

Topic 3 Solutions

THINGS TO NOTE:

1. In these solutions we are very precise about how the units are written. Percentage change in exchange rate, forward premiums etc. are all in percentages. Notice how we write percentages. For instance, in the example in lecture slide 13 the answer is written as -1.07% – in percentages – and not in decimals (-0.0107). We expect you to be precise in your answers; so, follow the instructions we provide.

To reiterate, forward premiums are always in percentages.

2. For the formulas of parity conditions, the text assumes direct quotes (i.e., domestic currency per unit of foreign currency). In the lecture slides and in these solutions, you would've noticed that I make no assumptions about the quote. It is just A/B , with A (B) the currency in the numerator (denominator).
3. Question 14 Part (b) addresses an issue to be covered in Topic 5. **For the purposes of preparing for the mid-semester exam, IGNORE it.** It will be covered in the tutorial for Topic 5.

1. Discuss the implications of interest rate parity for exchange rate determination.

If the forward rate unbiasedness condition holds (*i.e.*, $F_{t,t+1} = E_t(S_{t+1})$)

Then IRP can be written as follows:

$$S_t^{A/B} = \frac{1 + i_B}{1 + i_A} \times E \left(S_{t+1}^{A/B} | I_t \right)$$

In this case, the exchange rate is determined by the two interest rates, and the expected future spot rate, conditional on information, I , available at time t . Expectations can be self-fulfilling. Since the information set will be continuously updated as news hits the market, the exchange rate will exhibit highly dynamic, random behaviour.

2. Explain purchasing power parity, both the absolute and relative version. What causes deviations from purchasing power parity?

The absolute version of PPP relates the exchange rate to the absolute price levels in two countries, while relative PPP relates the change in the exchange rate to the change in price levels in the two countries.

PPP can be violated if there are barriers to trade, transaction costs or if people in different countries have different tastes.

3. Discuss the implications of the deviations from purchasing power parity for countries' competitive positions in the world market.

If the exchange rate changes satisfy PPP, competitive positions of countries will remain unaffected following exchange rate changes. Otherwise, exchange rate changes will affect the relative competitiveness of countries. If a currency appreciates (depreciates) by more than what is warranted by PPP, it will hurt (strengthen) the country's competitive position.

4. Suppose that the treasurer of IBM has an extra cash reserve of \$100 million to invest for six months. The six-month interest rate is 8 percent per annum in the United States and 7 percent per annum in Germany. Currently, the spot exchange rate is €1.01 per dollar and the six-month forward exchange rate is €0.99 per dollar. The treasurer of IBM does not wish to bear any exchange risk. Where should he or she invest to maximize the return?

$$i_{\$} = 4\%, i_{\text{€}} = 3.5\%, S = \text{€}1.01/\text{\$} \text{ and } F = \text{€}0.99/\text{\$}$$

\$1,000,000 invested in the US for 6 months will be worth \$100,000,000 $(1.04) =$ \$104,000,000

If it is invested in €, it will be worth: $\text{\$}100,000,000 \times 1.01 \times (1.035) \times (1/0.99) =$ \$105,590,909

Therefore, it is better to invest in Germany.

5. The annual inflation of Netherlands is given to be 4.22% and that of the US is 3.8%. According to purchasing power parity (PPP) will the US dollar will appreciate or depreciate? And by (approximately) how much?

The expected currency depreciation is the differential of inflation rates between the two countries: $\Delta S_{\$/\text{NLG}} = \text{Inf}_{\text{US}} - \text{Inf}_{\text{NLG}}$ measures the US\$ depreciation/appreciation. In this case, it is $3.8\% - 4.22\% = -0.42\%$. Implies US\$ appreciation of 0.42% or NLG depreciation of 0.42%.

(Please note: This answer utilizes the approximate version of Relative PPP. The answer will be slightly different if you use the “proper” formula. In that case the answer is – 0.403%. The approximate version should **only** be used if the question specifically asks for it.)

6. Derive the relative PPP formula using Absolute PPP.

Recall, that Relative PPP links the change in the exchange to the difference in the inflation rates.

