

Luento 5.

Puhtaan siirtymän hankkeiden rahoitus

Markku Kaustia

*Hannes Gebhard Professor of Finance and Insurance,
Department of Finance, Aalto University*

Agenda

Project appraisal examples

Optimizing capital structure

Green financing instruments & capital

Green shift investment project example: Photovoltaics (PV) energy production facility

Initial investment in solar panel installation and other facility infrastructure: 400 (units in 1,000s)

First year production 350 kWh, solar panel degradation by 0.5% per year; Operating cost 5 per year

Project life 20 years; Decommissioning and recycling end-of-life cost of 40

Fixed price for selling electricity: 15 cents/kWh

Cost of capital is 6%

Project value

T	kWh	Revenue	CF	PV (@6%)
0	0.00	0.00	-400.00	-400.00
1	350.00	52.50	47.50	44.81
2	348.25	52.24	47.24	42.04
3	346.51	51.98	46.98	39.44
4	344.78	51.72	46.72	37.00
5	343.05	51.46	46.46	34.72
6	341.34	51.20	46.20	32.57
7	339.63	50.94	45.94	30.56
8	337.93	50.69	45.69	28.67
9	336.24	50.44	45.44	26.89
10	334.56	50.18	45.18	25.23
11	332.89	49.93	44.93	23.67
12	331.22	49.68	44.68	22.21
13	329.57	49.44	44.44	20.83
14	327.92	49.19	44.19	19.54
15	326.28	48.94	43.94	18.34
16	324.65	48.70	43.70	17.20
17	323.03	48.45	43.45	16.14
18	321.41	48.21	43.21	15.14
19	319.80	47.97	42.97	14.20
20	318.20	47.73	2.73	0.85
			NPV:	110.05

Internal Rate of Return (IRR)

9.4%

Payback time

Cumulative CF after year 12 is 388, after year 13 it's 409

$$409 - 388 = 21$$

$$400 - 388 = 12$$

$$12 / 21 = 0.57$$

→ 12.6 years (12 years 7 months)

Battery second-life project

Startup investment in facility to collect, test, and repurpose used electric vehicle (EV) batteries into stationary energy storage

Initial investment \$2.5 mil.; Project life 6 years; batteries sourced at low/no cost

Output 5 MWh of storage/year, resold to commercial customers and grid operators; Revenue: Selling energy storage services (peak shaving, demand response); Yearly O&M cost for labor, testing, warranty management

Decommission cost: Net positive, at equipment + batteries = 300

Discount rate: Medium-risk (early-stage but proven technology), may receive subsidies or favorable loans → 8%

Cash flow projection and NPV

Year	Storage, MWh	Output, MWh	Revenue from Grid Services	Sales Revenue	Total Revenue	Costs	CF	PV @8%
0						-2 500	-2 500	-2 500
1	5	1 250	125	1 500	1 625	-200	1 425	1 319
2	6	1 375	138	1 650	1 788	-220	1 568	1 344
3	6	1 500	150	1 800	1 950	-230	1 720	1 365
4	7	1 625	163	1 950	2 113	-240	1 873	1 376
5	7	1 750	175	2 100	2 275	-250	2 025	1 378
6	8	1 875	188	2 250	2 438	-260	2 178	1 372
							NPV =	5 655

Short project life estimate (6 years)

EV batteries lose 20-30% capacity by end of use; 2nd-life lasts 5-10 years

Innovation in battery technology may outcompete today's refurbished packs in 6-7 years

Commercial energy storage systems come with performance guarantees or warranties of 5-7 years

Make a scenario: Project life could be a bit longer

Revenue modeling

Storage capacity deployed is 5 MWh per year; Battery throughput = charge/discharge cycles: 250/year

Output $5 \times 250 = 1,250$ MWh, per cohort of deployed systems, cumulative installed capacity will grow

Price varies by country/market, assume: \$100/MWh value for typical US/European programs; Year 1: $100 \times 1,250$ MWh = 125k

Storage System Sales and Leasing: ~250 kWh sold or leased, price \$300/kWh; Annual deployment: 5k kWh
→ $\$300 \times 5k = 1,500k$

