NPTEL

INDUSTRIAL AND MANAGEMENT ENGINEERING DEPARTMENT, IIT KANPUR

QUANTITATIVE FINANCE

ASSIGNMENT-5 (2015 JULY-AUG ONLINE COURSE)

1.

a. Assume that LIBOR6 (annualized) and the ¥/$ exchange rate evolve as follows. Calculate the *net* dollar amount that 3M pays to BT ("-") or receives from BT ("+") each six-month period.

Time (months)	LIBOR6	¥/$ (spot)	Net $ receipt (+)/payment (-)
t	5.7%	128	
t + 6	5.4%	132	
t + 12	5.3%	137	
t + 18	5.9%	131	
t + 24	5.8%	123	

ANSWER. The semiannual receipts, payments, and net receipts (payments) are computed as follows:

Time (months)	LIBOR6	¥/$ (spot)	Receipt	Payment	Net $ receipt (+)/payment (-)
t	5.70%	128			
t + 6	5.40%	132	$630,303	$2,700,000	$2,069,697
t + 12	5.30%	137	$607,299	$2,650,000	$2,042,701
t + 18	5.90%	131	$635,115	$2,950,000	$2,314,885
t + 24	5.80%	123	$676,423	$2,900,000	$2,223,577

There is no payment or receipt at time t. The semiannual payment is calculated as $100,000,000 x LIBOR6/2. The semiannual receipt is calculated as 12,800,000,000 x 0.013/2 x 1/S, where S is the current spot rate (¥/$).

b. What is the all-in dollar cost of 3M's loan?

ANSWER. The net payments made semiannually by 3M are shown in the table below. The net payment is computed as the LIBOR6 payment made to BT less the dollar value of the 0.05% semiannual difference between the yen interest received and the yen interest paid (shown in the column labeled "Receipt.")

Time (months)	LIBOR6	¥/$ (spot)	Receipt	Payment	Net payment
T	5.70%	128			-$100,000,000
T + 6	5.40%	132	$48,485	$2,700,000	$2,651,515
T + 12	5.30%	137	$46,715	$2,650,000	$2,603,285
T + 18	5.90%	131	$48,855	$2,950,000	$2,901,145
t + 24	5.80%	123	$52,033	$2,900,000	$102,847,967
				IRR	2.75%
				Annualized	5.50%

c. Suppose 3M decides at t + 18 to use a six-month forward contract to hedge the t + 24 receipt of yen from BT. Six-month interest rates (annualized) at t + 18 are 5.9% in dollars and 2.1% in yen. With this hedge in place, what fixed dollar amount would 3M have paid (received) at time t + 24? How does this amount compare to the t + 24 net payment computed in part a?

ANSWER. Given the interest rates presented in the problem, we can use interest rate parity to compute the 6-month forward rate at time t + 18 as ¥128.58/$:

$$f_{180} = 131 x \frac{1 + \frac{0.021}{2}}{1 + \frac{0.059}{2}} = ¥128.58$$

3M will pay out $2.9 million (0.059/2 x $100,000,000) and receive $647,056 (0.013/2 x 12,800,000 x 1/128.58). The latter figure is calculated by converting its yen receipt into dollars at the forward rate of ¥128.58/$. 3M's net payment equals $2,252,944 ($2,900,000 - $647,056). This amount is $29,367 more than the net payment of $2,223,577 it would have made otherwise.

d. Does it make sense for 3M to hedge its receipt of yen from BT? Explain.

ANSWER. No. As it now stands, 3M receives yen and pays out yen, resulting in a zero net exposure on the swap (aside from the net 0.05% semiannual yen receipt). Hedging would expose 3M to currency risk and negate the purpose of the cross-currency swap, which is to allow 3M to engage in arbitrage while being shielded from currency risk.

1 (b)

Suppose that IBM would like to borrow fixed-rate yen, whereas Korea Development Bank (KDB) would like to borrow floating-rate dollars. IBM can borrow fixed-rate yen at 4.5 percent or floating-rate dollars at LIBOR + 0.25 percent. KDB can borrow fixed-rate yen at 4.9 percent or floating-rate dollars at LIBOR + 0.8 percent.

a. What is the range of possible cost savings that IBM can realize through an interest rate/currency swap with KDB?

ANSWER. The cost to each party of accessing either the fixed-rate yen or the floating-rate dollar market for a new debt issue is as follows:

Borrower	Fixed-Rate Yen Available	Floating-Rate Dollars Available
Korea Development Bank	4.9%	LIBOR + 0.80%
IBM	4.5%	LIBOR + 0.25%
Difference	0.4%	0.55%

Given the differences in rates between the two markets, the two parties can achieve a combined 15 basis point savings through IBM borrowing floating-rate dollars at LIBOR + 0.25% and KDB borrowing fixed-rate yen at 4.9% and then swapping the proceeds. IBM would be able to borrow fixed-rate yen at 4.35% if all these savings were passed along to it in the swap. This could be accomplished by IBM providing KDB with floating-rate dollars at LIBOR + 0.25%, saving KDB 0.55%, which then passed these savings along to IBM by swapping the fixed-rate yen at 4.9% - 0.55% = 4.35%. Thus, the potential savings to IBM range from 0 to 0.15%.

b. Assuming a notional principal equivalent to $125 million, and a current exchange rate of ¥105/$, what do these possible cost savings translate into in yen terms?

