Practice Set #5: Hedging with forwards vs. futures

What to do with this practice set?

To help students with the material, eight practice sets with solutions shall be handed out. These sets contain mostly problems of my own design as well as a few carefully chosen, worked-out end-of-chapter problems from Hull. None of these Practice Sets will 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/his command of the material is whether s/he can handle the questions of the relevant practice sets.

The questions on the mid-term and final exams will cover the material covered in class. Their format, in particular, shall in large part reflect questions such as the numerical exercises solved in class and/or the questions in the practice sets.

Question 1 (15 points)

We are on February 1st, 2010. Your employer, General Motors Corp. (Ann Arbor, Michigan), plans to import a first batch of 500 Opel Insignias from its plant in Rüsselheim, Germany, to rebadge them as “Regals” and to sell them in the U.S. via Buick dealerships. The German subsidiary of the company, Adam Opel A.G., has agreed to sell these cars to the US parent for a total of 10 million Euros, payable on April 9th, 2010.

a. Explain how GM (U.S.) can use currency futures to hedge its exchange risk. Approximately how many futures contracts will GM need for the first monthly payment? (Recall that, on the CME, a Euro futures calls for delivery of Euro 125,000).

(Hint #1: since April 9th falls in between the delivery date for the March contract (03-17-2010) and the delivery date for the June contract (06-16-2010), 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 the April Euro exposure, think about what exchange risk you would bear between 04-09-2009 and the respective delivery dates of each contracts.)

b. 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 part a.?)
**Question 2 (5 points)**

(i) The CAPM beta of the S&P 500 is approximately

a. 0.5 or less    
   b. 1.0    
   c. 1.5 or more

(ii) If you hedge a portfolio with a CAPM beta of 1.5, you should use $______ of S&P 500 futures contract for each $100 of portfolio hedged.

a. <100    
   b. 100    
   c. 150    
   c. >150

**Question 3 (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>
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</tbody>
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<td></td>
</tr>
<tr>
<td>¥ 10,900,000</td>
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The exchange rates on 02-16 are as follows:

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</tr>
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</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?
Question 1 (15 points)

Your employer, General Motors Corp., plans to import 500 Opel Insignias from its plant in Rüsselheim, Germany, rebadge them as "Regals" and sell them in the U.S. via Buick 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 9th, 2010. We are on February 1st, 2010.

a. Explain how GM can use currency futures to hedge the exchange-rate risk stemming from this account payable. Should GM go long or short? Approximately how many futures contracts will GM need? Each Euro futures is for delivery of Euro 125,000.

(Hint #1: since April 9th falls in between the delivery date for the March contract (03-17-2010) and the delivery date for the June contract (06-16-2010), 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 the April Euro exposure, think about what exchange risk you would bear between 04-09-2010 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 10m Euros 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 division of the CME offers March and June futures contracts in the amount of 125,000 Euro per contract.1 In each case, GM should therefore go long approximately 80 futures contracts (covering the underlying short exposure of 10,000,000 Euro divided by the contract size of 125,000 Euro).2

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 15 and June 14, 2010. The corresponding delivery dates are March 17 and June 16.

Possibility 1: GM could go long 80 March Euro futures on February 1st. In this case, GM would have to make one of two choices on March 15th:

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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. The exact formula is in Hull, 7th Edition, Chapter 9.
1. Either GM decides that it will take delivery of the Euros, in which case GM is, as of February 1st, exposed to foreign interest rate risk. Put differently, GM would hold Euro 10m from March 17th till April 9th but cannot know, as of February 1st, the interest rate 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 1st, however, it faces no exchange-rate risk.

Note that, while GM could use a forward rate agreement (FRA) to hedge that interest-rate risk, there is a further problem with this approach: GM would need to come up with the cash (i.e., the US dollars to get the Euros) three weeks ahead of the April 9th deadline, which defeats the (credit) purpose of using account payable in the first place.

