Fundamental financial concepts

INTRODUCTION TO FINANCIAL CONCEPTS IN PYTHON

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Course objectives

- The Time Value of Money
- Compound Interest
- Discounting and Projecting Cash Flows
- Making Rational Economic Decisions
- Mortgage Structures
- Interest and Equity
- The Cost of Capital
- Wealth Accumulation

Calculating Return on Investment (% Gain)

$$\text{Return (\% Gain)} = \frac{v_{t_2} - v_{t_1}}{v_{t_1}} = r$$

- v_{t_1}: The initial value of the investment at time
- v_{t_2}: The final value of the investment at time

Example

- You invest \$10,000 at time = year 1
- At time = 2, your investment is worth \$11,000

$$\frac{\$11,000 - \$10,000}{\$10,000} * 100 = 10\% \text{ annual return (gain) on y}$$

Calculating Return on Investment (Dollar Value)

$$v_{t_2} = v_{t_1} * (1 + r)$$

- v_{t_1}: The initial value of the investment at time
- v_{t_2}: The final value of the investment at time
- r: The rate of return of the investment per period t

Example

- Annual rate of return = 10% = 10/100
- You invest $10,000 at time = year 1

$$\$10{,}000 * (1 + \frac{10}{100}) = \$11{,}000$$

Cumulative growth (or depreciation)

- r: The investment's expected rate of return (growth rate)
- t: The lifespan of the investment (time)
- v_{t_0}: The initial value of the investment at time 0

$$\text{Investment Value} = v_{t_0} * (1 + r)^t$$

If the growth rate r is negative, the investment's value will depreciate (shrink) over time.

Discount factors

$$df = \frac{1}{(1+r)^t}$$

$$v = fv * df$$

- df: Discount factor
- r: The rate of depreciation per period t
- t: Time periods
- v: Initial value of the investment
- fv: Future value of the investment

Compound interest

$$\text{Investment Value} = v_{t_0} * (1 + \frac{r}{c})^{t*c}$$

- r: The investment's annual expected rate of return (growth rate)
- t: The lifespan of the investment
- v_{t_0}: The initial value of the investment at time 0
- c: The number of compounding periods per year

The power of compounding returns

Consider a $1,000 investment with a 10% annual return, compounded quarterly (every 3 months, 4 times per year):

$$\$1,000 * (1 + \frac{0.10}{4})^{1*4} = \$1,103.81$$

Compare this with no compounding:

$$\$1,000 * (1 + \frac{0.10}{1})^{1*1} = \$1,100.00$$

Notice the extra *$3.81* due to the quarterly compounding?

Exponential growth

Compounded Quarterly Over 30 Years:

$$\$1,000 * (1 + \frac{0.10}{4})^{30*4} = \$19,358.15$$

Compounded Annually Over 30 Years:

$$\$1,000 * (1 + \frac{0.10}{1})^{30*1} = \$17,449.40$$

Compounding quarterly generates an extra *$1,908.75 over 30 years*

Let's practice!

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Present and future value

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The non-static value of money

Situation 1

- **Option A**: $100 in your pocket today
- **Option B**: $100 in your pocket tomorrow

Situation 2

- **Option A**: $10,000 dollars in your pocket today
- **Option B**: $10,500 dollars in your pocket one year from now

Time is money

Your Options

- **A**: Take the $10,000, stash it in the bank at 1% interest per year, risk free
- **B**: Invest the $10,000 in the stock market and earn an average 8% per year
- **C**: Wait 1 year, take the $10,500 instead

Comparing future values

- **A**: 10,000 * (1 + 0.01) = 10,100 future dollars
- **B**: 10,000 * (1 + 0.08) = 10,800 future dollars
- **C**: 10,500 future dollars

Present value in Python

Calculate the present value of $100 received 3 years from now at a 1.0% inflation rate.

```
import numpy as np
np.pv(rate=0.01, nper=3, pmt=0, fv=100)
```

```
-97.05
```

Future value in Python

Calculate the future value of $100 invested for 3 years at a 5.0% average annual rate of return.

```
import numpy as np
np.fv(rate=0.05, nper=3, pmt=0, pv=-100)
```

```
115.76
```

Let's practice!

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Net present value and cash flows

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Cash flows

Cash flows are a series of gains or losses from an investment over time.

Year	Project 1 Cash Flows	Project 2 Cash Flows
0	-$100	$100
1	$100	$100
2	$125	-$100
3	$150	$200
4	$175	$300

Assume a 3% discount rate

Year	Cash Flows	Formula	Present Value
0	-$100	pv(rate=0.03, nper=0, pmt=0, fv=-100)	-100
1	$100	pv(rate=0.03, nper=1, pmt=0, fv=100)	97.09
2	$125	pv(rate=0.03, nper=2, pmt=0, fv=125)	117.82
3	$150	pv(rate=0.03, nper=3, pmt=0, fv=150)	137.27
4	$175	pv(rate=0.03, nper=4, pmt=0, fv=175)	155.49

Sum of all present values = 407.67

Arrays in NumPy

Example:

```
import numpy as np
array_1 = np.array([100,200,300])
print(array_1*2)
```

```
[200 400 600]
```

Net Present Value

Project 1

```
import numpy as np
np.npv(rate=0.03, values=np.array([-100, 100, 125, 150, 175]))
```

```
407.67
```

Project 2

```
import numpy as np
np.npv(rate=0.03, values=np.array([100, 100, -100, 200, 300]))
```

```
552.40
```

Let's practice!

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