**Practice set #4 and solutions**

To help students with the material, seven practice sets with solutions will be handed out. They will not be graded: the number of "points" for a question solely indicates its difficulty in terms of the number of minutes needed to provide an answer.

Students are strongly encouraged to try hard to solve the practice sets and to use office hours to discuss any problems they may have doing so. The best self-test for a student of her or his command of the material is whether s/he can handle the questions of the relevant practice sets.

**Question 1 (7.5 points)**

J.P. Morgan sells a "3 against 12" FRA for $1m at an annualized rate of 4.75%. Three months after the sale, interest rates have the following term structure:

<table>
<thead>
<tr>
<th>maturity (# months)</th>
<th>rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**a.** How much cash does the bank pay to, or receive from, the FRA buyer?

**b.** What is J.P. Morgan's effective lending rate for the 270-day lending period?

**Question 2 (10 points)**

The quoted futures price is 114:26. Which of the following 3 bonds is cheapest to deliver?

<table>
<thead>
<tr>
<th>Bond</th>
<th>Price</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>162:20</td>
<td>1.3987</td>
</tr>
<tr>
<td>2</td>
<td>138:31</td>
<td>1.2820</td>
</tr>
<tr>
<td>3</td>
<td>131:02</td>
<td>1.1273</td>
</tr>
</tbody>
</table>

**Question 3 (10 points)**

Alcoa has just made a $10 million issue (face value) of floating rate bonds on which it pays an interest rate 1% over the LIBOR rate. The bonds are selling at par value. Alcoa is worried that rates are about to rise, and it would like to lock in a fixed interest rate on its borrowings. Alcoa sees that dealers in the swap market are offering swaps of LIBOR for 7%.
(a) What interest rate swap will convert the firm’s interest obligation into one resembling a synthetic fixed-rate loan?
(b) What interest rate will the firm pay on that synthetic fixed-rate loan?

**Question 4 (15 points)**

Your employer, General Motors Corp., plans to import 250 Opels from its plant in Rüsselheim, Germany, to rebadge them as "CTS" and sell them in the US via Cadillac dealerships. The German subsidiary of the company has agreed to sell them for a total of 10 million Euros, which will be payable on April 09. We are on February 1, 2003.

a. Explain how GM can use currency futures to hedge its exchange risk.

(Hint #1: since April 09 falls in between the delivery date for the March contract (03-21-03) and the delivery date for the June contract (06-20-03), you must argue whether GM would be better off with a March or with a June contract)

(Hint #2: when arguing which of the March or June futures is better to hedge April Euro exposure, think about what exchange risk you would bear between 04-09 and the respective delivery dates of each contracts)

b. How many futures contracts will GM need? Each Euro futures is for delivery of Euro 125,000.

c. Is GM completely hedged? Would GM's hedge be better with a customized forward contract?

(Hint: what is the delivery date for the futures you used in a.?)

**Question 5 (TBD in class if exam material)**

Suppose that we are on 02-16-94, and that your company expects the following cash-flows during the end of March:

<table>
<thead>
<tr>
<th>Cash-ins</th>
<th>03-16</th>
<th>03-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM 100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DG 45,000 (Dutch Guilder)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM 125,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cash-outs</th>
<th>03-16</th>
<th>03-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM 140,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¥ 10,900,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The exchange rates on 02-16 are as follows:

<table>
<thead>
<tr>
<th>Exchange Rate</th>
<th>Spot</th>
<th>30-day forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM:</td>
<td>1.66 DM/1$</td>
<td>1.64</td>
</tr>
<tr>
<td>DG:</td>
<td>1.5 DG/1$</td>
<td>1.48</td>
</tr>
<tr>
<td>¥:</td>
<td>120 ¥/1$</td>
<td>120</td>
</tr>
</tbody>
</table>

