INTRO TO FINANCIAL CONCEPTS USING PYTHON

Mortgage Basics

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Taking Out a Mortgage

A **mortage** is a loan that covers the remaining cost of a home after paying a percentage of the home value as a **down payment**.

- A typical down payment in the US is at least 20% of the home value
- A typical US mortgage loan is paid off over 30 years

Example:

- $500,000 house
- 20% down ($100,000)
- $400,000 remaining as a 30 year mortgage loan

Converting from an Annual Rate

To convert from an annual rate to a periodic rate:

$$R_{Periodic} = (1 + R_{Annual})^{\frac{1}{N}} - 1$$

- **R:** Rate of Return (or Interest Rate)
- **N:** Number of Payment Periods Per Year

Example:

Convert a 12% annual interest rate to the equivalent monthly rate.

$$(1 + 0.12)^{\frac{1}{12}} - 1 = 0.949\% \text{ monthly rate}$$

Mortgage Loan Payments

You can use the **NumPy** function `.pmt(rate, nper, pv)` to compute the periodic mortgage loan payment.

Example:

Calculate the *monthly* mortgage payment of a $400,000 30 year loan at 3.8% interest:

```
In  [1]: import numpy as np
In  [2]: monthly_rate = ((1+0.038)**(1/12) - 1)
In  [3]: np.pmt(rate=monthly_rate, nper=12*30, pv=400000)
Out [3]: -1849.15
```

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Amortization, Principal and Interest

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Amortization

Principal (Equity): The amount of your mortgage paid that counts towards the value of the house itself

Interest Payment

$$IP_{Periodic} = RMB * R_{Periodic}$$

Principal Payment

$$PP_{Periodic} = MP_{Periodic} - IP_{Periodic}$$

- **PP:** Principal Payment
- **MP:** Mortgage Payment
- **IP:** Interest Payment
- **R:** Mortgage Interest Rate (Periodic)
- **RMB:** Remaining Mortgage Balance

Accumulating Values via For Loops in Python

Example:

```
In [1]: accumulator = 0
In [2]: for i in range(3):
   ...:     if i == 0:
   ...:         accumulator = accumulator + 3
   ...:     else:
   ...:         accumulator = accumulator + 1
   ...:     print(str(i)+": Loop value: "+str(accumulator))
0: Loop value: 3
1: Loop value: 4
2: Loop value: 5
```

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Home Ownership, Equity and Forecasting

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Ownership

To calculate the percentage of the home you actually own (**home equity**):

$$\text{Percent Equity Owned}_t = P_{Down} + \frac{E_{Cumulative,t}}{V_{Home}}$$

$$E_{Cumulative,t} = \sum_{t=1}^{T} P_{Principal,t}$$

- $E_{Cumulative,t}$: Cumulative home equity at time t
- $P_{Principal,t}$: Principal payment at time t
- V_{Home}: Total home value
- P_{Down}: Initial down payment

Underwater Mortgage

An **underwater** mortgage is when the remaining amount you owe on your mortgage is actually higher than the value of the house itself.

Cumulative Operations in NumPy

Cumulative Sum

```
In  [1]: import numpy as np
In  [2]: np.cumsum(np.array([1, 2, 3]))
Out [2]: array([1, 3, 6])
```

Cumulative Product

```
In  [1]: import numpy as np
In  [2]: np.cumprod(np.array([1, 2, 3]))
Out [2]: array([1, 2, 6])
```

Forecasting Cumulative Growth

Example:

What is the cumulative value at each point in time of a $100 investment that grows by 3% in period 1, then 3% again in period 2, and then by 5% in period 3?

```
In  [1]: import numpy as np
In  [2]: np.cumprod(1 + np.array([0.03, 0.03, 0.05]))
Out [2]: array([ 1.03, 1.0609, 1.113945])
```

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