COMPUTATIONAL FINANCE & FINTECH

Interest Rates

Interest rate quotes and adjustments

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LECTURE OUTLINE

Interest rates

PART 1 Interest rate quotes and adjustments

PART 2 Discount rates and loans

PART 3 Inflation, investment and the yield curve

PART 4 Risk and interest rates

PART 5 Review

PART 1 OF 5

Interest rate quotes and adjustments

01

EAR

Interest earned over one year, including compounding.

02

APR

Rate for each interest period, shown as an annual rate.

03

PERIOD

Rate for the time between two cash flows.

Use a rate for the same period as the cash flows.

Borrowing today creates repayments later

Effective annual rate (EAR)

The effective annual rate (EAR) is the interest earned over one year, including the effect of compounding.

A 5% EAR means that £100,000 becomes £105,000 after one year.

$$\mathrm{FV}_n = \mathrm{PV}_0(1 + \mathrm{EAR})^n \quad \Longrightarrow \quad £100{,}000(1.05)^2 = £110{,}250.$$

After two years, the total return is 10.25%, not 10%, because the first year's interest also earns interest in the second year.

Converting an annual rate to another time period

A rate for n years must give the same growth as the EAR over n years:

$$\underbrace{1 + r_n}_{\text{growth over the new period}} = (1 + \text{EAR})^n \implies \boxed{r_n = (1 + \text{EAR})^n - 1}.$$

Use $n = 2$ for two years, $n = 1/2$ for six months, and $n = 1/12$ for one month.

For a 5% EAR, the equivalent six-month rate is

$$r_{6m} = (1.05)^{1/2} - 1 = 2.4695\%.$$

Two six-month periods: $(1.024695)^2 = 1.05$.

A 5% annual return is not the same as 2.5% every six months. Two periods at 2.5% would give 5.0625% over the year.

Converting an EAR to a monthly rate

A savings account pays 6% EAR and adds interest monthly.

For one month, use $n = 1/12$ in the rate-conversion formula:

$$\boxed{r_m = (1 + \text{EAR})^{1/12} - 1} \qquad \Longrightarrow \qquad r_m = (1.06)^{1/12} - 1 = 0.4868\%.$$

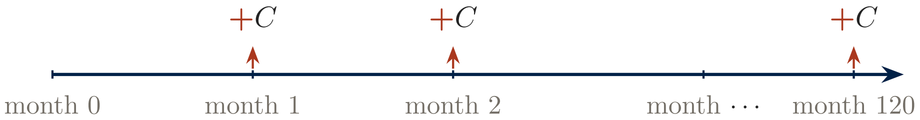
12 months at 0.4868%

$$(1.004868)^{12} \approx 1.06.$$

Do not divide the 6% EAR by 12. A monthly rate of 0.5% would give an annual return of 6.1678%, not 6%.

Monthly deposits for a savings target

Deposit the same amount C at the end of each month. The account pays 6% EAR, or 0.4868% per month.



At month n, the first deposit has earned interest for $n-1$ months; the final deposit has earned none:

$$\mathrm{FV}_n = C(1+r)^{n-1} + C(1+r)^{n-2} + \cdots + C = C\,\frac{(1+r)^n - 1}{r},$$

$$100{,}000 = C\,\frac{(1.004868)^{120} - 1}{0.004868} \quad \Longrightarrow \quad \boxed{C = £615.47 \text{ per month.}}$$

FV_n: value after n deposits; C: deposit each month; r: monthly rate; n: number of deposits. Here, $\mathrm{FV}_n = 100{,}000$, $r = 0.004868$, and $n = 120$.

The rate and the deposits are both monthly, so the annuity formula can be used directly.

Annual percentage rate (APR)

The annual percentage rate (APR) reports the rate for each interest period on an annual scale. The quoted APR does not include interest earned on earlier interest.

If interest is added k times a year, the rate for each period is

$$\boxed{r_{\text{period}} = \frac{\text{APR}}{k}}, \qquad k = 12: \quad r_m = \frac{6\%}{12} = 0.5\% \text{ per month.}$$

After 12 months, £1 becomes

$$£1(1.005)^{12} = £1.061678.$$

Therefore,

$$\boxed{\text{EAR} = 6.1678\%.}$$

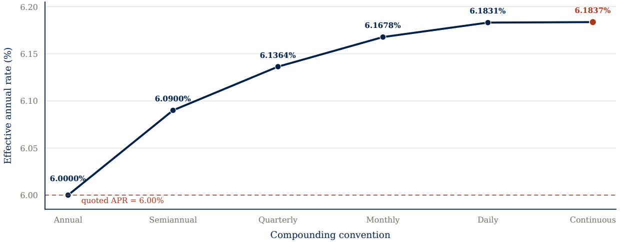
The APR is 6%, but the actual one-year return is 6.1678% because interest is added every month.

