WELCOME TO
Introduction to Finance
for
MSc Financial Technology and Innovation

Lecture 7

Zsófia Kräussl

Recap from last lecture
We did a lot last week, most importantly

Valuing equities cont'd

- Three fundaments to value equities: Cash-flow assessment, risk assessment and value equals price
- Quantifying opportunity cost of capital
- Dividend payments are not a "must": Payout vs plowback ratio
- Addressing long-term growth in the context of dividend payment policies, PVGO
- Understanding why stock price "moves up and down" (ref. constant growth model)

Introduction to **risk**

- Transactions "behave"(!): Measuring risk
- Conceptualizing risk: Specific (non-systemic) vs Unspecific (systemic) risk
- Standard deviation aka dispersion from expected return: I want to be on the safe side with my investment!

To assess the conceptual underpinning of a financial problem that deals with equity valuation, ask yourself the following questions:

- Do I have / are there future payments given in forms of dividends?
  - ***Series*** of payments with timing? I immediately associate the problem with DDM
  - Concrete dividend is given, no reference of finite set of payments? I immediately associate the problem with **perpetuity-based** valuation problem
- Does the problem deal with growth?
  - Is there a growth rate given? I have the constant growth model to apply
  - Is there no growth rate given? Look at the exercise settings! It either must lead me toward calculating payout / plowback ratio to eventually derive the growth rate, or I need to rearrange the constant growth model
- Do I need to calculate growth opportunities?
  - I immediately associate the problem with “constant growth” versus “no growth” scenarios. I also recall the two main ratios, and see from the exercise settings, how I need to manipulate the formulas to calculate the PVGO

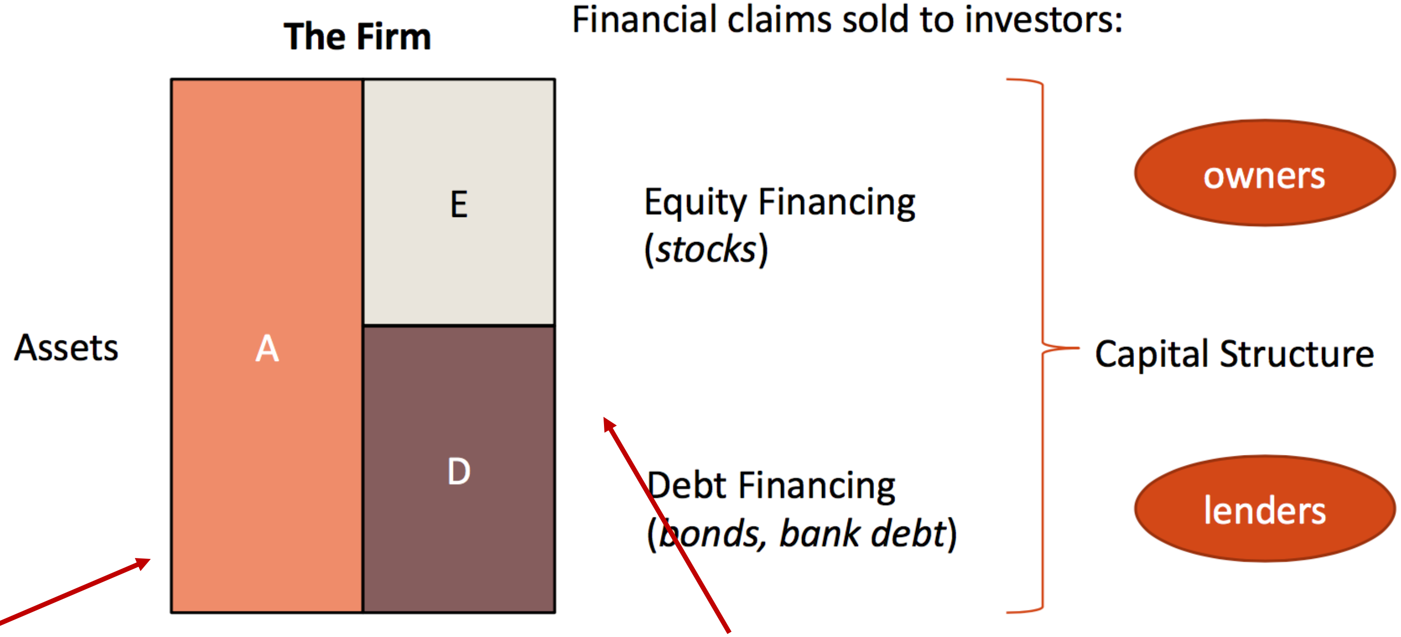
Markets as source of funding
Corporations raise money via financial claims

Recall the slides of Lecture1:

Real assets:
Contribute directly to my operation;
I (re)invest to mainitain it

Financial assets:
A contractual relationship, a promise I make to raise capital, and a promise I must keep

Financial claims sold to investors:



Deciding on real assets is a capital budgeting decision

Deciding on financial assets is a capital structuring decision

Your toolset so far: Fundaments

- PV, FV
- Discount factor
- NPV, DCF
- Rate of Return rule
- Interest rates: simple or compounding

<u>Annual Percentage Rate (APR)</u>

$$\text{APR} = \text{rate per period} \times \text{periods per year}$$

<u>Effective Annual Interest Rate (EAR)</u>

$$\text{EAR} = (1 + \text{rate per period})^{\text{periods per year}} - 1$$

$$\text{PV} = \underbrace{\frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_t}{(1+r)^T}}_{\textbf{DCF}}$$

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

$$\text{NPV} = \text{PV} - \text{required investment}$$

$$\text{Return} = \frac{\text{profit}}{\text{investment}}$$

$EAR = [1 + \frac{r}{m}]^m - 1$, where
$\boldsymbol{m}$ = period; $\boldsymbol{r}$ = rate

Your toolset so far: Series of payments

- Annuity

$$\text{PV of annuity}_t\text{: } C\times\left[\frac{1}{r}-\frac{1}{r\times(1+r)^t}\right]$$

$$\boxed{\text{PV of annuity}_{due}=C_1\times\left[\frac{1}{r}-\frac{1}{r(1+r)^t}\right]\times(1+r)}$$

$$\text{FV of annuity}=C\times\left[\frac{(1+r)^t-1}{r}\right]$$

- Perpetuity

$$\text{PV of perpetuity}=\frac{C_1}{r}$$

$$\boxed{\text{PV of perpetuity}_{due}=\frac{C_1}{r}\times(1+r)}$$

- Both their rates can grow, in fact(!)

$$\text{PV of perpetuity}_{\text{g=grow}}=\frac{C_1}{r-g}$$

$$\text{PV of Growing Annuity}=$$

$$=C_1\times\frac{1}{r-g}\times\left[1-\frac{(1+g)^t}{(1+r)^t}\right]$$

Your toolset so far: Bonds

- Price of a bond = PV of a bond $$\mathrm{PV} = \frac{\mathrm{cpn}}{(1+r)^1} + \frac{\mathrm{cpn}}{(1+r)^2} + \ldots + \frac{(\mathrm{cpn} + \mathrm{par})}{(1+r)^t}$$

