To: anenduser@gmail.com

From: jehung@me.com

Subject: IRR and NPV Functions – Python NumPy Package

Dear Mr. Edward:

Thank you for contacting FINCAD. I am writing in response to your questions on the selection of appropriate functions from Python NumPy package. In particular, the purpose of the email is to provide recommendations on how to choose and use the IRR and NPV codes for the 2 scenarios you have raised.

Question 1: How to find the average periodically compounded rate of return, given that the account has a nil balance at the end of the 3rd year?

Recommendation:

In response to your first question, the "IRR" function in the NumPy package should be used. Specifically, `round(irr([-100,20,-25,150],5)` should be applied to the first scenario.

IRR, the internal rate of return, is the discount rate often used in investment analysis that makes the net present value of all cash flows from a particular investment equal to zero. You can think of IRR as the rate of growth an active account (i.e. an account with multiple deposits and withdrawals) actually generates over a period of time. Mathematically, this particular rate equates the net present value of all cash inflows to the net present value of all cash outflows of an investment over the entire investment cycle. In your first scenario, you have a zero balance at the end of the third year, which means precisely that the net present value of all cash flows of the account is equal to zero. Therefore, the IRR function should be used for your calculation of the "average" periodically compounded rate of return.

As a note, the NumPy convention is that, net "deposits" are negative and net "withdrawals" are positive. Thus, in your code, the initial deposit and all the subsequent deposits should be negative. Further, since all of your deposits and withdrawals occur on an annual basis, the function returns the annual IRR.

Question 2: How to calculate the overdraft at the end of the 3rd year, assuming average periodically compounded rate of return is 5%?

Recommendation:

In response to your second question, the "NPV" function in the NumPy package should be used. Specifically, `np.npv(0.05,[100,-20,25,-150])` should be applied to the second scenario. We are assuming that the 5% is the annual rate of the return (more on compounding periods later).

The NumPy NPV function automates the calculation of all interest earned from the account, adjusting for all the account activities. Therefore all you have to do is to apply the function as above, and you should get the correct answer. However, particular attention should be paid to the following:

- NPV analysis is sensitive to the reliability of cash inflows and outflows, as well as the compounded rate used in the calculation. Thus you must make sure that the time interval between cash flow events matches the period for which the rate is given.
- Furthermore, when interest rates are less than a year, the rates and the number of compounding periods must be restated to be consistent with the length of the interest period. To illustrate, 5% annual interest for 3 years requires us to have a value array of 4 elements (corresponding to time equals 0, 1, 2, 3, where the elements in the array represent the deposit and/or withdrawal at that time). If compounding is quarterly, the interest period is one quarter of a year, and the quarterly interest rate would be 1.25% per quarter. And we would require a value array of 12 elements (3 years x 4 quarters a year) in order for the NPV function to work properly.
- By NumPy convention, from the perspective of the investor, "deposits" are negative, income or "withdrawals" are positive. However, since you are calculating the account balance or overdraft (from the perspective of the account), deposits should be treated as positive, and withdrawals treated as negative.

Mathematically, NPV is the difference between the present value of cash inflows and the present value of cash outflows. It compares the value of a dollar today to the value of that same dollar in the future, taking inflation and returns into account. In your scenario, if the NPV is positive, then the account will have a positive balance at the end of the third year. Conversely, a negative NPV indicates an overdraft.

ADDITIONAL REMARKS

In both of IRR and NPV analyses, we have relied on the fact patterns supplied by you, and assumed that any account activity occurs at the end of each interest period. Any deposits or withdrawals made at times other than the end of the year will change the numerical outcomes of the analyses. This, however, does not change the recommended NumPy functions to adopt in your respective questions.

In our IRR and NPV analysis, we have assumed the annual interest rate and annual compounding and discounting period. We stress again that in cases where interest rates are less than a year, additional care must be exercised to match the total number of periods to total number of elements in the array.

I hope the above explanations answered your questions. If you have any further questions, or have more information to provide to us, please feel free to contact me.

Sincerely yours,

Jenny Hung