Converting an APR to an EAR

The rate for each period is APR $/k$. Starting with £1, after k periods,

$$\underbrace{1+\text{EAR}}_{\text{one-year growth}} = \left(1+\frac{\text{APR}}{k}\right)^k \implies \boxed{\text{EAR} = \left(1+\frac{\text{APR}}{k}\right)^k - 1}.$$

k is the number of times interest is added during the year: 2 for semiannual, 4 for quarterly, 12 for monthly, and 365 for daily.



At a 6% APR, monthly compounding gives a 6.1678% EAR. Daily gives 6.1831%; continuous compounding, where interest is added almost constantly, gives 6.1837%.

Converting a semiannual APR to a monthly rate

A firm can borrow at 5% APR with interest added every six months. Its lease payments are monthly.

1. **Find the rate for six months.**

$$r_{6m} = \frac{\text{APR}}{2} = \frac{5\%}{2} = 2.5\%.$$

2. **Find the monthly rate with the same six-month return.**

$$(1 + r_m)^6 = 1 + r_{6m} \quad \Longrightarrow \quad r_m = (1.025)^{1/6} - 1 = 0.4124\%.$$

The monthly rate can now be used with the monthly lease payments.

The APR period is six months, but the payment period is one month. Both conversions are needed.

Buy or lease: comparing present values

Buy the phone system now for £150,000, or lease it for 48 payments of £4,000 at the end of each month. Use the monthly rate of 0.4124%.

For the lease, $C = 4{,}000$, $r = 0.004124$, and $n = 48$:

$$\mathrm{PV}_0 = \sum_{t=1}^{n} \frac{C}{(1+r)^t} = C\,\frac{1-(1+r)^{-n}}{r},$$

$$\mathrm{PV}_0(\text{lease}) = 4{,}000\,\frac{1-(1.004124)^{-48}}{0.004124} = \pounds 173{,}867.$$

Option	Cost today
Buy now	£150,000
Lease: present value of 48 payments	£173,867

Buying costs £23,867 less today.

Taxes and accounting treatment are omitted. Including them could change the decision.

Discount rates and loans

01

PAYMENT

Find the amount paid each month to repay the loan.

02

BALANCE

Use the unpaid payments to find what is still owed.

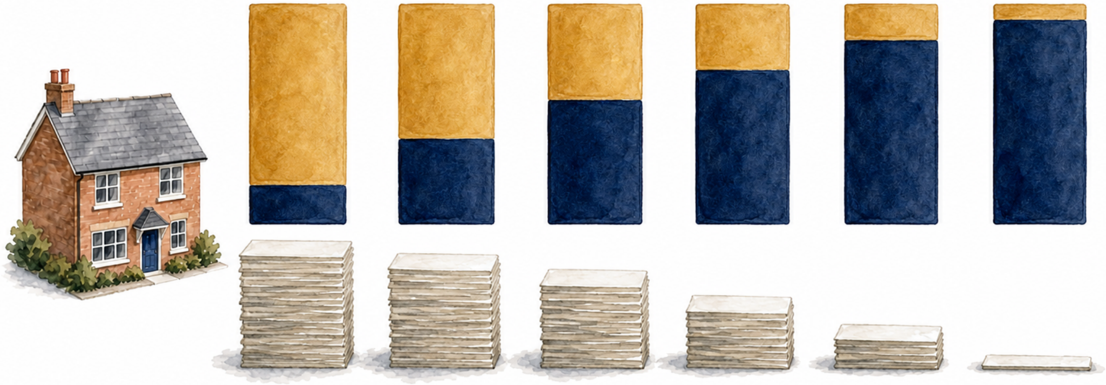
03

INTEREST

Split each payment into interest and loan repayment.

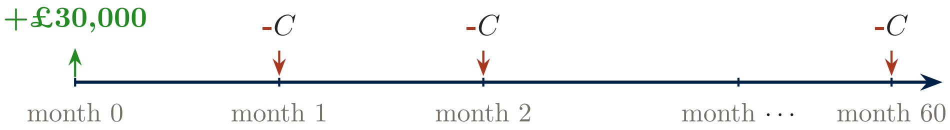
Use a loan rate for the same period as the payments.

Fixed loan payments: interest falls and principal repayment rises



Amortising loans

The principal is the amount still owed on a loan. In an amortising loan, each payment covers interest and repays some principal. The final payment clears the balance.

