Econ 690
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Answers to Homework 5

1. Suppose the spot rate is CHF0.9976/$ in the spot market, and the 180-day forward rate is CHF0.9908/$. If the 180-day dollar interest rate is 3% p.a., what is the annualized 180-day interest rate on Swiss francs that would prevent arbitrage?

   Answer: Interest rate parity requires equality of the return to investing in CHF versus converting the CHF principal into dollars, investing the dollars, and selling the dollar principal plus interest in the forward market for CHF:

$$\big(1 + i(CHF)\big) = \frac{1}{S(CHF/\$)} \times (1 + i(\$)) \times F(CHF/\$)$$

   If we "de-annualize" the dollar interest rate, we find that the 180 day interest rate is 0.015. Hence, the Swiss franc interest rate that prevents arbitrage is

$$\text{i(CHF)} = \frac{1}{\text{CHF0.9976/\$}} \times 1.015 \times \text{CHF0.9908/\$} - 1 = 0.0081$$

   If we annualize this value, we find 0.0081 × (100) × (360/180) = 1.62%.

2. As a trader for Goldman Sachs you see the following prices from two different banks:

1-year euro deposits/loans:	6.0% – 6.125% p.a.
1-year Malaysian ringgit deposits/loans:	10.5% – 10.625% p.a.
Spot exchange rates:	MYR 4.6602 / EUR – MYR 4.6622 / EUR
1-year forward exchange rates:	MYR 4.9500 / EUR – MYR 4.9650 / EUR

   The interest rates are quoted on a 360-day year. Can you do a covered interest arbitrage?

   Answer: We need to check the two inequalities that characterize the absence of covered interest arbitrage. In the first, we will borrow euros at 6.125%, convert to ringgits in the spot market at MYR4.6602 / EUR, invest the ringgits at 10.5%, and sell the ringgit principal plus interest forward for euros at MYR4.9650 / EUR. We find that

$$1.06125 > \frac{MYR\ 4.6602}{EUR} \times 1.105 \times \frac{1}{MYR\ 4.9650/EUR} = 1.0372$$

   Thus, it is not profitable to try to arbitrage in this direction as the amount that we would owe is greater than the amount that we would gain.

   Let's try the other direction, arbitraging out of ringgits into euros and covering the foreign exchange risk. We will borrow ringgits at 10.625%, convert to euros in the spot market at

MYR4.6622 / EUR, invest the euros at 6.0%, and sell the euro principal plus interest forward for ringgits at MYR4.9500 / EUR. We find that

$$1.10625 < \frac{1}{MYR\ 4.6622/EUR} \times 1.06 \times \frac{MYR\ 4.9500}{EUR} = 1.1254$$

Thus, there is a possible arbitrage opportunity because the amount that we owe from borrowing ringgits is less than the amount that we gain by converting from ringgits to euros, investing the euros, and covering the transaction exchange risk with a forward sale of euros for ringgits.

3. As an importer of grain into Japan from the United States, you have agreed to pay \$377,287 in 90 days after you receive your grain. You face the following exchange rates and interest rates: spot rate, ¥106.35/\$, 90-day forward rate ¥106.02/\$, 90-day USD interest rate, 3.25% p.a., 90-day JPY interest rate, 1.9375% p.a.

a. Explain two ways to hedge the foreign exchange risk.

Answer: You could hedge your risk by buying dollars forward at ¥106.02/\$. Alternatively, you could determine the present value of the dollars that you owe and buy that amount of dollars today in the spot market. You could borrow that amount of yen to avoid having to pay today.

b. Which of the alternatives in part b is superior?

