Finance

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

Last sessions

- You know how to:
  - Compute the net present value of a project.

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

  - Which rules should be used to choose between projects.
    - NPV should be preferred to IRR or payback period when possible.
    - For mutually exclusive projects, pick the one with the highest NPV.
    - When resources are constrained, choose the projects that maximize total NPV.

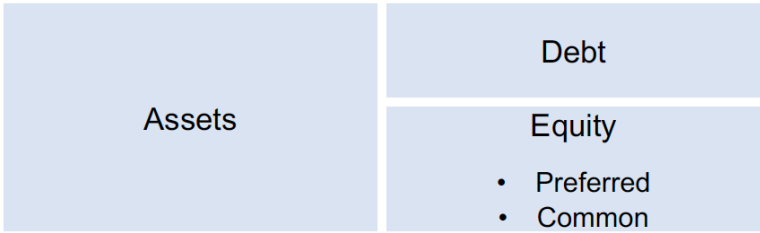
  $\longrightarrow$ When you can fund several different projects, compute the profitability index ($\frac{NPV}{Investment}$) to choose the most profitable ones.

Today

- In previous sessions, we have taken r, the discount rate, as given.
  - Easy to compute for riskless projects: it corresponds to the risk-free rate (*e.g.* U.S. government bonds).
  - More complicated for risky projects.
- In this session we will learn how to compute it.
- Don't forget: midterm next session, after holidays.
  - Multiple-choice questions and exercises as in the problem sets.
  - 1h30 max.
  - Contents until rules to chose between projects.

Valuing stocks

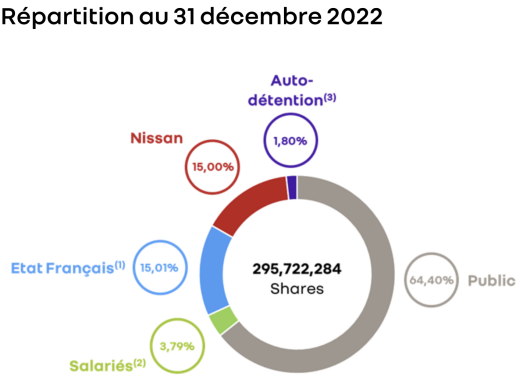
- The Capital Structure of a firm is a mix of liabilities to finance assets.



Valuing stocks

How are common stocks traded?

- A company like Renault has around 300 million shares.



Valuing stocks

How are common stocks traded?

- If Renault wants to raise new capital, it can borrow or sell new shares to investors on the primary market.

- For now, most of the action happens on the secondary market.

Renault S.A. (RNO.PA), Euronext Paris: daily closing share price, 20 October 2025 to 16 October 2026.
Source: Yahoo Finance, downloaded 18 October 2026. Unadjusted closing prices; dividends excluded.

Valuing stocks

How are common stocks valued?

- How to value these stocks?
- One can look at the quarterly balance sheet: in 2026Q2, Renault's assets were 124 billion euros.
- Renault's equity was 20.6 billion euros: this is the **book value** of Renault's equity.
- Does it represent the value of Renault?
  - Not really because these assets are valued on a historical basis.
  - Renault's market capitalization is 8 billion euros!

Valuing stocks

How are common stocks valued?

- One can also look at the liquidation value: what a business would immediately receive upon selling the asset on the open market.
  - Depreciated assets might still have value on the market.
  - Some assets (*e.g.* real estate) might have appreciated.
  - Useful for creditors but... does not take intangible assets into account for instance.

Valuing stocks

The determinants of stock prices

- Next idea: use the net present value of the stock.
- Just as with the PV of an asset or a project, we use the Discounted Cash Flow (DCF) formula to value stocks.
- Cash flows are discounted by the return that can be earned in the capital market on securities of a comparable risk.

$\longrightarrow$ $PV(\textit{stock}) = PV(\textit{expected future dividends})$

Valuing stocks

The determinants of stock prices

- A stock generates cash through:
  - Dividend payment (DIV_1)
  - Capital gain: $P_1 - P_0$

- The expected rate of return on a stock is then:

$$r = \frac{\overbrace{DIV_1}^{\text{Dividend}} + \overbrace{P_1 - P_0}^{\text{Capital gain}}}{\underbrace{P_0}_{\text{Initial Price}}}$$

Valuing stocks

The determinants of stock prices

$$r = \frac{DIV_1 + P_1 - P_0}{P_0}$$

- r is the cost of equity capital: the expected return on other securities with the same risk.
- If a company offers a lower return than stocks of similar risk, investors sell stock because they can get a better return for no additional risk: $P_0 \searrow \Longrightarrow r \nearrow$
  - To check this just compute $\frac{\partial r}{\partial P_0}$
  - The equilibrium price makes investors indifferent between this stock and other similar investments.

