**Project 2 report**

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**Data collection**

1. Dividend

图形用户界面

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电脑萤幕的截图

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Since the dividend yield does not change much with the strike, we choose 1.489% to be our continuous compounded dividend yield.

1. Implied volatility

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We choose 31.667% to be our implied volatility.

1. Risk-free rate

电脑萤幕画面

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From the data above, we can get the risk-free rate is approximately 0.0012305.

**Valuation Procedure**

In our project, we choose Crank-Nicolson (CN) finite-difference method and LU decomposition to calculate the valuation of “Auto Callable Yield Notes Linked to the S&P 500® Index due July 21, 2023” (the first portfolio).

In the code part, the first step is to set parameters, which are partly collected from the Bloomberg:

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And for other parameters: jmax is number of S steps; imax is number of t steps that we choose 5460 which is a multiple of T; S0 is the initial value which is 4577.11$; Barr is the trigger price which is 0.7 of S0; T is the total days of the portfolio which is the number of days from Pricing Date, January 18, 2022, to Maturity Date, July 21, 2023 divided by 365; SL is the minimum S value; SU is the maximum S value; Face is the face value of the note and CPN is the interest payment on the Interest Payment Dates that the interest rate is 0.5375% per month.

Now, we start at the function step. In the function, we firstly create the parameters we need in the follow CN method calculation:

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In particular, ireview and ipayment are the list of review date and interest payment dates.

Next, we calculate the value if the trigger event has occurs in “VT” code:

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In this part code, we firstly calculate the imax date value. Then, we respectively calculate the two situations if i is on review dates. If i is on the review dates, we calculate the value from j=0 to j=j0 through LU decomposition and di0 equals to PV(remaining coupons) and dij0 equals to (Face+CPN)\*exp(-r\*(time from the next payment date to i). By LU decomposition, we calculate the value and then adds the PV(CPN). For j >=j0, values are (Face+CPN)\*exp(-r\*(time from the next payment date to i). If i is not on the review dates, we calculate the value from j=0 to j=jmax through LU decomposition, dijmax equals to (Face+CPN)\*exp(-r\*(time from the next payment date to i), and finally add CPN on the first two payment dates.

Then, we assume there is no trigger in “V” code:

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Now we also calculate the imax date value but the difference from trigger events is that we set the condition boundary is Barr or not S0 in “VT” code. For j equal and less than jb, V=VT. Similarly, we divide into two situations but we calculate value through LU decomposition starting with jb or not j0 because we use value from VT under jb.

Finally, we calculate the value is about [953.51].

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**Further Discussion**

**Nonlinearity**

In the product, coupons are paid based on stock prices levels on discrete dates which may leads to nonlinearity error. In order to solve this nonlinearity error, we can have the barrier halfway between nodes. Therefore, we choose jmax = 409 so that the lambda equals to 0.48 which equals to 0.5 approximately.

However, because S0 is not an integer, the nonlinearity error can not be removed completely.

**Sensitivity Analysis**

The volatility we use in the tree will affect tree value. So, we conduct a sensitive analysis.

图表, 散点图

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And we choose the at money volatility at maturity to build the tree.