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) are U.S. 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 U.S. bilateral exchange rates (defined as U.S. dollar per unit of foreign exchange, or FX) in the table provided.

(b) Use the trade shares as weights to compute the percentage change in the nominal effective exchange rate for the United States between 2015 and 2016 (in U.S. dollars per foreign currency basket).

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

Solution 1

(a) The percentage changes are

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

So the U.S. 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) To find 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) The effective exchange rate of the U.S. 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 U.S. dollar did not appreciate as much (or at all).

Problem 2

You are a financial adviser to a U.S. corporation that expects to receive a payment of 60 million Japanese yen in 180 days for goods exported to Japan. The current spot rate is 100 yen per U.S. dollar. You are concerned that the U.S. dollar is going to appreciate against the yen over the next six months.

(a) Assuming the exchange rate remains unchanged, how much does your firm expect to receive in U.S. dollars?

(b) How much would your firm receive (in U.S. dollars) if the dollar appreciated to 110 yen per U.S. dollar?

(c) Describe how you could use an options contract to hedge against the risk of losses associated with the potential appreciation in the U.S. dollar.

Solution 2

(a) The trick to conversion is to use the exchange rate that has the original currency in the denominator (and thus the new currency in the numerator) so that the original units cancel out — this is called *dimensional analysis* and is helpful for keeping track of units. Here the original currency is yen, so the conversion is

$$60,000,000\,\cancel{\text{JPY}} \times \frac{1\,\text{USD}}{100\,\cancel{\text{JPY}}} = 600,000\,\text{USD},$$

where $E_{\text{USD}\,/\,\text{JPY}} = 1/100$ is the relevant exchange rate (0.01 USD per JPY).

(b) If the dollar appreciated to 110 yen per U.S. dollar, then we'd just take the preceding equation and change the 100 to 110, yielding

$$60,000,000\,\cancel{\text{JPY}} \times \frac{1\,\text{USD}}{110\,\cancel{\text{JPY}}} = 545,454.55\,\text{USD},$$

so now the relevant exchange rate is $E_{\text{USD}\,/\,\text{JPY}} = 1/110$, or 0.009 USD per JPY.

(c) A **put option** gives you the right to sell your currency in the future at an agreed-upon exchange rate, should you choose to exercise that option.

As we have just seen, the firm receives $54,545.45\,\text{USD}$ less if the dollar appreciates, i.e. if the exchange rate falls from $1/100$ to $1/110$. If the firm thinks this is a possibility and wants to avoid that much loss, then the firm might choose to purchase a put option for, say, 10,000 USD, that allows them to sell their 60,000,000 JPY at the original exchange rate. In this case, even if the USD appreciates, the firm would end up with

$$60,000,000\,\cancel{\text{JPY}} \times \frac{1\,\text{USD}}{100\,\cancel{\text{JPY}}} - 10,000 = 590,000\,\text{USD},$$

which is an improvement over the $545,454.55\,\text{USD}$ they would receive had they not purchased the put option.

On the other hand, if the USD does not appreciate as expected and remains at the existing exchange rate of $1/100$, then the put option is useless. That's why hedging is a kind of insurance — it's only useful when things go bad.

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 1% in Britain and 5% in the Netherlands. The (one-year) forward euro-pound exchange rate is 1.65 euros per pound and the spot rate is 1.5 euros per pound. Answer the following questions, using *exact* equations for covered interest parity (CIP) as necessary.

(a) What is the euro-denominated return on Dutch deposits for this investor?

(b) What is the (riskless) euro-denominated return on British deposits for this investor using forward cover?

(c) Is there an arbitrage opportunity here? Explain why or why not. Is this an equilibrium in the forward exchange market?

(d) If the spot rate is 1.5 euros per pound, and interest rates are as stated previously, what is the equilibrium forward rate, according to CIP?

Solution 3

(a) The euros invested in the Netherlands receives $1,000\,\text{EUR}(1+.05) = 1,050\,\text{EUR}$.

(b) Let's proceed in steps.

(i) Convert 1,000 euros to British pounds using the current spot rate,

$$1,000\,\text{EUR} \times E_{\text{GBP / EUR}} = 1,000\,\cancel{\text{EUR}} \times \frac{1\,\text{GBP}}{1.5\,\cancel{\text{EUR}}} = 666.67\,\text{GBP}\,.$$

(ii) Invest 666.67 GBP in British banks for 666.67 GBP $\times (1 + .01) = 673.34$ GBP.

(iii) The forward contract requires you to convert 673.34 GBP back into euros at exchange rate of 1.65 euros per pound, which yields

$$673.34\,\text{GBP} \times F_{\text{EUR / GBP}} = 673.34\,\cancel{\text{GBP}} \times \frac{1.65\,\text{EUR}}{1\,\cancel{\text{GBP}}} = 1111.01\,\text{EUR}\,.$$

Note that unlike the put option in a previous question, the forward contract *requires* you to sell at the forward rate — you cannot decline the sale at the agreed-upon rate like you could with a put option.

Or to summarize this all up in a single equation (which also avoids rounding issues),

$$1{,}000\,\text{EUR} \times (1.01) \times \frac{1.65}{1.5} = 1{,}111.00\,\text{EUR},$$

which is a nominal increase of 11.1%. Note that this return is exactly the equation given in the book (albeit with different currencies),

$$(1 + i_{\text{GBP}})\frac{F_{\text{EUR / GBP}}}{E_{\text{EUR / GBP}}}.$$

(c) There is absolutely an arbitrage opportunity because the safe rate of euro-denominated return is higher by investing in British banks. For example, a rogue bank in the Netherlands could say, "Hey, I'll give you 6% interest instead of the 5% interest the other banks are giving." Then the rogue bank could invest that money in Britain with a forward contract, earn 11.1% interest, and make an easy profit of 5.1%.

This cannot be an equilibrium; the spot rate will have to rise, the forward rate will have to fall, or some combination of the two, so that the CIP condition holds, i.e.

$$(1 + i_{\text{EUR}}) = (1 + i_{\text{GBP}})\frac{F_{\text{EUR / GBP}}}{E_{\text{EUR / GBP}}}.$$

(d) Solve the previous equation for the equilibrium forward rate, then plug and chug:

$$\begin{aligned} F_{\text{EUR / GBP}} &= E_{\text{EUR / GBP}}\left(\frac{1 + i_{\text{EUR}}}{1 + i_{\text{GBP}}}\right) \\ &= 1.5\left(\frac{1 + .05}{1 + .01}\right) \\ &= 1.56. \end{aligned}$$

Note that this implies a **forward premium** of

$$\frac{1.56 - 1.50}{1.50} \times 100 = 4\%.$$