Cost of capital

- Back to the topic of

Expected/required equity return increases as a function of leverage

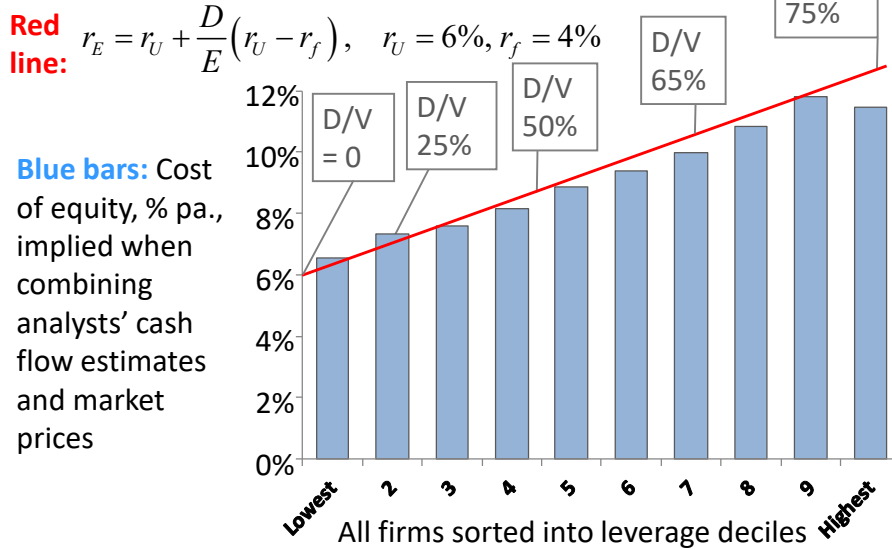
For a levered firm:

Additional risk premium
due to leverage effect

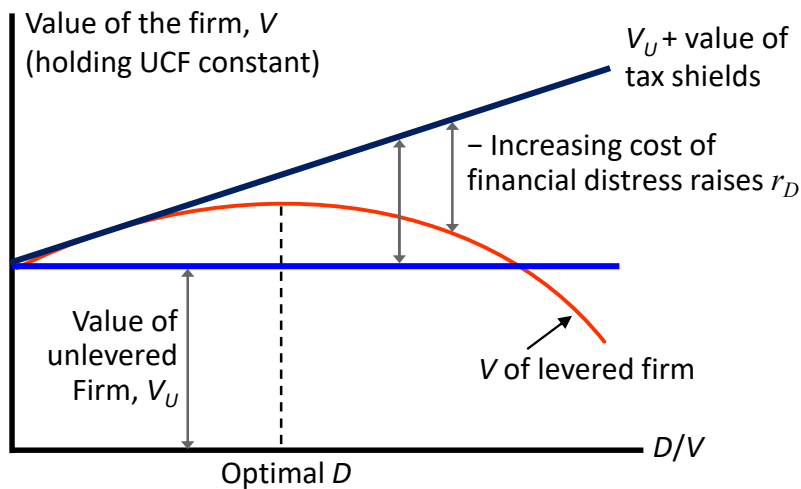
$$r_E = r_U + \frac{D}{E}(r_U - r_f)$$

↑
Expected return if the firm had no debt,
i.e., depends only on the riskiness of the
firm's assets (= business)

Expected/required equity return increases as a function of leverage



Firm value is a concave function of leverage



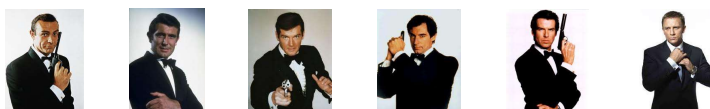
Fixed-income instruments

- Key bond concepts
- Green and sustainability linked bonds

Bonds*

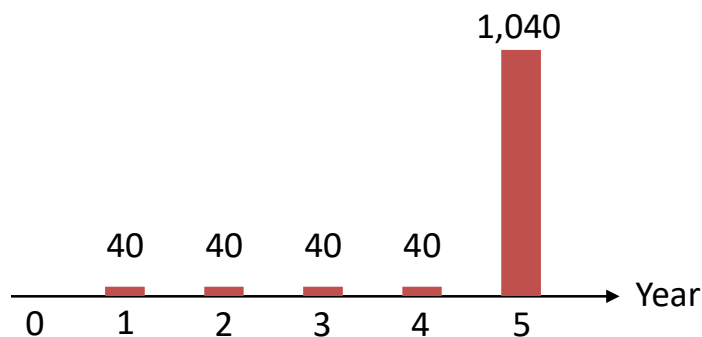
* When a corporation or government wants to borrow money from public markets on a long-term bases they usually issue bonds. Q: Why don't we just call them loans? A: Bond is a loan with many different lenders, broken into small pieces (individual bonds) that are transferable securities.

