

Chapter II

PURCHASING POWER PARITY

PROBLEMS

Problem 1

The current exchange rate is Yen 122/\$. If inflation rate in Japan is 2% and that in the USA 3%, calculate the expected exchange rate after one year.

Solution

Currently, one dollar and 122 yen can buy the same basket of goods if we use the PPP principle.

After one year, we need \$ (1) (1.03) = \$ 1.03 to buy the same basket of goods in USA.

Similarly, we would need Yen (122) (1.02) = Yen 124.44 to buy an identical basket of goods in Japan after one year.

Thus, if PPP holds, \$ 1.03 = Yen 124.44 or
\$ 1 = Yen 120.82

Hence, the expected spot rate after one year is Yen 120.82 / \$.

Problem 2

You are told that the spot rate is \$ 1.65 / L.

The expected inflation rates in UK and USA for the next three years are given below.

Year	UK Inflation (%)	US Inflation(%)	1	3.0	2.0
2	3.5	2.5			
3	3.0	2.0			

Calculate the expected \$ / L spot rate after three years.

Solution

Today, L1 and \$ 1.65 can both buy the same basket of goods if we apply PPP.

The same basket of goods will have the following price after three years.

In UK, $(1)(1.03)(1.035)(1.030) = 1.1098$

In USA, $(1.65)(1.02)(1.025)(1.020) = \1.760

If we apply PPP again, $L1.098 = \$1.760$

So, $L1 = \$1.603$

Hence, the expected spot rate after three years is $\$1.603 / L$

Problem 3

You are given the following information.

Spot rate : DM 1.50 / \$

3 Month forward rate : DM 1.51 / \$

The information rate in Germany is 4%. Calculate the inflation rate in USA assuming that Purchasing Power Parity holds good even in the short run.

Solution

Applying PPP, we can state that DM 1.50 and \$1 can buy the same basket of goods today.

Let inflation rate in USA be i .

After three months, the price of the basket will be as follows.

In Germany, $(1.50)(1 + .04 / 4) = \text{DM } 1.5150$

In USA, $(1)(1 + i / 4) = \$ (1 + i / 4)$

The expected spot rate after three months is then $(1.5150) / (1 + i / 4)$.

But, the expected spot rate is nothing but the forward rate.

So, we can write $1.51 = (1.5150) / (1 + i / 4)$

or $i = .0132 = 1.32\%$.

Hence, the inflation rate in USA is expected to be 1.32%.

Problem 4

An Indian company is planning to make a capital investment of DM 500,000 in Germany. The spot rate is Rs 23 / DM. The project is expected to generate annual after tax cash

flows of DM 100,000 for 5 years. At the end of this period, the salvage value of the plant and equipment will be DM 50,000. Calculate the Internal Rate of Return for the project if inflation rates in Germany and India are as follows.

Year	German Inflation(%)	Indian Inflation(%)
1	1.40	8.00
2	1.40	7.50
3	1.60	7.20
4	1.80	7.60
5	2.00	8.00

Solution

At time, $t=0$, outflows = (500,000) (23) = Rs 11,500,000.

The expected spot rates at the end of each year can be calculated as given below. We can also make a reasonable assumption that the conversion into rupees and repatriation occurs at the end of each year.

Year	Expected Spot rate (Rs / DM)
1.	$(23.00)(1.080)/(1.014) = 24.50$
2.	$(24.50)(1.075)/(1.014) = 25.97$
3.	$(25.97)(1.072)/(1.016) = 27.40$
4.	$(27.40)(1.076)/(1.018) = 28.96$
5.	$(28.96)(1.080)/(1.020) = 30.66$

The Indian company is interested in cash flows in rupee terms. Hence, we have to calculate the after tax cash flows in rupee terms applying the spot rates calculated for each year.

Year	Rupee Cash Flows (millions)
0	- 11.500
1	$+ (24.50)(.10) = + 2.450$
2	$+ (25.97)(.10) = + 2.597$
3	$+ (27.40)(.10) = + 2.740$
4	$+ (28.96)(.10) = + 2.896$
5	$+ (30.66)(.10) = + 4.599$

To calculate IRR we have to equate the present value of all cash flows taken together to 0.

Thus, we get :

$$- 11.5 + 2.45 / (1 + r) + 2.597 / (1 + r)^2 + 2.74 / (1 + r)^3 + 2.896 / (1 + r)^4 + 4.599 / (1 + r)^5 = 0$$

By trial and error, we find that r is around 9.3%.

Problem 5

You are given the following information.

Spot rate	:	DG 2.0000 / \$
3 month forward rate	:	DM 1.60 / \$
Inflation rates	:	US - 3%
		Netherlands - 4%

Calculate the 3 month DM - DG forward rate.