- Duration of a bond = weighted average(!) life of cashflows $$\mathrm{Duration} = \frac{1 \times \mathrm{PV}(C_1)}{\mathrm{PV}} + \frac{2 \times \mathrm{PV}(C_2)}{\mathrm{PV}} + \frac{3 \times \mathrm{PV}(C_3)}{\mathrm{PV}} + \ldots + \frac{T \times \mathrm{PV}(C_T)}{\mathrm{PV}}$$

- Modified duration (since returns vary over time, so the cashflow) $$\text{Modified duration} = \text{volatility}\,(\%) = \frac{\text{duration}}{1 + \text{yield}}$$

Your toolset so far: Equities

- Understanding the return of a common stock

$$\text{Expected return} = r = \frac{\text{DIV}_1 + P_1 - P_0}{P_0} \quad \text{Expected Return} = r = \frac{Div_1}{P_0} + \frac{P_1 - P_0}{P_0}$$

- DDM

$$\text{Price} = P_0 = \frac{\text{DIV}_1 + P_1}{1 + r} \xrightarrow[\text{leads to}]{\text{generalizing the one-period calculation + defining a horizont}} P_0 = \frac{\text{DIV}_1}{(1+r)^1} + \frac{\text{DIV}_2}{(1+r)^2} + \ldots + \frac{\text{DIV}_H + P_H}{(1+r)^H}$$

- No growth

$$Perpetuity = P_0 = \frac{Div_1}{r} \; or \; \frac{EPS_1}{r}$$

- With growth (Gordon Growth Model)

$$PV_0 = \frac{C_1}{r - g}$$

Your toolset so far: Ratios for equity valuation

$$\text{Payout Ratio} = \frac{Dividend}{Earnings\ per\ Share\ (EPS)}$$

$$\text{Plowback Ratio} = \frac{Earnings\ per\ Share\ (EPS) - Dividend}{Earnings\ per\ Share\ (EPS)} = \frac{Amount\ Reinvested}{Earnings\ per\ Share}$$

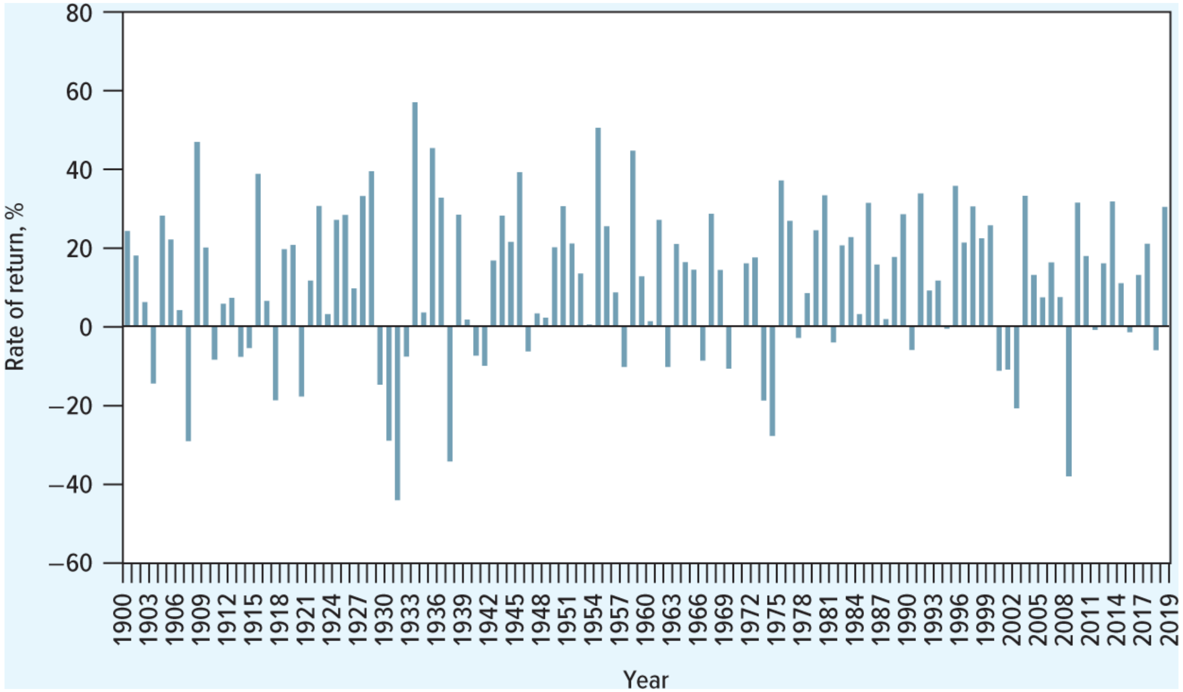
Plowback Ratio+ Payout Ratio=1

$$\text{Return on Equity} = ROE$$

$$ROE = \frac{\text{EPS}}{\text{Book Equity Per Share}}$$

g = return on equity X plowback ratio

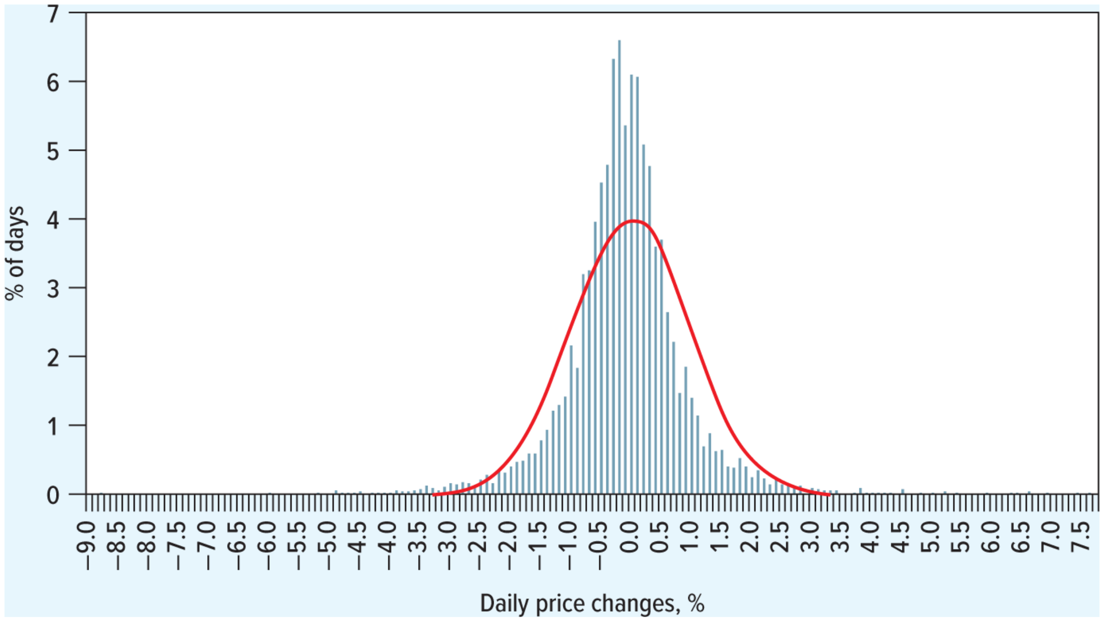
Stock market is an agora of volatile investment opportunities as returns indicate



Source: E. Dimson, P. R. Marsh, and M. Staunton, **Triumph of the Optimists: 101 Years of Global Investment Returns** (Princeton, NJ: Princeton University Press, 2002), with updates provided by the authors.

