WELCOME TO
Introduction to Finance
for
MSc Financial Technology and Innovation

Lecture 3

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Quick recap: We did a lot previously, most importantly:

- Principle 4: Incentives, conflict of interest among stakehodlers, agency theory and agency cost
- Corporate governance, agency theory and agency costs
  - Governance is needed to reduce agency costs!

- Discount factor determines the PV of future inflow
- Deciding upon investments today: We instumentalize
  - NPV (my costs today shall not be higher as the PV of prediced inflow)
  - DCF (adding up the PV of multiple cash flows of different timeframes)
  - rate of return, opportunity cost of capital vs hurdle rate

Your toolset so far:

- PV, FV
- Discount factor
- NPV, DCF

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

- Rate of Return rule

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

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

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

THE FIVE BASIC PRINCIPLES OF FINANCE

- Today's money worth more: Money has a time value
- There is a risk-return trade-off
- Cash flow is the source of value
- Individuals respond to incentives
- ??

Our Principles suggest to control for **time** and for **risk today**
PV calculations help us to deal with both effects separately

[...] long-dated government bond yields [...]

- Yield (for the moment) == RoR of a fixed-income financial asset
- How risky is this asset?
- Expected return? What would Principle2 suggest?
- So, if I invest into a corporate bond instead, what would the "Investment trade-off model" suggest regarding the expected return?
    - HINT: Are corporate bonds "riskier"?

Investors "lend", ie provide a loan to an agent that ***promises*** a higher return

So, Principle2 suggests that corporate loans shall always provide higher return rate, or?

- Higher return rate has its costs, too!

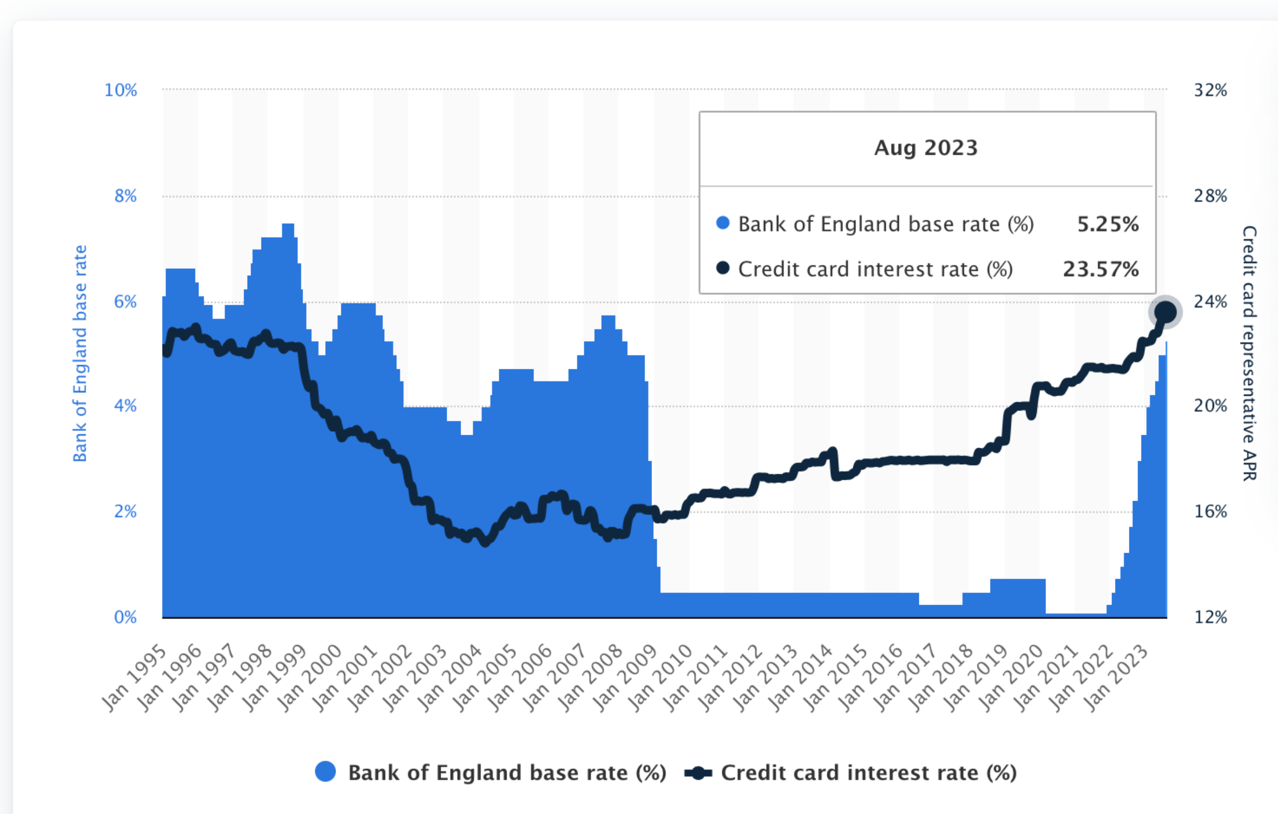
Time to talk about **rates**.
What is the difference between RoR and interest rates?

