Problem 1

Consider the United States and the countries it trades with the most (measured in trade volume): Canada, Mexico, China, and Japan. For simplicity, assume these four are the only countries with which the United States trades. Trade share (trade weights) and US nominal exchange rates for these four countries are as follows:

Country (currency)	Share of Trade	$ per FX in 2015	$ per FX in 2016
Canada (dollar)	36%	0.8271	0.6892
Mexico (peso)	28%	0.0683	0.0538
China (yuan)	20%	0.1608	0.1522
Japan (yen)	16%	0.0080	0.0086

(a) Compute the percentage change from 2015 to 2016 in the four US bilateral exchange rates (defined as US dollar per unit of foreign exchange, or FX) in the table provided.

Solution. The percentage changes are

$$\begin{aligned}
\text{Canada}: &\quad \frac{0.6892 - 0.8271}{0.8271} \times 100 = -16.67\%, \\
\text{Mexico}: &\quad \frac{0.0538 - 0.0683}{0.0683} \times 100 = -21.23\%, \\
\text{China}: &\quad \frac{0.1522 - 0.1608}{0.1608} \times 100 = -5.35\%, \\
\text{Japan}: &\quad \frac{0.0086 - 0.0080}{0.0080} \times 100 = 7.5\%.
\end{aligned}$$

The US dollar appreciates relative to the Canadian dollar, the Mexico peso, and the Chinese yuan: it takes fewer dollars to buy the other currency, meaning a dollar can buy more. The opposite occurs relative to Japanese yen.

(b) Compute the percentage change in the nominal effective exchange rate for the US between 2015 and 2016 (in US dollars per foreign currency basket).

Solution. To find the change in the effective exchange rate, take the weighted-average of the percentage changes we just calculated. You get

$$\begin{aligned}
\%\Delta E_{\text{effective}} &= (0.36)(-16.67) + (0.28)(-21.23) + (0.20)(-5.35) + (0.16)(7.5) \\
&= -11.82\%.
\end{aligned}$$

(c) Based on your answer to part (b), what happened to the value of the US dollar against this basket between 2015 and 2016? How does this compare with the change in the value of the US dollar relative to Mexican peso? Explain your answer.

Solution. The effective exchange rate of the US dollar has appreciated by 11.82%. This number is less than the appreciation relative to the Mexican peso, however, because the effective exchange rate also includes other currencies against which the US dollar did not appreciate as much (or at all).

Problem 2

While on a trip to Baja California, Mexico, in January 1994, Mary bought a house worth 150,000 MXN (i.e. Mexican pesos). At that time, 1 USD was worth 3.10 MXN. One year later 1 USD was worth 5.64 MXN. Use this information to answer the following questions. Round your answer to the nearest whole number.

(a) In USD, how much was Mary's house worth when she bought it?

Solution. I'm going to use a technique called *dimensional analysis* to deal with the units. The basic idea is that if you have the same unit in the numerator and the denominator, then they cancel out. In this case, we want to do something that will "cancel out" the MXN units so that we're only left with USD units, and we can use the exchange rate $E_{\text{USD / MXN}}$ to do so.

$$150,000 \ \cancel{\text{MXN}} \times \frac{1 \text{ USD}}{3.10 \ \cancel{\text{MXN}}} = 48,387 \ \text{ USD}.$$

Note that the exchange rate here is $E_{\text{USD / MXN}} = 0.323$ USD per MXN.

(b) All else equal, in USD, how much was Mary's house worth one year later?

Solution. Same idea, different exchange rate.

$$150,000 \ \cancel{\text{MXN}} \times \frac{1 \text{ USD}}{5.64 \ \cancel{\text{MXN}}} = 26,596 \ \text{ USD}.$$

Note that the exchange rate here is $E_{\text{USD / MXN}} = 0.177$ USD per MXN. The exchange rate decreased from 0.323, therefore the USD appreciated relative to the MXN. Makes sense: 1 USD used to be able to purchase only 3.10 MXN, but now 1 USD can buy 5.64 MXN, so the USD has more "purchasing power" when it comes to purchasing MXN.

(c) All else equal, did the value of Mary's house in USD increase or decrease due to exchange rate changes between the Mexican peso and the dollar?

Solution. It obviously decreased in USD. The lesson: the value of a foreign asset denominated in home currency falls (all else equal) when home currency appreciates relative to that foreign currency.

Problem 3

Consider a Dutch investor with 1,000 euros to place in a bank deposit in either the Netherlands or Great Britain. The (one-year) interest rate on bank deposits is 2% in Britain and

4.04% in the Netherlands. The (one-year) forward euro-pound exchange rate is 1.53 euros per pound and the spot rate is 1.5 euros per pound.