What would statistics tell us about prices?
See daily price changes e.g. for IBM, following a normal distribution

Price changes versus normal distribution 1997–2019.



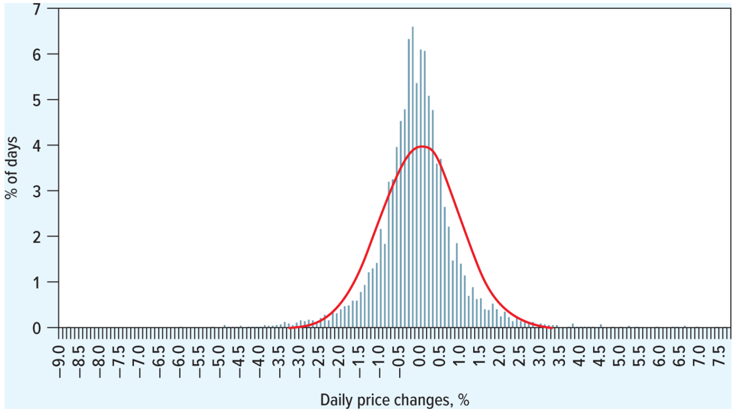
So, apparently, transaction data “behaves”, if we ignore the notion of time

Digest the term: Measuring risk

<u>Variance</u> (σ^2) (*remember Math: square as a measure indicates "distance" == "deviance" for Finance*)

Average value of squared deviations from mean

For our Finance universe, it means: How "far" are the ***measured*** return results "located" from the average return? It is a measure of volatility: How "volatile" is the average return I calculated?



<u>Standard Deviation</u> (σ)

The square-root of Variance.

We "***project***" the return results to a scale and address the "***spread***" of these projected results. Spread corresponds to the **dispersion** of the observed return data relative to its mean. It is as well the measure of volatility.

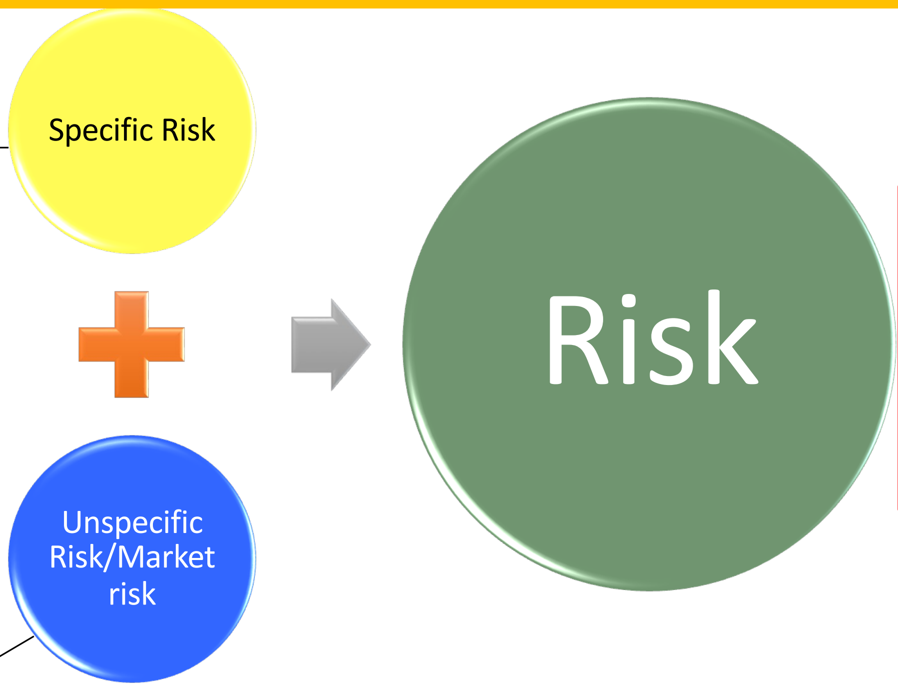
Statistics and probabilities allow us to **quantify** risk
Say hello to variance (σ^2) and standard deviation (σ)

(A) **Percent Rate of Return** (Actual) $\hat{r}$	**(B)** **Deviation from Expected Rate of Return** (Actual – Expected) $(\widehat{r} - \mathbf{r})$	**(C)** **Squared Deviation** (Column B Squared) $(\widehat{r} - \mathbf{r})^2$	**(D)** **Probability** of Given Outcome	**(E)** **Probability x Squared Deviation (Column C x Column D)**
+40	40-10=30	$30^2 = 900$	0.25	900 x 0.25 =225
+10	10-10=0	$0^2 = 0$	0.5	0 x 0.5=0
-20	-20-10=-30	$(-30)^2 = 900$	0.25	900 x 0.25 = 225
		Variance $=$ expected value of $(\widehat{r} - \mathbf{r})^2 = \mathbf{450}$ Standard deviation = $\sqrt{variance} = \sqrt{450} = 21\%$		

SD is expressed in percentage term, which is as same as the unit of rate of return.

Conceptualizing "Risk" for Finance

The risk that potentially can be eliminated by diversification



The total risk of an asset consists of two components (types of risk):

- specific risk
- unspecific risk.

And that is why investors are exposed to market uncertainties, no matter how many stocks they hold.

Measuring risk and return seems possible:
Say "HI" to **Efficient Market Hypothesis** (EMH)

The **efficient market hypothesis (EMH)** states that securities prices accurately reflect future expected cash flows and are based on **all information** available to investors.

Chicago Booth Review MONETARY POLICY INEQUALITY HEALTH CARE CLIMATE CHANGE ARTIFICIAL INTELLIGENCE MOTIVATION JOBS +ALL CBR TOPICS

Chicago Booth Review ▸ Eugene F. Fama, Efficient Markets, and the Nobel Prize

Eugene F. Fama, Efficient Markets, and the Nobel Prize

Gene's bottom line is always: Look at the facts. Collect the data. Test the theory.

