An Introduction to Portfolio Optimization

By RC4 Invest

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01 Introduction

What is a portfolio?

Stocks

Security that represents the ownership of a fraction of a corporation

Cash

Can consist of a multitude of different currencies traded on Forex

Commodities

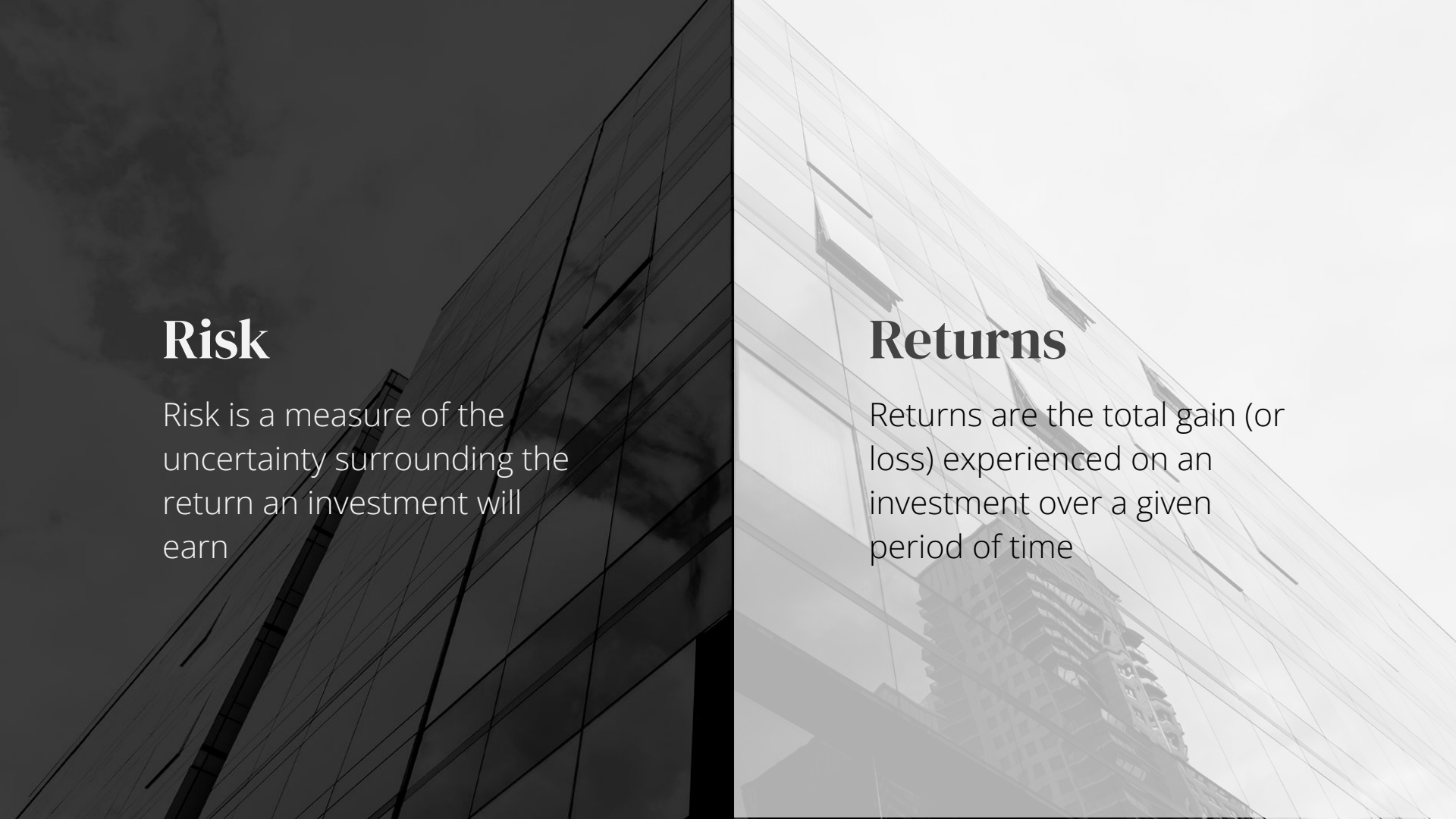
A basic good used in commerce that is interchangeable with other goods of the same type (Usually raw materials)

Bonds

Promise by a borrower to pay a lender their principal and usually interest on a loan

Risk and Returns

02



Risk

Risk is a measure of the uncertainty surrounding the return an investment will earn