ANSWER. At a current exchange rate of ¥105/$, IBM's borrowing would equal ¥13,125,000,000 (125,000,000*105). A 0.15% savings on that amount would translate into ¥19,687,500 per annum (¥13,125,000,000*0.0015).

c. Redo Parts a and b assuming that the parties use Bank of America, which charges a fee of 8 basis points to arrange the swap.

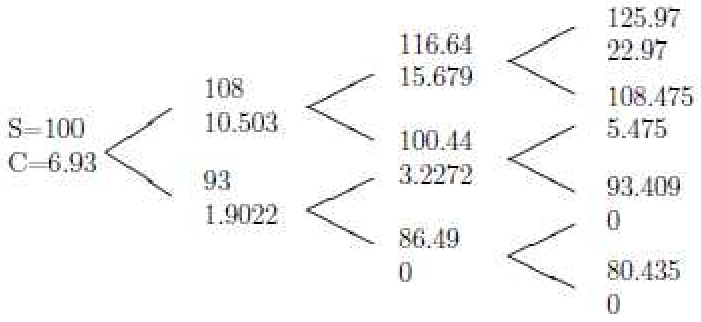
ANSWER. In this case, the potential savings from a swap net out to 7 basis points. If IBM realizes all these savings, its borrowing cost would be lowered to 4.43% (4.5% - 0.07%). The 7 basis point saving would translate into an annual saving of ¥9,187,500 (¥13,125,000,000*0.0007).

3.(a)

We first calculate the Martingale probability in the tree. We get

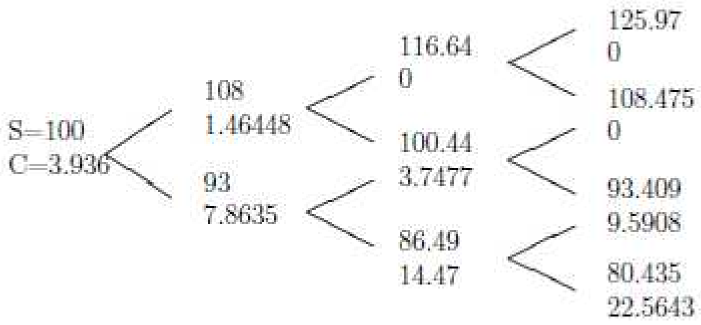
$$p = \frac{r-d}{u-d} = \frac{e^{0.06/3} - 1 + 0.07}{0.08 + 0.07} = 0.6013423$$

(a) The tree for the call option looks as follows:



time $t=0$ $t=1/3$ $t=2/3$ $t=1$

(b) The tree for the put option is:



time $t=0$ $t=1/3$ $t=2/3$ $t=1$

(c) The Put-Call parity holds:

$$C-P = 6.9342 - 3.936 = 2.9982 = 100 - 103e^{-0.06} = 100 - 97.0017 = S - Ke^{-rT}.$$

3.(b)

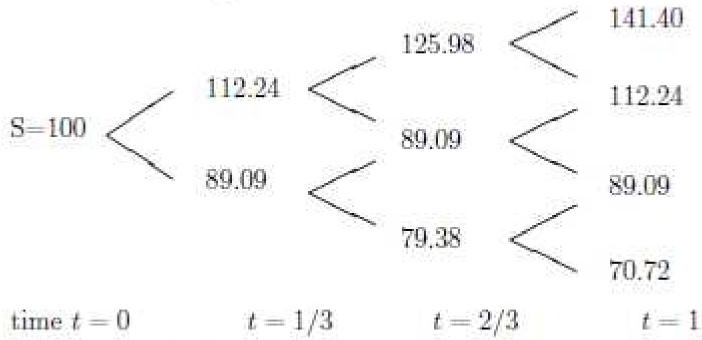
(a) The parameter-values are

$$\Delta = \frac{1}{3}, \quad 1+r_d = e^{r\Delta} = 1.0202, \quad 1+u = e^{\sigma\sqrt{\Delta}} = 1.1224, \quad 1+d = e^{-\sigma\sqrt{\Delta}} = 0.8909.$$