Answer: If you do the forward hedge, you will have to pay

$$¥106.02/\$ \times \$377,287 = ¥39,999,967.74$$

in 90 days. If you do the money market hedge, you first need to find the present value of \$377,287 at 3.25%. The de-annualized interest rate is $(3.25/100) \times (90/360) = 0.008125$. Thus, the present value is

$$\$377,287 / 1.008125 = \$374,246.25$$

Purchasing this amount of dollars in the spot market costs

$$¥106.35/\$ \times \$374,246.25 = ¥39,801,088.69$$

To compare this value to the forward hedge, we must take its future value at 1.9375% p.a. The de-annualized interest rate is $(1.9375/100) \times (90/360) = 0.00484375$, and the future value is

$$¥39,801,088.69 \times (1.00484375) = ¥39,993,875.21$$

The cost of the money market hedge is essentially the same as the cost of the forward hedge because interest rate parity is satisfied. The forward hedge is just slightly more expensive.

4. Over the next 30 days, economists forecast that the pound may strengthen relative to the dollar by as much as 6%, or it may weaken by as much as 7%. The possible values for the rate of change of the dollar–pound spot exchange rate are –7%, –5%, –3%, –1%, 0%, 2%, 4%, and 6%. If these values are equally likely, what are the mean and standard deviation of the future spot exchange rate if the current rate is \$1.3345/£? (We can use the fact that if x_t is the standard deviation of the rate of change of the exchange rate – that is, if $x_t \equiv sd_t\left(\frac{S_{t+1}-S_t}{S_t}\right)$, then $sd_t\left(S_{t+1}\right)=sd_t\left(S_{t+1}-S_t\right)=x_t S_t$. We can use the fact that $sd_t\left(S_{t+1}\right)=x_t S_t$ to answer the question.)

   Answer: The mean is the probability weighted average of the future possibilities. Because the events are equally likely and there are 8 events, each gets weight 1/8 in the average. Thus the mean is

   $$(1/8) \times [(-7\%) + (-5\%) + (-3\%) + (-1\%) + 0\% + 2\% + 4\% + 6\%] = -0.5\%$$

   Consequently, the expected future spot rate is (1 – 0.005) × \$1.3345/£ = \$1.3278/£. The standard deviation is the square root of the variance. The variance is the probability weighted average of the squared deviations of the possible realizations from their mean. Upon taking the average of the squared deviations of the realizations from their means, we find the standard deviation equal to 4.1533%. Because the standard deviation of the future exchange rate is the current exchange rate times the volatility of the rate of change, we find the volatility of the future exchange rate to be 4.1533% × \$1.3345/£ = \$0.0554/£.

5. Suppose that the 90-day forward rate is \$1.19/€, the current spot rate is \$1.20/€, and you expect the future spot rate in 90 days to be \$1.21/€. What contract would you make to speculate in the forward market by either buying or selling €10,000,000? What is your expected profit? If the standard deviation of the 90-day rate of appreciation of the euro relative to the dollar is 3%, what range covers 95% of your possible profits and losses?

   Answer: The forward rate of \$1.19/€ is less than your expected future spot rate of \$1.21/€. Therefore, if you buy the euro forward, you expect to be able to sell euros at a higher dollar price. You should speculate by buying the euro forward, in which case you want to sell €10,000,000 forward. If we contract to buy €10,000,000 forward, our expected dollar profit is

   $$\left(\frac{\$1.21}{€}-\frac{\$1.19}{€}\right)\times €10{,}000{,}000 \ = \$200{,}000$$

   If the rate of appreciation of the euro is conditionally normally distributed, 95% of the possible rates of appreciation will be between plus or minus 1.96 standard deviations of the mean. The standard deviation of the level of the exchange rate is the current spot rate multiplied by the standard deviation of the rate of appreciation or \$1.20/€ × 0.03 = \$0.036/€. Therefore, 95% of the possible future exchange rates lie within a range from \$1.1394/€ = \$1.21/€ - (1.96 × \$0.036/€) to \$1.2806/€ = \$1.21/€ + (1.96 × \$0.036/€). The 95% range of dollar profits on our forward contract is therefore from

$$\left(\frac{\$1.1394}{€}-\frac{\$1.19}{€}\right)\times €10{,}000{,}000\ = -\$506{,}000$$

to

$$\left(\frac{\$1.2806}{€}-\frac{\$1.19}{€}\right)\times €10{,}000{,}000\ = \$906{,}000$$