- Valuation
- Interest rate risk
- Default risk



Fixed-rate coupon bond

Example: Bond with 5-year *maturity*, \$1,000 *face value*, and 4% annual *coupon rate*, has this cash flow pattern:



Bonds are valued by calculating the present value of their cash flows

Example: Bond from previous slide. Q: Discount rate? A: Yield-to-Maturity (YTM) of bonds with similar risk is 5%

Year	Cash flow	PV
1	40	38.10
2	40	36.28
3	40	34.55
4	40	32.91
5	1,040	814.87
	Total PV =	956.71

Note: No default risk considered here

= value of the bond

Annuity formulas are handy with bond valuation

Annuity represents coupon payments, plus a single cash flow for face value in the end

$$PV = C \times \frac{\left[1 - \frac{1}{(1+r)^T}\right]}{r} + \frac{F}{(1+r)^T}$$

where C is the fixed coupon payment, T is the total number of periods, F is face value, and r is the discount rate

Bond's Yield-to-Maturity (YTM)

Insert bond cash flows into the valuation formula, subtract current acquisition cost (market price), make that equal to zero, and solve for an unknown r

- This is the bonds YTM; i.e., it's the IRR of the bond cash flows if you invested with current market price

What's the point of valuing a bond if you can just look up the market price?

- When you are valuing a bond with no market price, a new bond for example; Or planning financing

Why is discount rate (YTM) different from coupon rate?

The coupon rate is fixed at bond issuance, set equal to YTM of similar bonds

- Bond's market value is close to face value at first

But over time the market environment changes (e.g., the FED might change short-term rates)

- Expected (= required) returns change, and so bond market prices change
- Bonds' market prices deviate from face values, and their YTM's deviate from coupon rates

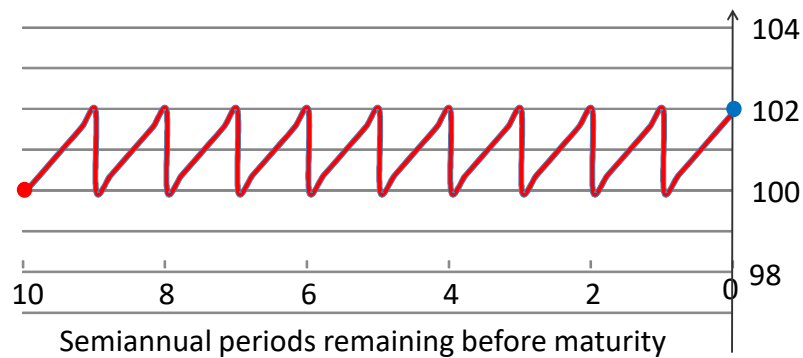
Bond risk 1: Interest-rate risk

- Fluctuations of market interest rates cause bond prices to change
- Bonds with longer maturities are more sensitive

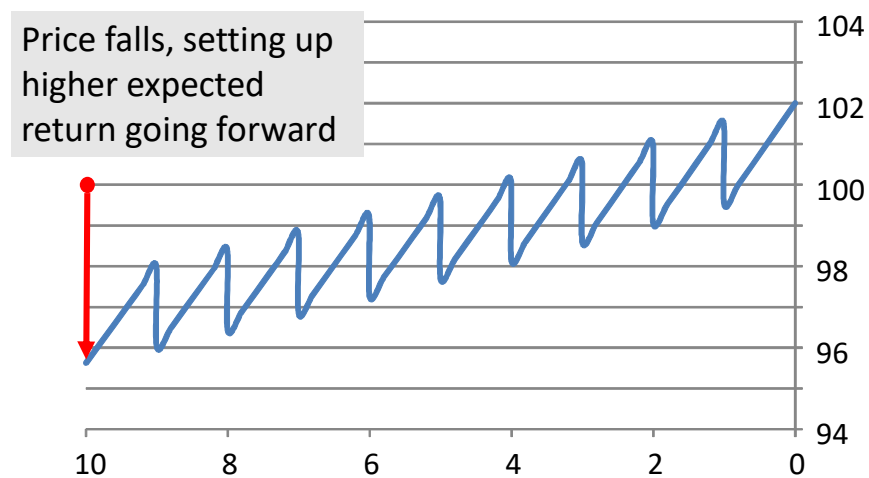
Bond value over time if no change in YTM

5y semiannual (6m) bond, $F = 100$, $C = 4\%$, YTM 4%

Value now? **\$100.00** And just before maturity? **\$102.00**



If YTM jumped from 4% to 5% right now



“Bond prices and yields move in opposite directions”

Sentence often found in financial media to remind readers and viewers of this fundamental relationship

– It’s true

...though sometimes the media still gets it wrong:

