Answers for Chapters 11, 12 and 13 Exercises

Chapter 11. Answers to end-of-chapter exercises

ARBITRAGE IN THE CURRENCY FUTURES MARKET

- Consider the following: Spot Rate: \$ 0.65/DM German 1-yr interest rate: 9% US 1-yr interest rate: 5%
 - a. Calculate the theoretical price of a one year futures contract.
 - b. What would you do if the futures price was quoted at \$0.65/DM in the market place? Where would you borrow? Lend? Calculate the gain on a \$100 million arbitrage transaction.
 - c. What would you do if the future price was quoted at \$ 0.60/DM in the market place? Where would you borrow? Lend? Calculate the gain on a \$100 million arbitrage transaction.

SOLUTIONS:

- a. $F = S^{*}(1 + r_{s}) / (1 + r_{FC}) = .65^{*}(1.05)/1.09 =$ \$.626/DM
- b. Borrow \$ at 5%; Exchange into DM at spot rate; Invest in DM at 9%; Sell forward at \$.65/DM. Earn interest differential on nominal amount with no loss or gain on currency. Gain = \$100,000,000 * (.09 .05) = \$4,000,000.
- Borrow DM at 9%; Exchange into \$ at spot rate; Invest in the US at 5%; Buy forward at \$.60/DM. Gain on currency more than offsets negative interest rate differential. Gain = 100,000,000 * (.05 .09) + 100,000,000 * (1/0.60 1/0.65) = \$882,051
- 2. Consider the following prices:

Spot Rate:	Yen 100/\$
1-yr US interest rate	5%
Futures price	Yen 97.62/\$

- a. What value of the one-year Japanese interest rate will remove arbitrage incentives conditional on the spot rate, futures price, and US interest rate?
- b. If the yen interest rate is higher than the one found above, what would you do to take advantage of arbitrage opportunities?

c. If the yen interest rate is lower than the one found above, what would you do to take advantage of arbitrage opportunities?

SOLUTIONS:

a. The exchange rate is expressed in FC/\$. Adjust formula to calculate the futures price to take this into consideration.

$$\begin{split} F &= S * (1 + i_{yen}) / (1 + i_{\$}) \\ i_{yen} &= (F / S) * (1 + i_{\$}) - 1 \\ i_{yen} &= (97.62 / 100) * (1.05) - 1 \\ i_{yen} &= 2.5\% \end{split}$$

- b. Borrow US\$ at i_{\$}; Buy yen at spot rate; Invest in yen securities at i_{yen}; Sell yen forward for US\$.
- c. Borrow in yen at i_{yen}; Sell yen at spot rate for US\$; Invest in the US\$ securities at i_{\$}; Buy yen forward.

ARBITRAGE IN THE INTEREST RATE FUTURES MARKET

- 3. Suppose the interest rate futures contract for delivery in three months is currently selling at 110. The deliverable bond for that particular contract is a 25-year bond, currently traded at 100 with a coupon rate of 10%. The current 3-month rate is 7%.
 - a. Is there any arbitrage opportunity? If yes, what would you do and what would be your potential gain from an arbitrage transaction?
 - b. What is the theoretical price of the futures contract?
 - c. Suppose the price was 95 instead of 110. What would you do to take advantage of arbitrage opportunities?

a. Yes, there is an arbitrage opportunity. Here is how:

Sell Futures contracts at 110; Purchase the bond at 100 Borrow 100 at 7%. Profit = Proceeds - Outlays Profit = (Price of Bond + Accrued Interest) - (Principal Repayment + Interest Payment); Profit = 110 + (100 * 10% / 4) - (100 - 100 * 7% / 4)= 110 + 2.5 - 100 - 1.75; Profit = 10.75

- b. The correct price is determined so that there are no arbitrage opportunities. 0 = (F + 2.5) - (100 + 1.75); F = 101.75 - 2.5 = 99.25
- Buy the futures at 95; Sell Bond at 100; Lend at 7% for 3 months.
 Profit = (Principal + Interest Payment) (Price of Bond + Accrued Interest);
 Profit = 100 + 1.75 95 2.5; Profit = 4.25