By John H. Cochrane May 20, 2014 CBR - Finance

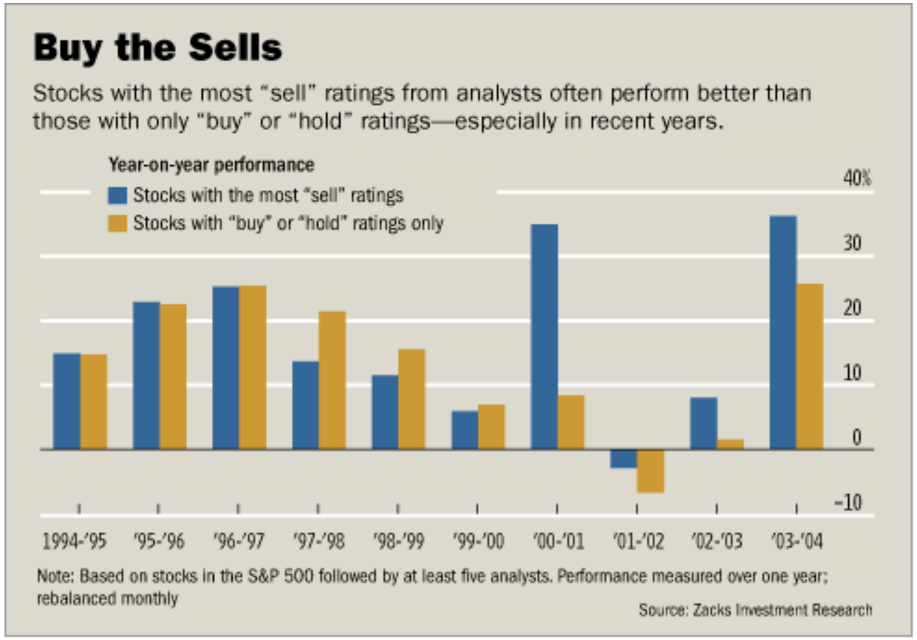
Efficient Market Hypothesis (EMH) works with hard assumptions

Efficient market hypothesis is based on the assumption that investors are

- Rational
- Maximize profit
- Act independent on the basis of full information

This is our calculative universe; our fair price relates to the time-value calculations of money!

Puzzling facts about textbook finance: Momentum matters!



Price moves as a result of demand and supply, so would that indeed accurately reflect PV, i.e. expectations on future cashflow?

- Demand increases – but would **always** the underlying value justify this dynamics?

Signals are not always justified!

Be fearful when others are greedy and greedy only when others are fearful." — Warren Buffett

Market efficiency strikes back!

If investors do not rationally process information, then markets may not accurately reflect even public information.

- **Market Inefficiency**: Markets are assumed to make mistakes in pricing assets across time, and are assumed to correct themselves over time, as new information comes out about assets

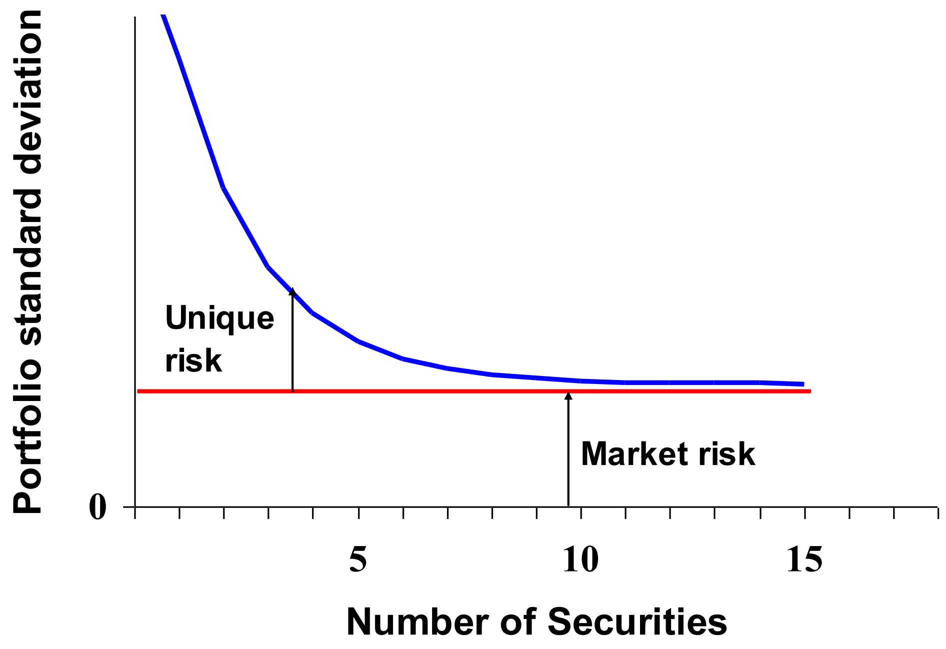
If there did exist simple profitable strategies, then the strategies would attract the attention of investors, who by implementing their strategies would compete away the profits.

Thus, financial markets are **likely to be efficient**, at least in the semi-strong form.

Diversification reduces variability: reducing exposure to specific risk associated with assets in portfolio

Diversification	• Strategy designed to **reduce** risk by spreading the portfolio across many investments.
Unspecific Risk	• Economy-wide sources of risk that affect the overall stock market. Also called **"market**" and **"systematic**" risk.
Specific Risk	• Risk factors affecting only that firm. Also called **"unique" "idiosyncratic"**and "**diversifiable**" risk.

Diversification reduces variability: reducing exposure to specific risk associated with assets in portfolio



The more stocks we add to a portfolio, the lower the unique risk associated with the assets included in the portfolio.

Quantifying market risk: Introducing Beta (β)

Beta (β) is our measurement of **market** (or unspecific, or systemic) **risk** for individual stocks.

- It captures the sensitivity of the return of the stock to the movements in market returns.

Thus, beta (β) measures unspecific (aka systematic/market) risk ***relative* to the market portfolio**

- It shows the relationship between the stock and the market.

Question remains: If the reference is the market, what is the "market portfolio", how to address it?

- Market portfolio: Theoretically, it consists of all the stocks in the economy
- Market portfolio: In reality, it is described by so-called "market indices", such as the S&P 500 index, that is following and aggregating the market performance (i.e. stock returns) of the top 500 listed companies in the US market.

Thus, market return is a historical measure, calculating and aggregating typically the monthly returns

Statistics and probabilities allow us to **quantify** risk
Say hello to variance (σ^2) and standard deviation (σ)

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SD is expressed in percentage term, which is as same as the unit of rate of return.

Calculating Beta: Following a conceptually similar exercise as for variance and standard deviation

	(B) Market return	(C) Company return	(D) Deviation from average market return	(E) Deviation from average company return	(F) Squared deviation from average market return	(G) Product of deviations from average returns (Columns D x E)
1	**-8**	**-11**	$-8-2=-10$	$-11-2=-13$	$(-10)^2=100$	$(-10)\ x\ (-13)=130$
2	**4**	**8**	$4-2=2$	$8-2=6$	$(2)^2=4$	$2\ x\ 6=12$
3	**12**	**19**	$12-2=10$	$19-2=17$	$(10)^2=100$	$10\ x\ 17=170$
4	**-6**	**-13**	$-6-2=-8$	$-13-2=-15$	$(-8)^2=64$	$(-8)\ x\ (-15)=120$
5	**2**	**3**	$2-2=0$	$3-2=1$	$(0)^2=0$	$0\ x\ 1=0$
6	**8**	**6**	$8-2=6$	$6-2=4$	$(6)^2=36$	$6\ x\ 4=24$
Avg.	**2**	**2**		Total	304	456

Variance of market returns $=\boldsymbol{\sigma_m^2} = \frac{304}{5} = 60.8$

Covariance between market returns and company returns = $\boldsymbol{\sigma_{im}}\ \frac{456}{5} = 91.2$

Beta $\beta = \frac{\text{Variance(company,market)}}{\text{Covariance(market)}} = \frac{\sigma_{im}}{\sigma_m^2} = \frac{91.2}{60.8} = 1.5$

Calculating Beta: Following a conceptually similar exercise as for variance and standard deviation

	(B) Market return	(C) Company return
1	**-8**	**-11**
2	**4**	**8**
3	**12**	**19**
4	**-6**	**-13**
5	**2**	**3**
6	**8**	**6**
Avg.	**2**	**2**

We have in **total 6 observations**, we want to average the values based on the number of observations, but we **divide** the variance and covariance calculations **by 5**(!)