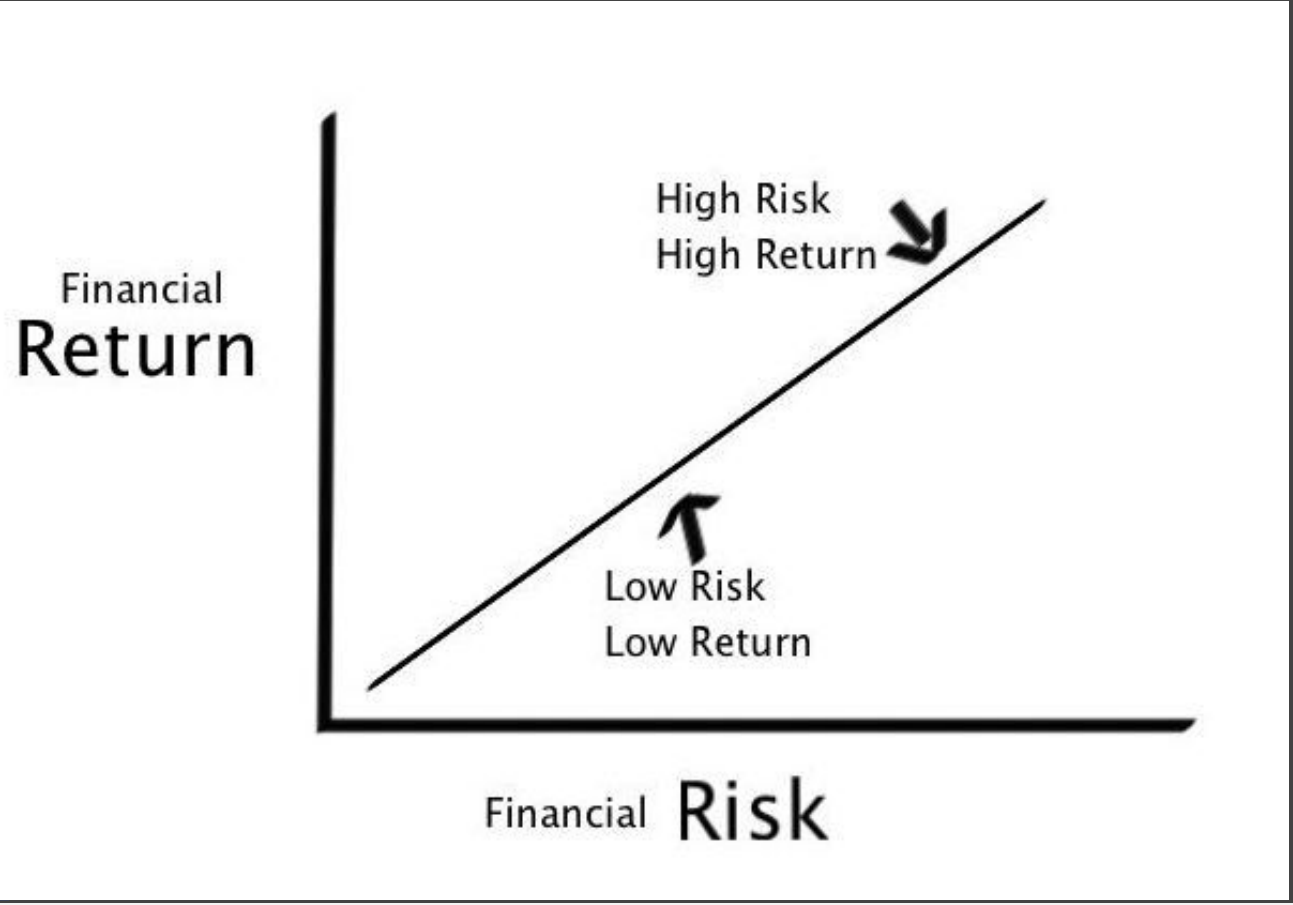
Returns

Returns are the total gain (or loss) experienced on an investment over a given period of time