(a) Is the forward market in equilibrium?

Solution. The forward market is in equilibrium if CIP holds. Let's break that down.

First, the investor could invest its 1,000 EUR in a Dutch bank with nominal interest rate $i_{\text{EUR}} = 0.0404$, which one year later would give a payment of

$$1,000\,\text{EUR}(1.0404) = 1040.40\,\text{EUR}\,.$$

Alternatively, the investor could exchange its 1,000 EUR today for

$$1,000\,\text{EUR} \times \frac{1\,\text{GBP}}{1.50\,\text{EUR}} = 666.67\,\text{GBP},$$

let those GBP earn $i_{\text{GBP}} = 0.02$, which one year later would give a payment of $666.67\,\text{GBP}(1.02) = 680\,\text{GBP}$, which could then be exchanged back into EUR according to the forward rate, which gives

$$680\,\cancel{\text{GBP}} \times \frac{1.53\,\text{EUR}}{1\,\cancel{\text{GBP}}} = 1040.40\,\text{EUR}\,.$$

Either investment strategy yields the same result: 1040.40 EUR after one year has passed. There is no arbitrage opportunity, therefore the forward market is in equilibrium.

We could write all of this one as one big CIP equilibrium condition,

$$1,000\,\text{EUR} \times (1.0404) = 1,000\,\text{EUR} \times \frac{1\,\text{GBP}}{1.5\,\text{EUR}} \times (1.02) \times \frac{1.53\,\text{EUR}}{1\,\text{GBP}}.$$

Note that this conforms exactly to the CIP equation in the textbook once you make some simplifications and substitutions.

$$\underbrace{(1+0.0404)}_{(1+i_{\text{EUR}})} = \underbrace{(1+0.02)\frac{\left(\frac{1.53\,\text{EUR}}{1\,\text{GBP}}\right)}{\left(\frac{1.5\,\text{EUR}}{1\,\text{GBP}}\right)}}_{(1+i_{\text{GBP}})\frac{F_{\text{EUR / GBP}}}{E_{\text{EUR / GBP}}}}.$$

(b) What is the forward premium?

Solution. The forward premium is defined to be the proportional difference between forward and spot rates. In our case, it is

$$\frac{1.53 - 1.50}{1.50} = 0.02,$$

or 2 percent. Note that a negative forward premium (i.e. when the forward rate is less than the spot rate) is called a *forward discount*.

The forward premium is useful because it can be used in a linear approximation of CIP that we can use to (approximately) verify that the forward market is in equilibrium, given by

$$i_{\text{EUR}} \approx i_{\text{GBP}} + \text{forward premium} \qquad \Longrightarrow \qquad 0.0404 \approx 0.02 + 0.02.$$

Yeah, pretty damn close.

Anyway, here's a leading question: why would the forward rate be different than the spot rate? On to part (c).

(c) What is the expected depreciation of the euro (against the pound) over one year?

Solution. To answer this, we use UIP, which says that investing in the British bank must have the same *expected* payoff as investing in the Dutch bank. (Note that we are assuming that investors are risk neutral so that expected monetary payoff is all that matters; they don't exhibit other risk characteristics like loss aversion.) In other words, we must have

$$1,000\,\text{EUR} \times (1.0404) = 1,000\,\text{EUR} \times \frac{1\,\text{GBP}}{1.5\,\text{EUR}} \times (1.02) \times E^e_{\text{EUR / GBP}}.$$

You can see that this is nearly identical to the CIP condition, except we have an expected future exchange rate instead of the forward rate. If both conditions hold, then they'll be the same.

The idea is that the forward premium reflects expected depreciation, which makes intuitive sense. If an investor expects to get back 1.53 EUR for each GBP, then why would they agree to accept anything less? And if the borrow expects to pay back 1.53 EUR for each GBP, then why would they agree to pay back anything more? Answer is: they wouldn't (still assuming no risk aversion or anything like that).

We can also use the UIP approximation formula

$$i_{\text{EUR}} = i_{\text{GBP}} + \frac{\Delta E^e_{\text{EUR / GBP}}}{E_{\text{EUR / GBP}}} \qquad \Longrightarrow \qquad 0.0404 = 0.02 + \frac{\Delta E^e_{\text{EUR / GBP}}}{E_{\text{EUR / GBP}}},$$

which gives an approximate expected depreciation of the EUR of 0.0204, whereas the exact expected depreciation is 0.02 as reflected by the forward premium solved earlier.