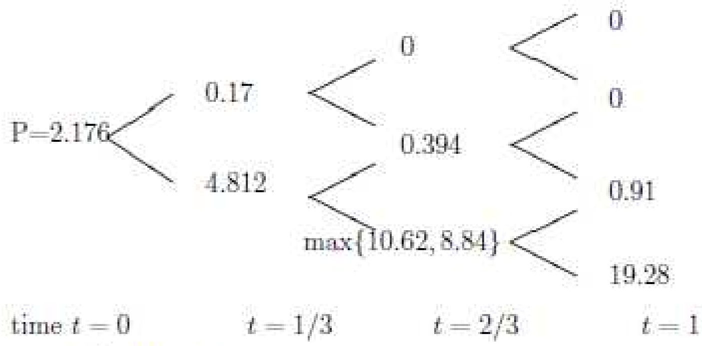
For the risk-neutral probability we get

$$p^* = \frac{r_d - d}{u - d} = 0.5584.$$

The tree with the stock prices is



(b) The prices for the american Put are



(c) Let $\Omega = \{u,d\}^3$. The optimal exercise date is

$$\tau(\omega) = \begin{cases} n = 2 & \omega \in \{ddu, ddd\} \\ n = 3 & \text{otherwise.} \end{cases}$$

For $\omega \in \{(ddu), (ddd)\}$, we have $\frac{1}{1+r_d}\mathrm{E}[p^* f_{32} + (1-p^*) f_{33}] < (K - S_0(1+d)^2)^+$. Here f_{ij} denotes the price of the claim in period i with j-down movements.

4.(a)

A bull spread is created by buying the \$30 put and selling the \$35 put. This strategy gives rise to an initial cash inflow of \$3. The outcome is as follows:

Stock Price	Payoff	Profit
$S_T \geq 35$	0	3
$30 \leq S_T < 35$	$S_T - 35$	$S_T - 32$
$S_T < 30$	-5	-2

A bear spread is created by selling the \$30 put and buying the \$35 put. This strategy costs \$3 initially. The outcome is as follows:

Stock Price	Payoff	Profit
$S_T \geq 35$	0	-3
$30 \leq S_T < 35$	$35 - S_T$	$32 - S_T$
$S_T < 30$	5	2

4.(b)

There are two alternative profit patterns for part (a). These are shown in Figures M10.1 and M10.2. In Figure M10.1 the long maturity (high strike price) option is worth more than the short maturity (low strike price) option. In Figure M10.2 the reverse is true. There is no ambiguity about the profit pattern for part (b). This is shown in Figure M10.3.

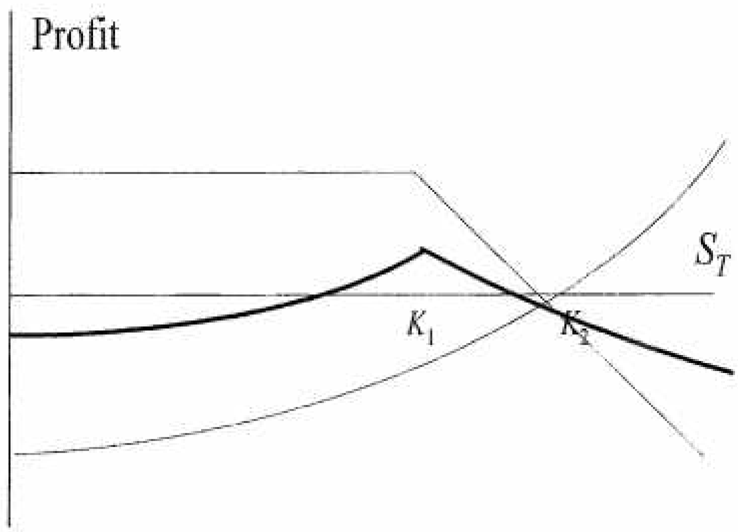


Figure M10.1 Investor's Profit/Loss in Problem 10.20a when long maturity call is worth more than short maturity call

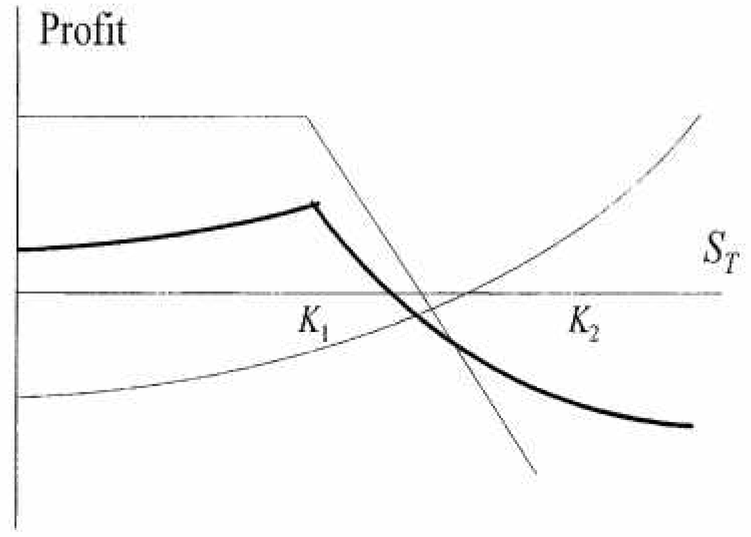


Figure M10.2 Investor's Profit/Loss in Problem 10.20a when short maturity call is worth more than long maturity call