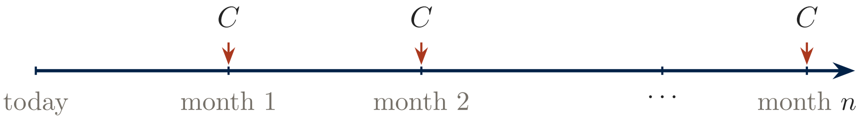


- The borrower receives £30,000 today.
- The borrower makes 60 equal payments of C at the end of each month.
- The payment is chosen so that the balance is zero after month 60.

Loan terms: 6.75% APR, 60 end-of-month payments and monthly compounding.

Present value of equal monthly payments

An annuity is a fixed payment made at regular intervals for a fixed number of periods. Here, the payments are made at the end of each month.



Discount each payment back to today and add them:

$$\mathrm{PV}_0 = \frac{C}{1+r} + \frac{C}{(1+r)^2} + \cdots + \frac{C}{(1+r)^n} = \boxed{C\,\frac{1-(1+r)^{-n}}{r}}.$$

C: payment each month; r: monthly rate; n: number of monthly payments; PV_0: their value today.

The loan amount equals the present value of its payments

The lender provides the loan amount today and receives the monthly payments. The loan equation values both sides at the same date.

Let L be the amount borrowed today. Then

$$\underbrace{L}_{\text{amount borrowed today}} = \underbrace{C\frac{1-(1+r)^{-n}}{r}}_{\text{value today of all monthly payments}}.$$

Solving for the monthly payment gives

$$\boxed{C = L\frac{r}{1-(1+r)^{-n}}}.$$

This is the present-value formula solved for the payment C.

The payment is not simply L/n. Each payment includes interest because the lender receives the money over time.

Converting a loan APR to a monthly rate

Loan amount: £30,000. Term: 60 months. Quoted rate: 6.75% APR with monthly compounding.

First convert the APR to a monthly rate:

$$r = r_m = \frac{\text{APR}}{12} = \frac{6.75\%}{12} = 0.5625\% \text{ per month.}$$

The loan amount equals the present value of the n monthly payments:

$$\boxed{L = C\,\frac{1-(1+r)^{-n}}{r}}.$$

Here $L = 30{,}000$, $r = 0.005625$, and $n = 60$. Therefore,

$$30{,}000 = C\,\frac{1-(1.005625)^{-60}}{0.005625}.$$

$L = 30{,}000$: amount borrowed today; C: fixed monthly payment; $r = 0.005625$: monthly rate; $n = 60$: number of payments. Payments occur at the end of each month and there are no fees. Use the monthly rate with the monthly payments.

Calculating the monthly loan payment

Solve the loan equation for C:

$$\boxed{C = L\frac{r}{1-(1+r)^{-n}}}.$$

Substitute $L = 30{,}000$, $r = 0.005625$, and $n = 60$:

$$C = 30{,}000\frac{0.005625}{1-(1.005625)^{-60}} = \boxed{£590.50}.$$

Item	Amount
Amount borrowed today	£30,000
60 monthly payments	about £35,430
Total interest over five years	about £5,430

The total interest is the total of the payments less the £30,000 originally borrowed. Small differences can arise from rounding the monthly payment.

Each monthly payment covers interest and reduces the loan balance

Let B_t be the balance immediately after payment t. During the next month, interest rB_t is added and the next payment C is deducted.

$$\underbrace{B_{t+1}}_{\text{new balance}} = \underbrace{B_t}_{\text{old balance}} + \underbrace{rB_t}_{\text{interest added}} - \underbrace{C}_{\text{payment}} = \boxed{(1+r)B_t - C}.$$

For the first payment, $B_0 = £30{,}000$, $r = 0.005625$, and $C = £590.50$:

$$B_1 = (1.005625)(30{,}000) - 590.50 = \boxed{£29{,}578.25}.$$

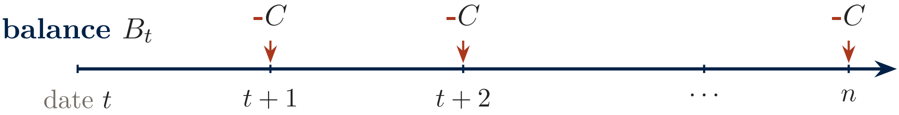
Interest: £168.75 **Principal repaid: £421.75**

The payment is fixed. As the balance falls, monthly interest falls and more of the payment reduces the balance.

The loan balance equals the value of the remaining payments

After payment t, the lender is still owed $n - t$ payments. Paying B_t immediately would settle those payments, so the two must have the same value at date t.

$$B_t = \sum_{j=1}^{n-t} \frac{C}{(1+r)^j} = \boxed{C\,\frac{1-(1+r)^{-(n-t)}}{r}}.$$



C: monthly payment; r: monthly loan rate; n: total number of payments; t: number already made; B_t: balance immediately after payment t.