Why?

We apply statistical measures for a sample, not for the total population. We do not have all return data! To make sure that our results remain unbiased, we **always divide by n-1**, where **n** is the **size of the sample**

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Covariance between market returns and company returns = $\boldsymbol{\sigma_{im}} \frac{456}{\mathbf{5}} = 91.2$

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Formulating Beta

$$B_i = \frac{\sigma_{im}}{\sigma_m^2}$$

Covariance of r_i and r_m

Variance of the r_m

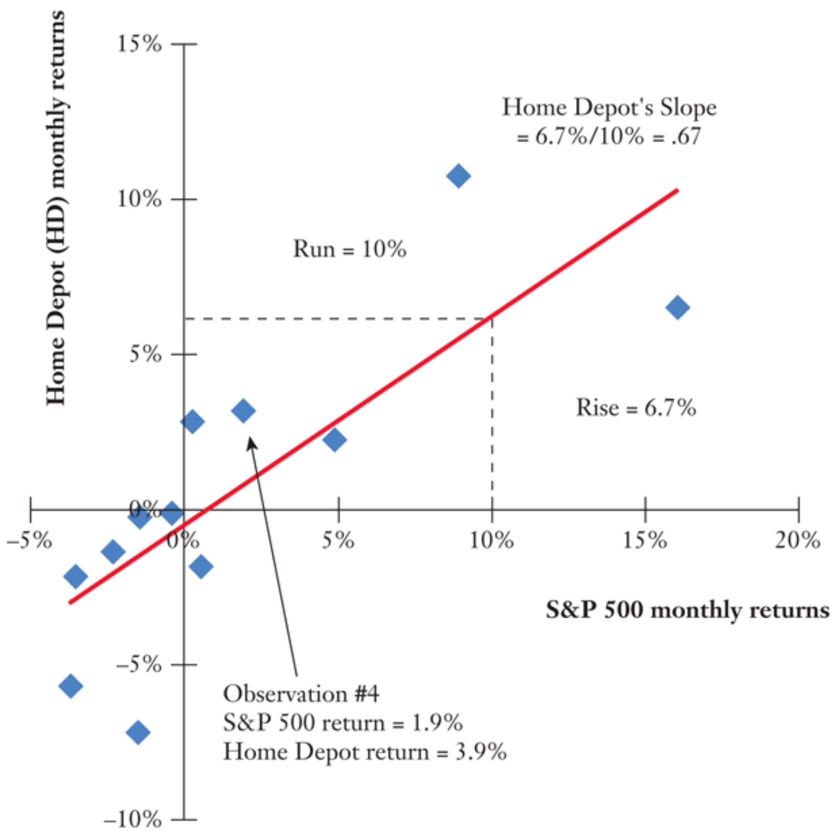
Theoretically, beta can take values from minus infinity to plus infinity.

If $\beta_i = 1$ the security's returns will behave exactly as the returns on the market portfolio.

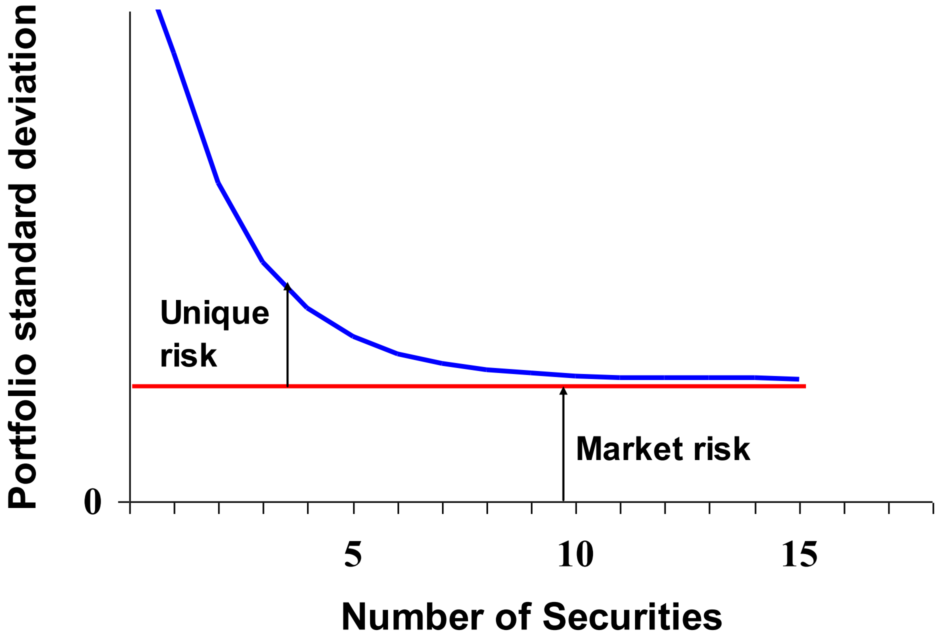
If $\beta_i > 1$ the security's returns are **more volatile** than those on the market portfolio; if the return on the market goes up, the security's return also **rises but in a greater proportion**.

If $\beta_i < 1$ the security's returns are less volatile than those on the market portfolio; if the return on the market goes up, the security's return **rises to a lesser degree.**

In practice, beta is estimated as the **slope** of a straight line:
Estimating Home Depot's (HD) Beta Coefficient



We keep adding assets to eliminate unique, firm-specific risk elements, but we cannot beat the market



So, we end up diversifying our portfolio with assets. We must make sure that the asset-specific return patterns "behave differently"

We compile a portfolio of common stocks to diversify

Portfolio: Grouping of financial assets (e.g. stocks, bonds)

- Can also consist of non-publicly tradable securities, i.e. private investments

We opt to **combine** investments whose **returns do not move together (aka "behave differently")**, thus, are not perfectly positively correlated.