Valuing stocks

The determinants of stock prices

- What is the price of the stock at time 0?

$$P_0 = \frac{DIV_1 + P_1}{1 + r}$$

- with r the return on investments of similar risk.
  - If price $> P_0$, return $(< r) \rightarrow$ investors sell, P_0 decreases.
  - If price $< P_0$, return $(> r) \rightarrow$ investors buy, P_0 increases.

Equilibrium price = P_0.

Valuing stocks

The determinants of stock prices

-

$$P_0 = \frac{DIV_1 + P_1}{1 + r}$$

- How is P_1 determined?

$$P_1 = \frac{DIV_2 + P_2}{1 + r}$$

- We can then rewrite P_0:

$$P_0 = \frac{1}{1 + r}\left(DIV_1 + \frac{DIV_2 + P_2}{1 + r}\right) = \frac{DIV_1}{1 + r} + \frac{DIV_2 + P_2}{(1 + r)^2}$$

- Investors might value the company today because they expect dividends in the future.

Valuing stocks

The determinants of stock prices

- Keeping this logic in mind for all the next periods, we get the general stock price formula or DCF formula:

$$P_0 = \sum_{t=1}^{\infty} \frac{DIV_t}{(1+r)^t}$$

- Despite being a source of cash, capital gains disappear from the formula.

- **The share value is equal to the discounted stream of dividends per share.**

Valuing stocks

The cost of equity capital

- Assume that we forecast a constant growth rate for a company's dividends.
  - Growing perpetuity.
- What is P_0?
- $P_0 = \frac{DIV_1}{r-g}$ (for $r > g$).
- This also gives us an estimate of r:

$$r = \frac{DIV_1}{P_0} + g$$

- The expected return is the dividend yield + the expected rate of growth.

Valuing stocks

An application: Renault (2026)

- Renault paid a dividend of €2.20 per share in May 2026.
- Suppose that:
  - The next dividend is $DIV_1 = €2.20$.
  - Dividends then grow by $g = 2\%$ per year.
  - Shareholders require a return of $r = 10\%$.
- What is the theoretical share value?

$$P_0 = \frac{DIV_1}{r - g} = \frac{2.20}{0.10 - 0.02} = €27.50$$

- Renault's closing share price on October 16, 2026 was €27.59.

Valuing stocks

An application: Renault (2026)

- Keep $DIV_1 = €2.20$ and $g = 2\%$ constant. What happens if shareholders require a different return?

$$P_0 = \frac{2.20}{r - 0.02}$$

Required return r	Estimated price P_0
9%	€31.43
10%	€27.50
11%	€24.44

- A higher required return reduces the present value of the same future dividends.

- Why might shareholders require a higher return?

Valuing stocks

An application: utility companies

- In the U.S., the prices charged by electric and gas utilities are regulated.
  - Keep consumer prices low but ensure that utilities earn a fair rate of return.
  - The fair rate is precisely proxied by r: the cost of equity, or the rate offered by securities that have the same risk as the utility's common stock.
- Utilities are mature and stable companies for which the constant-growth DCF formula is expected to work well.

Valuing stocks

An application: utility companies

- Company A sells its stock for \$42.45 per share, with expected dividends of \$1.68 per share.
- From this we get the dividend yield: $\frac{1.68}{42.45} = 0.04$
- We need to find g. Analysts expect an annual dividend growth of 6.1%.
- $r = \frac{DIV_1}{P_0} + g = 0.04 + 0.061 = 0.101$
- Its cost of capital is 10.1% according to this method.

Valuing stocks

An application: utility companies

- Alternatively, we can use the payout ratio, which is the ratio of dividends to earnings per share (EPS).
- Company A's payout ratio is expected to be 60%: each year the company pays 60% of its earnings in dividends and plows back 40% of them.
- Plowback ratio = 1- payout ratio = 0.4
- Company A's ROE ($\frac{Earnings}{book\ equity}$) is 11%.
- By how much does book equity increase?
  - $Plowback\ ratio \times ROE = 0.4 \times 0.11 = \frac{\text{Earning - Dividends}}{Book\ equity} = 0.044$
  - It gives us the growth rate of earnings and dividends.
- Therefore, $g = plowback\ ratio \times ROE$ is an alternative formula.
- It gives us : $r = 8.4\%$

Valuing stocks

Limits of the DCF formula

- Regular future growth is at best an approximation that can only be computed with errors.

  $\longrightarrow$ Compute it for many similar companies and take an average to get a more reliable benchmark.

