Financial Mathematics Assignment

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Market data such as stock price, call option details, put option details are taken from Yahoo Finance, interest free interest rate are taken from treasury.gov, ABBV performance chart is taken from Yahoo Finance. Currency used is USD.

Initial value assumptions

Market data such as stock price, call option details, put option details are taken from Yahoo Finance, interest free interest rate are taken from treasury.gov, ABBV performance chart is taken from Yahoo Finance. Currency used is USD. Initial investment is assumed to be $10000 throughout the assignment.

Product 1: Partially Principal Protected Note (PPPN)

Bank's perspective:

The customer is ready to invest $10000, ABBV stock price is $121.73. The risk-free interest rate is of .65% is taken as yield on 2 years T-Bond as of 07th December 2021. We assumed it remains the same during the lifetime of our investment.

PPPN is structured as follows : To pay 90% of initial investment amount at the maturity date in all situations, first we need to invest 8934.69 to buy risk-free bonds with interest rate of .65% (compounded annually). The remaining amount is 1065.31 which will be used to structure the PPPN product.

We have 409 days to the maturity. Bank aims to buy N/S0 number of calls to fulfill the obligation of payoff at maturity, depending upon the situation. We will buy (10000/121.73)=82 call options. To keep a desired margin, the bank plans to choose the options (strike price and ask price) in such a way such that the bank can save some money for itself on their purchasing price. Bank will buy options at optimal prices to save some margin for itself.

After investing in a risk-free fixed income security for guaranteed return at maturity, the amount available for purchasing the options to structure the product is 1065.31. Since the bank plans to buy call options, the average cost of buying an option is (1065.31/(82)) = $12.99.

Bank aims to find the call option with strike price near 121 with price near $12.99, from the available calls in the market with maturity date 21 January 2023. The best available call option(lower the strike, more valuable is the call) given our purchasing power is with strike $120 at ask price of $12.6. Total amount required to buy 82 call options: 82x12.6=1033.2.

The bank takes the participation rate to be 1% whenever the stock price goes above the strike of the call option.

Bank saves $32.11 and makes a margin of 3.01% when stock price is less than the strike price of the call option. When the stock price goes up above than the strike price of the call option, then we get 1% of the profit of the returns.

Below is the graph for bank payoff:

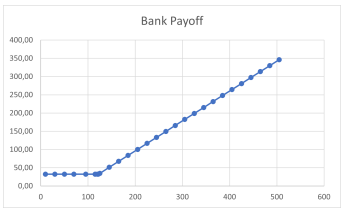

Figure 1: Bank payoff

Investor's Perspective

PPPN is structured on 07th December 2021 with an underlying stock of ABBV. In this product, the capital is 90% protected and in addition to this, premium will be paid depending upon the performance of ABBV stock. The initial stock price is $121.73. The maturity date of the product is 20th January 2023. The investor with an investment of $10000 has always a protected amount of $9000 in all scenarios.

The investor will receive the different payoffs at the maturity depending on the performance of ABBV's stock. In case, stock price at the time of maturity is below the intial stock price(121.73) the investor gets $9000. Participation rate of the Investor in stock return is 99%. If stock price at maturity is above strike price then payoff will be 9000+0.99x82(St - 121.73).

The investor expects to make a gain if there is large price movement of ABBV stock in upward direction, but in any case at least 90% of the initial investment will be preserved. This product provides unlimited profit potential. The below figure shows the client payoff of PPPN at maturity, depending upon the performance of ABBV stock.

Figure 2: Client payoff

Product 2: Partially Principal Protected Note (PPPN)

1.2 Bank's perspective

The client is ready to invest $10000, ABBV stock price is $121.73. The risk-free interest rate is of 0.65% is taken as yield on 2 years T-Bond as of 07th December 2021. We assumed it remains the same during the lifetime of our investment.

PPPN is structured as follows : To pay 90% of initial investment amount at the maturity date when stock price is below the strike price of the call option, first we need to invest $8934.69 to buy risk-free bonds with interest rate of .65% (compounded annually). The remaining amount is $1065.31 which will be used to structure the PPPN product.
If the bank follows the following payoff, the bank incurs loss. Bank cannot offer it as it is not lucrative for the bank.

$$\text{premium} = \begin{cases} 0 & \text{if } S_T \leq K, \\ 0.1 \cdot N & \text{if } K < S_T \leq 1.1 \cdot S_0, \\ \frac{N}{S_0} \cdot (S_T - S_0) & \text{if } S_T > 1.1 \cdot S_0. \end{cases}$$

To avoid any losses, the bank has introduced the participation rate and follows the following payoff:

$$\text{premium} = \begin{cases} 0 & \text{if } S_T \leq K \\ 0.02 \cdot N & \text{if } K < S_T \leq 1.1 \cdot S_0 \\ 0.2 \cdot \frac{N}{S_0} \cdot (S_T - S_0) & \text{if } S_T > 1.1 \cdot S_0 \end{cases}$$

By looking at the historical performance chart, we don't expect the price to rise above 200 till the maturity date of 20th January 2023. We can pay the above-mentioned payoff till the stock price is 200. If the stock price rises more than that, the bank would have to incur the loss.