You are further told that a March DM futures contract on the same day costs $76,000, including all transactions costs. The third Wednesday of March is 03-16-94. Finally, you are told that --
over the past 2 years -- for each 1% appreciation of the $ against the DM, the $ has appreciated
by 1% against the guilder and by 0.4% against the ¥.

a. Suppose that your company wants you to hedge as much as possible of its end-of-March
   transaction exposure, yet wants to minimize hedging costs. What would you recommend?
   Explain thoroughly, and state your assumptions.

b. Suppose the company wants a perfect hedge. Would your recommendations change? Explain
   in details.

c. (Bonus) Suppose that your company is more interested in minimizing hedging costs than
   hedging. What could you recommend? What risks would the company be exposed to?
**Practice set #4 solutions**

**Question 1 (7.5 points)**

J.P. Morgan sells a "3 against 12" FRA for $1m at an annualized rate of 4.75%. Three months after the sale, interest rates have the following term structure:

<table>
<thead>
<tr>
<th>maturity (# months)</th>
<th>rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**a.** How much cash does the bank pay to, or receive from, the FRA buyer?

**b.** What is J.P. Morgan's effective lending rate for the 270-day lending period?

**Answer.**

**a.** By selling the FRA at 4.75%, JP Morgan wanted to make sure that it would obtain a 4.75% annualized rate on a $1m 9-month loan it would make 3 months later. Since, 3 months after the FRA sale, the 9-month rate has become 5%, JP Morgan in fact can lend at 5%.

Since this is more than 4.75%, JP Morgan will pay the interest rate differential to the FRA buyer on the nominal amount of the contract. The exact cash settlement, 3 months after the FRA sale, is:

\[
\text{amount paid by the FRA seller} = (\text{nominal amount of contract}) \times \frac{(S-A) \times \left(\frac{\text{# days the FRA runs}}{\text{# days in the year}}\right)}{1 + S \times \left(\frac{\text{# days the FRA runs}}{\text{# days in the year}}\right)}
\]

\[
= (\$ 1m) \times \frac{(.05 - .0475) \times (270)}{(360)} \times \frac{1 + .05 \times (270)}{(360)}
\]

\[
= $1,807.23
\]

**b.** 4.75%.

By entering into the FRA agreement, JP Morgan has ensured that, regardless of the actual 9-month rate that will prevail 3 months after the FRA sale, it would receive 4.75% on money that it would lend for 270 days: if the cash rate 3 months after the FRA sale were higher than 4.75%,
then JP Morgan would pay the interest difference to the FRA buyer; and if the cash rate were lower, then it would receive the interest difference from the FRA buyer.

**Question 2 (10 points)**

The quoted futures price is 114:26. Which of the following 3 bonds is cheapest to deliver?

<table>
<thead>
<tr>
<th>Bond</th>
<th>Price</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>162:20</td>
<td>1.3987</td>
</tr>
<tr>
<td>2</td>
<td>138:31</td>
<td>1.2820</td>
</tr>
<tr>
<td>3</td>
<td>131:02</td>
<td>1.1273</td>
</tr>
</tbody>
</table>

**Solution:**

For each $100 of face value, the futures price is $(114 + 26/32) = $114.8125 and the net return to the short is:

<table>
<thead>
<tr>
<th>Bond</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>114.8125 x 1.3987 - 162.625 = -2.0368</td>
</tr>
<tr>
<td>2</td>
<td>114.8125 x 1.2820 - 138.96875 = 8.2208</td>
</tr>
<tr>
<td>3</td>
<td>114.8125 x 1.1273 - 131.0625 = -1.6344</td>
</tr>
</tbody>
</table>

By far, Bond #2 is the cheapest to deliver.

**Question 3 (10 points)**

Alcoa has just made a $10 million issue (face value) of floating rate bonds on which it pays an interest rate 1% over the LIBOR rate. The bonds are selling at par value. Alcoa is worried that rates are about to rise, and it would like to lock in a fixed interest rate on its borrowings. Alcoa sees that dealers in the swap market are offering swaps of LIBOR for 7%.