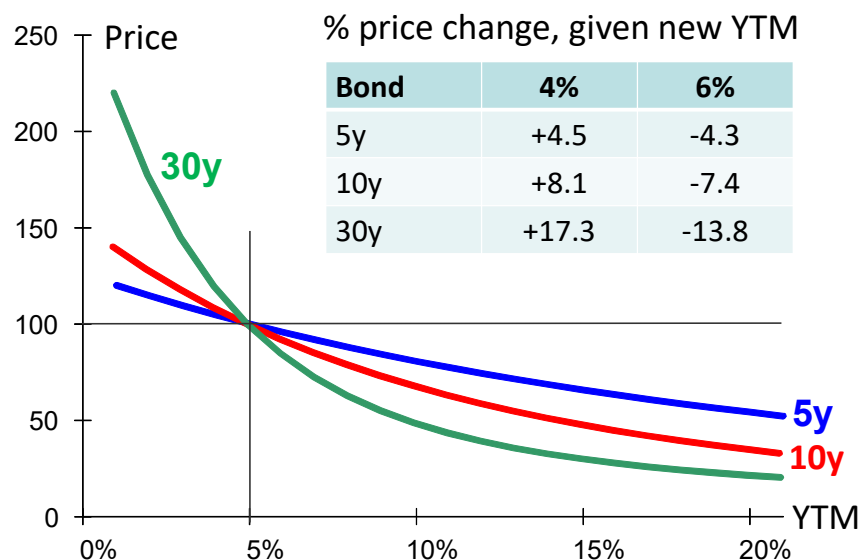
“Fannie and Freddie mortgage bonds had been trading well above their face value because so few people were refinancing, keeping returns on the bonds high.”

- New York Times, Aug 25, 2011

What edit would make the above statement correct?

→ change either 1) “returns” to “prices”, or 2) “High” to “low”

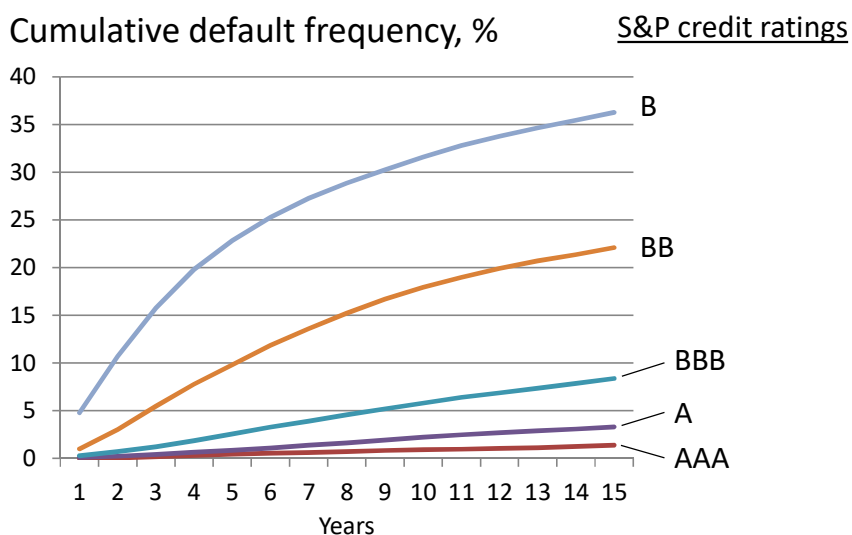
Bond prices fall when required returns rise, and the effect is proportional to maturity



Bond risk 2: Default risk

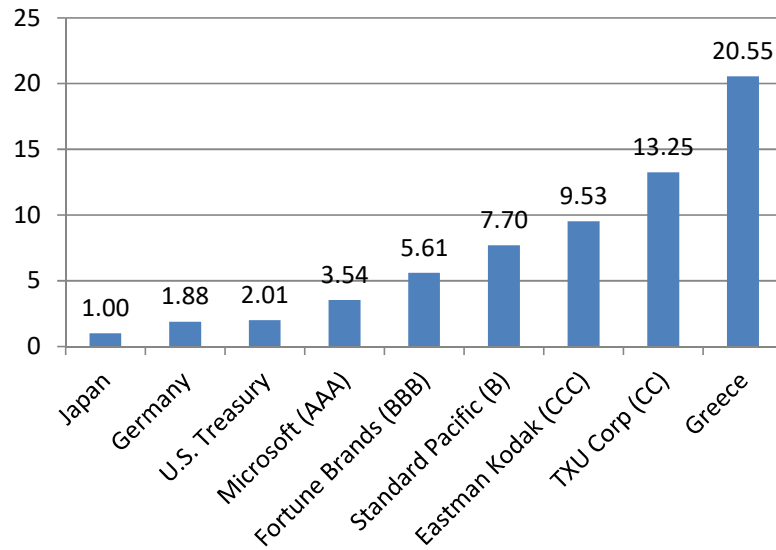
- For bonds, *risk-free* means no default risk (e.g., US treasuries)
 - No escaping from interest rate risk though
- All bonds have default risk
 - Bond issuer *defaults* on payments, i.e., fails to pay in full
 - Bonds of certain governments are thought to have practically no default risk