- **Rate of return** (RoR) on an investment is the percentage of loss or gain **generated by an investment**
  - Based on the initial investment (C) and the amount regained over a certain period

- **Interest rate** is indicative of the amount of interest that **has to be paid on a loan**
  - **No relationship** with any gain or loss made on an investment
  - Repayment: Interest rate and the actual principal

- Both rate of return and interest rate are expressed as percentages
  - Return rate is based on investments made
  - Interest is paid on a loan

Average representative credit card interest rate in the UK from January 1995 to August 2023



Why is credit card rate so high compared to base rates?

Because they are so-called **unsecured** loans: Lending provided to individuals that is **not secured on an asset**.

Examples:
Credit card lending, personal loans, student loans,
loans from payday lenders

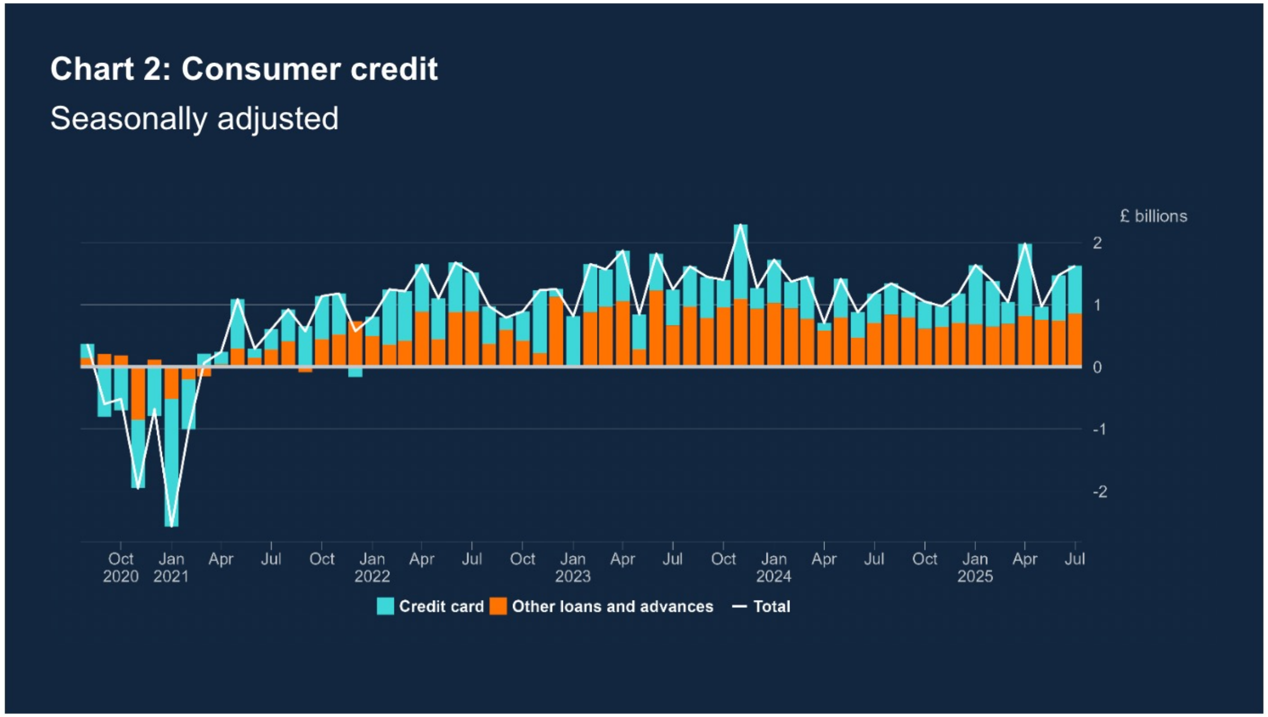
Again: Why such a high credit card interest rate?