The Tradeoff between Risk and Return

Increased probability of a higher return

Increase in the level of risk taken



03 Hedging your bets

Correlation

A mutual relationship or connection between two or more things

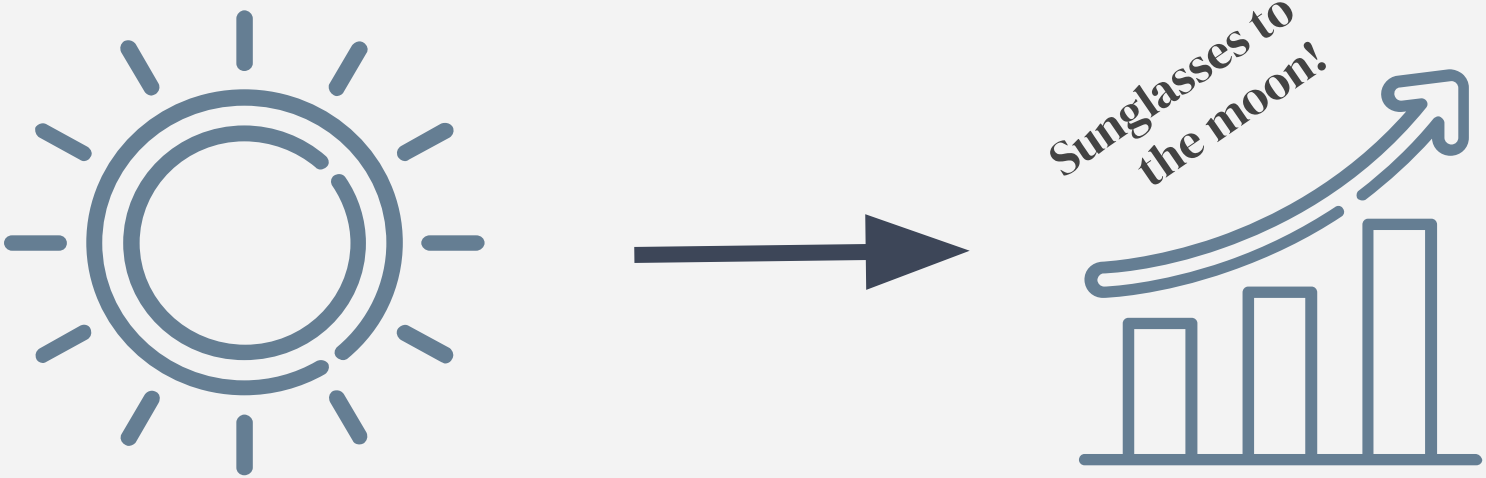
Hedging

A hedge is an investment that is made with the intention of reducing the risk of adverse price movements in an asset

An Example of Hedging

Sunglasses Corp.

If it’s Sunny...



The Hedge

Umbrellas Inc.

Portfolio Theory

04

Harry Markowitz

- American Economist who pioneered Modern Portfolio Theory
- Won Nobel Prize in Economic Sciences in 1990
- Prize shared with Merton Miller and William Sharpe

Modern Portfolio Theory (MPT)

- A key component of the MPT theory is diversification
- Most investments are either *high risk* and *high return* or *low risk* and *low return*.
- Investors can achieve the best results by choosing an **Optimal Mix** of the two based on an assessment of their individual tolerance to risk.

Assumptions

- The MPT assumes that investors are risk-averse
- For same expected return:

  Less Risk > More Risk

- MPT shows that an investor can construct a portfolio of multiple assets that will **Maximize Returns** for a given level of risk

Portfolio Returns

- The expected return of the portfolio is calculated as a **weighted sum** of the returns of the individual assets.
- For example:
  - For a portfolio containing 4 equally weighted assets with expected returns of 4%, 6%, 10%, and 14%
  - Expected return = (4% x 25%) + (6% x 25%) + (10% x 25%) + (14% x 25%) = 8.5%

Calculating Portfolio Risk with matrix algebra

Weight Vector

- For a given portfolio, the weight vector is just a list of how much of its overall value each stock within it contributes to
- Sum of individual weights adds up to 1
- E.g. w1 + w2 + w3 + w4 = 1

$$\begin{pmatrix} w_1 & w_2 & w_3 & w_4 \end{pmatrix}$$

Covariance Matrix

- For a given portfolio, the covariance matrix is a square matrix giving the covariance between each pair of stocks within the portfolio

$$\begin{pmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} & \sigma_{14} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} & \sigma_{24} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} & \sigma_{34} \\ \sigma_{41} & \sigma_{42} & \sigma_{43} & \sigma_{44} \end{pmatrix}$$

Portfolio Risks

- The risk of a portfolio depends on the individual risk and correlations of the stocks within it
- Overall risk also affected by weights of individual stocks
- Equation of portfolio variances takes the form:

$$\sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \, \mathrm{Cov}(r_i, r_j)$$

Portfolio Risks (Part 2)

- Hence to calculate the risk of a portfolio is not just as simple as adding up the variances unfortunately
- Also have to consider the covariance and correlation between the individual stocks
- Can be done using matrix multiplication
- Think of **Hedging Effect** mentioned just now
- Having negatively correlated stocks in your portfolio leads to lower portfolio variance

Calculating Portfolio Risk with matrix algebra (Part 2)

To calculate the portfolio risk:

- **Portfolio risk = Weight matrix** x **Covariance matrix** x **Transposed weight matrix**

$$\sigma_p^2 = \begin{pmatrix} w_1 & w_2 & w_3 & w_4 \end{pmatrix} \begin{pmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} & \sigma_{14} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} & \sigma_{24} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} & \sigma_{34} \\ \sigma_{41} & \sigma_{42} & \sigma_{43} & \sigma_{44} \end{pmatrix} \begin{pmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{pmatrix}$$


