Question 1

My student’s ID is 23399066

Δr0.5 = 2339 / 104

= 0.2339

Δr1.0 = 9066 / 104

= 0.9066

r0.5 = 5 + 0.2339

= 5.2339%

r1.0 = 5 + 0.9066

= 5.9066%

For t=0.66

ratek = ( (tk-tt) \* ratet+1 + (tt+1-tk) \* ratet ) / (tt+1-t1) where t<k<t+1

r0.66 = ( (0.66-0.5) \* 5.9066% + (1.0-0.66) \* 5.2339% ) / (1.0-0.5)

= 5.45%

Prove :

The maximum number of ID is 99999999

r0.5 = 5+0.9999 = 5.9999%

r1.0 = 5+0.9999 = 5.9999%

rk = ( (tk-0.5) \* 5.9999% + (1.0-tk) \* 5.9999% ) / (1.0-0.5)

= ( (tk-0.5+1.0-tk) \* 5.9999% ) / 0.5

= (0.5\*5.9999%) / 0.5

= 5.9999%

Thus, yield curve will be flat, for tk = any number of time

The ratek will be 5.9999% , the ratek will be always less than 6.0%

For minimum number of ID is 00000001;

r0.5 = 5+0.0000 = 5.0000%

r1.0 = 5+0.0001 = 5.0001%

rk = ( (tk-0.5) \* 5.0001% + (1.0-tk) \* 5.0000% ) / (1.0-0.5)

= 5.0000% + 0.0002% \* tk

The ratek will be always greater than 5.0% or approximately equal to 5%

Therefore,

Question 2

2.1 European call

(1) Today t0

(a) buy the call (market price = 1), loss money 1

(b) short stock, value S0 (1 < S0 <100)

(c) cash in bank (S0 - 1)

(2) Expiration T

Terminal stock price = ST . Analyze scenarios for various values of ST.

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that ST < K | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Profit  Cash in the bank - cost to buy back stock  =  > 0 |
| Note that ST < K | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Break even  Cash in the bank - cost to buy back stock  =  = 0 |
| Note that ST < K | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Loss  Cash in the bank - cost to buy back stock  =  < 0 |

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position | Profit  Cash in bank - strike price  =  > 0 |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Break even  Cash in bank - strike price  =  = 0 |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Loss  Cash in bank - strike price  =  < 0 |

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Decide not to exercise the option.  Buy back stock, pay ST  Close out short stock position. | Profit  Cash in bank - cost to buy back stock  =  > 0 |
| Note that | Option is in the money  Decide not to exercise the option.  Buy back stock, pay ST  Close out short stock position. | Break even  Cash in bank - cost to buy back stock  =  = 0 |
| Note that | Option is in the money  Decide not to exercise the option.  Buy back stock, pay ST  Close out short stock position. | Loss  Cash in bank - cost to buy back stock  =  < 0 |

2.2 American call

(1) Today t0

(a) buy the call (market price = 1), loss money 1

(b) short stock, value S0 (1 < S0 < 100)

(c) cash in bank (S0 - 1)

(2) Expiration T

Terminal stock price = ST . Analyze scenarios for various values of ST.

(Same analysis as European call.)

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that ST < K | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Profit  Cash in bank - cost to buy back stock  =  > 0 |
| Note that ST < K | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Break even  Cash in bank - cost to buy back stock  =  = 0 |
| Note that ST < K | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Loss  Cash in bank - cost to buy back stock  =  < 0 |

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Profit  Cash in bank - strike price  =  > 0 |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Break even  Cash in bank - strike price  =  = 0 |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Loss  Cash in bank - strike price  =  < 0 |

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Decide not to exercise the option.  Buy back stock, pay ST  Close out short stock position. | Profit  Cash in bank - cost to buy back stock  =  > 0 |
| Note that | Option is in the money  Decide not to exercise the option.  Buy back stock, pay ST  Close out short stock position. | Break even  Cash in bank - cost to buy back stock  =  = 0 |
| Note that | Option is in the money  Decide not to exercise the option.  Buy back stock, pay ST  Close out short stock position. | Loss  Cash in bank - cost to buy back stock  =  < 0 |

(3)

Early exercise t < T

Stock price = St

Early exercise requires St ≥ K

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Profit  Cash in bank - strike price  =  > 0 |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Break even  Cash in bank - strike price  =  = 0 |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Loss  Cash in bank - strike price  =  < 0 |

If at any time , we buy the stock at the price and close out our short stock position, and make a profit. We do not have to exercise the option. Exercising the option requires us to pay the strike K, which leads to a loss. We can simply throw away the option, even if it expires in the money.