- Macroeconomic uncertaininty and the effect of extreme high inflation rate
- Unsecured loan implies high risk
- Households are under high financial stress: Debt-to-income ratio is high

Why are mortgage rates then “so low”, compared to a credit rate? Mortgage is a credit, too, or?

- Collateral exists, and the time-frame of a mortgage is typically longer

BoE: Money and Credit statistical release 1 September 2025



The annual growth rate for all consumer credit increased to 7.0% in July, from 6.8% in June. Over the same period, **the annual growth rate for credit card borrowing rose to 10.1% from 9.7%,** and the annual growth rate for other forms of consumer credit slightly increased to 5.6% from 5.5%.

Principle 5: Market Prices Reflect Information

Investors respond to new information by buying and selling their investments.

Price == information.

Q1: Release of good news makes a stock price: Higher

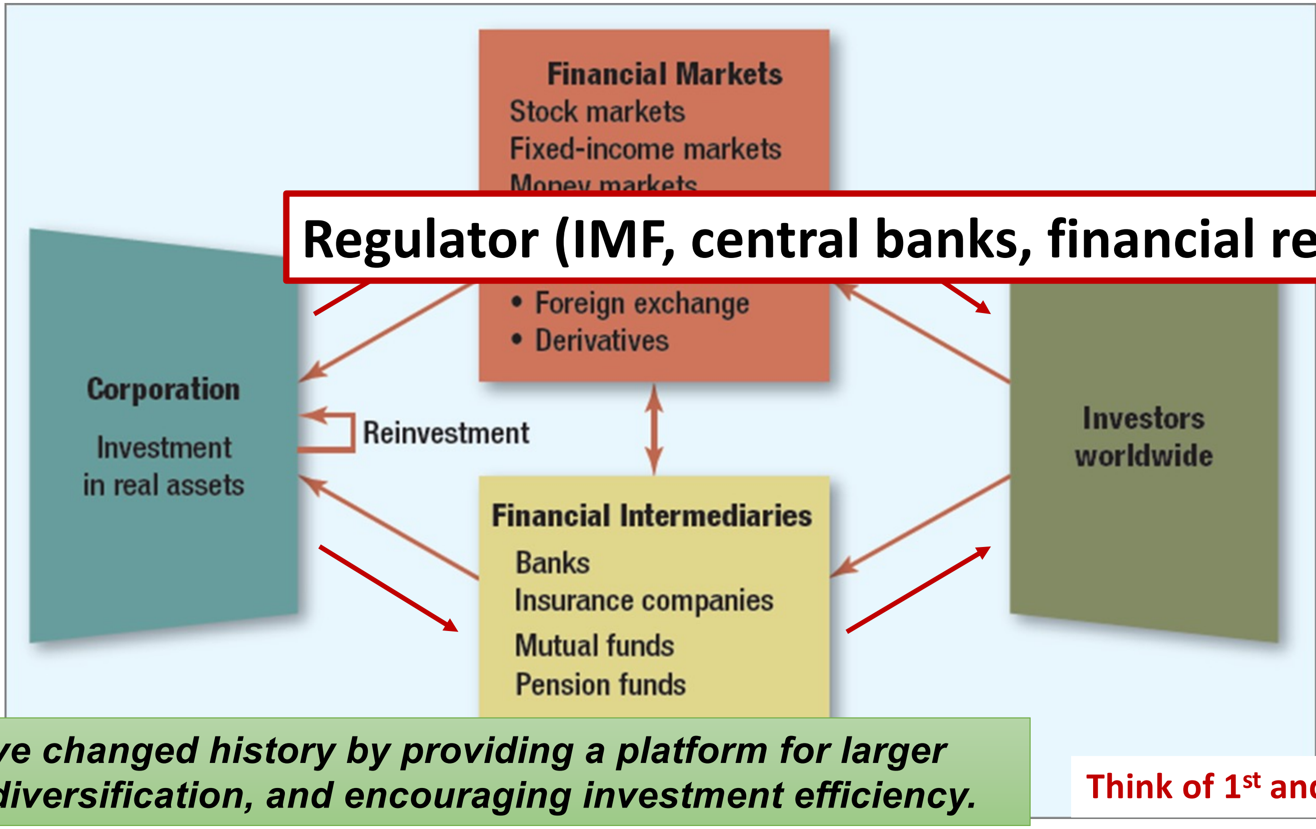
Q2: Release of bad news makes a stock price: Lower

FT-Question: “further rises in gilt yields” - Good news or bad news? For whom?

