Finance

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Marinus van Reymerswale,
The Money Changer and his Wife, 1539

Last week

- The Capital Asset Pricing Model (CAPM)
  - $$\underbrace{r_i}_{\text{Expected return of stock } i} = \underbrace{r_f}_{\text{Return of the risk-free asset}} + \underbrace{\beta_i}_{\text{Beta of stock } i} \times \underbrace{(r_M - r_f)}_{\text{Expected risk premium of the market}}$$
  - Expected returns depend only on the asset's non-diversifiable (systematic) risk.
    - Investors should not be rewarded for taking diversifiable risk.
  - What differentiates expected returns across assets is β_i, a measure of covariation between asset i's return and the market return. It is a measure of non-diversifiable risk.
  - $\beta_i = \frac{\mathsf{Cov}(r_i, r_M)}{\mathsf{Var}(r_M)}$.

Market Efficiency

- What we have seen in this course relies on the assumption of market efficiency.
- It ensures that the market price reflects all available information, so we can use it to assess cost of capital, risk, prices, etc.
- Relies on investors being fully rational, *e.g.* all wanting to hold a portfolio on the SML.

Market Efficiency

- No free lunch, i.e. no arbitrage.
- Prices reflect all available information.
- Prices follow random walks.
- Trade-off between risk and return.
- Active management does not add value.

Paradox: Why would anyone participate in the market? (Grossman and Stiglitz, 1980).

Market Efficiency

Random Walk

- Observed since the 19th century (Regnault, Bachelier): daily market returns follow a random walk.
- Random successive change in returns $\longrightarrow$ independence of daily returns.
  - Might include a positive drift.
  - *e.g.* you bet \$100 on a game: if tails, you win 3% of your investment; if heads, you lose 2.5%.

Market Efficiency

Random Walk

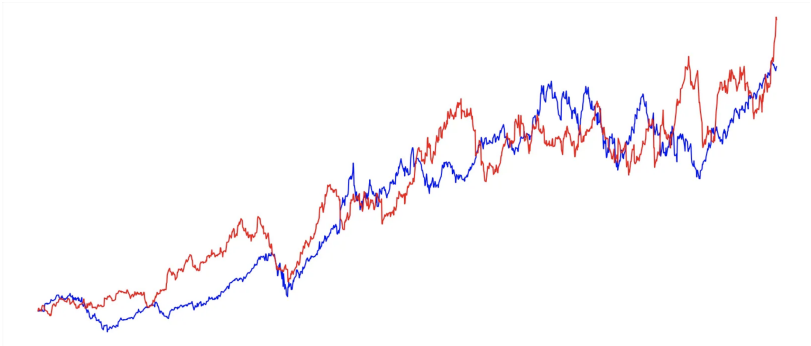
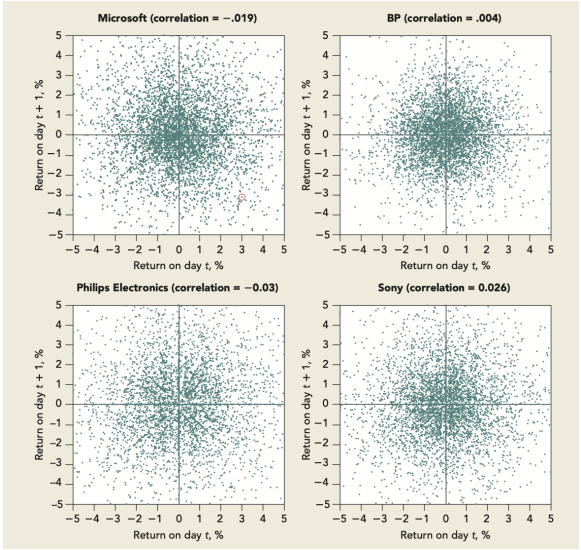


Figure: Stock prices: Apple vs random walk

Market Efficiency

Random Walk



Market Efficiency

Three forms of efficiency

- **Weak form**: Prices reflect all past trading information.
- **Semi-strong form**: Prices reflect all publicly available information.
- **Strong form**: Prices reflect all public and private information.