SPREAD RISK IN THE EUROCURRENCY MARKET

- 4. The Treasurer of the WXYZ firm wants to protect herself against future interest rate rises. The firm's planned borrowing is indexed to 3-month LIBOR at LIBOR+1/2. The current LIBID-LIBOR spread in the interbank market is 7.000-7.125%, and the current price of a CME futures contract (on a three-month Eurodollar **deposit**) is 93.00 reflecting a 7.000% interest rate.
 - a. How could the firm use the futures market to hedge itself? What is the maximum interest that the firm locks in?
 - b. Suppose that at maturity, Eurodollar rates have increased to 8.000-8.125% in the interbank market. Evaluate the hedge. What LIBOR rate has the firm secured?
 - c. Suppose that at maturity, Eurodollar rates have increased to 8.000-8.375% in the interbank market. Assume that the LIBID-LIBOR spread has widened because of a Bank of England policy affecting bank reserves. Now, evaluate the hedge. What LIBOR rate has the firm secured?

SOLUTIONS:

a. The firm can sell 3-month LIBOR futures. If rates rise, the futures price will fall, yielding a profit to the firm that will cover the extra interest rate charge from rising rates. The selling price will be 93.00. The LIBID interest rate locked in is 7.000% so the firm can expect a LIBOR rate of 7.125%. LIBOR + 0.50% = 7.625%

- b. With LIBID at 8.000%, the CME contract closes at 92.00. The firm has a 1% gain on its futures contract. It borrows in the market at 8.125% + 0.5% = 8.625%, and the 1% gain on futures gives it a net cost of 7.625%, as expected in (a).
- c. With LIBID at 8.000%, the CME contract closes at 92.00. The firm again has a 1% gain on its futures contract. However, it borrows in the market at 8.375% + 0.5% = 8.875%, and the 1% gain on futures gives it a net cost of 7.875%. The extra 0.25% cost is the result of the wider than expected spread in the Eurocurrency market.

Chapter 12 Answers to end-of-chapter exercises

DISCRETE TIME BINOMIAL MODEL

- 4. Suppose the Yen is traded at Yen 100/\$ on January 1. The one-year Japanese yen interest rate is 2.5%. The one-year US Treasury Bill yields 5.5%. The volatility of the Yen/\$ exchange rate is 17%. Suppose there is a call on the yen with exercise price 100 Yen/\$ and maturity of one year.
 - a. In a simple binomial model with only two scenarios (Yen up or down), what is the expected value of the Yen at the end of the year according to both scenarios? (use the simplified formula to calculate the multiplicative factors <u>u</u> and <u>d</u>)
 - b. What is the value of the call at maturity considering the two scenarios?
 - c. Using the formulas in Appendix 1, show how a combination of borrowing and lending can replicate the payoff of the call. What is the value of the call today?
 - d. Suppose the volatility of the exchange rate increases to 25%. What would be the effect on the value of the call?

SOLUTIONS:

A call gives the right to buy Yen at 100 $\frac{1}{9}$, or 0.01/Yen. If the Yen appreciates, then the investor will exercise, buying at the less expensive strike price. If the Yen depreciates, the investor has no incentive to buy at 100 since he/she could buy at a cheaper rate on the spot market.

To determine the expected future spot rates along the two scenarios, we need to calculate the multiplicative factors:

 $u = exp\{(r_d - r_f) + s\}$ or $u = exp\{(5.5\% - 2.5\%) + 17\%\} = 1.2214$ $d = exp\{(r_d - r_f) - s\}$ or $d = exp\{(5.5\% - 2.5\%) - 17\%\} = 0.8694$ Therefore, the Yen will either go up to 0.012214 (or 81.87 ¥/\$) or down to 0.008694 \$/¥ (or 115.02 ¥/\$). A call option with a strike price of 100/\$ or \$0.01/Yen will be worth either \$0.0022 or zero. (Since prices are quoted per 100 Yen, the call would be worth either 22 cents, or zero.)