This gives the same balance as repeating $B_{t+1} = (1+r)B_t - C$ month by month, but it calculates the balance directly.

After two years, the loan balance is £484,332

A firm has a 30-year office loan at 4.8% APR with monthly payments of £2,623.33. Two years, or 24 payments, have passed.

The monthly rate is

$$r_m = \frac{\text{APR}}{12} = \frac{4.8\%}{12} = 0.4\%.$$

At date 24, the balance is the value of the $360 - 24 = 336$ unpaid payments:

$$\begin{aligned} B_{24} &= \sum_{j=1}^{336} \frac{2{,}623.33}{(1.004)^j} \\ &= 2{,}623.33 \frac{1-(1.004)^{-336}}{0.004} = \boxed{£484{,}332}. \end{aligned}$$

The balance immediately after payment 24 is the value at that date of the 336 payments still due.

Interest paid during the second year

Repeat the unpaid-payment calculation after payment 12, when 348 payments remained:

$$B_{12} = \sum_{j=1}^{348} \frac{2{,}623.33}{(1.004)^j} = 2{,}623.33 \frac{1 - (1.004)^{-348}}{0.004} = \pounds 492{,}354.$$

Calculation	Amount
Principal repaid: 492,354 – 484,332	£8,022
Total of 12 monthly payments	£31,480
Interest: 31,480 – 8,022	£23,458

Interest paid = total payments - reduction in the loan balance.

Only £8,022 of the second year's payments reduced the amount owed; the rest paid interest.

Higher loan rates increase monthly payments

An adjustable-rate mortgage has an interest rate that can change. When the rate changes, the payment is recalculated from the current balance and the remaining term.

Suppose the office-loan rate rises after two years from 4.8% APR to 7.2% APR. The balance is £484,332 and 336 payments remain. Here $r_{\text{new}} = \text{APR}_{\text{new}}/12 = 7.2\%/12 = 0.006$ and $n - t = 336$, so

$$B_{24} = C_{\text{new}} \frac{1 - (1 + r_{\text{new}})^{-336}}{r_{\text{new}}},$$

$$C_{\text{new}} = 484{,}332 \frac{0.006}{1 - (1.006)^{-336}} = £3{,}355.62.$$

APR	Monthly rate	Monthly payment
4.8%	0.4%	£2,623.33
7.2%	0.6%	£3,355.62

The payment rises by £732.29 per month even though the balance and the remaining term have not changed.

Inflation, investment and the yield curve

01

INFLATION

Separate money growth
from growth in purchasing power.

→

02

MATURITY

Use the rate for the same date as each cash flow.

→

03

FUTURE RATES

Use expected future short rates to explain the curve's shape.

This block focuses on inflation, maturity and expected future rates.

Inflation reduces purchasing power

Nominal and real returns

A nominal return measures growth in money. A real return measures growth in purchasing power after allowing for inflation.

Quantity	Interpretation
Nominal return, r_{nom}	Growth in the money invested
Inflation, π	Growth in the price level
Real return, r_{real}	Growth in what the money can buy

£1 grows to $1 + r_{\text{nom}}$ pounds, while prices grow by $1 + \pi$. Purchasing power therefore grows by their ratio:

$$1 + r_{\text{real}} = \frac{1 + r_{\text{nom}}}{1 + \pi}, \qquad \boxed{r_{\text{real}} = \frac{r_{\text{nom}} - \pi}{1 + \pi}}.$$

For low inflation, $r_{\text{real}} \approx r_{\text{nom}} - \pi$. Use the exact formula when inflation is large.

Inflation can make a positive nominal return negative in real terms

Apply the exact purchasing-power formula to a one-year investment:

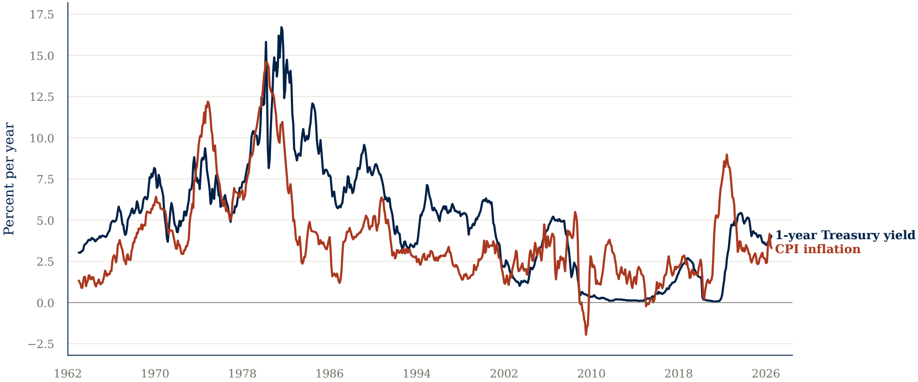
$$r_{\text{real}} = \frac{1 + r_{\text{nom}}}{1 + \pi} - 1.$$

One-year period	Nominal rate	Inflation	Real rate
Mar 2019–Mar 2020	2.40%	1.50%	0.89%
Mar 2021–Mar 2022	0.10%	8.50%	-7.74%
Jul 2025–Jul 2026	4.08%	3.30%	0.75%

A positive money return does not guarantee higher purchasing power.