Diversifying **lowers the risk** of your portfolio without lowering it's ***expected rate*** of return

- There is some risk that diversification cannot eliminate = Measured by Beta

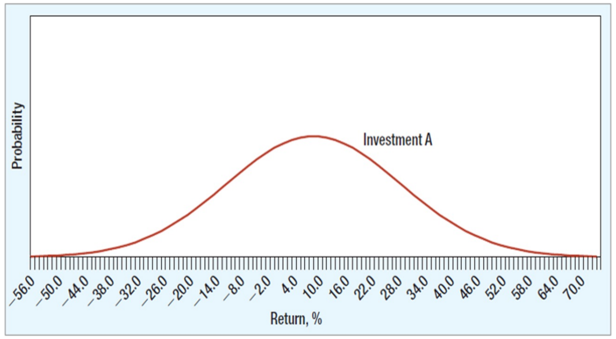
"Moving together" is measured by using the **correlation coefficient:**

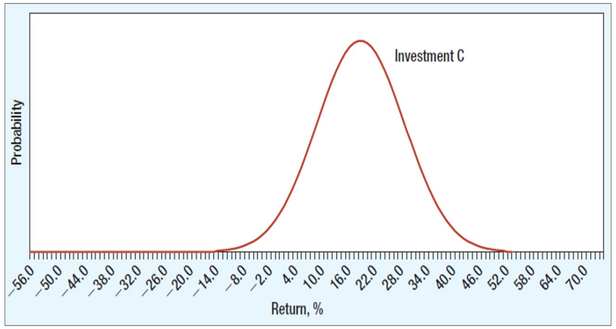
- A value ranging between -1 (perfectly uncorrelated) and 1 (perfectly correlated)

“Behave differently”? == Returns often do not move together! It implies that we can measure as well **portfolio risk**

Question: What statistical measures did we instrumentalize to measure risk?

Answer: Variance and standard deviation





Variance (σ^2)

Average value of squared deviations from mean.

For our Finance universe, it means: How “far” are the ***measured*** return results “located” from the average return? It is a measure of volatility: How “volatile” is the average return I calculated?

Standard Deviation (σ)

The square-root of Variance. We “project” the return results to a scale and address the “spread” of these projected results. Spread corresponds to the dispersion of the observed return data relative to its mean. It is as well the measure of volatility.

We can apply the same calculation strategy and conceptualisation to address **portfolio risk.**
Only: We need a measure that relates performance of different assets.
Say "HI" to **correlation coefficient**!

If σ_1 and σ_2 are the standard deviations of the returns of the two stocks (stock1 and stock2), then ρ_{12} is the *correlation coefficient* between the returns of the two stocks

$$\rho_{12} = \frac{\sigma_{12}}{\sigma_1 x\, \sigma_2} \longrightarrow \boxed{\rho_{X,Y} = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y}}$$

The correlation coefficient between the returns on stock1 and the returns on stock 2 measures the degree to which the returns of the two securities "**move**" together.

We can apply the same calculation strategy and conceptualisation to address **portfolio risk.**

Only: We need a measure that relates performance of different assets. Say “HI” to **correlation coefficient**!

The **variance** of a two-stock portfolio is the sum of these four boxes.

The **standard deviation** of a two-stock portfolio is then the square-root of the variance!

	Stock 1	Stock 2
Stock 1	$x_1^2\sigma_1^2$	$x_1x_2\sigma_{12} = x_1x_2\rho_{12}\sigma_1\sigma_2$
Stock 2	$x_1x_2\sigma_{12} = x_1x_2\rho_{12}\sigma_1\sigma_2$	$x_2^2\sigma_2^2$

How the risk of a portfolio depends on the risk of the individual shares?

X_1 is the proportion invested in Stock 1, X_2 is the proportion invested in Stock 2.

σ_1 is the standard deviation of Stock 1 and σ_2 is the standard deviation of Stock 2.

ρ_{12} is the correlation coefficient between the returns on Stock 1 and Stock 2.

We can apply the same calculation strategy and conceptualisation to address **portfolio risk.**

Only: We need a measure that relates performance of different assets. Say "HI" to **correlation coefficient**!

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	Stock 1	Stock 2
Stock 1	$x_1^2\sigma_1^2$	$x_1x_2\sigma_{12} = x_1x_2\rho_{12}\sigma_1\sigma_2$
Stock 2	$x_1x_2\sigma_{12} = x_1x_2\rho_{12}\sigma_1\sigma_2$	$x_2^2\sigma_2^2$

$$\boxed{\text{Portfolio Variance} = x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + 2(x_1x_2\rho_{12}\sigma_1\sigma_2)}$$

Example on portfolio risk

Suppose you invest 60% of your portfolio in Wal-Mart and 40% in IBM. The expected dollar return on your Wal-Mart stock is 10% and on IBM is 15%.

The standard deviation of their annualized daily returns are 19.8% and 29.7%, respectively.

Assume a correlation coefficient of 1.0 and calculate the portfolio variance.

	Wal-Mart	IBM
Wal-Mart	$x_1^2\sigma_1^2 = (.60)^2 \times (19.8)^2$	$x_1 x_2 \rho_{12} \sigma_1 \sigma_2 = .40 \times .60 \times 1 \times 19.8 \times 29.7$
IBM	$x_1 x_2 \rho_{12} \sigma_1 \sigma_2 = .40 \times .60 \times 1 \times 19.8 \times 29.7$	$x_2^2\sigma_2^2 = (.40)^2 \times (29.7)^2$

$$\text{Portfolio Variance} = [(.60)^2 x (19.8)^2] + [(.40)^2 x (29.7)^2] + 2(.40x.60x19.8x29.7) = 564.5$$

$$\text{Standard Deviation} = \sqrt{564.5} = 23.8\,\%$$

Which Portfolio Would You Prefer to Invest In?

Portfolio 1:

You invest 60% of your portfolio in Wal-Mart and 40% in IBM

Expected Return = 12%

Standard Deviation = 23.8%

Portfolio 2:

You invest 60% of your portfolio in Exxon Mobil and 40% in Coca Cola

Expected Return = 12%

Standard Deviation = 21.8%

Correlation coefficient (ρ) is an important measure to assure a heathy portfolio performance

We select a basket of stocks in our portfolio smartly and carefully, not randomly.

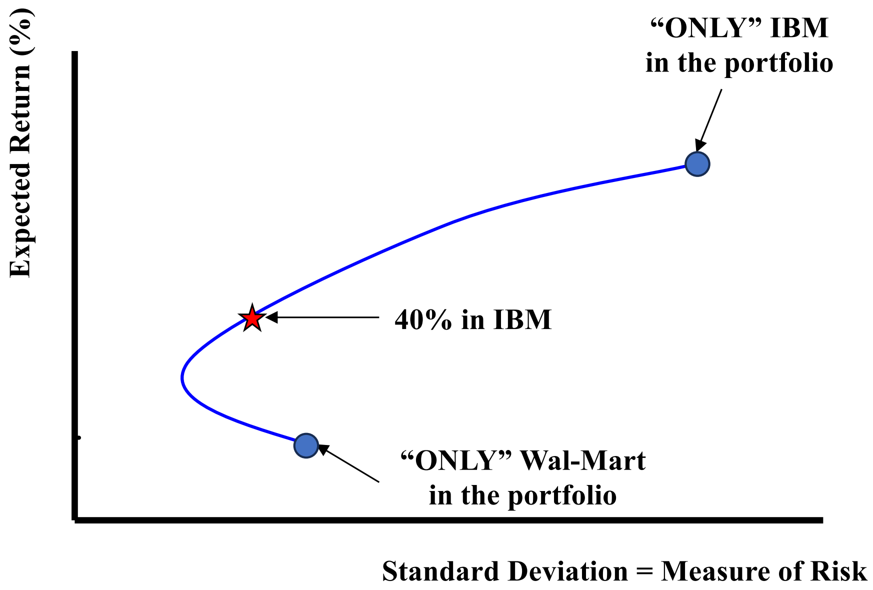
Assume that we have two stocks in the portfolio:

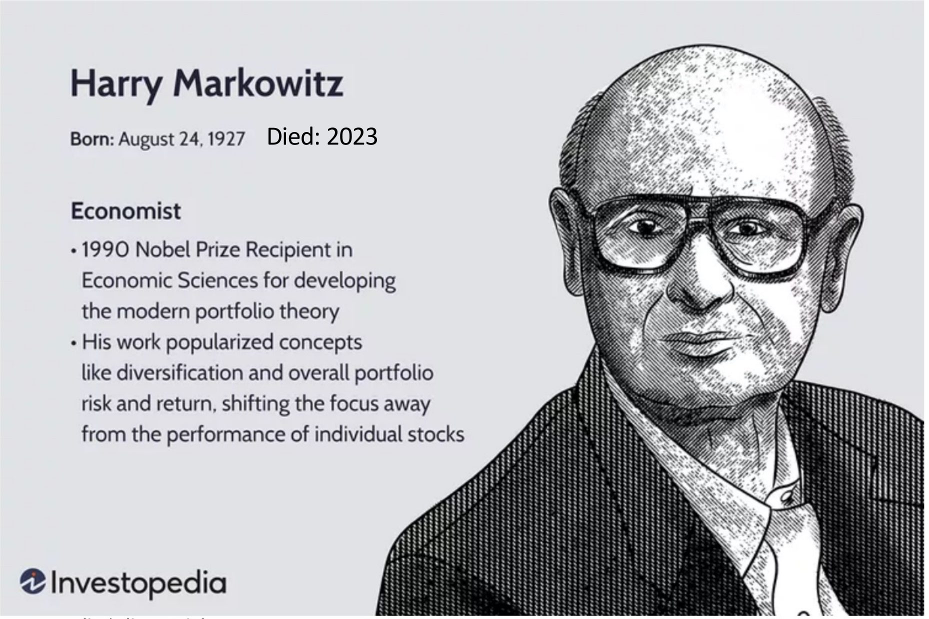
- The diversification is only going to achieve its benefits when the correlation coefficient between the two stocks is less than 1 (ρ<1).
- When ρ =1, there are no benefits for combining these two stocks in the portfolio because they are reacting the exactly the same way (not balancing off the risks)
- The lower the correlation coefficient between the two stock, the better benefits from the diversification.
- Something bad happened to one of the stocks, the other stock is unlikely be affected by that.(or it is likely to be offset by the behavior of the other stock)

The more stocks that we add to the portfolio with the correlation coefficient less than 1, the higher benefits of diversification.

Diversification helps maintaining expected return of a portfolio

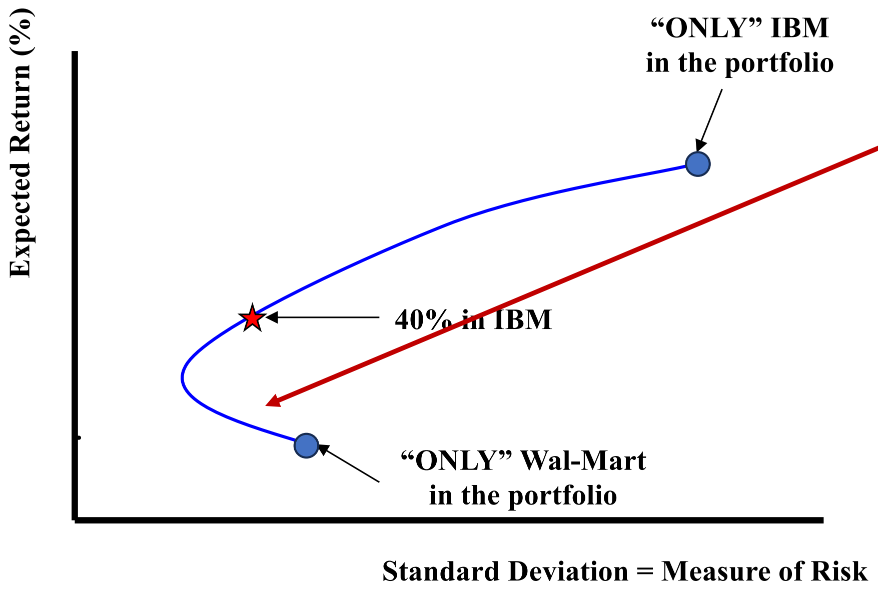
“American economist Harry Markowitz pioneered this theory in his paper "Portfolio Selection," which was published in the Journal of Finance in 1952. He was later awarded a Nobel Prize for his work on modern portfolio theory” (see: Investopedia)





The effects of diversification is graphically represented by the **efficient frontier** (i.e. the curvature)

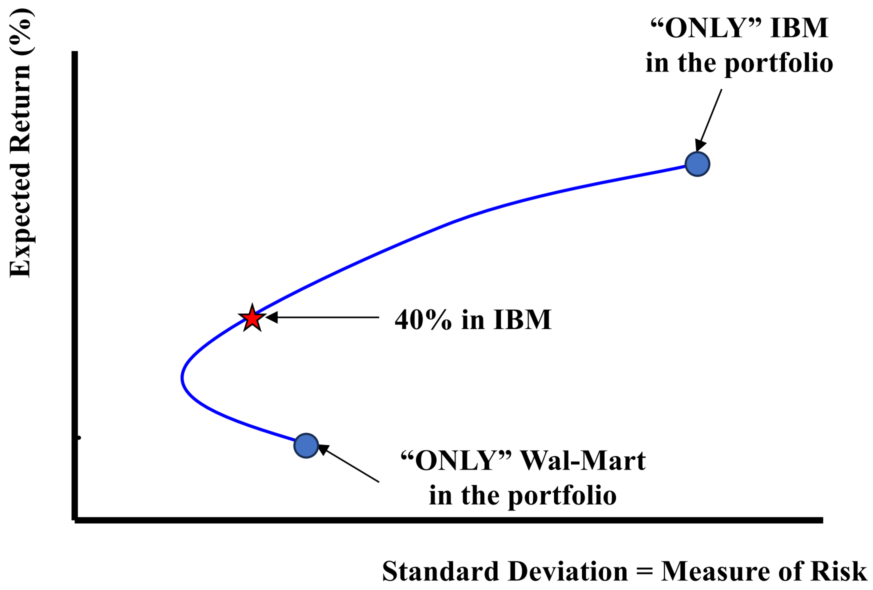
Key finding #1: Expected Returns and Standard Deviations vary given different weighted combinations of the two stocks