Replicating portfolio:

	<u>Today</u>	End of Period	
		Up	Down
Dollar Borrowing	0.5143	-\$0.5434	-\$0.5434
Yen Purchase	-0.6096	0.7634	0.5434
Combined Positions	-0.0953	+0.22	0
Call Option	0.0953	+0.22	0

A change in volatility will have a direct effect on u and d, therefore on the value of the call at maturity.

 $u = \exp\{(r_d - r_f) + s\}$ or $u = \exp\{(5.5\% - 2.5\%) + 25\%\} = 1.3231$ $d = \exp\{(r_d - r_f) - s\}$ or $d = \exp\{(5.5\% - 2.5\%) - 25\%\} = 0.8025$

Therefore, the Yen will either go up to 0.013231 /Y (or 75.58 /S) or down to 0.008025 /Y (or 124.61 /S). A call option with strike price of 100/S or 0.01/Yen will be worth either 0.0032 or zero.

We can see that the value of the call in the positive state is greater than previously.

Replicating portfolio:

	<u>Today</u>	End of Period	
		Up	Down
Dollar Borrowing	0.4811	-\$0.5083	-\$0.5083
Yen Purchase	-0.5995	0.8234	0.5083
Combined Positions	-0.1184	+0.32	0
Call Option	0.1184	+0.32	0

We can see that the value of the call today has increased, confirming the relationship between volatility and option prices.

PUT-CALL-FORWARD PARITY

5. Using the Put-Call-Forward Parity, demonstrate that the price of a call with the strike price equal to the futures price is equal to the price of a put with the same strike price and the same maturity.

SOLUTIONS:

Put-Call-Forward Parity tells us that:

 $C - P = (F_{0,T} - X) / exp(r_dT)$

If the strike price equals the futures price, or $X = F_{0,T}$, then C - P = 0, or C = P. Therefore, for a strike price equals to the futures price, the price of the call and the price of the put are equal.

- 6. Suppose call options on the DM with a strike price of \$0.63/DM and maturity of one month are traded at \$0.01/DM. One-month futures on the DM are traded at \$0.624/DM. One-month US Treasury Bills yield 5.5%. One-month German government securities yield 7.5%. The spot \$/DM exchange rate is \$0.625/DM.
 - a. Using the Put-Call-Forward Parity, determine the value of the put option with a strike price of \$0.63 and one month maturity.
 - b. How would you take advantage of arbitrage opportunities if you find that the actual price of the put is below the theoretical price determined using the Parity condition?

SOLUTIONS:

 $P = C - (F_{0,T} - X) / exp(r_dT)$ C = .010 X = .63 $F_{0,T} = .624$ $r_d = 5.5\%$ T = 1/12 P = .010 - (.624 - .63) / exp(.055* 1 / 12)P = .016

HEDGING

7. The treasurer of the XYZ company is expecting a dividend payment of DM 10,000,000 from a German subsidiary in two months. His/her expectations of the future DM spot rate are mixed: The DM could strengthen or stay flat over the next two months. The current exchange rate is \$0.63/DM. The two-month futures rate is at \$0.6279/DM. The two-month German interest rate is 7.5%. The two-month US T-Bill yields 5.5%. Puts on the DM with maturity of two months and strike price of \$0.63 are traded on the CME at \$0.0128/DM. Compare the following choices offered to the Treasurer:

- Sell a futures on the DM for delivery in two months for a total amount of DM 10 million.
- Buy 80 put options on the CME with expiration in two months and strike price equal to the current price.
- Set up a forward contract with the firm's bank XYZ.
- a. What is the respective cost of each strategy?
- b. Which strategy would best fit the treasurer's mixed forecast for the future spot rate of the DM?

a. Strategy One: Sell futures contracts at the current price of .6279. In this case, the US firm is assured to get \$ 6,279,000 (DM 10,000,000 * \$.6279/DM). However, it has to deposit the margin requirements and risks having to make payments to maintain the maintenance margin, introducing cash-flow issues in the future.