Solution

We calculate the 3 month DG - \$ forward rate using Purchasing Power Parity.

$$\begin{aligned} \text{3 month DG - \$ forward rate} &= (2) (1+0.04/4) / (1+0.03/4) \\ &= \text{DG 2.0050 / \$} \end{aligned}$$

Using cross rates, 3 month DM - DG

$$\begin{aligned} \text{forward rate} &= 2.0050 / 1.60 \\ &= \text{DG 1.2531 / DM} \end{aligned}$$

Problem 6

An exchange forecaster expects the dollar to trade at 125 yen, one year from now. If the spot rate is Yen 121 / \$ and US inflation rate is 2%, what is the expected inflation rate in Japan ?

Solution

We use the principle of Purchasing Power Parity.

Let the inflation rate in Japan be i

$$\begin{aligned} \text{Then } 121 (1 + i) &= 125 \\ (1 + 0.02) & \end{aligned}$$

$$\begin{aligned} \Rightarrow i &= 0.0537 \\ &= 5.37\% \end{aligned}$$

Problem 7

The spot rate is Rs. 36.00 / \$. Inflation rates in India and USA are expected to be 8% and 3% respectively. What is the expected rate of depreciation of the rupee ?

Solution

We use the principle of Purchasing Power Parity.

One year from now, the expected spot rate is $(36) (1.08) / (1.03)$
 $= \text{Rs. } 37.7476 / \$$

Spot rate today = Rs. 36.00 / \$ = \$ 0.0278 / Re

Expected spot rate = Rs. 37.7476 / \$ = \$ 0.0265 / Re
after one year

Depreciation of the Re = $\frac{0.0278 - 0.0265}{0.0278} \times 100 = 4.68\%$

Appreciation of the dollar = $\frac{37.7476 - 36}{36} \times 100$
 $= 0.0485 = 4.85\%$

Students thus need to note the following points carefully.

- i) The approximation that inflation differential equals the forward premium/discount is not quite correct.
- ii) When we track the exchange rate between two currencies, the appreciation of one currency does not equal the depreciation of the other currency.

The second point can be explained in a more rigorous way.

Let S_1 be the spot rate (Rs / \$)

Let S_2 be the expected spot rate (Rs / \$) after one year.

Then, appreciation / depreciation of \$ = $\frac{S_2 - S_1}{S_1} \times 100$

$$S_1$$

$$\text{Appreciation/depreciation of Rupee} = \frac{1}{S_2} - \frac{S_1}{S_2} \times 100$$

$$= \frac{S_1 - S_2}{S_1 \times S_2} \times 100$$

$$= \frac{S_1 - S_2}{S_2} \times 100$$

Thus not only the sign but the denominator is different while calculating depreciation of the rupee.

Problem 8

The dollar is quoting Rs. 35.50 today. After one year, it quotes Rs. 37.00. Inflation in India and US are 7% and 3% respectively. Calculate the real appreciation/depreciation of the dollar.

Solution

Adjusting for inflation, the spot rate should be $(35.50) (1.07/1.03) = 36.88$ after a year.

Real appreciation of the dollar

$$= \frac{37 - 36.88}{36.88} \times 100 = 0.32\%$$

Problem 9

The DM which was quoting Rs. 20.50 a year ago is now quoting Rs. 22.00. Inflation in Germany is 2% and that in India 7%. Compute the real appreciation of the DM.

Solution

Adjusting for inflation, the exchange rate should have been $(20.5) (1.07 / 1.02) = 21.50$ after one year

$$\text{Real appreciation of DM} = \frac{22 - 21.50}{21.50} \times 100 = 2.33\%$$

Problem 10

You are given that inflation in India is 7% and that in Switzerland is 2%. The Swiss Franc

is quoting Rs. 24.00 today. If the real appreciation of the SF against the rupee is 5%, compute the exchange rates at the end of one, two and three years.

Solution

Year	Exchange rate based on PPP	Adjustment required for real appreciation	Exchange rate
(1)	(2)	(3)	(4)
1	$(24) (1.07)_2 / (1.02)$	$(2) \times (1.05)$	26.44
2	$(24) (1.07)_3 / (1.02)^2$	$(2) \times (1.05)^2$	29.12
3	$(24) (1.07)^3 / (1.02)$	$(2) \times (1.05)^3$	32.06

Problem 11

A company will avail of a \$2 million loan on 01.06.1997. It will repay the loan with interest by making instalment payments of \$ 1 million at the end of each year for three years after receipt of the loan. The spot rate at the time of disbursement of the loan is Rs. 35.00/\$. The inflation rates in India and USA are 7% and 3% respectively. The expected real annual appreciation of the \$ is 5%. Estimate the cost of funds.

Solution

We first calculate the expected exchange rates at the end of year 1, 2, 3.