The July 2025 one-year Treasury yield is matched with CPI inflation from July 2025 to July 2026, the same one-year holding period.

Nominal interest rates and inflation often move together



FRED: DGS1 and CPIAUCSL, monthly, January 1962–July 2026. Retrieved 17 August 2026.

The CPI line is backward-looking. Subtracting it from the current one-year yield does not produce a horizon-matched realised real return.

Higher discount rates reduce project NPV

The project costs \$10 million today and pays \$3 million at each year-end for four years. The cash flows are assumed risk-free.

Add the discounted cash flows: $\mathrm{NPV}_0 = C_0 + \sum_{t=1}^{T} C_t/(1+r)^t$.

$$\mathrm{NPV}_0(r) = -10 + \sum_{t=1}^{4} \frac{3}{(1+r)^t}.$$

Discount rate	NPV (\$m)	Decision
5%	+0.638	Accept
9%	-0.281	Reject

The future benefits lose value when the discount rate rises; the \$10 million cost occurs today and does not change. The break-even rate is about 7.71%.

Policy rates affect borrowing, spending and inflation

The policy rate is the short-term interest rate targeted or administered by a central bank. It affects other borrowing and investment rates.

Policy rate → Borrowing and investment rates → Investment and household spending

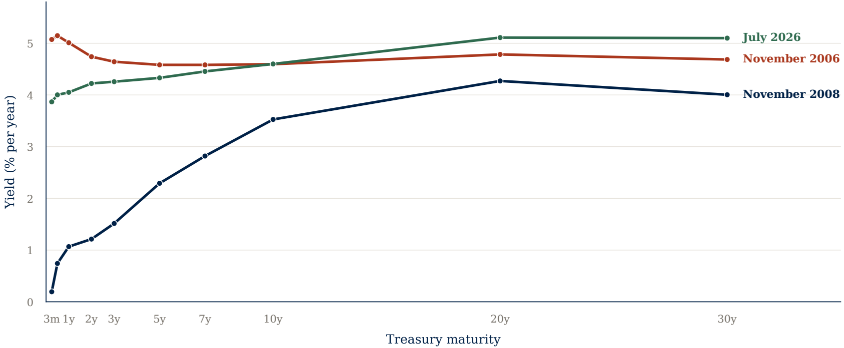
Higher rates reduce the present value of future cash flows and raise borrowing costs.

- In 2008 and 2020, the Federal Reserve cut short-term rates to near zero as economic activity fell.
- In 2022, the Federal Reserve raised short-term rates as inflation increased.
- Longer-term rates are market prices and also reflect expected future short rates and risk.

Interest rates across maturities

The yield curve compares rates across maturities

The term structure is the relationship between maturity and interest rates. A graph of that relationship is the yield curve.



FRED Treasury monthly averages: Nov 2006, Nov 2008 and Jul 2026; retrieved 17 Aug 2026.

November 2006 was inverted, November 2008 was steep, and July 2026 was upward sloping across the observed maturities.

Discount each cash flow at the rate for its maturity

Let C_t be a risk-free cash flow received in year t, let r_t be the annual rate for that maturity, and let T be the final payment year.

The year-t cash flow has value $C_t/(1+r_t)^t$ today. Add these present values:

$$\boxed{\mathrm{PV}_0 = \frac{C_1}{1+r_1} + \frac{C_2}{(1+r_2)^2} + \cdots + \frac{C_T}{(1+r_T)^T} = \sum_{t=1}^{T} \frac{C_t}{(1+r_t)^t}}$$

Cash-flow date	Cash flow	Discount rate
Year 1	C_1	r_1
Year 2	C_2	r_2
Year T	C_T	r_T

A single-rate annuity formula is valid only when the same rate is appropriate for every payment date.