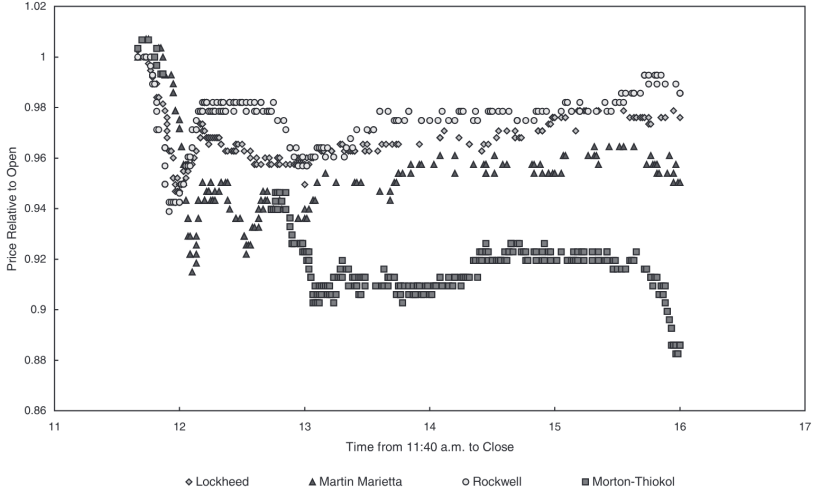
Market Efficiency

Examples of information incorporated into prices: Challenger

- Challenger exploded at 11:39 a.m. on January 28, 1986.
- Big surprise... Six months later, the cause of the crash was made public: one supplier out of four (Morton-Thiokol) was involved (O-ring issue).
- What happened to the suppliers' stock prices in between?

Market Efficiency

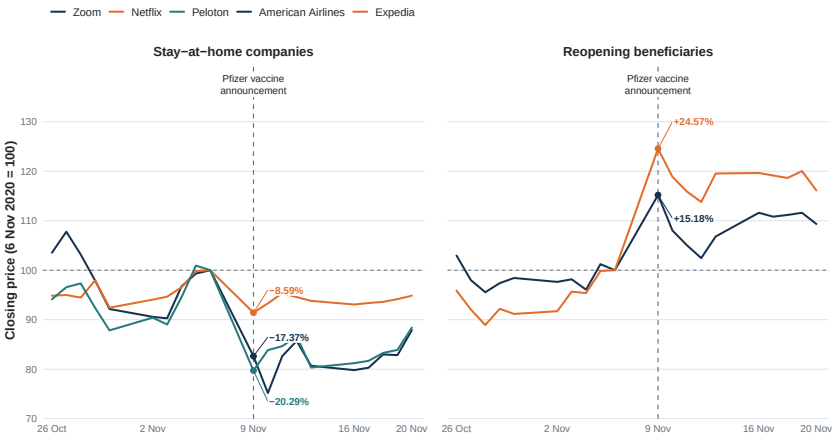
Examples of information incorporated into prices: Challenger



The company lost \$200m (lost contracts, forfeiture, etc.) $\approx$ loss is market capitalization.

Market Efficiency

Examples of information incorporated into prices: Covid vaccine announcement



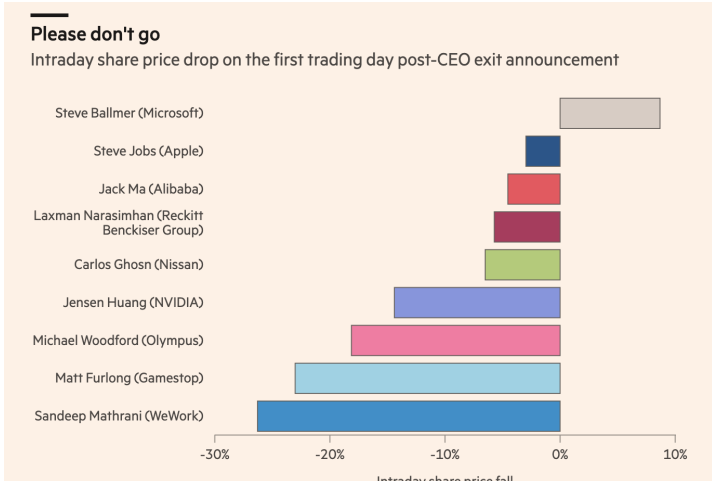
Daily closes, 26 Oct–20 Nov 2020; identical vertical scales. Labels: 6–9 Nov close–to–close returns; dividends excluded.
Announcement: 9 Nov, 6:45 a.m. ET; preliminary efficacy above 90%. Sources: Yahoo Finance; Pfizer/BioNTech (9 Nov 2020).

Market Efficiency

Examples of information incorporated into prices: CEO dismissal

- NVIDIA's price lost 14% of value after the announcement of the resignation of its CEO.

- What is the market pricing?



Market Inefficiencies

- Last week: small-firm stocks perform better with respect to risk. Should not be the case if the market were efficient.
- Many other puzzles:
  - Stocks perform better in January.
  - Worse on Mondays.
  - etc.
- These anomalies are small (e.g. relative to transaction costs) and hard to exploit.

Market Inefficiencies

Bubbles

- Keynes: The stock market is like a casino and agents are guided by “animal spirits”.
- They are not interested in assessing the present value of future dividends and holding an investment for a significant period, but rather in estimating the short-run price movements.
- Not only risk (*e.g.* quantifiable) but uncertainty. Opinions are based on what others think rather than on actual information $\longrightarrow$ beauty contest. This gives coherence to irrational behavior.
- Creates speculation and bubbles.