Look at Tesla:

Look at Tesla:

Financial systems channel funds from investors to companies in forms of equity or debt



Regulator (IMF, central banks, financial regulators)

Markets have changed history by providing a platform for larger businesses, diversification, and encouraging investment efficiency.

Think of 1st and 2nd Axiom!

What is a financial system?

Finance: Study of transactions. Money: Medium of exchange.

- Set of actors that maintain transactions, i.e. permit the exchange of funds
- Exist on corporate, regional, and global levels

The financial system also includes ***sets of rules*** and practices to conceptualize, control and coordinate transactions. In the UK: The Financial Conduct Authority (FCA)

"In fact, financial systems are often strictly regulated because they directly influence decisions over real assets, economic performance, and consumer protection."

There is no such a thing as a free market(?)

Role of the Financial System: To maintain money flow

What is the toolset of the financial system to maintain money flow?

A sophisticated **payment** mechanism

- Allows individuals to make and receive payments quickly and safely over long distances

Two main mechanism elements: **Borrowing** and **lending**

- A distribution channel of savings toward investments (lenders to borrowers)

Pooling **Risk**

- Allows individuals to share risk, that is, insurance companies

Provides **information**

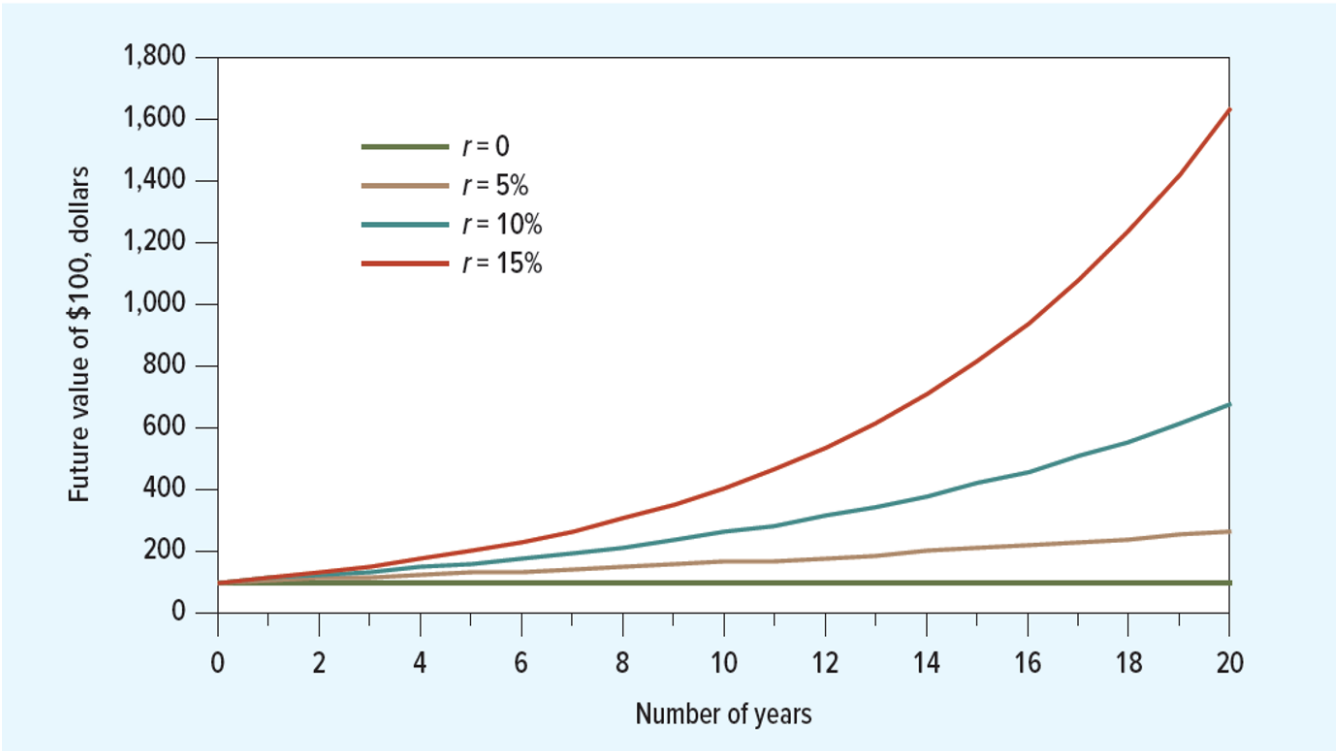
- Allows estimation of expected rates of return