Present value with yearly discount rates

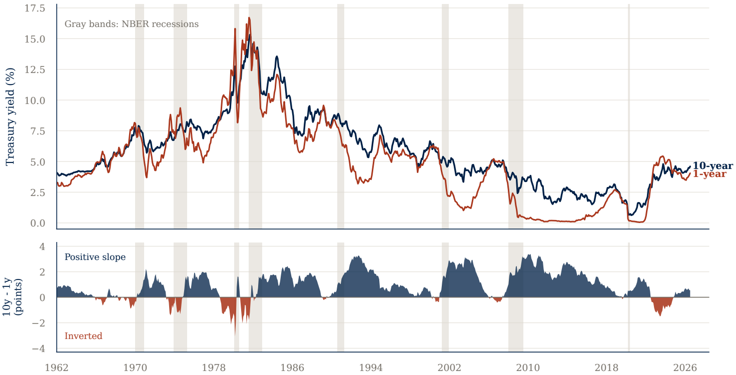
A risk-free cash-flow stream pays \$1,000 at the end of each of the next five years. Discount each payment at its November 2008 maturity-specific rate.

Each table entry uses $\mathrm{PV}_0(C_t) = C_t/(1 + r_t)^t$. For year 3, $\mathrm{PV}_0(C_3) = 1{,}000/(1.0126)^3 = \$963.13$.

Year	Rate for that year	Present value of \$1,000
1	0.91%	\$990.98
2	0.98%	\$980.68
3	1.26%	\$963.13
4	1.69%	\$935.16
5	2.01%	\$905.29
	Total present value	**\$4,775.25**

Each payment uses its own maturity rate. Using 2.01% throughout gives \$4,712.09, which is \$63.16 too low.

Yield-curve inversions and U.S. recessions



FRED: DGS1, DGS10 and USREC, monthly, January 1962–July 2026. Retrieved 17 August 2026.

The lower panel is the 10-year yield minus the one-year yield. Red periods are inversions. An inversion is a warning signal, not a recession date or a guarantee.

Expected short rates help shape the yield curve

Ignoring risk and term premia, locking in an n-year rate should give the same expected payoff as repeatedly investing for one year.

Strategy	Expected value after n years
Lock in the n-year rate	$(1+r_n)^n$
Roll one-year investments	$\prod_{t=1}^{n}(1+\mathbb{E}_0[r_{1,t}])$

- Expected increases in future short rates tend to produce an upward-sloping curve.
- Expected decreases in future short rates tend to produce an inverted curve.
- Risk and term premia also affect long-term yields, so this relation is not a complete model of the curve.

Expected rate increases can produce an upward-sloping curve

The one-year rate is 1% today, 2% next year and 4% in the following year.

Match the total return over n years: $(1+r_n)^n = (1+r_{1,1})(1+r_{1,2})\cdots(1+r_{1,n})$.

$$
\begin{aligned}
r_1 &= 1.000\%, \\
(1+r_2)^2 &= (1.01)(1.02) &\Longrightarrow \quad r_2 &= 1.499\%, \\
(1+r_3)^3 &= (1.01)(1.02)(1.04) &\Longrightarrow \quad r_3 &= 2.326\%.
\end{aligned}
$$

The curve slopes upward because the expected one-year rate rises over time.

Risk and interest rates

01

DEFAULT

A borrower may fail to make the promised payment.

02

SPREAD

Extra yield above a same-term government benchmark.

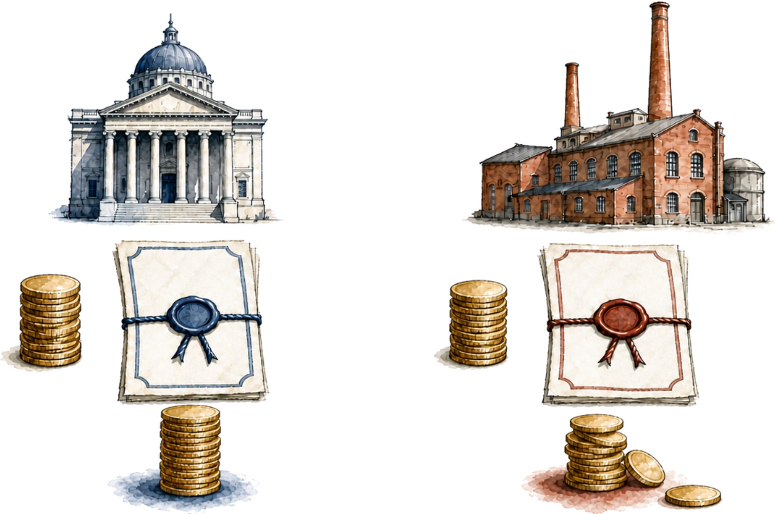
03

RATING

A standard opinion of relative credit risk.

Use a discount rate for comparable risk and term.

Risk raises the required interest rate



Default risk raises the required interest rate

Default means that a borrower fails to make a promised interest or principal payment.