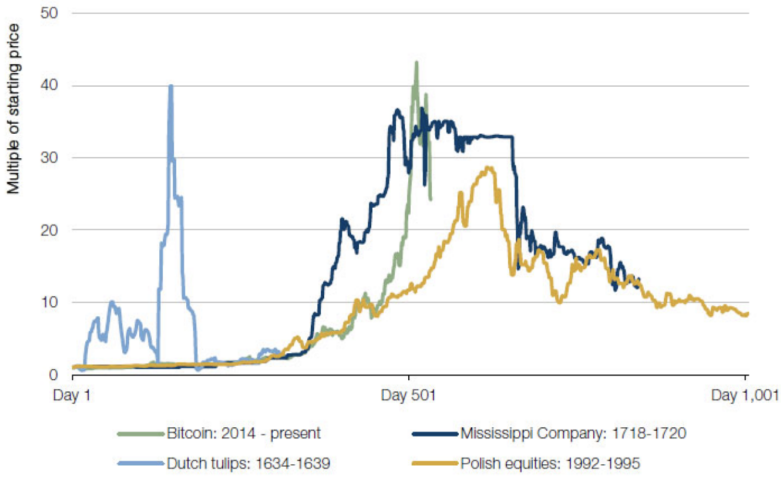
Market Inefficiencies

Bubbles

- Speculative frenzies known as bubbles can grow without any change in expected profits and dividends.
- Bubbles are self-sustaining: it can be rational to participate. Why?
- If the bubble is expected to continue, investors can make important gains if they are able to cash out before it bursts.
- Minsky: markets are fundamentally unstable because they tend to create bubbles when investors become optimistic.

Market Inefficiencies

Bubbles



Market Inefficiencies

Bubbles



Market Inefficiencies

Behavioral Agents

- Do you prefer:
  - A: 240k €
  - B: 1mn € with 25% probability, 0 otherwise

Market Inefficiencies

Behavioral Agents

- Do you prefer:
  - C: -750k €
  - D: -1mn € with 75% probability, 0 otherwise

Market Inefficiencies

Behavioral Agents

- Do you prefer:
  - A+D: 240k € with 25% probability, -760k € with 75% probability
  - B+C: 250k € with 25% probability, -750k € with 75% probability

Market Inefficiencies

Behavioral Agents

- Agents are not (perfectly) rational:
  - Loss aversion $\longrightarrow$ see prospect theory by Kahneman and Tversky.
  - Beliefs about probability.
  - Overconfidence.
  - Framing.
  - etc.

Market Inefficiencies

Limits to arbitrage

- Experienced investors could take advantage of these biases, and this arbitrage would then lead markets to equilibrium.
- But arbitrage is costly: fees, infrastructure, risks, etc.
- Many examples of arbitrage strategies going wrong (*e.g.* VW, LTCM).

Taking Stock

- Capital budgeting process:
  1. Given the capital structure, find the appropriate discount rate for the firm using WACC.

$$r_{WACC} = \frac{E}{E+D} r_E + \frac{D}{E+D}(1-T) r_D$$

  2. Compute the NPV of the project.

$$NPV = \sum_{t=0}^{T} \frac{CF_t}{(1+r_{WACC})^t}$$

  3. Make investment decision using the appropriate investment decision rule.

WACC

Financing Weights

$$r_{WACC} = \frac{E}{E+D} r_E + \frac{D}{E+D}(1-T) r_D$$

- WACC corresponds to the weighted average of r_E and r_D.
- Weights correspond to the share of equity in total assets ($\frac{E}{E+D}$) and the share of debt in total assets ($\frac{D}{E+D}$).
- In some cases the share of common equity *vs.* preferred equity must be distinguished.
- When possible, E and D are computed using their **market values**. These are the values that matter to investors.

WACC

Cost of Debt

$$r_{WACC} = \frac{E}{E+D} r_E + \frac{D}{E+D}(1-T) r_D$$

- r_D is the cost of debt. This is the opportunity cost of holding debt of the company.
- r_D is such that given the price of the debt, investors want to keep holding it: $P_{debt} = NPV_{debt}(r_D)$.
- This is the **yield-to-maturity**: $r_D = YTM$.
  - This is the rate an investor would earn by buying the bond at today's price and holding it to maturity.
- The cost of debt vis-a-vis investors is the YTM but this is not the actual cost of issuing debt. The tax shield of debt reduces the effective cost of debt: $r_D^* = r_D \times (1-T)$.

$$r_{WACC} = \frac{E}{E+D} r_E + \frac{D}{E+D}(1-T) r_D$$

- r_E is the cost of equity. This is the opportunity cost of holding the firm's equity or the foregone return from holding other firms' equity with similar risk.
- To evaluate the return, one has to use an asset pricing model.
  - The CAPM is one of the most widely used asset-pricing models.
  - The Constant Growth model is an alternative.