- Estimation with varying growth rates is possible: multi-stage DCF.
  - Young firms grow fast but it eventually stabilizes at lower rates (growth stocks *vs.* income stocks).
  - Decompose the DCF formula *e.g.* if dividend growth stabilizes after 3 years:
  - $P_0 = \frac{DIV_1}{1+r} + \frac{DIV_2}{(1+r)^2} + \frac{DIV_3+P_3}{(1+r)^3} = \frac{DIV_1}{1+r} + \frac{DIV_2}{(1+r)^2} + \frac{DIV_3}{(1+r)^3} + \frac{1}{(1+r)^3} \times \frac{DIV_4}{r-g}$

Valuing stocks

Exercise

- Company A has $DIV_1 = 0.5 \quad and \quad P_0 = 50$. Its book equity at year 1 is 10\$.
- Plowback Ratio = 80% and ROE=25%.
  - Dividend growth rate = plowback ratio $\times$ ROE = $0.8 * 0.25 = 0.2$
- If g is constant, what is r?
  - $r = \frac{.5}{50} + 0.2 = 0.21$
  - The assumption that a firm can grow by 20% per year is too strong.
- From year 3, ROE = 16% and the plowback ratio = 50%. This means that g drops to $0.5 * 0.16 = 0.08$.
- Compute r.

Valuing stocks

Exercise

	Year			
	1	2	3	4
Book equity	10.00			
Earnings per share, EPS				
Return on equity, ROE	.25	.25	.16	.16
Payout ratio	.20	.20	.50	.50
Dividends per share, DIV	.50			
Growth rate of dividends (%)	—			

Valuing stocks

Exercise

	Year			
	1	2	3	4
Book equity	10.00	12.00	14.40	15.55
Earnings per share, EPS	2.50	3.00	2.30	2.49
Return on equity, ROE	.25	.25	.16	.16
Payout ratio	.20	.20	.50	.50
Dividends per share, DIV	.50	.60	1.15	1.24
Growth rate of dividends (%)	—	20	92	8

Valuing stocks

Exercise

- We can use the multi-stage DCF formula.

$$P_0 = \frac{DIV_1}{1+r} + \frac{DIV_2}{(1+r)^2} + \frac{DIV_3 + P_3}{(1+r)^3} = \frac{DIV_1}{1+r} + \frac{DIV_2}{(1+r)^2} + \frac{DIV_3}{(1+r)^3} + \underbrace{\frac{1}{(1+r)^3} \times \frac{DIV_4}{r-g}}_{\text{Discounted growing perpetuity}}$$

- In the case of our exercise:

$$P_0 = \frac{0.5}{1+r} + \frac{0.6}{(1+r)^2} + \frac{1.15}{(1+r)^3} + \frac{1}{(1+r)^3} \times \frac{1.24}{r-0.08}$$

- Trial and error gives $r \approx 0.099$

The Cost of Capital

The Weighted Average Cost of Capital (WACC)

- So far, we have used a single discount rate r to value cash flows.
- But a firm is financed by **both equity and debt**.
  - Equity holders require a return r_E (reflecting higher risk).
  - Debt holders require a lower return r_D (since debt is safer and interest is tax-deductible).
- The overall cost of financing the firm's assets is a **weighted average** of these two sources of capital.
- This overall rate is called the **Weighted Average Cost of Capital (WACC)**.
- It represents the opportunity cost of investing capital in the firm rather than elsewhere with similar risk.

The Cost of Capital

The Weighted Average Cost of Capital (WACC)

- Given the capital structure, what is its cost?

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

  - E for equity and D for debt.
  - r_E the cost of equity.
  - r_D the cost of debt.
  - $E + D$ = Assets. $\frac{E}{E+D}$ and $\frac{D}{E+D}$ the financing weights.
  - T is the corporate tax rate.

- For an unlevered firm (*i.e.*, with no debt): $r_{WACC} = r_E$

The Cost of Capital

The Weighted Average Cost of Capital (WACC)

- If equity is split between common equity and preferred equity, then

$$r_{WACC} = \frac{C}{C+P+D} r_C + \frac{P}{C+P+D} r_P + \frac{D}{C+P+D}(1-T) r_D$$

- Preferred equity: a hybrid between debt and equity. Preferred equity is more senior, *i.e.*, it has priority in the payment of dividends.

- It is generally associated with fixed dividends and comes without voting rights.

The Cost of Capital

The Weighted Average Cost of Capital (WACC)

- How should we compute financing weights?
  - Book values: reflect accounting and historical quantities.
  - Market values: forward-looking measures based on how the firm is valued by investors.
- When the firm is traded and market values are observable, use **market values** (this is what investors care about).