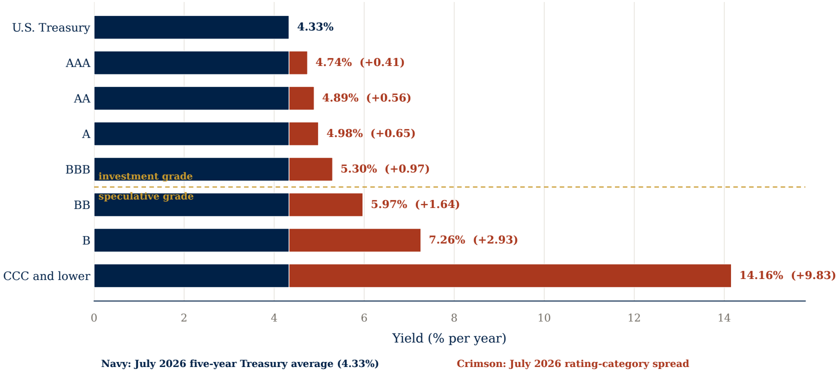
For two cash flows with the same currency and payment date, investors normally require a higher rate from the riskier borrower.

$$r_{\text{borrower},T} = r_{\text{government},T} + \underbrace{\text{credit spread}_T}_{\text{compensation for credit risk}}$$

same-term government bond
benchmark rate → borrower can default
+ credit spread → market loan rate
discount rate

A high quoted yield is not a guaranteed high return. If default occurs, the investor may receive less.

Lower ratings have wider credit spreads



The corporate bars add the July 2026 average spread for each rating category to the July 2026 five-year Treasury average. The added spread shows the risk adjustment; the corporate indices contain bonds with different maturities.

The credit spread is the part of the yield above the government benchmark.

Higher default risk lowers present value

The U.S. government and DirecTV each promise to pay \$1,000 in five years. Use their April 2022 market yields.

Because $F = \text{PV}_0(1+r)^n$, the present value is $\text{PV}_0 = F/(1+r)^n$. Use the rate for that borrower.

U.S. government promise

Discount at the 2.8% government yield.

$$\text{PV}_0 = \frac{\$1{,}000}{(1.028)^5} = \$871.03$$

DirecTV promise

Discounted at the comparable risky bond rate.

$$\text{PV}_0 = \frac{\$1{,}000}{(1.076)^5} = \$693.33$$

Present-value difference: \$871.03 − \$693.33 = \$177.70

The payment date and promised amount are the same. The borrower risk is different.

Credit ratings summarise relative default risk

A credit rating summarises an agency's view of an issuer's or bond's relative credit risk.

Agency	Long-term scale	What it publishes
S&P Global Ratings	AAA to D	Rating, outlook and written reasons
Moody's Ratings	Aaa to C	Rating, outlook and written reasons
Fitch Ratings	AAA to D	Rating, outlook and written reasons

- Agencies assess ability and willingness to pay; issue ratings may also reflect expected recovery.
- Ratings change as information changes. They are not guarantees or recommendations to buy or sell.

Investment-grade and speculative-grade ratings

Investment grade

S&P/F.	Moody	Meaning
AAA	**Aaa**	Extremely strong
AA	**Aa**	Very strong
A	**A**	Strong
BBB	**Baa**	Adequate

Speculative grade

S&P/F.	Moody	Meaning
BB	**Ba**	Important uncertainty
B	**B**	More vulnerable
CCC or lower	**Caa or lower**	Very high risk or default

Investment-grade boundary:

BBB−/Baa3 versus BB+/Ba1

S&P and Fitch use + and − within most categories; Moody's uses 1, 2 and 3.

AA: very strong credit quality. BBB: adequate credit quality and more exposure to adverse conditions.

Credit spreads reflect default and recovery risk

Cash available

Operating cash flow, debt level, interest cover and refinancing needs.

Debt contract

Seniority, collateral, covenants and the bond's maturity.

Recovery after default

Asset value, legal priority and the cost and length of restructuring.

July 2026 BBB-category bond yield

4.33% government benchmark + 0.97% credit spread = 5.30% yield

Bonds with the same rating can still have different yields because maturity, liquidity and contract terms differ.

Sovereign risk includes economic and political factors

A sovereign rating is an agency's view of a government's ability and willingness to repay.

S&P long-term sovereign ratings

	Ratings
Germany	**AAA**
United States	**AA+**
United Kingdom	**AA**
Türkiye	**BB−**

affirmed in 2026; status checked 17 August 2026.

- **Public finances:** tax capacity, spending, debt and interest costs.
- **Institutions:** policy stability, legal framework and willingness to pay.
- **Inflation and currency:** monetary credibility and loss of purchasing power.
- **External finance:** foreign-currency debt, reserves and access to funding.

Compare sovereign yields only after matching currency and maturity. A yield difference may reflect inflation or currency risk as well as default risk.