If you invest, you are after the Future Value (FV): Amount to which an investment will grow **by earning on interest**

$$FV = C_0 \times (1 + r)^t$$

Where

- C: capital, ie investment
- r: interest rate
- t: year
  (as well as nr of installments)

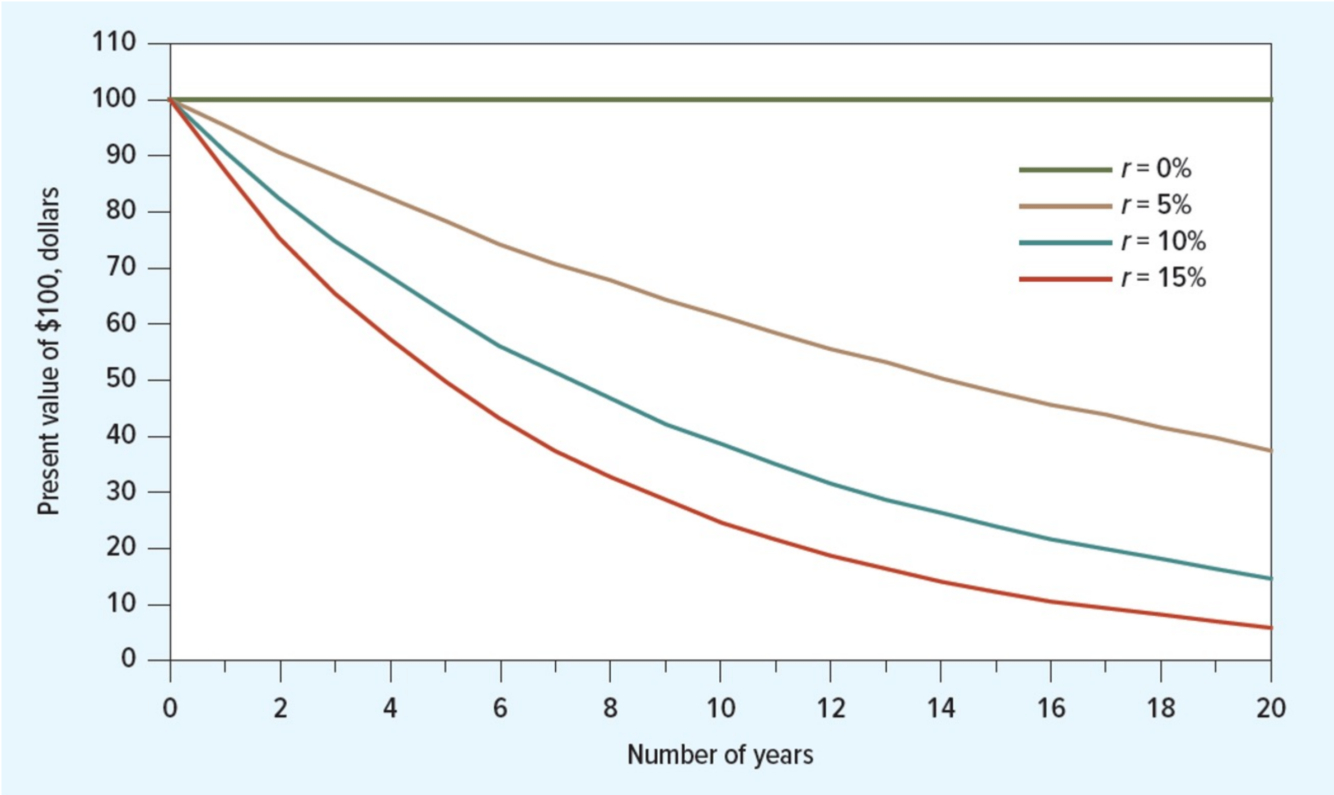


PV works with **discounting** to express: The longer you have to wait for your money, the less it is worth today

$$PV = Ct \times \frac{1}{(1+r)^t}$$

Where

- C_t: future cashflow
- r: discount rate
- t: year
  (as well as nr of installments)



CHECKPOINT 1: *Working with data*

Shall I take a bank loan to fully cover my investment?