The Cost of Capital

The Weighted Average Cost of Capital (WACC)

- A company has:
  - Debt with a face value of 10m, trading at 95%
  - Book equity of 10m.
  - 1 million shares of common stock trading at $30 per share.
  - What are the financing weights?
    - $MVD = 0.95 \times 10 = 9.5m$
    - $MVE = 30 * 1m = 30m$
    - $MV = 39.5m$
    - Financing weights are therefore: 24.1% for debt and 75.9% for equity.

The Cost of Capital

The Weighted Average Cost of Capital (WACC)

- Central to the WACC are r_E and r_D.
- These are the costs of equity and debt at which current investors agreed to finance the firm.
- To do so, they had to forego other investment opportunities with similar risk.
- r_E and r_D already incorporate the compensation to investors for foregoing these alternative opportunities.
  - If this were not the case, they wouldn't invest, and r_E and r_D would increase to attract more investors and compensate them adequately.
  - If they were overestimated, more investors would come in and they would decrease.
- r_{WACC} is therefore the r we are after: the opportunity cost of capital.

The Cost of Capital

The Cost of Debt

- The firm's cost of debt r_D is the opportunity cost for an investor of holding debt from the firm.
- This rate must be set so that, given its price, creditors want to keep holding the firm's debt.
- r_D is such that: $P_{debt} = NPV_{debt}(r_D)$.
- The rate that equates the PV of the bond's future payments to today's market price is the **yield to maturity**.
  - This is the discount rate that sets the PV of the promised bond payments equal to the current market price of the bond.
  - This is the rate an investor would earn by buying the bond at today's price and holding it to maturity.
- $r_D = YTM$

The Cost of Capital

The Cost of Debt

- Imagine an OAT that has a face value of 100, pays an 8.5% coupon rate, and has a market price of 120.44.

- The NPV is:

$$\frac{8.5}{1+y} + \frac{8.5}{(1+y)^2} + \frac{8.5}{(1+y)^3} + \frac{108.5}{(1+y)^4}$$

- The price is 120.44, so the YTM is defined as the rate for which:

$$P = NPV \Leftrightarrow 120.44 = \frac{8.5}{1+y} + \frac{8.5}{(1+y)^2} + \frac{8.5}{(1+y)^3} + \frac{108.5}{(1+y)^4}$$

- The YTM is 3% here. You can find it by trial and error.

The Cost of Capital

The Cost of Debt

- The cost of debt vis-a-vis investors is the YTM but this is not the actual cost of issuing debt.
- **Tax shield of debt** = interest expenses that are deductible for tax purposes = interest expenses $\times$ tax rate.
  - Tax expenses = (EBIT - Interest expenses) $\times$ Tax rate
- The firm pays interest to creditors but receives a tax break in return.
- Therefore the effective cost of debt for the firm is $r_D^* = r_D(1 - T)$

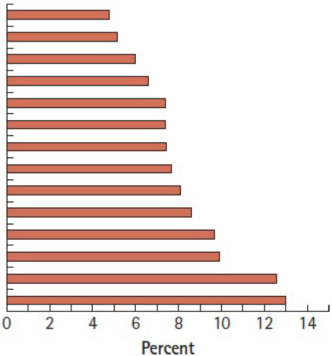
The Cost of Equity

The Cost of Equity

- r_E is simply the opportunity cost of holding equity from the firm.
- This is precisely what we computed at the beginning of the course.
- We will see later an alternative way of computing it.

WACC

	Beta	Cost of Equity	Cost of Debt	% Equity	% Debt	WACC
Hershey Company	0.37	5.2%	1.5%	89.1%	10.9%	4.8%
Target	0.54	6.2%	2.5%	75.9%	24.1%	5.1%
Nike	0.51	6.1%	3.2%	98.6%	1.4%	6.0%
Nordstrom	0.9	8.4%	3.4%	70.8%	29.2%	6.6%
Johnson & Johnson	0.79	7.7%	2.1%	94.1%	5.9%	7.4%
Garmin Ltd	0.73	7.4%	N/A	100.0%	0.0%	7.4%
Starbucks	0.77	7.6%	2.0%	97.1%	2.9%	7.4%
Exxon Mobil	0.9	8.4%	2.1%	89.3%	10.7%	7.6%
Apple	0.98	8.9%	2.3%	89.3%	10.7%	8.1%
Microsoft	1.05	9.3%	2.4%	91.0%	9.0%	8.6%
Boeing	1.27	10.6%	2.8%	89.0%	11.0%	9.7%
Weyerhaeuser	1.41	11.5%	3.6%	82.7%	17.3%	9.9%
Amazon.com	1.64	12.8%	2.5%	97.7%	2.3%	12.6%
AMD	2.32	16.9%	10.9%	59.8%	40.2%	13.0%



2016 numbers

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.