2.3 European put

(1) Today t0:

Buy the put (market price = 1)

borrow 1

(2) Expiration T.

Terminal stock price = ST. Analyze scenarios for various values of ST.

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Profit  Cash from option exercise - Cost to buy the stock - repay loan  =  > 0 |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Break even  Cash from option exercise - Cost to buy the stock - repay loan  =  = 0 |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Loss  Cash from option exercise - Cost to buy the stock - repay loan  =  < 0 |

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is out of the money  Do not exercise the option  Repay the loan. | Loss  Repay loan = |
| Note that | Option is in the money  Decide not to exercise the option  Repay the loan | Loss  Repay loan = |

2.4 American put

(1) Today t0:

Buy the put (market price = 1)

borrow 1

(2) Expiration T.

Terminal stock price = ST. Analyze scenarios for various values of ST.

(Analysis is the same as for European put.)

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Profit  Cash from option exercise - Cost to buy the stock - repay loan  =  > 0 |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Break even  Cash from option exercise - Cost to buy the stock - repay loan  =  = 0 |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Loss  Cash from option exercise - Cost to buy the stock - repay loan  =  < 0 |

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is out of the money  Do not exercise the option  Repay the loan. | Loss  Repay loan = |
| Note that | Option is in the money  Decide not to exercise the option  Repay the loan | Loss  Repay loan = |

(3) Early exercise. This only happens if

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Profit  Cash from option exercise - Cost to buy the stock - repay loan  =  > 0 |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Break even  Cash from option exercise - Cost to buy the stock - repay loan  =  = 0 |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock. | Loss  Cash from option exercise - Cost to buy the stock - repay loan  =  < 0 |

Question 3

3.1 European Call

a) sell the call and receive: $3

b) buy one share of stock at S0 = $98

c) borrow money from a bank at T0 = $98 - $3 = $95

The money borrows from the bank compounds is

, where r = 5% and = 1, so

There will be two conditions, and

Expiration T in

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  The holder exercises the call option  The writer delivers the stock  Receives cash K = 100  Amount of loan is  Use cash K = 100 to repay loan | Profit  Cash from holder exercise pay - repay load  = 100 - 99.87 = 0.13  > 0 |
| Note that | Option is in the money  Holder decides not to exercise the call option  The writer sells the stock  Receive cash = ST  Amount of loan is  Use cash = ST to repay loan | Profit  Cash from sell stock - repay loan  = ST - 99.87  >0 |

Expiration T in

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is out of the money  The writer sells the stock  Receive cash = ST  Amount of loan is  Use cash = ST to repay loan | Profit  Cash from sell stock - repay loan  = ST - 99.87  > 0 |
| Note that | Option is out of the money  The writer sells the stock  Receive cash = ST  Amount of loan is  Use cash = ST to repay loan | Break even  Cash from sell stock - repay loan  = ST - 99.87  = 0 |
| Note that | Option is out of the money  The writer sells the stock  Receive cash = ST  Amount of loan is  Use cash = ST to repay loan | Loss  Cash from sell stock - repay loan  = ST - 99.87  < 0 |

3.2 European put

a) Sell the put and receive: $2

b) Sell one share of stock at S0 = $99

c) Money to invest in Bank at T0 = $99 + $2 = $101

The cash save in bank compounds is

, where r = 5% and = 1, so

There will be two conditions, and

Expiration T in

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  The holder exercises the put option  The writer receives the stock  Pay cash K = 100  Money in the bank is 106.18  We sell the stock and receive cash ST | Profit  Cash in the bank + Cash from sell stock - strike price  = 106.18 + ST -100  = ST + 6.18  >0 |
| Note that | Option is in the money  Holder decides not to exercise the put option  Receive nothing  Money in the bank is 106.18 | Profit  Cash in the bank  = 106.18  >0 |

Expiration T in

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is out of the money  Holder does not to exercise the put option  Throw away the option  Receive nothing and deliver nothing  Money in the bank is 106.18 | Profit  Cash in the bank  = 106.18  >0 |

Question 4

4.1 Investor A

(1) Investor A pays 100 on t0=0, receives 0.07 on day 3 and receives S5 on day 5.