2. Alternatively, on March 15th – the last day of trading for 2010 March futures -- GM could reverse its trade on the CME by shorting the same number (80) of Euro March futures. By doing so, GM would pocket the gain or pay the loss from having gone long March Euro futures on February 1st, 2010. The flip side, of course, is that GM would still need to purchase 10m Euro on the spot market on April 9th, at a rate that cannot be known for sure (neither on February 1st nor on March 15th). In this case, then, GM would be exposed to foreign exchange risk from March 15th (after it exits its futures hedge) to April 7th (when it must buy the euros spot to ensure payment two days later, on April 9th). While this is a shorter period than from February 1st till April 9th, the amount of forex risk would remain high.

The bottom line is that, by using the March Euro futures, GM is arguably exposed to quite a bit of risk. Whether GM would choose, on March 15th, to take delivery of the Euro 10m or to offset its futures hedge, would depend on its estimate of exchange rate movements from 03-15 to 04-07 (remember that spot deliveries take 2 days) and of interest rate movements between 03-17 and 04-09 -- the time interval between the decision and the delivery of the Euro 10m.

Possibility 2: GM could go long 80 June Euro futures on February 1st. In this case, GM would face two choices on March 15:

A 2010 June futures requires delivery on June 16th. GM, however, needs the dollars on April 9th. Hence, if GM used a June 2010 Euro futures hedge, it would have to liquidate its long Euro June futures position two days before April 9th, and buy 10m Euros on the spot market that day.3

As of February 1st, of course, GM knows neither the Euro spot price nor the June Euro futures price that will clear the markets on April 9th. All GM knows is that changes in the price of a June Euro futures is positively correlated changes in the spot USD/EUR exchange rate, so that GM can hope to offset any loss (resp. gain) on its underlying short Euro position with the gain (resp. loss) on its June futures hedge.

The following graph gives an idea of the change. Of course, as the picture below illustrates, the correlation between the June futures price and the spot FX rate is not perfect. Hence, using June futures would leave GM open to some risk – as we discuss in class see after the Spring Break, this risk is called basis risk.

3 Since delivery in the spot market takes place 2 days after the purchase, GM really has to offset its futures on 04-07.
Convergence of Futures to Spot

Hedge initiated at time $t_1$ (Feb. 1st) and closed out at time $t_2$ (April 7th)

Note: Hedge based on “own” futures maturing at $T$ (June)

b. 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

As argued in part a., if GM uses futures (whether March futures or June contracts) then it will face some risk and will not be 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 April 9th of 10m Euros at a price fixed as of today, February 1st.4

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4 In the last part of the course, we will (time permitting) see that GM could guarantee itself the deposit rate from March 17th through April 9th by entering into an FRA or Forward Rate Agreement – FRAs 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.
Question 2 (5 points)

(i) The CAPM beta of the S&P 500 is approximately
   a. 0.5 or less
   b. 1.0: is the answer – the S&P 500 is a good proxy for (and, thus, as volatile as) the
      overall stock market.
   c. 1.5 or more

(ii) If you hedge a portfolio with a CAPM beta of 1.5, you should use $______ of S&P 500
     futures contract for each $100 of portfolio hedged.
     a. <100
     b. 100
     c. 150: is the answer – you need to make your hedge as volatile as the portfolio hedged.
     d. >150
**Question 3 (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:

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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:

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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:

\[(30,000-24,000)\times1.5=\text{DG 9,000}.\]

After this first round of netting across currencies, you are left with the following amounts to worry about:

Cash-ins:  
- DG 9,000 (Dutch Guilder) (03-16)  
- DM 125,000 (03-20)

Cash-outs:  
- ¥ 10,900,000 (03-20)

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:

\[
\text{change in ¥/$ rate} = 0.4 \times (\text{change in DM/$ rate})
\]
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 $75,000 and pay out $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 $80,000 from Germany and pay out $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 $68,182 from Germany and pay out $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.