Strategy Two: Buy 80 put options on the DM at a strike price of 63. Total cost: $80 \times 125,000 \times 0.0128 = 128,000$. The firm is assured to get at least 6,172,000 but it reserves itself the right to sell the DM on the spot market and not to exercise its options. Break-even rate is 0.6428/DM. If the DM falls below that rate, the firm will be able to sell on the spot market and get more for its DM.

Strategy Three: Set up a forward contract with bank XYZ. The expected forward rate will be:

F = S(1+i\$)/(1+iDM) = 0.63 (1+0.055*2/12)/(1+0.075*2/12) = 0.6279

Which is precisely the same as the futures price. No cash-flows are involved until maturity. However, the firm needs a credit line with its bank.

b. The treasurer's expectations are that the future exchange rate will be equal to the current spot rate (\$0.63/DM) or higher. For future spot values between \$0.63/DM and \$0.6428/DM, the forward hedge is preferred. (It is preferred over the futures hedge because the latter contains a cash flow risk.) For values greater than \$0.6428/DM, the option hedge is preferred. The treasurer could decide between the forward hedge and the option hedge on the basis of the expected (i.e. probability weighted cash flows) from each choice.

- 8. Refer to the previous question. Suppose the DM actually rose in value to \$0.67/DM when the dividend payment is made.
 - a. Which of the three strategies enables the treasurer to take advantage of the rise in the DM against the dollar?
 - b. What is the final gain (loss) incurred in each case?

- a. The only strategy that allows for a potential future gain from a rising DM is the second strategy using the put option.
- b. If the DM rises to \$0.67, the firm can forego its put option at 63 and actually sell its DM on the spot market. The firm loses the initial \$128,000 spent on the put option. It gets \$6,700,000 for its DM. Total cash proceeds from the dividend payment: \$6,700,000 128,000 = \$6,572,000. With the other two strategies, the firm receives \$ 6,279,000 and incurs an opportunity loss of \$6,572,000 \$6,279,000 = \$293,000.
- 9. Suppose a trader at Citibank has the following positions on his/her book:
 - short £ 15,000,000 Call
 - short £ 30,000,000 Put

The delta is .60 on the call and -0.30 on the put.

- a. Calculate the delta hedge for each position.
- b. What remaining exposure does the trader actually have on the portfolio?

SOLUTIONS:

- a. Short £ 15,000,000 Call Delta = 0.60 Delta Hedge: £ 15MM * 0.60 = £ 9,000,000 Short £ 30,000,000 Put Delta = -0.30 Delta Hedge: - £ 30MM * 0.30 = - £ 9,000,000 Final Exposure = 0. The portfolio is perfectly delta hedged.
- b. The portfolio is still exposed to gamma risks. If there are large changes in the exchange rate in either direction, the portfolio will gain or lose.

Chapter 13 Answers to end-of-chapter exercises

- 1. Suppose Firm ABC can issue 7-year bonds in the US at the fixed rate of 8% and in France at 13%. Suppose Firm XYZ can issue 7-year bonds at the fixed rate of 10% in the US in US\$ and at 14% in France in FFr.
 - a. Which firm has a comparative advantage in the French capital market?
 - b. How would you advise both firms so that they take advantage of each other's comparative advantage in the US and French capital markets?
 - c. How much could be saved in borrowing costs by both firms?
 - d. What could cause the relative comparative advantages in international credit markets?

SOLUTIONS:

a.		ABC	XYZ	Difference
	US\$	8%	10%	-2%
	FFr	13%	14%	<u>-1%</u>
				-1%

XYZ has a comparative advantage in the French franc market; ABC has a comparative advantage in the US\$ market.