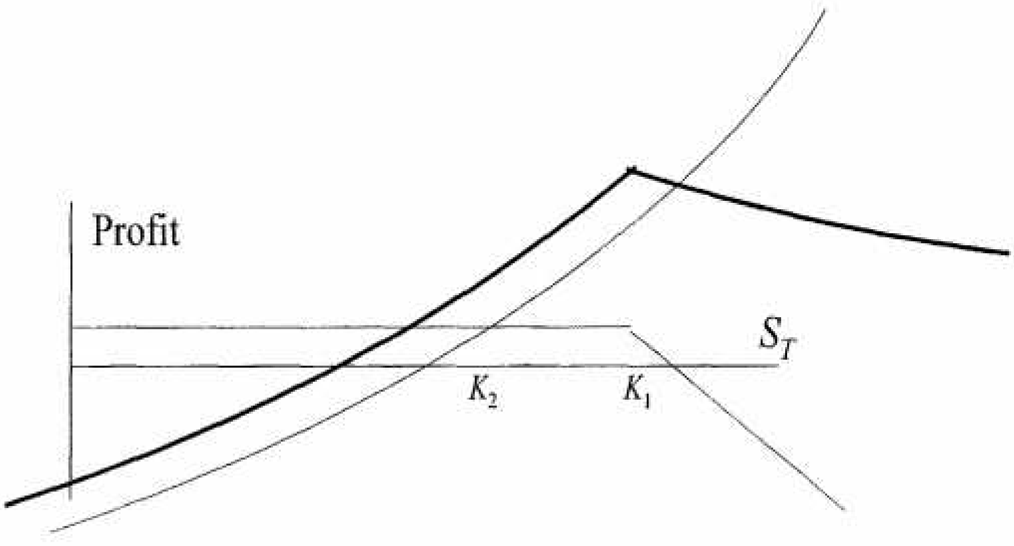


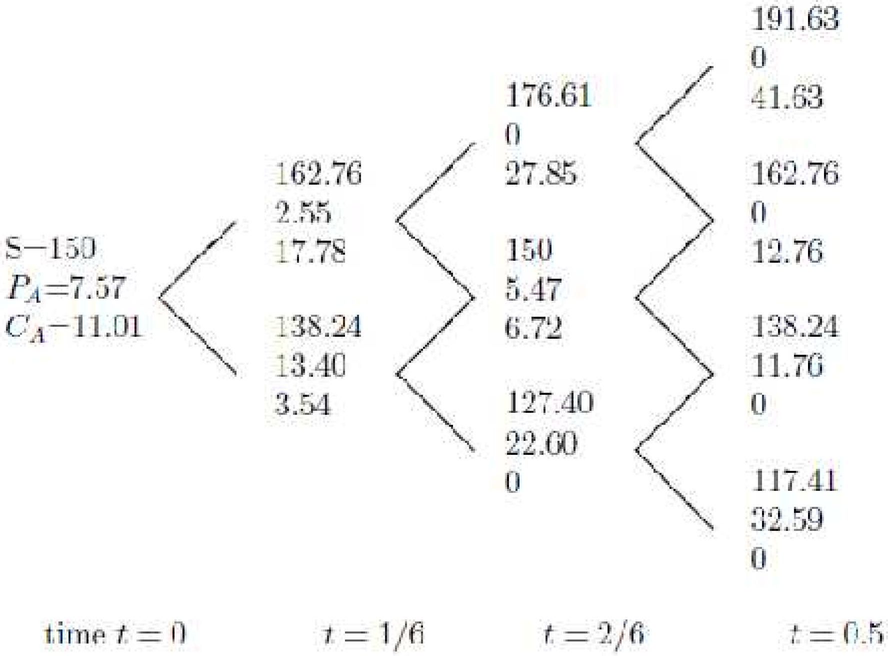
Figure M10.3 Investor's Profit/Loss in Problem 10.20b

5. (a) (iii)
5. (b) (ii)
5. (c) (iv)
5. (d) (v)
5. (e) (v)

5. (f)

The martingale probability is $p = 0.5308$ with $u = 0.085$, $d = -0.0784$ and $r = 0.0084$.

(a), (b) For the American Put and Call we get:



(c) We have $0 \leq 11.01 - 7.57 = 3.44 \leq 3.7035 = 150 - 150 \cdot e^{-0.025}$