WACC

Cost of Equity: the CAPM

- $$\underbrace{r_i}_{\text{Expected return of stock } i} = \underbrace{r_f}_{\text{Return of the risk-free asset}} + \underbrace{\beta_i}_{\text{Beta of stock } i} \times \underbrace{(r_M - r_f)}_{\text{Expected risk premium of the market}}$$

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WACC

Cost of Equity: the CAPM

- To compute r_E using the CAPM, we need:
  1. Which alternative projects should be used to compare with the current firm.
  2. Forecast the returns from investing in these alternative opportunities.

- The Constant Growth Model, or Gordon model, is an alternative pricing model.
- Assuming the firm's dividends grow at a constant rate g, we can use the DCF model to forecast returns.
- $r = \frac{DIV_1}{P_0} + g$

WACC

Cost of Equity: CAPM *vs.* CGM

- Both models should give similar estimates but might also differ.
- Which one should we choose?
  - The CGM is sensitive to analysts' forecasts of dividend growth (especially over multiple years).
    - Best fit for large companies with stable dividend streams.
  - CAPM assumes only one factor can predict returns.
    - After 40 years of research, many other factors have been found to predict returns.
    - Best fit for companies paying no dividends, or volatile dividends that are hard to predict.
- In practice, the CAPM is more popular.

WACC

Cost of Equity: CAPM *vs.* CGM

	Capital Asset Pricing Model	Constant Dividend Growth Model
Inputs	Equity beta	Current stock price
	Risk-free rate	Expected dividend next year
	Market risk premium	Future dividend growth rate
Major Assumptions	Estimated beta is correct	Dividend estimate is correct
	Market risk premium is accurate	Growth rate matches market expectations
	CAPM is the correct model	Future dividend growth is constant

WACC

- r_E and r_D must always be based on **comparable** projects.
- One has to use historical values of comparable projects to choose them.

Net Present Value

General Formula

- Once r_{WACC} and the CF are known, one can compute the NPV.

$$NPV = C_0 + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + ... + \frac{C_T}{(1+r)^T} = \sum_{t=0}^{T} \frac{C_t}{(1+r)^t}$$

- This formula is always right. Use it for complex CF structures and when the number of periods is not too large.

Net Present Value

Specific Securities

- Some securities have specific CF payments that are easy to compute.
- Projects' CF structure generally follows a combination of these specific structures:
  - (Growing) Perpetuity.
  - (Growing) Annuity.

Net Present Value

Specific Securities

- Growing Perpetuity: a CF payment with an infinite horizon and a constant growth rate g:

$$PV = \frac{C}{r-g}$$

- Growing Annuity: a CF payment until a (finite) time horizon T and a constant growth rate g:

$$PV = \frac{C}{1+r} + \frac{C(1+g)}{(1+r)^2} + .. + \frac{C(1+g)^{T-1}}{(1+r)^T} = \frac{C}{r-g}\left(1 - \frac{(1+g)^T}{(1+r)^T}\right)$$

- Take $g = 0$ if the payment is constant.

Net Present Value

Important Rules

- Always bring CF at different horizons to the same period.
  - CF at different points in time cannot be aggregated.
  - This generally happens when a project has a CF profile that combines different types of formulas (*e.g.* an annuity and a growing perpetuity).
- In the above formulas, the first payment is always in year 1. Add manually the CF (*e.g.* investment) in year 0 if necessary.

Decision Rules

Investment Rules

- How should we decide whether to invest in a project? How should we choose between different projects?
- Different criteria can be used depending on the constraints and on available information.
  - The Net Present Value.
  - The Internal Rate of Return.
    - It is the unknown in:

$$NPV(IRR) = C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + ... + \frac{C_T}{(1+r)^T} = 0$$

  - The Payback period
    - The amount of time it takes a project to pay back the initial investment.
- How should we choose between these alternatives?

Decision Rules

Investment Rules

- How should we choose between these alternatives?
  - NPV is the most informative and reliable rule: choose it when possible.
  - Information-intensive but necessitates less information than the IRR.
  - The Payback rule requires less information but is less reliable.
  - A good practice is to use several different rules.

Decision Rules

Alternative Projects and Limited Funds

- Mutually exclusive projects:
  - Choose the project with the highest NPV.
- When resources are limited:
  - Compute the profitability index of each project: $\frac{\text{NPV}}{\text{Investment}}$
  - Rank the projects by profitability.
  - Pick projects until resources are exhausted.
- Always discard projects with negative NPV.