(a) What interest rate swap will convert the firm’s interest obligation into one resembling a synthetic fixed-rate loan?

(b) What interest rate will the firm pay on that synthetic fixed-rate loan?

**Solution:**

(a) The firm should enter a swap in which it pays a 7% fixed rate and receives LIBOR on $10 million of notional principal. Its total payment will be as follows:

Interest payments on bond...........(LIBOR + 0.01) x $10 million par value
Net cash flow from swap.........(0.07 – LIBOR) x $10 million notional principal

TOTAL 0.08 x $10 million

(b) The interest rate on the synthetic fixed-rate loan is 8%.
**Question 4 (15 points)**

Your employer, General Motors Corp., plans to import 250 Opels from its plant in Rüsselheim, Germany, to rebadge them as "CTS" and sell them in the US via Cadillac dealerships. The German subsidiary of the company has agreed to sell them for a total of Euro 10 million, which will be payable on April 09. We are on February 1, 2003.

**a. and b.** Explain how GM can use currency futures to hedge its exchange risk. How many futures contracts will GM need? Each Euro futures is for delivery of Euro 125,000.

(Hint #1: since April 09, 2003 falls in between the delivery date for the March contract (03-21-03) and the delivery date for the June contract (06-20-03), you must argue whether GM would be better off with a March or with a June contract)

(Hint #2: when arguing which of the March or June futures is better to hedge April exposure, think about what exchange risk you would bear between 04-09 and the respective delivery dates of each contracts)

**Answer**

To hedge its foreign-exchange risk, GM needs to lock in *today* the $ price that it will pay for the Euro on April 09. Buying an appropriate number of Euro futures contracts with a delivery date close to April 09 is one attempt to do that.

The IMM offers March and June futures contracts in the amount of 125,000 Euro per contract. In each case, GM would therefore have to purchase 80 futures contracts (= the total exposure of 10,000,000 Euro divided by the contract size of 125,000 Euro).

The last day of trading for March and June contracts is the Monday before the third Wednesday of March and June, respectively, i.e., March 19 and June 18, 2003. The corresponding delivery dates are March 21 and June 20.

If GM purchases 80 March futures on February 01, it will face two choices on March 19.

1. Either GM decides that it will take delivery of the DM, in which case GM is, as of 02-01, exposed to foreign *interest rate* risk. Put differently, GM will hold Euro 10m from March 21 till April 09 but does not know, as of February 01, the rate of interest that will prevail on Euro deposits during this period. Since GM takes delivery of Euro 10m at a price (the March futures price) that is known by February 01, however, it faces no exchange-rate risk.

2. Or, on March 19 -- the last day of trading for 2003 March futures -- GM will reverse its trade on the IMM, i.e., it will short 80 Euro March futures. By doing so, GM will pocket the gain

---

1 Exhibit 6.1 in Shapiro mistakenly makes reference to an "April futures" traded in January. April contracts could only be traded in March (1-month futures) and April (spot month).

2 As I mentioned in class, the exact number of futures contracts needed for the hedge is not exactly equal to 80 because of *basis risk*, i.e., the fact that futures price and spot price do not change at the same rate over time. The more sophisticated method to calculate the number of futures needed in order to hedge FX-risk is called a *delta hedge*.
or pay the loss from having bought March Euro futures in February, 2003. The flip side, of course, is that GM still needs to purchase Euro 10m on the spot market on 04-09, at a rate that cannot be known for sure either on 02-01 or on 03-19. In this case, then, GM is exposed to foreign exchange risk from 03-19 to 04-09 -- a much shorter period than from 02-01 till 04-09.