Interest rates and present value

01

QUOTES

Convert EAR or APR to the cash-flow period.

02

LOANS

Value the payments that remain.

03

DISCOUNTING

Match inflation, maturity and risk.

Check the rate before calculating present value.

Matching the rate to the cash-flow period

EAR

Actual growth over one year, including compounding.

$$1 + \mathrm{EAR} = (1 + r_{\text{period}})^k$$

APR with k periods

Annualised periodic rate; the frequency is part of the quote.

$$r_{\text{period}} = \frac{\mathrm{APR}}{k}$$

Cash-flow rate

Use a rate for the time between two cash flows.

$$r_m = \frac{6.75\%}{12} = 0.5625\%$$

Convert first; then value the cash flows.

The loan balance is the value of unpaid payments

For an amortising loan, the amount borrowed equals the present value of all scheduled payments.

At the start

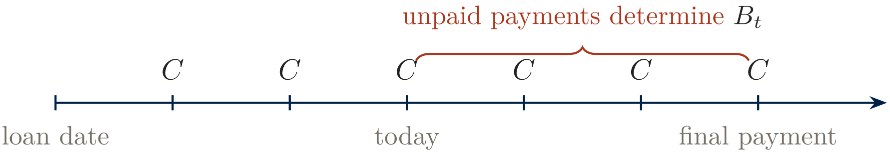
$$L = C\,\frac{1-(1+r)^{-n}}{r}$$

L is the loan amount at date 0, C the payment, r the rate per payment period, and n the total number of payments.

After t payments

$$B_t = C\,\frac{1-(1+r)^{-(n-t)}}{r}$$

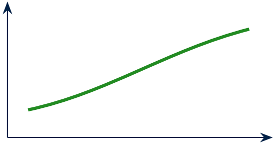
B_t is the balance immediately after payment t; $n-t$ payments remain.



Reading the shape of the yield curve

Each point is today's market yield for lending to the same type of borrower for a different term.

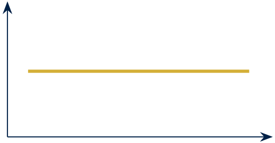
Upward sloping



Long

rates are above short rates.

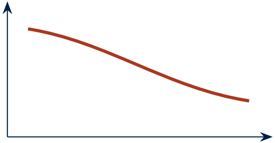
Flat



Short

and long rates are similar.

Inverted



Short

rates are above long rates.

- Use the rate at the same maturity as each cash flow.
- An inverted curve has often preceded U.S. recessions, but it does not make a recession certain.

Choosing the discount rate

Cash-flow feature	Rate to use
Payment interval	Rate for the same interval
Inflation basis	Nominal rate for nominal cash flows; real rate for real cash flows
Payment date	Market rate for that maturity
Default risk	Market rate for comparable borrower or project risk
Currency	Rate in the same currency as the cash flow

$$\mathrm{PV}_0 = \sum_{t=1}^{T} \frac{C_t}{(1 + r_t)^t}$$

For each cash flow, check period, inflation, maturity, risk and currency before choosing r_t.

REFERENCE MATERIAL

Sources

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- MIT OpenCourseWare, 15.401 Finance Theory I, Lectures 2–3.
- Aswath Damodaran, *Foundations of Finance*, Session 6.
- CFA Institute, time-value-of-money materials and effective annual rate terminology.
- S&P Global Ratings, Moody's Ratings and Fitch Ratings, official long-term rating scales and definitions.
- S&P Global Ratings, 2026 sovereign rating actions and sovereign ratings list.

Numerical examples: author calculations. Data-figure construction is documented on the next slide.

FRED figures

- **Nominal rate and inflation:** DGS1 monthly average and the 12-month percentage change in CPIAUCSL, January 1962–July 2026.
- **Yield curves:** monthly averages of DGS3MO, DGS6MO, DGS1, DGS2, DGS3, DGS5, DGS7, DGS10, DGS20 and DGS30 for November 2006, November 2008 and July 2026.
- **Rates, slope and recessions:** DGS1 and DGS10 monthly averages; slope computed as DGS10 minus DGS1; USREC supplies the NBER-based recession indicator.
- **Provider:** Federal Reserve Economic Data, Federal Reserve Bank of St. Louis. Treasury yields originate in the Federal Reserve H.15 release and U.S. Treasury data.
- **Credit-risk figure:** July 2026 average DGS5 plus July averages of ICE BofA option-adjusted spreads for AAA, AA, A, BBB, BB, B and CCC-and-lower U.S. corporate indices.

Retrieved 17 August 2026. Frozen source data and plotting code are supplied with the deck. ICE BofA data are licensed; consult the FRED series notes before redistribution.