At time t , Absolute PPP is $P_t^A = S_t P_t^B$

At $t+1$, Absolute PPP is $P_{t+1}^A = S_{t+1} P_{t+1}^B$

$$\frac{P_{t+1}^A}{P_t^A} = \frac{S_{t+1}^{A/B}}{S_t^{A/B}} \frac{P_{t+1}^B}{P_t^B} \text{ where } \frac{P_{t+1}}{P_t} - 1 = inf \Rightarrow \frac{P_{t+1}}{P_t} = 1 + inf.$$

Substituting, we get

$$1 + inf_A = \frac{S_{t+1}^{A/B}}{S_t^{A/B}} (1 + inf_B)$$

Re-arranging the above equation and subtracting 1 from both sides.

$$\frac{S_{t+1}^{A/B}}{S_t^{A/B}} - 1 = \frac{1 + inf_A}{1 + inf_B} - 1$$

$$\frac{S_t^{A/B} - S_{t-1}^{A/B}}{S_{t-1}^{A/B}} = \frac{\pi_A - \pi_B}{1 + \pi_B}$$

7. When PPP fails, does it imply the presence of profit-making opportunities?

Deviations from PPP that are measured using available data reflect many factors including transport costs, taxes and customs duties, products sold with financing included with after-sales service contracts, quality differences, price indices with different mixtures of traded and non-traded goods etc. Measured deviations from PPP are not necessarily indicative of profit opportunities through arbitrage.

8. Currently, the spot exchange rate is \$1.50/£ and the three-month forward exchange rate is \$1.52/£. The three-month interest rate is 8.0 percent per annum in the U.S. and 5.8 percent per annum in the U.K. Assume that you can borrow as much as \$1.5 million or £1 million.

- (a) Determine whether interest rate parity is currently holding.

$$i_{\$} = 2\%, i_{£} = 1.45\%, S = \$1.5/£ \text{ and } F = \$1.52/£$$

$$(1 + i_{\$}) = 1.02 \text{ (wealth from investing in the US)}$$

$$\frac{F}{S}(1 + i_{£}) = 1.0280 \text{ (wealth from investing in the UK)}$$

IRP does not hold.

In this question, the pound is overvalued in the forward market.

Note: Subtracting 1 from both sides of the IRP formula

$$\frac{F_{t,t+1}^{A/B}}{S_t^{A/B}} = \frac{1+i_A}{1+i_B} \text{ gives us } \frac{F_{t,t+1}^{A/B} - S_t^{A/B}}{S_t^{A/B}} = \frac{i_A - i_B}{1+i_B}$$

- (b) If IRP is not holding, how would you carry out covered interest arbitrage?
Show all the steps and determine the arbitrage profit.

(1) Borrow \$1.5m – will have to repay \$1.53m

(2) Buy £1m using \$1.5m at the prevailing spot rate

(3) Invest £1m at the pound interest rate of 1.45% and the maturity value will be £1,014,500

(4) Sell £1,014,500 forward for \$1,542,040

Arbitrage profit is \$12,040

(c) Explain how IRP will be restored as a result of covered arbitrage activities.

Following the arbitrage transactions described above:

The \$ interest rate will rise;

The £ interest rate will fall;

The spot exchange rate will rise;

The forward rate will fall;

The adjustments will continue until IRP holds.

9. In July, the one-year interest rate is 12% on British pounds and 9% on US dollars.

(a) If the current exchange rate is \$1.63: 1 GBP. What is the expected future exchange rate in one year?

International Fisher Effect (IFE) states that
$$\frac{E\left(S_{t+1}^{A/B}\right) - S_t^{A/B}}{S_t^{A/B}} = \frac{i_A - i_B}{1 + i_B}$$

$$\begin{aligned} E(S_{t+1}) &= (0.09 - 0.12)/1.12 * 1.63 + 1.63 \\ &= \$1.5863 \end{aligned}$$

(b) Suppose a change in expectations regarding future US inflation causes the expected future spot rate to decline to \$1.52: GBP 1. What should happen to the U.S. interest rate?