A June futures, on the other hand, requires delivery on 06-20-03. GM, however, needs the dollars on April 09. Hence, if GM uses a June Euro futures hedge, it will have to liquidate its long Euro June futures position on April 09, and buy 10,000,000 Euro on the spot market. As of February 01, unfortunately, GM knows neither the Euro spot price nor the June Euro futures price that will clear the markets on April 09. All GM knows is that the February price of a June Euro futures is a good forecast of the Euro spot price on 06-20 but, since there are approximately 10 weeks between April 09 and June 18, this is a poor forecast of the Euro spot and June futures prices on April 09. Using June futures would thus leave GM open to a lot of FX risk.

The bottom line is that, by using March Euro futures, GM will be exposed to less risk. Whether GM will choose, on 03-19, to take delivery of the Euro 10m or to reverse its March futures trade, will depend on its estimate of exchange rate movements from 03-19 to 04-07 (remember that spot deliveries take two days) and of interest rate movements between 03-19 and 03-21 -- the time interval between the decision and the delivery of the Euro 10m.

c. Is GM completely hedged? Would GM's hedge be better with a customized forward contract? (Hint: what is the delivery date for the futures you used in a.?)

Answer

GM needs the Euro on April 09, yet the delivery date for the March Euro futures contract is March 21. As argued in part a., GM therefore bears some risk and is not perfectly hedged. The only way for GM to completely hedge its foreign exchange risk would be to enter into a forward contract with a bank, whereby GM would agree to take delivery on 04-09 of 10,000,000 Euro at a price fixed as of today, 02-01.4

Question 5 (TBD in class if exam material))

Suppose that we are on 02-16-94, and that your company expects the following cash-flows during the end of March:

<table>
<thead>
<tr>
<th>cash-ins:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DM 100,000</td>
<td>(03-16)</td>
<td></td>
</tr>
<tr>
<td>DG 45,000</td>
<td>(03-16)</td>
<td></td>
</tr>
<tr>
<td>DM 125,000</td>
<td>(03-20)</td>
<td></td>
</tr>
</tbody>
</table>

3 Since delivery in the spot market takes place 2 days after the purchase, GM really has to sell its futures on 04-07.
4 In the last part of the course, we will (time permitting) see that GM could guarantee itself the deposit rate from March 22 through April 09 by entering into an FRA or Forward Rate Agreement -- FRA's can be thought of as forward contracts on interest rates, and are important for global risk management. Doing so, however, would involve further costs and GM is better off with a forward hedge.
The exchange rates on 02-16 are as follows:

<table>
<thead>
<tr>
<th></th>
<th>spot</th>
<th>30-day forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM:</td>
<td>1.66 DM/1$</td>
<td>1.64</td>
</tr>
<tr>
<td>DG:</td>
<td>1.5 DG/1$</td>
<td>1.48</td>
</tr>
<tr>
<td>¥:</td>
<td>120 ¥/1$</td>
<td>120</td>
</tr>
</tbody>
</table>

You are further told that a March DM futures contract on the same day costs $76,000, including all transactions costs. The third Wednesday of March is 03-16-94. Finally, you are told that -- over the past 2 years -- for each 1% appreciation of the $ against the DM, the $ has appreciated by 1% against the guilder and by .4% against the ¥.

**a.** Suppose that your company wants you to hedge as much as possible of its end-of-March transaction exposure, yet wants to minimize hedging costs. What would you recommend? Explain thoroughly, and state your assumptions.

**Answer.**

First, to reduce costs, you can assume away the credit risk, i.e., you can assume that the amounts receivable (the "cash-ins") will be paid to your company on the due date. This enables you to net out the cash-ins and cash-outs, per currency per date. In the case at hands, this enables you to net out 100,000 DM on 03-16, which leaves you with the following amounts to worry about:

- **Cash-ins:**
  - DG 45,000 (Dutch Guilder) (03-16)
  - DM 125,000 (03-20)

- **Cash-outs:**
  - DM 40,000 (03-16)
  - ¥ 10,900,000 (03-20)

