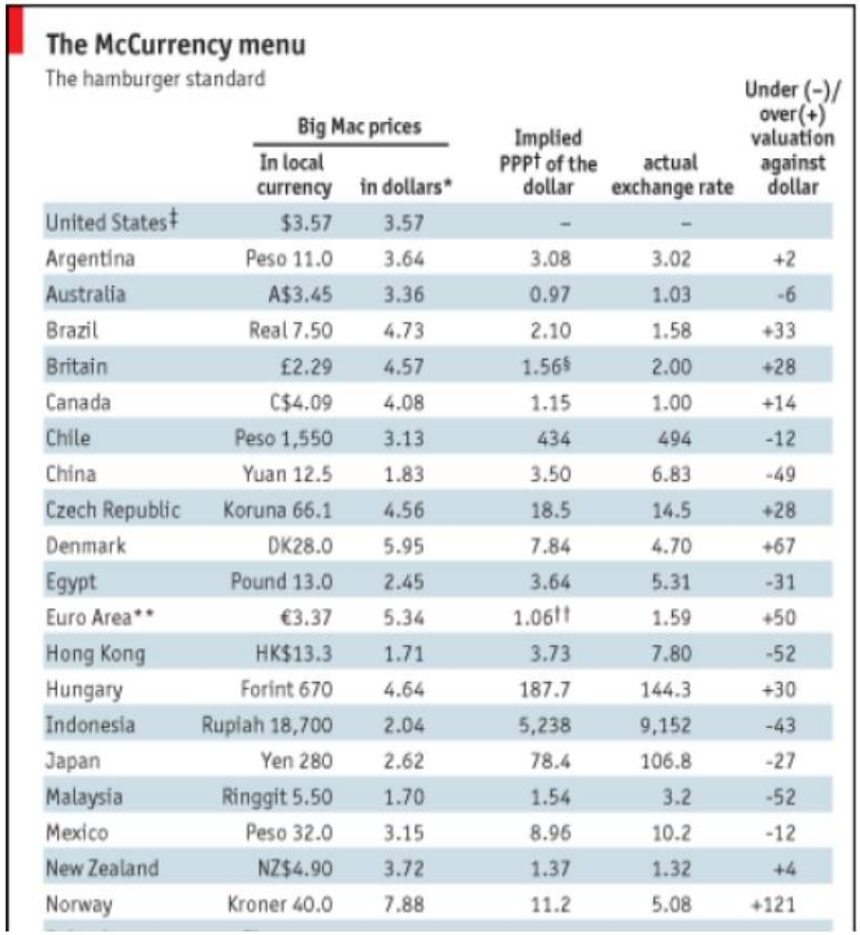
$$t_{est} = \frac{0.417 - 1}{0.237} = -2.46 \tag{8}$$

Interpretation t-values



Outline

Big Mac Index



The McCurrency menu

The hamburger standard

	Big Mac prices		Implied PPP† of the dollar	actual exchange rate	Under (–)/ over(+) valuation against dollar
	In local currency	in dollars*			
United States‡	$3.57	3.57	–	–	
Argentina	Peso 11.0	3.64	3.08	3.02	+2
Australia	A$3.45	3.36	0.97	1.03	-6
Brazil	Real 7.50	4.73	2.10	1.58	+33
Britain	£2.29	4.57	1.56§	2.00	+28
Canada	C$4.09	4.08	1.15	1.00	+14
Chile	Peso 1,550	3.13	434	494	-12
China	Yuan 12.5	1.83	3.50	6.83	-49
Czech Republic	Koruna 66.1	4.56	18.5	14.5	+28
Denmark	DK28.0	5.95	7.84	4.70	+67
Egypt	Pound 13.0	2.45	3.64	5.31	-31
Euro Area**	€3.37	5.34	1.06††	1.59	+50
Hong Kong	HK$13.3	1.71	3.73	7.80	-52
Hungary	Forint 670	4.64	187.7	144.3	+30
Indonesia	Rupiah 18,700	2.04	5,238	9,152	-43
Japan	Yen 280	2.62	78.4	106.8	-27
Malaysia	Ringgit 5.50	1.70	1.54	3.2	-52
Mexico	Peso 32.0	3.15	8.96	10.2	-12
New Zealand	NZ$4.90	3.72	1.37	1.32	+4
Norway	Kroner 40.0	7.88	11.2	5.08	+121

Big Mac Index

- A popular way of studying PPP is to use the Big Mac Index,
- developed by the journal *The Economist*

Why using the Big Mac for studying PPP?

- The Big Mac is more or less homogeneous around the world (no differences in quality).
- Preferences are the same.
- Unfortunately, the Big Mac is NOT an internationally traded good.
- However, the Big Mac price can be interpreted as a Producer Price Index (PPI), because factors of production (land, capital, labor) are used to produce a Big Mac

Big Mac Index: Example: Danish DKK/$

- A BigMac sells in Denmark at $28 DKK$
- A BigMac sells in the US at $3.57\$$
- IMPORTANT (IMPLICIT) ASSUMPTION: Goods prices do not adjust!
- The equilibrium exchange rate level is given by:

$$3.57\$ \cdot E = 28 DKK$$

Equilibrium exchange rate and degree of over-/undervaluation

$$3.57\$ \cdot E = 28DKK$$

$$E = \frac{28DKK}{3.57\$} = 7.84DKK/\$$$

- However on July 24th, 2008 the actual exchange rate was at a level of 4.70 DKK/USD
- If one compares the actual exchange rate with the equilibrium exchange rate the Danish Krona to be overvalued.
- What is the degree of overvaluation?

$$\frac{equ - act}{act} = \frac{7.84 - 4.70}{4.70} = +0.668 \Rightarrow 67\%$$