(2) No cash received/paid on other days

(3) Final cash = S5 + 0.07 – 100 = S5 - 99.93

(4) Profit if S5 > 99.93; loss if S5 < 99.93

(5) Investor A makes profit / loss on day 5

4.2 Investor B

1. Cashflows for investor B:

(a) day 0 : zero

(b) day 1 : pay F0 - F1 = 103.25 - 101.55 = 1.7

(We can find F0 & F1 from the form in the problem)

(c) day 2 : receive F2 - F1

(d) day 3 : receive F3 - F2

(e) day 4 : receive F4 - F3

(f) day 5 : (i) pay F4 – F5, (ii) pay F5 ( = S5 ) to take delivery of stock

2. Investor B pays a total of 103.25

(a) The value 103.25 is F0, the price of the futures contract which B bought on

day 0.

(b) We know that all the cashflows in / out of the mark to market account (plus

the payment of ( S5 ) F5 to take delivery of stock) add up to F0

(c) Proof:

Total payment = (F0 - F1) - (F2 - F1) - (F3 - F2) - (F4 - F3) + (F4 - F5) + S5 = F0

pay

receive

pay

(d) Investor B does not receive the dividend

(e) It does not receive dividends, because the holder of a futures (or forward)

contract is not a shareholder.

3. Investor B receives the underlying stock after closing the futures contact.

4.3 Investor C

1. Yes. Investor C can long a future contract on day 1.

This locks in a guaranteed profit of 103.25 – 101.55 = 1.7

(neglect interest rate compounding)

2. Cashflows for investor C:

(a) day 0 : zero

(b) day 1 : zero

(c) day 2 : receive F2 - F1

(d) day 3 : receive F3 - F2

(e) day 4 : receive F4 - F3

(f) day 5 : (i) pay 101.55 and receive stock, to close the future contract

(ii) receive 103.25 and deliver stock, to close the forward contract.

(g) The stock positions on day 5 cancels between the short forward and long

futures contracts

3. Profit = (close of forward) – (close of futures) = 103.25 – 101.55 = 1.7

4. Investor C makes the profit on day 5.

4.4 Investor D

1. Investor D pays/ receives:

(a) day 0 : zero

(b) day 1 : pay F0 - F1 ( = 1.7 )

(c) day 2 : receive F2 - F1

(d) day 3 : receive F3 - F2

(e) futures contract sold on day 3 so no other cashflows

2. Profit : - (F0 - F1) + (F2 - F1) + (F3 - F2) = F3 – F0 = F3 - 103.25

3. Investor D makes the profit on day 3

If F3 > 103.25, then F3 - 103.25 > 0 we make profit.

If F3 = 103.25, then F3 - 103.25 = 0 we make break even.

If F3 < 103.25, then F3 - 103.25 < 0 we make loss.

4. Nothing happens for Investor D on day 5

Question 5

5.1

1. Take a short position

2. Reason for trading decision:

(a) Terminal payoff of short call and long put is (use put-call parity at expiration)

p(ST,T) - c(ST,T) = K - ST

(b) A (long) forward contract has a terminal payoff ST - F and

we are given F = K (= 99)

(c) Terminal payoff of total portfolio is

p(ST,T) - c(ST,T) - F(ST,T) = K - ST + (ST - F) = 0

(d)Therefore the portfolio is worth ZERO at expiration.

(e) Cost of portfolio today = 1

(f)Portfolio is overprice, therefore short the portfolio, receive cash 1, save in

bank

(g) At expiration, cash in bank worth e0.05 and payoff of portfolio = 0.

(h) Guaranteed profit = e0.05, always positive

5.2

1. Terminal payoff of long call and short put is (use put-call parity at expiration)

c(ST,T) - p(ST,T) = ST - K

2. A (long) forward contract has a terminal payoff ST - F and we are given

F = K + 1 (= 102)

3. Terminal payoff of total portfolio is

c(ST,T) - p(ST,T) - F(ST,T) = ST - K - (ST - (K + 1)) = 1

4. Therefore the portfolio is worth 1 at expiration

5.2.1

1. Take a short position

2. Cost of portfolio today = 1

3. Portfolio is overpriced, therefore short the portfolio, receive cash 1, save in

bank.

4. At expiration, cash in bank is worth e0.05 and payoff of short portfolio = -1.

5. Guaranteed profit = e0.05 - 1 = 0.05 , always positive

5.2.2

1. Take a long position

2. Cost of portfolio today = 0.9

3.Portfolio is underpriced, therefore long the portfolio, pay cash 0.9, borrow

from bank

4. At expiration, cash borrow from bank is worth 0.9 \* e0.05 = 0.95 and payoff of

long portfolio = 1.

