INTRODUCTION TO FINANCIAL CONCEPTS IN PYTHON

A Tale of Two Project Proposals

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Common Profitability Analysis Methods

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Equivalent Annual Annuity (EAA)

Net Present Value (NPV)

NPV is equal to the sum of all discounted cash flows:

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$$

- C_t: Cash flow C at time t
- r: Discount rate

NPV is a simple cash flow valuation measure that does not allow for the comparison of different sized projects or lengths.

Internal Rate of Return (IRR)

The internal rate of return must be computed by solving for IRR in the NPV equation when set equal to 0.

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+IRR)^t} - C_0 = 0$$

- C_t: Cash flow C at time t
- IRR: Internal Rate of Return

IRR can be used to compare projects of different sizes and lengths but requires an algorithmic solution and does not measure total value.

IRR in NumPy

You can use the **NumPy** function `.irr(values)` to compute the internal rate of return of an array of values.

Example:

```
In  [1]: import numpy as np
In  [2]: project_1 = np.array([-100,150,200])
In  [3]: np.irr(project_1)
Out [3]: 1.35
```

Project 1 has an IRR of 135%

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The Weighted Average Cost of Capital (WACC)

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What is WACC?

$$WACC = F_{Equity} * C_{Equity} + F_{Debt} * C_{Debt} * (1 - TR)$$

- F_{Equity} : The proportion (%) of a company's financing via equity
- F_{Debt} : The proportion (%) of a company's financing via debt
- C_{Equity} : The cost of a company's equity
- C_{Debt} : The cost of a company's debt
- TR : The corporate tax rate

Proportion of Financing

The proportion (%) of financing can be calculated as follows:

$$F_{Equity} = \frac{M_{Equity}}{M_{Total}}$$

$$F_{Debt} = \frac{M_{Debt}}{M_{Total}}$$

$$M_{Total} = M_{Debt} + M_{Equity}$$

- M_{Debt}: Market value of a company's debt
- M_{Equity}: Market value of a company's equity
- M_{Total}: Total value of a company's financing

Calculating WACC

Example:

Calculate the WACC of a company with a 12% cost of debt, 14% cost of equity, 20% debt financing and 80% equity financing. Assume a 35% effective corporate tax rate.

```
In  [1]: percent_equity = 0.80
In  [2]: percent_debt = 0.20
In  [3]: cost_equity = 0.14
In  [4]: cost_debt = 0.12
In  [5]: tax_rate = 0.35
In  [6]: wacc = (percent_equity*cost_equity) + (percent_debt*cost_debt) *
          (1 - tax_rate)
In  [7]: print(wacc)
Out [7]: 0.1276
```

Discounting Using WACC

Example:

Calculate the NPV of a project that produces $100 in cash flow every year for 5 years. Assume a WACC of 13%.

```
In  [1]: cf_project1 = np.repeat(100, 5)
In  [2]: npv_project1 = np.npv(0.13, cf_project1)
Out [2]: print(npv_project1)
397.45
```

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Comparing Two Projects of Different Life Spans

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Different NPVs and IRRs

Year	Project 1	Project 2
1	-$100	-$125
2	$200	$100
3	$300	$100
4	N / A	$100
5	N / A	$100
6	N / A	$100
7	N / A	$100
8	N / A	$100

Assume a 5% discount rate for both projects

Project	NPV	IRR	Length
#1	362.58	200%	3
#2	453.64	78.62%	8

Notice how you could undertake multiple Project 1's over 8 years? Are the NPVs fair to compare?

Project 2 has a higher net present value simply because of the length of the project.
It’s fair to compare IRRs between the two projects, whereas the NPV is misleading.
However, the IRR doesn’t give you a sense of the size of the project in terms of total profitability.

Equivalent Annual Annuity

Equivalent Annual Annuity (EAA) can be used to compare two projects of different lifespans in present value terms.

Apply the EAA method to the previous two projects using the computed NPVs * -1:

```
In  [1]: import numpy as np
In  [2]: npv_project1 = 362.58
In  [3]: npv_project2 = 453.64
In  [4]: np.pmt(rate=0.05, nper=3, pv=-1*npv_project1, fv=0)
Out [4]: 133.14
In  [5]: np.pmt(rate=0.05, nper=8, pv=-1*npv_project2, fv=0)
Out [5]: 70.18
```

Project 1 has the highest EAA

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