Bonds having default risk may not be paid back, in part or full



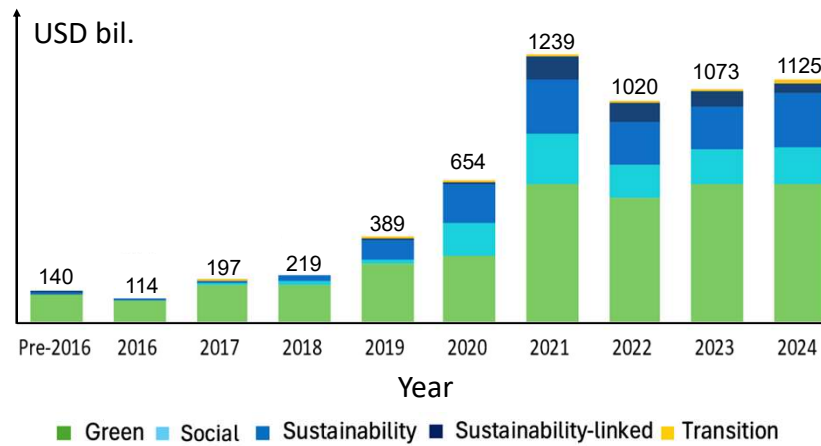
Source: Standard and Poor's

YTM's at the height of the European debt crisis in 2011



Sustainable fixed income instruments

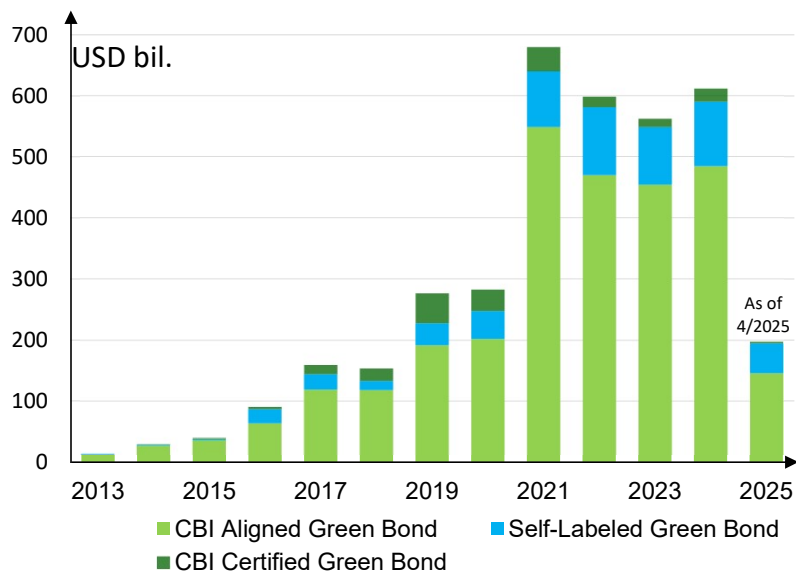
Global labeled sustainable bond issuance



World Bank, 2025, "Labeled Sustainable Bonds Market Update February 2025".

Green Bonds

Green bond issuance



Data (15/05/2025): LSEG

Green bonds

Proceeds committed to environmental and climate-friendly projects

- Self-labeled green bond is designated as “green” by the issuer without external verification or certification
- CBI Aligned green bond is aligned with the Climate Bonds Initiative (CBI) criteria
- CBI Certified green bond is additionally certified by a third-party to ensure CBI compliance

Climate Bonds Standard and Certification Scheme

CBI green bond investments are consistent with the 1.5°C limit in Paris Agreement

Sector-specific eligibility criteria

Establish benchmarks for specific sectors and help identify projects that support sustainable business

Why companies issue green bonds?

Proceeds from green bonds are restricted to green projects, which limits companies' investment policies

Certification as a green bond increases compliance and administrative costs

Flammer 2021 study*: certified and non-certified corporate green bonds, 2013-2018

* Flammer, Caroline, 2021, "Corporate green bonds", Journal of Financial Economics 142, 499-516.