Shall I rather lease an equipment?

(Shall I buy or rent?)

1st Axiom: We need money to purchase real assets

To manage shareholder expectations, we want to **fully repay the loan by *amortizing* the loan.**
The bank requests annual repayments.

Suppose we take a 4-year loan of 1.000 USD on 10% interest; we repay the loan within 4 years

Question: What is our **annual payment**?

Remember

Step 1: Picture the problem, *list what you know*

Step 2: Decide on the solution strategy, *list what you have*

Step 3: Apply the techniques and solve the problem

Step 4: Conclude, interpret results

Step 1: *List what you know*

PV, FV, I need 1.000 USD, question: What is our annual payment?
I am taking 1000 USD today, I pay it back in 4 years, and I deal with 10% interest

Step 2: *Solution strategy?*

… So, the PV of **all** payments shall be equal to 1000, i.e. the whole loan, otherwise, we over- or underpay.

Step 2: *List what you have: Introducing a new concept*

… So, the PV of all payments shall be equal to 1000
We work with the **annuity factor** to understand the *value effect* of consecutive, finite series of payments today

PV = (annual loan payment) x **(4-year annuity factor)** = $1,000

$$\text{Annual loan payment} = \$1,000 / 4 - \text{year annuity factor} \qquad \left[\frac{1}{r} - \frac{1}{r(1+r)^t}\right]$$

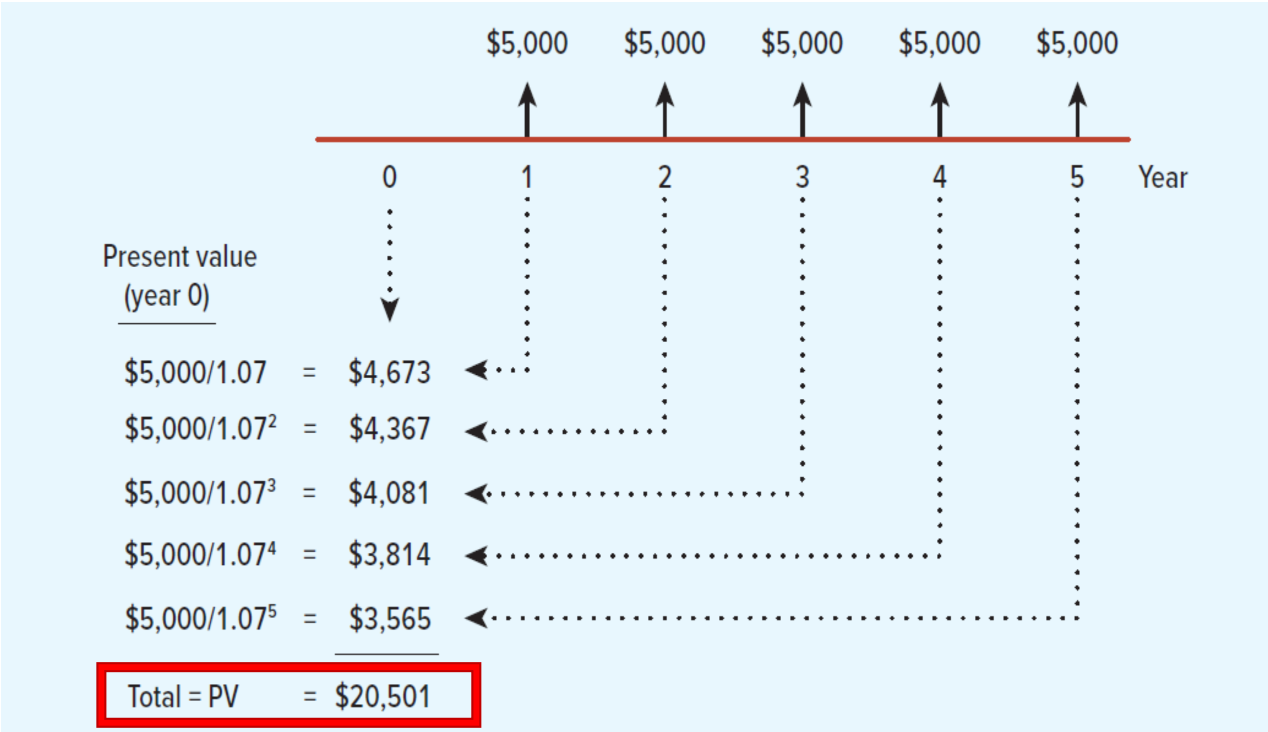
$$4 - \text{year annuity factor} = \left[\frac{1}{0.10} - \frac{1}{0.10(1.10)^4}\right] = 3.170$$

$$\text{Annual loan payment} = \$1,000 / 3.170 = \$315.47$$

If you look at the cash flow, **as interest decreases**, so the loan **amortization increases**