Second, notice that the DG (Dutch Guilder) and the DM have, in the last 8 or 9 years, moved almost perfectly together against other currencies. This is due not only to the fact that the two currencies belong to the ERM, but also to the fact that, within the ERM, the Dutch government has made a point of avoiding any devaluation of the DG against the DM. As a result, it is a safe bet to consider DG and DM cash-flows as very close substitutes (the DG is almost perfectly pegged to the DM). Since the DG 45,000 cash-in and DM 40,000 netted cash-out are taking place on the same day, it is reasonable to net them out. At the current exchange rates, the Dutch cash-in is worth 45,000/1.5=$30,000, whereas the German cash-out is worth 40,000/1.66=$24,000. This leaves you with a netted-out cash in on 03-15 that amounts to:

\[(30,000-24,000) \times 1.5 = DG 9,000.\]

After this first round of netting across currencies, you are left with the following amounts to worry about:
At this point, you could recommend to the company to sell DG 9,000 30-day forward, short 125,000 DM 35-day forward and buy ¥ 10,900,000 35-day forward, both of which require a customized contract at a bank. This would leave the company with little exchange risk, and would contain hedging costs.

If the company prefers cutting costs to the complete elimination of risk, however, you could recommend that it short 1 DM March futures contract at the IMM (125,000 DM). Notice that, since March futures contracts next year require delivery on 03-15, the company would bear some basis risk between 03-15 and 03-20 on its DM 125,000 exposure.

b. Suppose the company wants a perfect hedge. Would your recommendations change? Explain in details.

Answer.

If the company wants a true hedge, then you should clearly rule out the last step in the answer to question 3.a. Exposing yourself to basis risk by using a delivery-date-mismatched futures when a customized forward is available can reduce transactions costs, but adds to the risk you bear.

On the other hand, cross-currency netting -- or simply not hedging -- is intrinsically speculative. Cross-netting DG and DM implicitly means that the corporation is taking bets on the future movement of exchange rates: not taking a hedge because you believe rates will behave in a particular way leaves you with two open positions, and is no different than taking an open position for speculative purposes (no negative connotation should be attached to speculation in this course).

On the other hand, assuming away credit risk and netting out the DM cash-ins and cash-outs on 03-15 is no riskier than not netting them out and taking two opposite forward contracts. To see why, suppose that you do no netting at all. Then, you must sell DM 100,000 30-day forward and buy DM 140,000 30-day forward to hedge your exchange risk. Now suppose that your debtor defaults on 03-16, i.e., you don't get the DM 100,000 cash-in that was due to your company. Since you had sold forward DM 100,000, you must deliver them. To do so, you must go and buy them on the spot market, where you will face a spot rate which can be anything. On the other hand, suppose that you had netted out the cash-ins and cash-outs, and hedged the remainder, i.e., bought only DM 40,000 forward. If your debtor defaults, then in this case on 03-15 you do not have the DM 100,000 that you were hoping to use to pay your creditor. Hence, you must get them on the spot market, at a rate that again can be anything. Put differently, regardless of your netting, you face the same risk when you use forward or futures.
The bottom line of the previous paragraph is that the only cost-effective way to eliminate all foreign-exchange risk here is to use options for the hedging of cash-ins, and buying forward or futures contracts for the hedging of cash-outs.

If your company thinks its debtors are safe credit risks, then you should recommend same-currency netting and the hedging of the remainder with forwards/futures. The netting out of DM cash-outs against DG cash-ins is also pretty riskless, and may be safely made. The use of mismatched futures, though, should be discouraged.

NOTE

THE MATERIAL IN PART C. BELOW IS DOES NOT CONSTITUTE EXAM MATERIAL; IT IS PRESENTED SOLELY TO ILLUSTRATE THE PRACTICES OF MANY CORPORATIONS

c. Suppose that your company is more interested in minimizing hedging costs than hedging. What could you recommend? What risks would the company be exposed to?

Answer.