5. Guaranteed profit = 1 - 0.9e0.05 = 0.05, always positive.

5.2.3

1. Take a short position.

2. Cost of portfolio today = 1.1

3. Portfolio is overpriced, therefore short the portfolio, receive cash 1.1, save in

bank.

4. At expiration, cash in bank is worth 1.1\*e0.05 = 1.16 and payoff of short

portfolio = -1.

5. Guaranteed profit = 1.1\*e0.05 - 1 = 0.16, always positive

5.3

5.3.1

1. Terminal payoff formula of portfolio.

c(ST,T) + p(ST,T) = max(ST - 99.5 , 0) + max(100.5 - ST , 0 )

2. Terminal payoff diagram of portfolio.

5

95.5

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| 1 |  |  |  |  |  |  |  |  |  |
|  |  |  |  | 99.5 | 100.5 |  |  |  | 104.5 |

1. Take a long position.

2. Reason for Trading decision.

(a) Minimum terminal payoff of portfolio = 1.

(b) Minimum present value of terminal payoff of portfolio

(c) Cost of portfolio today 0.9

(d) Portfolio is underpriced, therefore buy (go long) the portfolio.

(e) Buy the portfolio, borrow money = 0.9 today (loan).

(f) At expiration amount of loan

(g) Portfolio pays at least 1, hence there is enough money to repay the

loan

(h) Minimum guaranteed profit = 1 – 0.95 = 0.05

5.3.2

1. Take a long position

2. Reason for trading decision

(a) options are American, therefore payoff diagram in Figure is applicable

always.

(b) Minimum payoff of portfolio = 1 (available immediately by early exercise).

(c) Cost of portfolio today = 0.94.

(d) Therefore, price of portfolio is below intrinsic value.

(e) Buy the portfolio, borrow money = 0.94 today (loan), exercise

immediately.

(f) Receive minimum payoff = 1, repay loan immediately.

(g) Minimum guaranteed profit = 1 - 0.94 = 0.06.

(h) Note: we can wait to exercise the options. The portfolio always pays at

least $1, which is always more than the amount of the loan to be repaid

at any time . Hence, we can wait to see if the options go

more deeply in the money and exercise at the relevant times, to obtain a

larger profit.

5.3.3

1. Take a long position

2. Reason for trading decision

(a) options are American, therefore payoff diagram in Figure is applicable

always.

(b) Minimum payoff of portfolio = 1 (available immediately by early exercise)

(c) Cost of portfolio today = 0.98

(d) Therefore, price of portfolio is below intrinsic value.

(e) Buy the portfolio, borrow money = 0.98 today (loan), exercise

immediately.

(f) Receive minimum payoff = 1, repay loan immediately.

(g) Minimum guaranteed profit = 1 – 0.98 = 0.02

(h) Note: we must exercise immediately. If we wait, the amount if loan to

repay will compound to This is greater than $1

Hence, we might make a loss if we do not exercise immediately.

5.4

5.4.1

1. Take a long position

2. Reason for trading decision :

The option intrinsic value is $1 \* (1000 - 920) = $80. The option price is

$65 Therefore, the option is trading below intrinsic value.

3. Trades :

Buy the option, pay $65 (borrow from bank). Exercise the option

immediately. Receive cash settlement = $80. Repay loan of $65. Arbitrary

profit of $15.

5.4.2

1. Take a long position

2. Reason for trading decision :

The option intrinsic is $1 \* (1050 - 1000) = $50. The option price is $45.

Therefore, the option is trading below intrinsic value.

3. Trades :

Buy the option, pay $45 (borrow from bank). Exercise the option

immediately. Receive cash settlement = $50. Repay loan of $45. Arbitrary

profit of $5.

Question 6

a) V = +1\*c(0) +1\*p(40)

|  |  |  |  |
| --- | --- | --- | --- |
| St | +1c(0) | +1p(40) | Total |
| 0 | 0 | 40 | 40 |
| 20 | 20 | 20 | 40 |
| 40 | 40 | 0 | 40 |
| 60 | 60 | 0 | 60 |
| 80 | 80 | 0 | 80 |
| 100 | 100 | 0 | 100 |

b) V = +0.5\*c(0) +0.5\*p(40) +0.5\*c(40)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| St | +0.5c(0) | +0.5p(40) | +0.5c(40) | Total |
| 0 | 0 | 20 | 0 | 20 |
| 20 | 10 | 10 | 0 | 20 |
| 40 | 20 | 0 | 0 | 20 |
| 60 | 30 | 0 | 10 | 40 |
| 80 | 40 | 0 | 20 | 60 |
| 100 | 50 | 0 | 30 | 80 |