Year	Beginning-of-Year Balance	Year-End Interest on Balance (r=10%)	Total Year-End Payment	Amortization of Loan	End-of-Year Balance
1	$1,000.00	$100.00	**$315.47**	$215.47	$784.53
2	784.53	78.45	**315.47**	237.02	547.51
3	547.51	54.75	**315.47**	260.72	286.79
4	286.79	28.68	**315.47**	286.79	0
	A	**B**	**C**	**D**	**E**

We could as well **lease** an asset instead of purchasing it … when would it make sense?



Suppose we lease a Ford Mustang at a cost of 5,000 USD for 5 years, with 7% interest rate

You can calculate the PV of each year's cash-flow and sum it up

OR

Annuities help us to calculate the costs related to the resulting installment plan:

$$PV = 5{,}000 \times \left[\frac{1}{0{,}07} - \frac{1}{0{,}07 \times (1 + 0{,}07)^5}\right]$$

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

Shortcut #1: Annuity

Annuity: A **financial asset, or security** that pays the same amount each year for a specified number of years.

Shall I invest into this security? Since it is for a ***fixed period***, it is, in fact, a series of payments that I foresee.

Question you ask yourself: *Is it worth – how would I know today?*

Answer: I calculate the PV of the series of payments foreseen

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

Where

- C_1 is the cash flow to be received each year
- *r* is the discount rate (an *assumed interest rate* or *rate of return*) and
- *t* is the number of payment periods

Each cash flow is received **at the end of each time period**

PV of annuity: What is my total annual payment for a bank loan today?

FV of annuity – what is my investment worth after *t* years?

$$\boxed{\mathrm{FV}_{\mathrm{A}_t} = \mathrm{PV}_{\mathrm{Annuity}_t} \times (1+r)^t}$$

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

Suppose you invest $150 annually **at the beginning of each year** at an assumed, 10% interest.

$$\text{PV of Annuity}_2\text{: } 150 \text{ USD} \times \left[\frac{1}{0.1} - \frac{1}{0.1 \times (1+0.1)^2}\right] = \mathbf{271\ USD}$$

After 2 years, how much would your investment be worth?:

$$\mathrm{FV}_{\mathrm{A}_t} = \mathrm{PV}_{\mathrm{Annuity}_t} \times (1+0.1)^2 = \mathbf{327.91\ USD}$$

Future Value of an Annuity: The future value of an asset that pays a fixed sum each year for a specified number of years

We can do that easier, too:

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

What is the future value of $20,000 paid at the end of each of the following 5 years, *assuming* your investment returns 8% per year?

$$\text{FV} = \$20,000 \times \left[\frac{(1+0.08)^5 - 1}{0.08} \right] = \$117,332$$

Shortcut #2: Perpetuity

Perpetuity: A **financial asset or security** in which a cash flow is received **forever, i.e.** a constant stream of **identical** cash flows with no end/ with no termination date.

$$\text{Return} = \frac{\text{Cash Flow}}{\text{Present Value}}$$

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

Where

- C_1 is the cash flow to be received each year
- PV_0 is the present value of an initial payment, aka "investment"
- r in this case is the rate of return

Each cash flow is received **at the end of each time period**

Present Value of "all perpetuities"?

I am looking for the PV (i.e. the cost, in case I want to invest) of a financial asset, or security, in which a cash flow is received **forever**