The US interest rate is unknown. Let us assume that the UK interest rate stayed at 12% (due to no change in expectations of British inflation), then according to International Fisher Effect

$$\begin{aligned} \frac{(1.52 - 1.63)}{1.63} &= \frac{(i_{US} - 0.12)}{1.12} \\ i_{US} &= 4.44\% \end{aligned}$$

10. Assume the interest rate is 16% on Pounds and 7% on Deutsche marks. At the same time, inflation is running at an annual rate of 3% in Germany and 9% in England.

(a) If the Deutsche mark is selling at a one-year forward premium of 10% against the pound, is there an arbitrage opportunity? Explain.

$$\text{IRP states that } \frac{F_{t,t+1}^{A/B} - S_t^{A/B}}{S_t^{A/B}} = \frac{i_A - i_B}{1 + i_B}$$

The % forward premium $[(F-S)/S]$ has been given. The DEM is buying 10% more Pounds in a year's time than today.

$$0.10 = \frac{i - 0.07}{1.07}$$

$$i = 17.7\%$$

The £ interest rate should be 17.7% instead of 16%.

To take advantage of this arbitrage opportunity, we borrow at 16% and convert into DEM and invest it at 7%. Then sell forward, locking the £ return of 17.7%.

(b) What is the real interest rate in Germany? In England?

$$1 + i_{nom.} = (1 + i_{real})(1 + inf)$$

$$\text{Germany: } \frac{1.07}{1.03} - 1 = 3.88\%$$

$$\text{UK: } \frac{1.16}{1.09} - 1 = 6.42\%$$

11. If the USD/Yen spot rate is Yen 218/USD and the interest rates in Tokyo and NY are 6% and 12% respectively. What is the expected USD/Yen exchange rate one year hence?

$$\frac{E(S_{t+1}^{A/B}) - S_t^{A/B}}{S_t^{A/B}} = \frac{i_A - i_B}{1 + i_B}$$

$$E(S_{t+1}) = S_t \times \frac{0.12 - 0.06}{1.06} + S_t$$

$$E(S_{t+1}) = 0.004587 \times \frac{0.12 - 0.06}{1.06} + 0.004587$$

$$E(S_{t+1}) = \text{USD } 0.004847 / \text{Yen} \quad (\text{Yen } 206.32 / \text{USD})$$

12. Discuss the impact of transaction costs on the interest rate parity condition.

When transaction costs are present, the Interest Rate Parity condition need no longer hold exactly. Deviations as large as, but not larger than, transaction costs may exist, forming a neutral band around the parity line.

13. Suppose the euro is pegged to gold at 7 Euros per ounce, while the dollar is pegged at \$14 per ounce. The current exchange rate is \$2.3 per euro. If shipping costs are €1 per ounce, we can make money by buying gold low and selling gold high. Explain.

Circle one: TRUE / FALSE / UNCERTAIN

$$(1) \text{ LAW of one price: } €7 \times \$2.3/€ = \$16.1 > \$14$$

$$(2) \text{ Buy in Perth and ship to Munich} = \$14 + \underline{€1} \times \underline{\$2.3/€} = 16.3$$

We cannot make money as “potential” arbitrage profits are eaten up by transportation costs.

14. The following information on interest rates and exchange rates is available to all with access to any of the finance data providers:

Currency	Spot	1 Month	3 Months	6 Months	12 Months
Euro	2.0310/20	22/18	64/54	128/105	227/228
GBP*	1.4890/00	55/22	160/156	302/289	560/523
Yen	154.20/30	8/6	33/27	75/62	164/137

- * The quote for the British Pound (GBP) is AUD per GBP. For the Euro and Yen it is foreign currency per AUD. For *most* currency pairs, a point is $1/100^{\text{th}}$ of 1% (i.e., 0.0001); the Japanese Yen currency pair is the only exception to this rule. Swap points for Japanese Yen currency pairs (e.g., Yen per AUD) are quoted to two decimal places only, so one point is $1/100$.

2021 exam question (*)

The table below provides bid and ask interest rates on the Australian dollar (AUD), the Euro, the British Pound (GBP) and the Japanese Yen. These rates are quoted on a per annum basis.