If the company really wants to cut costs, you may make some additional suggestions.

1. Notice that, if the forward rates are good predictors of the future spots, then it is clear that the market expects the DM and DG to appreciate in the next month, and the ¥ to stay even. As a consequence, you could therefore suggest that no hedging is needed: your cash-ins are invoiced in the currencies that should appreciate, making you strictly better off if market expectations come to fruition; and your cash out should not see its value change.

2. Alternatively, if you don't believe the market forecasts but believe that the past will repeat itself, then you could recommend further cross-netting, i.e., netting across currencies and/or maturities. To do this, observe that, based on the data you have, ¥ and DM have moved against the $ in the following way:

\[
\text{change in } ¥/\$ \text{ rate} = 0.4 \times (\text{change in } \$ \text{ rate}).
\]

Suppose that you believe the historical correlation ¥/DM against the $ will continue: can you use this assumption for hedging decisions? The answer is "yes", because you can then use the anticipated movements of the $ value of your ¥ cash-outs to "hedge" part of the variation in the $ value of your DM cash-ins. You will need, however, to make your own predictions about the future behavior of exchange rates. A few calculations are helpful to see this.

Suppose that you do not hedge anything payable/receivable on 03-20. Then, on 03-20, if the spot exchange rates is the same as today, your company will receive 125,000/1.66 = $ 75,000 and pay out 10,900,000/120 = $90,933.
If the DM appreciates -- say by 10% against the $ -- and the ¥ appreciates -- by 4% -- against the $, then the cash-ins from Germany will increase faster than the cash-outs to Japan: you now shall receive $125,000/(1.66-1.66\times10\%)=125,000/1.5=$80,000 from Germany and pay out 10,900,000/(120+120\times10\%)=10,900,000/115.2=$94,618 to Japan. Your net FX-gain would be: ($80,000-$75,000)-($94,618-$90,833)=$1,215. This would be good news, so you should not be worried by FX appreciations in the present case, under the assumption that history will repeat itself.

If, on the other hand, the DM depreciates by 10% against the $ and the ¥ depreciates by 4% against the $, then the cash-ins from Germany will decrease faster than the cash-outs to Japan: you now shall receive 125,000/(1.66+1.66\times10\%)=125,000/1.83=$68,182 from Germany and pay out 10,900,000/(120+120\times10\%)=10,900,000/124.8=$87,340 to Japan. Your net FX-loss would be: ($68,182-$75,000)-($87,340-$90,833)=$3,325. This would be bad news, and you should therefore try to hedge against this. Notice, however, that the bad news is less bad than it would be if the gains on the depreciated ¥ cash-outs did not help offset the loss on the depreciated DM cash-ins.

The bottom line is that, if you believe the historical correlation ¥/DM against the $ will continue and if you believe that the $ will depreciate against other currencies, the solution is to do nothing: this is because, under those assumptions, you expect to make a net gain, as explained above. The risk is that, if the $ appreciates against other currencies, you will make a $3,325 loss.

If you believe the historical correlation ¥/DM against the $ will continue but if you believe that the $ will appreciate against other currencies, the solution may be to cut by only half your long DM exposure by selling forward about 50% of your DM and to do nothing to cover your ¥ exposure. To see this, notice that, when both ¥ and DM depreciate, the company loses more money on the depreciated cash-ins than it gains on the depreciated cash-outs. The solution would be to decrease the DM exposure, to be less exposed to the DM depreciation. The risk here is that, by doing so, you would now take a hit when the ¥ and the DM both appreciate against the $ rather than make the net gain you would make if you had done nothing.

Notice that, if the past does not repeat itself, you can be blown out of the water. Further notice that, as discussed in class, an alternative to reducing the DM exposure is to increase the ¥ exposure. Finally, notice that the exact proportions of increase/decrease of exposure depend on the amounts receivable/payable, which you can convince yourself of by simulating a few cases.