Signaling argument

Information asymmetry between investors and management

Issuing green bonds signals company's commitment to environment

- Companies hope to attract green capital
- Positive market reaction
- Among public firms, average green bond issue is \$260 mil. (0.8% of total assets)

Flammer, Caroline, 2021, "Corporate green bonds", *Journal of Financial Economics* 142, 499-516.

Signaling argument

	CAR % [-5, 10]*
Panel A. Certified vs. noncertified	
Certified green bonds ($N = 192$)	0.710**
Noncertified green bonds ($N = 192$)	0.268
Panel B. First-time issue vs. seasoned issue	
First-time green bond issue ($N = 169$)	0.798**
Seasoned green bond issue ($N = 215$)	0.246
Panel C. Financial materiality of the environment	
SASB score above median ($N = 172$)	0.699***
SASB score below median ($N = 212$)	0.318

* Cumulative abnormal return (CAPM alpha) from days -5 to +10 around green bond issue announcement

Flammer, Caroline, 2021, "Corporate green bonds", *Journal of Financial Economics* 142, 499-516.

Greenwashing argument

Companies issue green bonds to portray as environmentally responsible, but without taking tangible actions

- Selective disclosures, misleading visual imagery, dubious eco-labels

CBI Green bonds account only < 4% of the market (1

Flammer (2021) finds environmental improvement post-issuance, rejecting greenwashing argument

¹LSEG.

Greenwashing argument rejected?

	Environmental performance			
	Environment rating		CO ₂ emissions	
	(1)	(2)	(3)	(4)
Green bond	6.118** (2.438)		-10.898*** (4.101)	
Green bond (pre-issue year)		1.333 (2.502)		1.083 (4.229)
Green bond (short-term, 1 year)		4.079 (2.663)		-7.667 (4.879)
Green bond (long-term, 2+ years)		7.034** (3.286)		-12.977** (5.325)
Firm fixed effects	Yes	Yes	Yes	Yes
Country-year fixed effects	Yes	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes	Yes
Observations	1466	1466	1196	1196
R-squared	0.88	0.88	0.90	0.90

Flammer, Caroline, 2021, "Corporate green bonds", *Journal of Financial Economics* 142, 499-516.

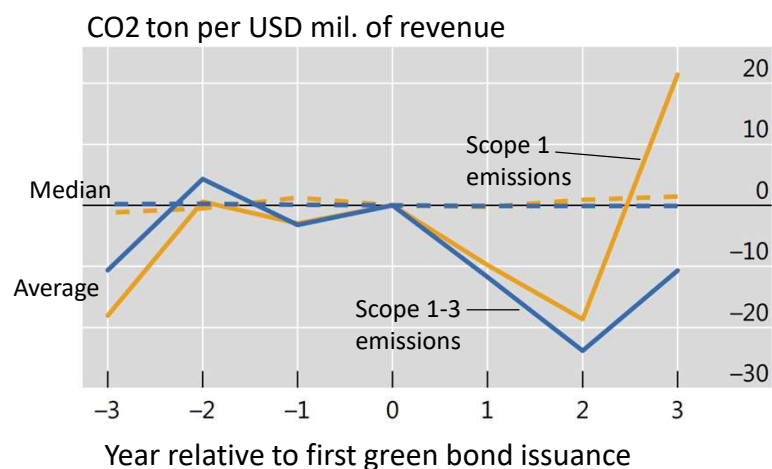
Mixed views on the environmental commitment

Flammer (2021) concludes that corporate green bonds serve as a credible signal of companies' commitment toward the environment

However, Ehlers, Mojon and Packer (2020) find there to be no strong evidence that green bond issuance is associated with any reduction in carbon intensities

Ehlers, Torsten, Benoit Mojon, and Frank Packer, 2020, "Green bonds and carbon emissions: exploring the case for a rating system at the firm level", *BIS Quarterly Review*, September.

Greenwashing argument not rejected?



Ehlers, Torsten, Benoit Mojon, and Frank Packer, 2020, "Green bonds and carbon emissions: exploring the case for a rating system at the firm level", *BIS Quarterly Review*, September.

Can green bonds lower the cost of debt financing?