Currency	1 Month	3 Months	6 Months	12 Months
AUD	5.6785-5.8125	5.5000-5.6250	5.5000-5.6250	5.6250-5.7500
Euro	4.4375-4.5625	4.3125-4.4375	4.3125-4.4375	4.3125-4.4375
GBP	10.0625-10.1875	9.8750-9.9375	9.6875-9.7500	9.6250-9.7500
Yen	5.1250-5.1875	4.7500-4.8125	4.6250-4.6875	4.6250-4.6875

COMMENTARY: Note that in financial markets, dealers will provide both bid and ask quotes and this applies to interest rates as well. The rate at which the bank/dealer will borrow from you (i.e., bid) is **LESS** than the rate at which they will lend to you (i.e., ask).

- (a) An investor who runs a family office expects the Japanese Yen to depreciate against the Australian dollar by 7% over the next three months. How can this investor try to profit on these expectations through (a) transactions in the spot market only (b) forward market transactions only? Assume that there are no regulatory restrictions whatsoever.

Calculate the profit (or loss) on a \$1 million position for each of the two cases. What other factors should this investor incorporate in his decision when he considers using spot versus forward markets to execute the transaction?

The first part is SPECULATION – the investor is trading based on his opinion of what will happen in the future.

1. Borrow Yen 154,300,000 for 3 months at $4.8125\%/4 = 1.2031\%$ (0.012031)
2. Convert yen to dollars at 154.30. receive **AUD** 1m
3. Invest the dollars for 3 months at $5.5\%/4 = 1.375\%$

Have at the end of 3 months: AUD 1m \times 1.01375 = 1,013,750

4. **SPECULATING USING THE SPOT MARKET**

Need to determine the expected future spot rate: $\frac{154.20}{(1-0.07)} = 165.81$

5. Repay YEN loan at the expected future spot rate.

$$\text{AUD needed to buy YEN} = 154,300,000 \times (1.012031) / 165.81 = 941,799.43$$

6. Expect the \$ profit on the transaction to be (3) – (5)

$$\mathbf{1,013,750 - 941,799.43 = 71,950.57}$$

Forward Transaction:

1. Sell yen forward and hope to buy in the spot market at a price lower than the forward sale price.

The yen can be sold forward at $154.30 - 0.27 = 154.03$ (i.e., selling 154m forward at 154.03).

2. If the yen depreciated by the predicted 7%, spot yen will be 165.81.

The expected profit is \$71,045 ($154,030,000/154.03 - 154,030,000/165.81$)

The FACTORS the investors need to take in to account include:

- (1) Ability to close the deal at low transaction costs.
- (2) Ability to borrow *Yen* and undertake the deal using forward markets for the maturity desired and for non-standard contract sizes.
- (3) Borrowing could be affected by pre-payment penalties.

NOTE: Part (b) addresses an issue covered in Topic 5. **For the purposes of preparing for the mid-semester exam, IGNORE it.** It will be covered in the tutorial for Topic 5.

- (b) Now suppose this investor expects a GBP 2 million payment in a month from client based in Glasgow. While he doesn't have a strong opinion on how the exchange rate is likely to move, he is intent on eliminating the uncertainty around the value of the GBP. What options does he have and what are the costs of eliminating this risk? Which approach should he utilize? Provide your answer in dollar terms.

Spot Exchange rate: **AUD1.4890 – 1.4900/GBP**

Here is the extract from Chapter 5, Eun & Resnick (i.e., the prescribed text) that explains how to arrive at the above quotation. Also, the way spot exchange rates have been presented here is no different to Question 5 in Tutorial 1.

In conversation, interbank FX traders use a shorthand abbreviation in expressing spot currency quotations. Consider the \$/£ bid-ask quotes from above, \$1.4397–\$1.4402. The “1.43” is known as the bid quote *big figure*, and it is assumed to be known by all traders. The second two digits to the right of the decimal place are referred to as the *small figure*. Similarly, the “1.44” is the ask *big figure*. Assuming spot bid-ask spreads for the British pound sterling are around 5 “points,” it is unambiguous for a trader to respond with “97 to 02” when asked what is his quote for British pound sterling.