10 Mins
Break Time


05
Python
Demo

06

Conclusion

Overall Tips

- Figure out your risk tolerance and base your portfolio around that.
- Buy multiple stocks across various industries (Or invest in an index fund)
- Invest in high growth areas if you are comfortable with higher variance
- Put a portion of your portfolio into fixed income if you prefer lower risk

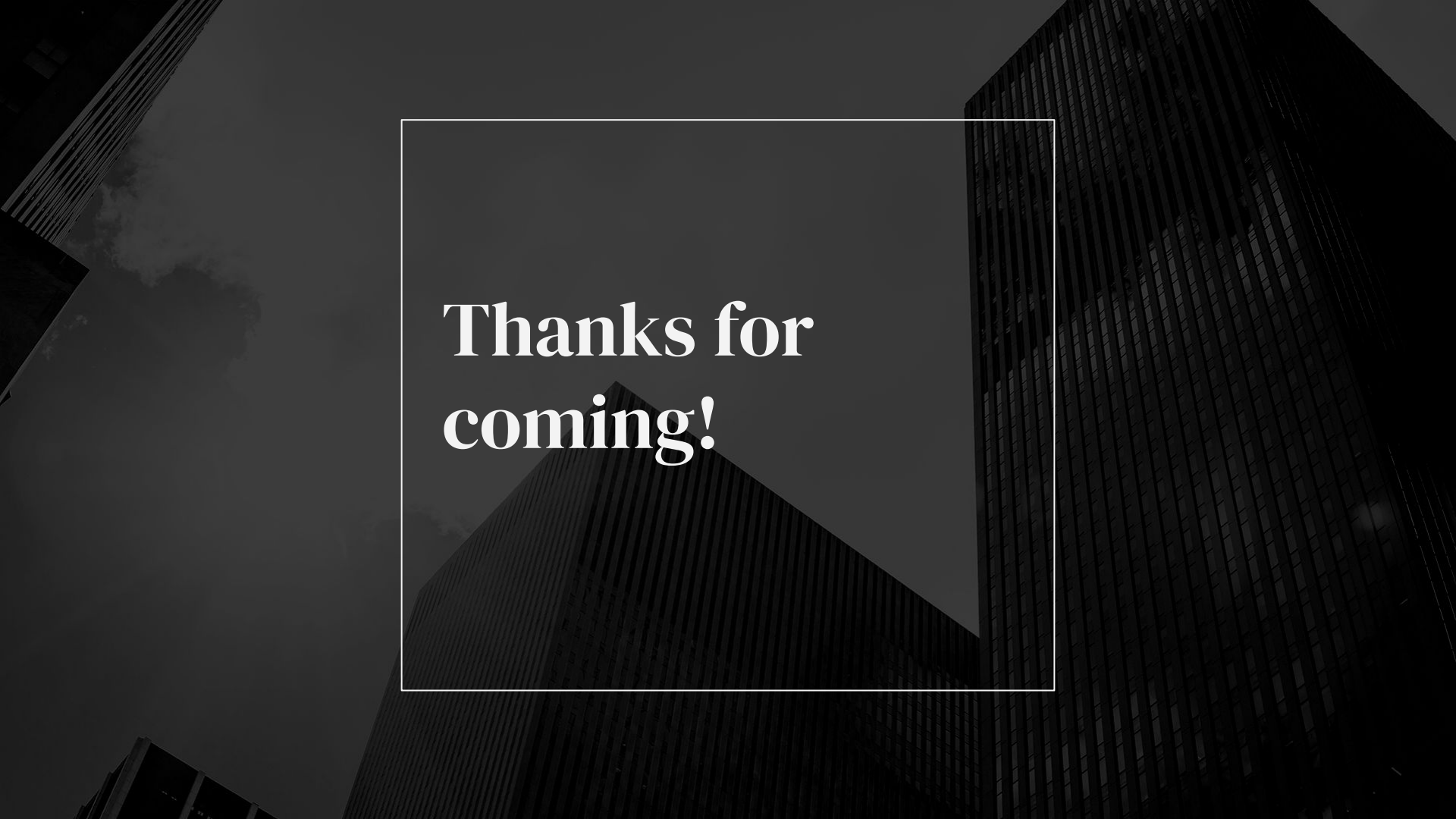
Q&A

Disclaimer:

None of the information contained here constitutes an offer (or solicitation of an offer) to buy or sell any currency, product or financial instrument, to make any investment, or to participate in any particular trading strategy.

Link to the slides will be posted on Telegram group

Github link for demonstration and program will also be sent


Thanks for
coming!