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

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

Where

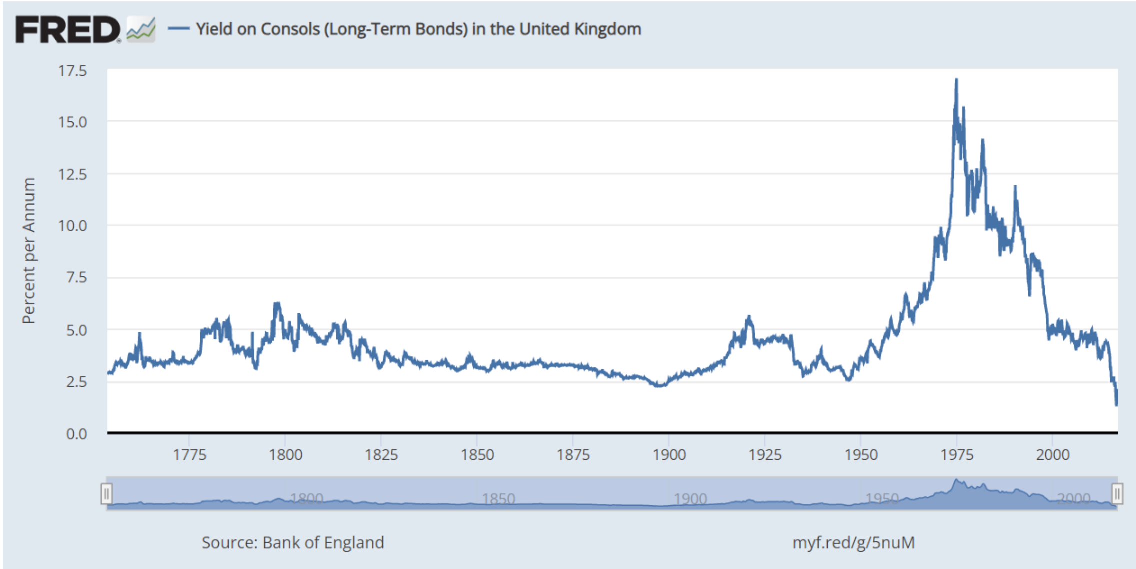
- C_1 is the cash flow to be received each year
- PV_0 is the present value
- r is the discount rate

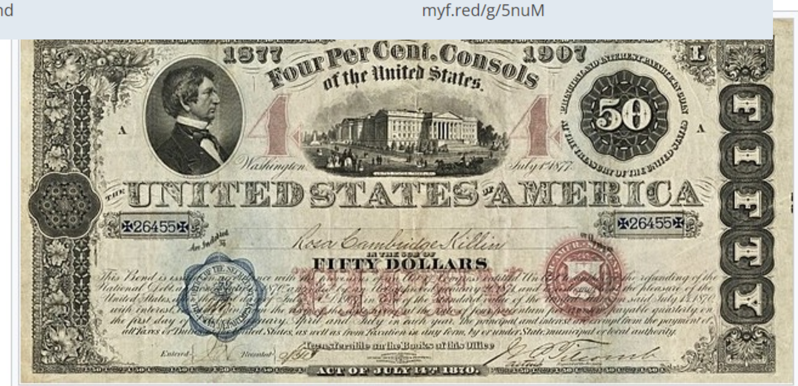
Each cash flow is received at the end of each time period

Any examples?

D-Tour to the past: Consol

- Government debt issues in the form of **perpetual bond**
- Redeemable at the option of the government
- They were issued by the Bank of England and the U.S. Government
- The first British consols were issued in 1751. They have now been fully redeemed (officially, in 2025!)
- The United States government issued consols from 1877 to 1930, which have likewise been redeemed.





U.S. Government 4% Consol Bond

Let us return to the Present Value of Perpetuity

Example

What is the cost, aka PV of $1,000 every year, for all eternity, if you estimate the perpetual discount rate to be 10%? The first payment will take place one year from today.

Payment Period	End of Year 1	End of Year 2	End of Year 3	End of Year 4	Payments Continue in Perpetuity
Payment Amount	$1,000	$1,000	$1,000	$1,000	

Let us return to the Present Value of Perpetuity

Example

What is the cost, aka PV of $1,000 every year, for all eternity, if you estimate the perpetual discount rate to be 10%? The first payment will take place one year from today.

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

Payment Period	End of Year 1	End of Year 2	End of Year 3	End of Year 4	Payments Continue in Perpetuity
Payment Amount	$1,000	$1,000	$1,000	$1,000	

$$PV = \frac{1{,}000 \text{ USD}}{0.10} = 10{,}000 \text{ USD}$$

We did a lot in this lecture, most importantly:

- What is the financial system?
- Principle 5: Market prices reflect information

- Annuity, perpetuity: Starting discussing the **mechanics** behind financial assets
- We started our journey into the universe of bonds
- *“Due” payments versus “regular” payments in a series – to be continued*

- Interest rate (cost of a loan) versus rate of return (what investor is seeking for)