The establishment of the bid-ask spread will facilitate acquiring or disposing of inventory. Suppose most \$/£ dealers are trading at \$1.4397–\$1.4402. A trader believing the pound will soon appreciate substantially against the dollar will desire to acquire a larger inventory of British pounds. A quote of “98–03” will encourage some traders to sell at the higher-than-market bid price, but also dissuade other traders from purchasing at the higher offer price. Analogously, a quote of “96–01” will allow a dealer to lower his pound inventory if he thinks the pound is ready to depreciate.

MONEY MARKET HEDGE

1. Borrow the PV of £2,000,000 so that the receivable covers interest and principal: $\frac{2,000,000}{\left(1 + \left(\frac{0.101875}{12}\right)\right)} = \text{GBP}1,983,164$.
2. This amount can be invested at 5.6875% for 30 days after converting into AUD (i.e., buying AUD at 1.4890).

$$\text{GBP}1,983,164 \times 1.4890 \times \left(1 + \left(\frac{0.056785}{12}\right)\right) = \$2,966,904.71$$

3. If they are converted £2,000,000 at the current spot rate (i.e., today), they would have: $GBP2,000,000 \times 1.4890 = \$2,978,000.00$
4. The dollar cost is the difference between receiving £2,000,000 today *versus* receiving it in 30 days = (\$11,095)

FORWARD HEDGE

The outright forward rate is:

$$\text{BID: } 1.4890 - 0.0055 = \text{AUD } 1.4835/\text{GBP}$$

$$\text{ASK: } 1.4900 - 0.0022 = \text{AUD } 1.4878/\text{GBP}$$

$$\text{The dollar cost is: } (1.4835 - 1.4890) \times GBP2,000,000 = \$11,000$$

If IRP holds, the costs should be the same, which it is.

16. 2022 exam question

The iTunes store, owned by Apple Inc. sells songs, movies and tv shows. These stores operate in several countries and the songs are priced in local currency terms.

What factor(s) could potentially explain the different prices charged for songs on iTunes? What advantage does the iTunes index have over the Big Mac index?

- (1) International price discrimination. Generally, the wealthier countries are charged a higher price – here the wealthiest country (in terms of GDP) – the US has the second cheapest price. It could be that the demand is less price sensitive (elasticity of demand is lower) in Australia and Japan.
- (2) iTunes price is free of variation in local costs unlike the Big Mac (ex. Price of beef could differ reflecting tariffs) and therefore the price differences of iTunes prices should reflect purely demand related issues. Thus, it should out predict the Big Mac index if Apple based the prices on long-term forecasts of exchange rates.
- (3) Hard to take advantage of price differences (buy in the market where it is trading at a low price and sell where it is trading at a high price) due to digital rights management (DRM). Countries tend to have their own stores and the song will be allocated to a user's account and password protected.

17. 2022 exam question

- (1) According to purchasing power parity, high inflation countries tend to experience nominal appreciations. True or False? Explain in no more than two or three sentences.

FALSE. High inflation countries should experience nominal depreciations to avoid any movement in the real exchange rate.

- (2) If purchasing power parity held exactly, then the yen would trade at one yen to the dollar. True or False? Explain in no more than two or three sentences.

FALSE. The real exchange rate would be one and NOT the nominal exchange rate.

- (3) If Country A has a current account surplus with the rest of the world, citizens in Country A are saving more than the rest of the world. True or False? Explain in no more than two or three sentences.

FALSE. A surplus means country A is saving more than investing. It says NOTHING about its level of savings compared to the savings of the rest of the world.

- (4) By closing off the financial account to the rest of the world Arcadia (a fictitious country) finds it hard to maintain high levels of investment. Agree or disagree? Explain in no more than two or three sentences.

Closing the financial account implies that investment equals domestic savings. This MAY *or* MAY NOT make it easier to maintain high levels of investment (note that foreign savings cannot flow in, but also domestic savings will not go abroad).