At the end of year 1, Exchange rate

$$= (35) (1.07 / 1.03) (1.05)$$

$$= 38.18$$

At the end of year 2, Exchange rate

$$= (35) (1.07 / 1.03)^2 (1.05)^2$$

$$= 41.64$$

At the end of year 3, Exchange rate

$$= (35) (1.07 / 1.03)^3 (1.05)^3$$

$$= 45.42$$

The cash inflows and outflows in terms of rupees can now be tabulated below.

Year	Cash flow (Rs million)
0	$+(2)(35) = +70.00$
1	$-(1)(38.18) = -38.18$
2	$-(1)(41.64) = -41.64$
3	$-(1)(45.42) = -45.42$

To calculate cost of funds, we have to determine IRR. Let us say $IRR = r$

$$\text{Then, } 70 = \frac{38.18}{(1+r)} + \frac{41.64}{(1+r)^2} + \frac{45.42}{(1+r)^3}$$

$$\Rightarrow r = 0.35$$

So, the cost of funds is approximately 35%.

Problem 12

You are given the following spot rates.

$$\text{Rs. } 35/\$ \quad \text{Rs. } 20.5/\text{DM}$$

Inflation : Indian - 7% Germany - 3% USA - 3.5%

The exchange rates after one year are

$$\text{Rs. } 36/\$ \quad \text{Rs. } 20.9/\$$$

Calculate the real appreciation of the dollar against the DM.

Solution

$$\text{Cross rate today} = 35/20.5 = \text{DM } 1.71/\$$$

Expected spot rate after one year based on PPP

$$\begin{aligned} & (1.71)(1.03) \\ & = \frac{(1.71)(1.03)}{1.07} = (1.035) \end{aligned}$$

$$1.70$$

$$\text{Actual cross rate after one year} = 36/20.9 = 1.72$$

$$\begin{aligned} \text{So, real appreciation of the dollar} &= \left[\frac{1.72}{1.70} - 1 \right] \times 100 \\ &= 1.18\% \end{aligned}$$

Problem 13

An Indian company needs long term funds. It has a choice between a dollar loan available at 8% and a DM loan available at 5%. In both cases, the principal will be repaid in 5 equal annual instalments and interest calculated on the outstanding amount. Currently, the exchange rates are DM 1.60 / \$ and Rs. 35 / \$. The long term inflation rates are expected to be 3% in Germany, 5% in USA and 8% in India. Determine, which loan is likely to be more beneficial for the Indian Company.

Solution

Spot rates : DM 1.60 / \$ Rs. 35 / \$

The cross rate is hence $35 / 1.60 = \text{Rs. } 21.88 / \text{DM}$

We assume that Purchasing Power Parity holds good. Hence, expected spot rates at the end of each year, for 5 years, can be calculated using the given trend inflation rates. Let us assume that the company needs \$1,000,000 million. Then, it has to choose between borrowing \$1,000,000 and DM1, 6,000,000. On each repayment date, we have to work out the total repayment consisting of interest and principal and apply the expected spot rate to determine the rupee outflow. We can then calculate the effective rate of interest by equating the present value of the cash outflows with the cash inflow.

\$ loan

Time	Interest (\$)	Principal (\$)	Total (\$)	Exchange rate (Rs/\$)	Rupee outflow(Rs)
1	80,000	200,000	280,000	36.00	10,080,000
2	64,000	200,000	264,000	37.03	9,775,920
3	48,000	200,000	248,000	38.09	9,446,320
4	32,000	200,000	232,000	39.17	9,087,440
5	16,000	200,000	216,000	40.29	8,702,640

Rupee inflow at time, $t=0$ is $(35) (1,000,000) = \text{Rs. } 35,000,000$

To arrive at effective rate of interest, r, we equate

$$35,000,000 = 10,080,000/(1+r) + 9,775,920 / (1+r)^2 + 9,446,320 / (1+r)^3 + 9,087,440 / (1+r)^4 + 8,702,640 / (1+r)^5$$

=> r = 11%

DM loan

Time	Interest (DM)	Principal (DM)	Total (DM)	Exchange rate(Rs/DM)	Rupee Outflow(Rs)
1	80,000	320,000	400,000	22.94	9,176,000
2	64,000	320,000	384,000	24.06	9,239,040
3	48,000	320,000	368,000	25.22	9,280,960
4	32,000	320,000	352,000	26.45	9,310,400
5	16,000	320,000	336,000	27.73	9,317,280

Rupee inflow at time, t = 0 is (21.88) (1,600,000)
= Rs. 35,000,000

To calculate the effective rate of interest, r, we equate

$$35,000,000 = 9,176,000 / (1 + r) + 9,239,040 / (1 + r)^2 + 9,280,960 / (1 + r)^3 + 9,310,400 / (1 + r)^4 + 9,317,280 / (1 + r)^5$$

Putting r = 0.104, we get LHS = RHS

So, it makes more sense to avail of the DM loan.