c) V = +1\*c(0) +1\*p(40) -1\*c(80)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| St | +1c(0) | +1p(40) | -1c(80) | Total |
| 0 | 0 | 40 | 0 | 40 |
| 20 | 20 | 20 | 0 | 40 |
| 40 | 40 | 0 | 0 | 40 |
| 60 | 60 | 0 | 0 | 60 |
| 80 | 80 | 0 | 0 | 80 |
| 100 | 100 | 0 | -20 | 80 |

d) V = +0.5\*c(0) +0.5\*p(40) +1\*c(40) -1.5\*c(80)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| St | +0.5c(0) | +0.5p(40) | +1c(40) | -1.5c(80) | Total |
| 0 | 0 | 20 | 0 | 0 | 20 |
| 20 | 10 | 10 | 0 | 0 | 20 |
| 40 | 20 | 0 | 0 | 0 | 20 |
| 60 | 30 | 0 | 20 | 0 | 50 |
| 80 | 40 | 0 | 40 | 0 | 80 |
| 100 | 50 | 0 | 60 | -30 | 80 |

e) V = +0.5\*c(0) +0.5\*p(40) +1\*c(20) -1.5\*c(40) +1.5\*c(60)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| St | +0.5c(0) | +0.5p(40) | +1c(20) | -1.5c(40) | +1.5c(60) | Total |
| 0 | 0 | 20 | 0 | 0 | 0 | 20 |
| 20 | 10 | 10 | 0 | 0 | 0 | 20 |
| 40 | 20 | 0 | 20 | 0 | 0 | 40 |
| 60 | 30 | 0 | 40 | -30 | 0 | 40 |
| 80 | 40 | 0 | 60 | -60 | 30 | 70 |
| 100 | 50 | 0 | 80 | -90 | 60 | 100 |

Question 7

S0 = 100 , K = 100

Expiration time T - t0 = 1

The interest rate is r =

7.1 American call

1. At today t0 :

(a) buy the call (market price = 2), loss money 2

(b) short sell one share of stock, get money value S0 = 100

(c) save money in the bank (S0 - 2 = 98)

2. At Expiration Date T :

The stock price at expiration date is ST.

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Profit  Cash in the bank - cost to buy back stock  =  > 0 |
| Note that | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Break even  Cash in the bank - cost to buy back stock  =  = 0 |
| Note that | Option is out of the money  Do not exercise the option.  Buy back stock, pay ST.  Close out short stock position | Loss  Cash in the bank - cost to buy back stock  =  < 0 |

If K =100, it will always bigger than

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Loss  Cash in bank – strike price  =  < 0 |
| Note that | Option is in the money  Decide not to exercise the option.  Buy back stock, pay ST  Close out short stock position. | Loss  Cash in bank – cost to buy back stock  =  < 0 |

3. Early exercise. This only happens if

We assume the money save in the bank is smaller than ,

so K (=100) will always bigger than

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option, pay the strike K. Receive stock.  Close out short stock position. | Loss  Cash in bank – strike price  =  < 0 |

7.2 American Put

1. At today t0 :

(a) buy the Put (market price = 2), loss money 2

(b) buy one share of stock, loss money value S0 = 100

(c) borrow money in the bank (S0+ 2 = 102)

2. At Expiration Date T :

The stock price at expiration date is ST.

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is out of the money  Do not exercise the option  We sell the stock to repay the loan | Profit  Cash from sell the stock - repay loan  =  > 0 |
| Note that | Option is out of the money  Do not exercise the option  We sell the stock to repay the loan | Break even  Cash from sell the stock - repay loan  =  = 0 |
| Note that | Option is out of the money  Do not exercise the option  We sell the stock to repay the loan | Loss  Cash from sell the stock - repay loan  =  < 0 |

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock | Loss  Cash from option exercise - Cost to buy the stock - repay loan  =  < 0 |

3. Early exercise. This only happens if

K (=100) is always smaller than at

|  |  |  |
| --- | --- | --- |
| ST | Trades | Profit / Loss |
| Note that | Option is in the money  Exercise the option and receive cash K  Buy stock (in stock market), pay ST.  Deliver stock to option writer.  Amount of loan is  Use cash K to repay loan and buy stock | Loss  Cash from option exercise - Cost to buy the stock - repay loan  =  < 0 |