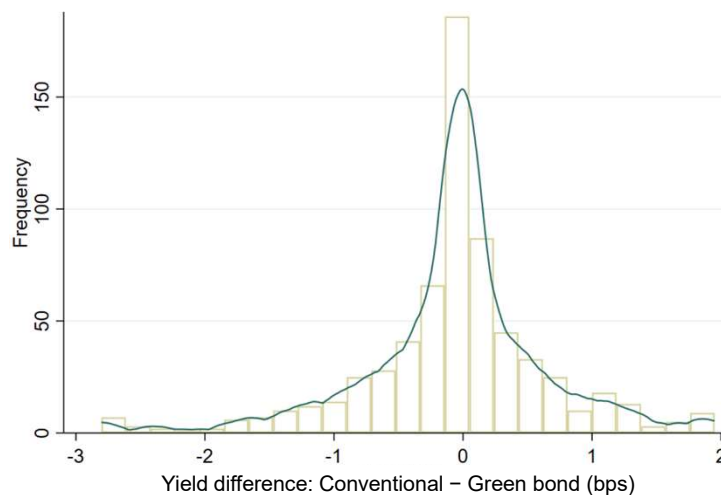
One might expect investors to be willing to pay an extra, so called “greenium” to acquire green bonds

- Sacrificing a portion of financial return to derive non-financial value
- No pricing difference between green bonds and quasi-identical brown bonds by the same issuer⁽¹⁾

Qualitative evidence reveals that investors are seeking for competitive returns and would not invest in green bonds if the returns were not competitive⁽²⁾

1) Flammer, Caroline, 2021, “Corporate green bonds”, *Journal of Financial Economics* 142, 499-516; 2) Chiang, John, 2017, “Growing the US Green Bond Market: Volume 1: The Barriers and Challenges”, California State Treasurer.

Differences in yields of matched pairs of 658 Green and conventional bonds



Kapraun, Julia, Carmelo Latino, Christopher Scheins, and Christian Schlag, 2021, “(In)-Credibly Green: Which Bonds Trade at a Green Bond Premium?”, Proceedings of Paris December 2019 Finance Meeting.

Who gets lower cost of debt with green bonds?

Green bonds issued by governments, supranational entities, denominated in EUR and corporate bonds with very large issue sizes trade at lower YTM

- The investors' trust in green labels and the willingness to contribute to national environmental efforts is particularly high in common law countries
- Also, if the green bond is certified by an external reviewer with a good reputation yield tends to be lower⁽¹⁾

1) Allman, Elsa, and Brandon Lock, 2024, "External reviews and green bond credibility", *Journal of Climate Finance* 7.



Sustainability-linked bonds

Sustainability-linked bonds (SLBs) have a performance-based structure

Introduced in 2019 as a more flexible alternative to other sustainability-related bonds

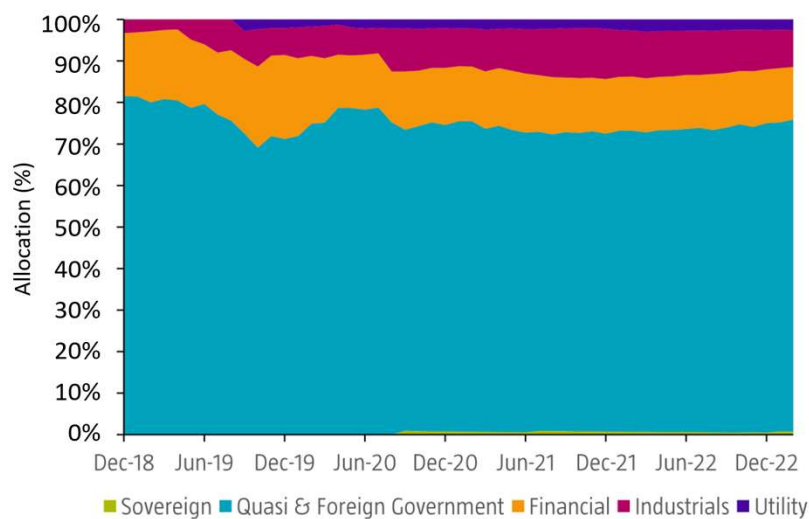
Proceeds can be used for any purpose as long as the predefined sustainability performance targets are met

Most common penalty mechanism is a coupon step-up

Also possibility for coupon step-down in the targets are exceeded

Mostly issued by government-linked institutions

Issuers of sustainability bonds



Vejarano, Gino B., and Laurens Swinkels, 2023, "Social, Sustainability, and Sustainability-linked Bonds", *Journal of Impact and ESG Investing* 4, 71-95.