We short sell 160 call options at strike price 130(K2) to gain some money to invest in call options. We gain $1224 after short selling call options at the bid price of $7.65 each. We have total $2289 in hand now. With the money in hand, we plan to buy 150 call options with strike price 120(K1) which is near the initial stock price, i.e. 121.73. Buying 150 call options at ask price 12.6 cost us $1890. Then we aim to buy call options with strike price near the 1.1xS0, i.e. 133.90. We bought 2 call options with strike $135(K3) at the ask price of $7.2 each.

After doing this, the bank has the remainder of $384 which is the bank margin when stock value is less than the strike price of the call option. The bank offers 2% of the initial investment as premium to the client when stock price is between 120 and 133.9. This could cause some negative payoff for the bank, but when we add the remainder amount $384 to that value, the payoff becomes positive. Bank only offers 20% stock return to the client and keep the rest as the margin for the bank when the stock price > 133.9.

The below figure shows the bank payoff of PPPN at maturity, depending upon the performance of ABBV stock.

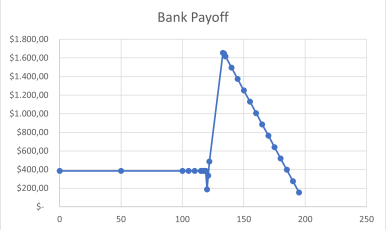

Figure 3: Bank payoff

Investor's Perspective

The product is structured on 07th December 2021 with an underlying stock of ABBV. The initial stock price is $121.73. The investor wants to make an investment of $10000. The maturity date of the product is 20th January 2023. In this product, the capital is 92% protected if the underlying stock price is between S0(121.73) and 1.1xS0(133.90). If the stock price is below S0, then 90% of the capital is protected.

The investor will receive the different payoffs at the maturity depending on the performance of ABBV's stock. In case, stock price at the time of maturity is above 1.1xS0 then total payoff will be 9000 + 82x0.2x(ST-121.73). The investor gets 20% of the stock return as premium when stock price is greater than 133.90.

If the stock price at maturity is between 121.73 and 133.90, then the total payoff would be $9200. The investor gets 2% of the initial investment as premium when stock price is between $121.73 and $133.90. If the stock price at maturity is below 121.73, then the total payoff would be $9000. In adverse scenarios, the investor will not lose more than 10% of the initial investment.The below figure shows the client payoff of PPPN at maturity, depending on the performance of the ABBV stock.

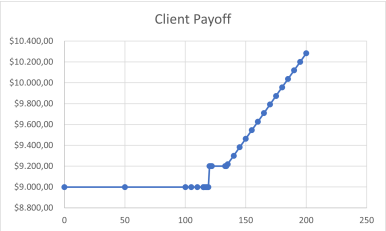

Figure 4: Client payoff

Stock screenshot

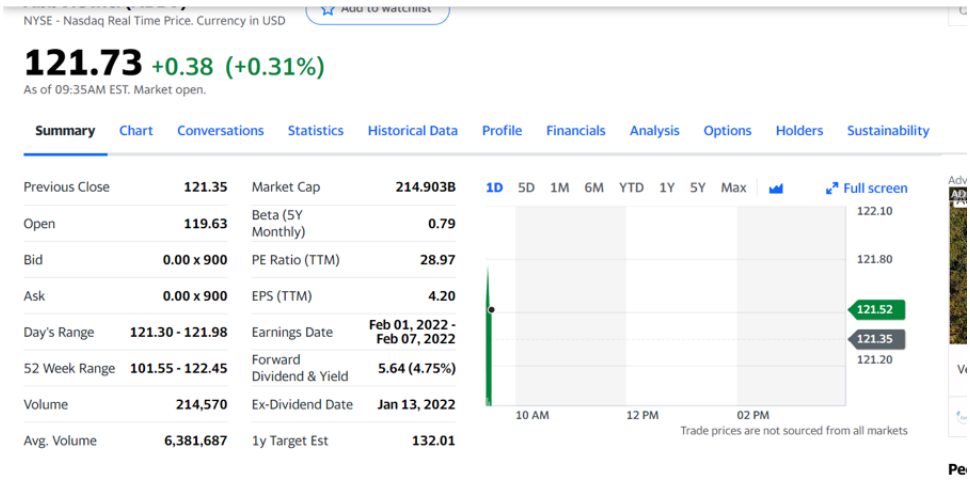

Figure 5: Stock price

Figure 6: Historical chart

Note: All the call options and put options data is available in the Excel sheet.