- b. Each firm has a comparative advantage in different markets. They should take advantage of that edge, then swap the proceeds, thus realizing borrowing cost savings.
- c. Total Costs:

ABC	Pays	8%	<u>XYZ</u>	Pays	14%
	Pays	13.5%		Pays	9%
	Receives	<u>9%</u>		Receives	<u>13.5%</u>
	Net	12.5%		Net	9.5%
	Savings	.50%		Savings	.50%
	_	To	tal Savings: 19	%	

d. Different comparative advantage for both firms may arise because a firm's local credit market is saturated with the firm's debt and would place value in the availability of debt issues by a foreign firm.

Different valuation on the same credit instrument could also arise because the French and US credit markets make different assessments of the riskiness of the same firms.

- 2. Suppose two parties enter a 5-year interest rate swap to exchange one-year LIBOR plus 50 basis points (bp) for a fixed rate on \$100 million notional principal.
 - a. If LIBOR turns out to be 10% in year 1, 9% in year 2, 9% in year 3, 8% in year 4 and 8.5% in year 5, what cash flows will be exchanged between the two parties? Assume a flat Eurodollar yield curve at 10%.
 - b. What is the value of the swap?
 - c. What fixed rate in the swap agreement will make the value of the swap equal to zero?

The cash-flow pattern is as follows:

	<u>1</u>	2	<u>3</u>	<u>4</u>	<u>5</u>
Fixed	10%	10%	10%	10%	10%
Cash-Flows	10	10	10	10	10
LIBOR + 50 bp	10.5%	9.5%	9.5%	8%	8.5%
Cash-Flows	<u>10.5</u>	<u>9.5</u>	<u>9.5</u>	<u>8</u>	<u>8.5</u>
Difference	5	.5	.5	2	1.5

The NPV at 10% yields a positive value of \$ 2.63 for the fixed-rate payer.

A fixed-rate of approximately 9.375% will make the NPV equal to zero.

- 10. Consider the following tables showing the swap transactions between the ABC Bank and XYZ, Inc. Suppose that XYZ files for bankruptcy and the firm defaults on it swap agreements with ABC Bank.
 - a. Calculate the potential loss of ABC Bank assuming that its swaps with XYZ are not in a Master Swap Agreement.
 - b. Calculate the potential loss of ABC Bank assuming that its swaps with XYZ are all part of a single Master Swap Agreement.

SUMMARY OF TRANSACTIONS WITH COUNTERPARTY XYZ, as of 12/31/97					
Date of	Currency	Maturity	Notional	Contract	Value
Swap			Amount	Description	
9/ 1/96	DM	5 years	20,000,000	Receive Fix /	\$25,000
				Pay LIBOR	
3/15/97	UK£	7 years	10,000,000	Receive Fix /	\$15,000
				Pay LIBOR	
6/ 1/97	US\$	3 years	10,000,000	Receive LIBOR /	-\$60,000
				Pay Fix	
8/31/97	US\$	7 years	5,000,000	Receive C.P. /	-\$30,000
				Pay Fix	

- a. If the swaps are <u>not</u> in a Master Swap Agreement, ABC Bank could lose \$40,000 (=25,000 + 15,000). These two swaps have positive value (NPV) for the bank, and after a default by XYZ, Inc. the bank would not obtain this value. At the same time, ABC Bank would have to fulfill its obligations on the other two swaps with XYZ, which as of 12/31/97 have the bank paying out \$90,000 in value to XYZ. This outflow is not an <u>incremental</u> loss to the Bank because of the default.
- a. If the swaps are within a Master Swap Agreement, the maximum potential loss is the arithmetic sum of the value of the swaps. In the case, the sum is negative, -\$50,000. This represents a loss to ABC Bank from entering into 4 swap agreements with XYZ that happen to have resulted in a loss to the Bank. However, there is no <u>incremental</u> loss to the Bank because of the default.