# Chapter 11: Risk and Return

## A first look

While in hindsight some investments have had very high returns, they have also had the most volatility over time.

## Historical risks and returns

To estimate the possible future returns for investors, it can be useful to use historical stock market data about the distribution of past returns.

The realized return is the total return that occurs over a particular time period. The realized return from your investment in the stock from period t to period t+1 can be calculated with this formula:

$$R(t+1) = \frac{Div(t+1) + P(t+1) - P(t)}{P(t)}$$

$$= \frac{Div(t+1)}{Pt} + \frac{P(t+1) - P(t)}{P(t)}$$

$$= Dividend\ yield + Capital\ gain\ yield$$

So, if you invest one euro in period t, you will receive 1 + R (t+1) in period t+1.

The average annual return (R) is the arithmetic average of an investment's realized returns for each year:

$$R = \frac{1}{T}(R1 + R2 + \cdots + RT)$$

The average annual return is an estimate of the return an investor can expect (the expected return), if the distribution is the same over time. You can calculate the standard deviation of the distribution of realized returns to determine the variability. The standard deviation is a common method used to measure the risk of a probability distribution, it is the square root of the variance. Variance is a method to measure the variability of returns, it is the expected squared variation of returns from the mean. The standard deviation is an indication of the tendency of the historical returns to be different from their average.
Variance estimate using realized returns:

$$Var(R) = \frac{1}{T-1}((R1-R)^2 + (R2-R)^2 + ... + (RT-R)^2)$$

(In this formula: R is the average annual return R).

The standard deviation is: $SD(R) = \sqrt{Var(R)}$

The standard deviation can be used to describe a normal distribution: a symmetric probability distribution that is completely characterized by its average and standard deviation.

Using a normal distribution, we can conclude with 95% confidence that next year's return will be within two standard deviations of the average: the 95% prediction interval =
average ± (2 x standard deviation) = R ± (2 x SD(R)).

## Historical tradeoff

There is a historical tradeoff between risk and reward. Risk is measured by price volatility and rewards are measured by returns. There is no clear relationship between returns and the volatility of individual stocks. However, there is a relationship between size and risk: larger stocks have got lower volatility, but large stocks are always more risky than a portfolio of large stocks.

## Common versus independent risk

Different types of risk:

- A common risk is a risk that is linked across outcomes.

- Independent risks are risks that bear no relation to each other: knowing the outcome of one provides no information about the other. Diversification is the averaging of independent risks in a large portfolio.

## Diversification in stock portfolios

The type of individual risks (common or independent) determines the risk of a portfolio. Common risks are not diversified in a large portfolio, independent risks are.

The realized return of a stock is risky, because the dividends plus the final stock price can vary. Dividends and stock prices can fluctuate due to company or industry-specific news and market-wide news. Fluctuations due to company or industry-specific news are independent risks, also called: unsystematic risk. These risks are independent risks unrelated across stocks. Fluctuations due to market-wide news are common risks: systematic risk. Unsystematic risk will be eliminated by diversification. Systematic risk will not be eliminated and will affect the entire portfolio.

Some rules to remember about risk premiums:

- A risk premium of a stock isn't affected by its unsystematic, diversifiable risk.

- The risk premium for diversifiable risk is zero. This means: investors don't get a compensation for holding unsystematic risk (because investors can eliminate unsystematic risk).

- The risk premium of a security is determined by its systematic risk and does not depend on its diversifiable risk. For this reason, the risk premium depends upon the amount of its systematic risk (not the total risk).

- Volatility and average returns for individual securities are not related.