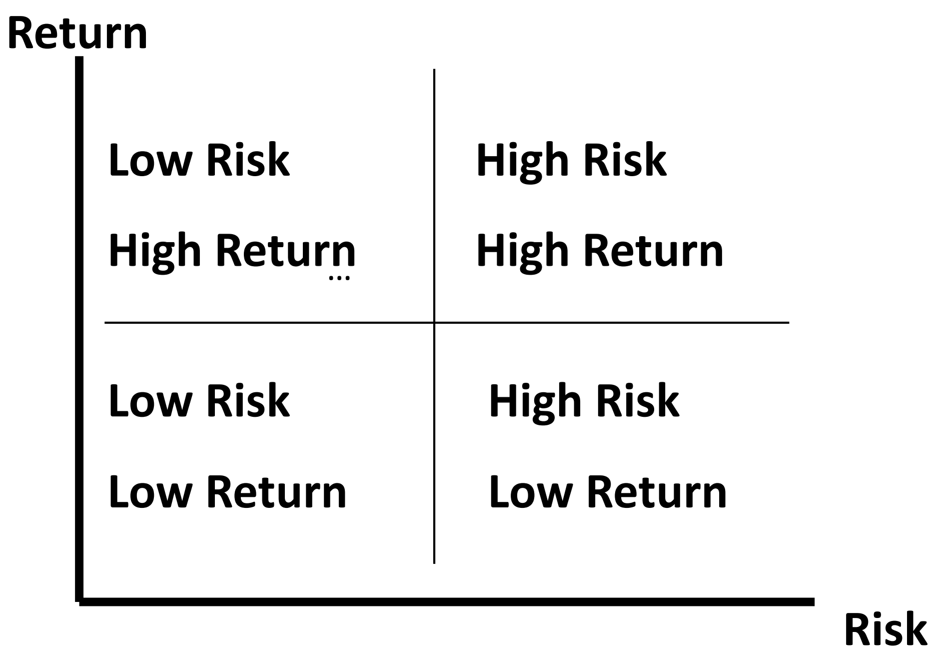


The **efficient frontier** graphically represents portfolios that maximize returns for the risk assumed.

Returns are dependent on the investment combinations that make up the portfolio.

Logic behind the curvature follows the conceptualisation of different risk appetites of investors

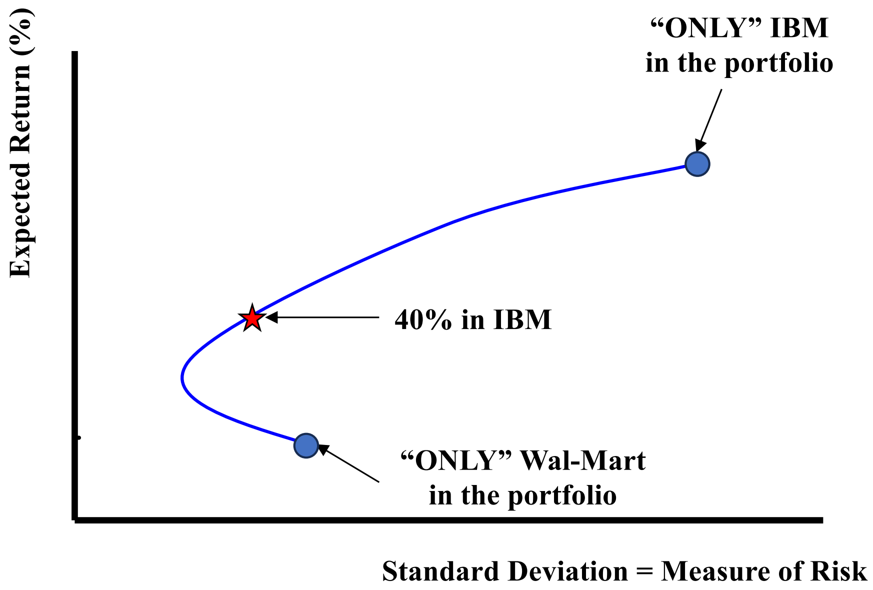




The effects of diversification is graphically represented by the **efficient frontier = constituting efficient portfolios based on different asset weights**

Key finding #2: Returns are dependent on the investment combinations that make up the portfolio.

Thus: Diversification helps maintaining expected return of a portfolio



The various weighted combinations of stocks on the blue line, i.e. curvature, constitute the set of ***efficient portfolios***.

These are portfolios that offer the <u>least risk</u> for a given level of return and the <u>highest return</u> for a given level of risk.

Rational investors are only willing to hold efficient portfolios.

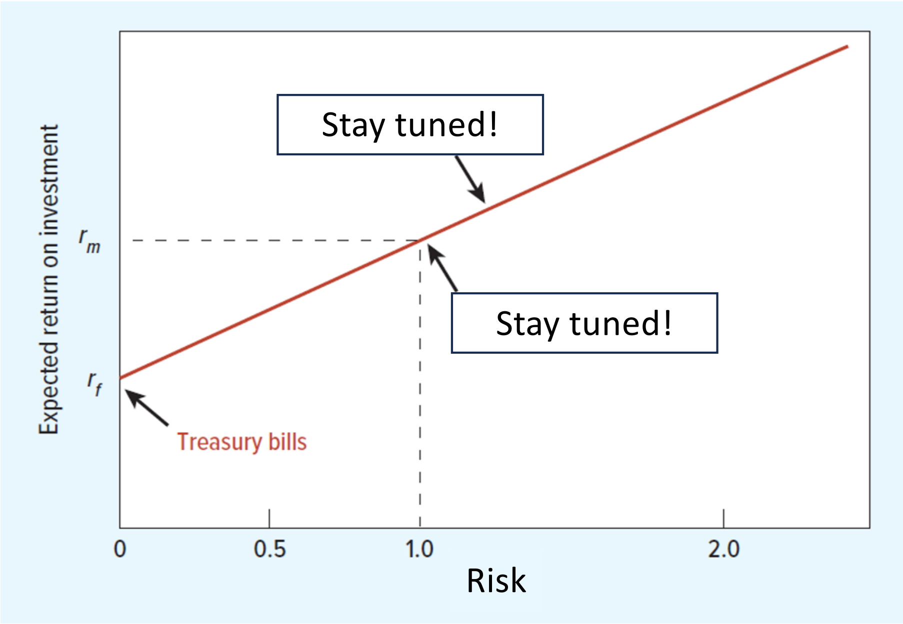
Efficient Frontier is as well our foreword to Capital Asset Pricing Theory and Model (CAPM)

Food for thought: If my portfolio was holding one **risk-free** asset and another, risky asset(s), my claim is that my efficient frontier would transform into a straight line

Why?

Sub-questions:

1. How do we measure risk?
2. What is the "measured risk" of a risk-free asset?



We did a lot in this lecture, most importantly:

- Continuing our journey into risk and return characteristics of
  - Stocks
  - Portfolios
  - Markets
- Introducing Nobel-Price-Worth theories on markets
  - Efficient Market Hypothesis
  - Efficient Frontier