Performance based structure is formed around the key performance indicators (KPIs)

KPI items (can have multiple one per SLB)	Count	Percentage
Greenhouse gas emissions	266	52.7 %
Renewable Energy	42	8.3 %
Energy Consumption/Efficiency	19	3.8 %
Increase in Women Board Members/Advisory Professionals	16	3.2 %
ESG Rating	12	2.4 %
Waste Management	11	2.2 %
Other	112	22.2 %
No information	27	5.3 %
Total	505	100 %

Tukiainen, Wilson, 2024, "A genuine commitment or a greenwashing trap: Investigating sustainability-linked bonds from a shareholder perspective", Master's thesis, Aalto University.

Pricing of sustainability-linked bond*

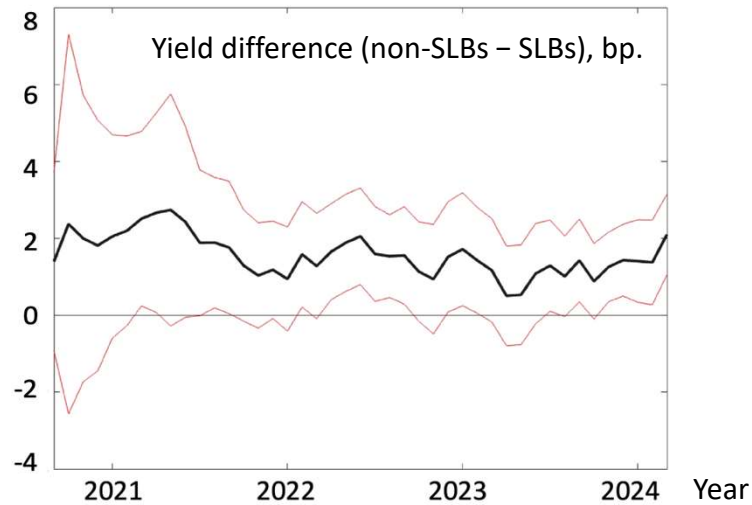
Investors accept a 1-2 bps lower yield

Probability of missing KPI target is 14% to 39%

Penalties relative to overall interest expenses is low, unlikely that it would have a material incentive effect on green transition

* Feldhütter, Peter, Kristoffer Halskov, and Arthur Krebbers, 2024, "Pricing of sustainability-linked bonds", *Journal of Financial Economics* 162.

SLBs have lower yield, stable through time



* Feldhütter, Peter, Kristoffer Halskov, and Arthur Krebbers, 2024, "Pricing of sustainability-linked bonds", *Journal of Financial Economics* 162.

Social, sustainability, and transition bonds

Definitions

Social bonds are targeted to achieve a specific positive social outcome

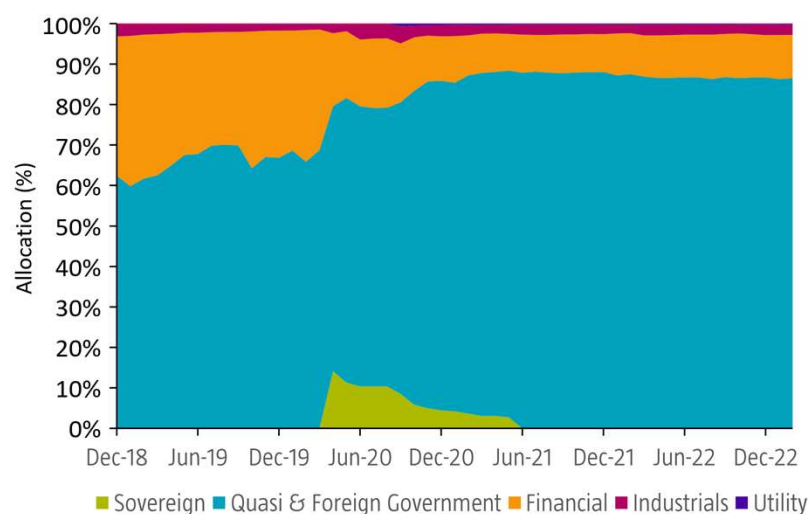
Sustainability bonds are used to finance a combination of green and social projects

Both are use-of-proceeds funds

Governments and government-related institutions have issued most social and sustainability bonds

– Tend to have higher credit qualities

Issuers of social bonds



Vejarano, Gino B., and Laurens Swinkels, 2023, "Social, Sustainability, and Sustainability-linked Bonds", *Journal of Impact and ESG Investing* 4, 71-95.

An Example: IFC - \$2 Billion Social Bond

To support low-income communities in Emerging Markets

Largest US dollar denominated social bond issued by supranational

Total deal size of \$11 billion

Maturity: 3 years; Rating: AAA

Reoffer vs. Benchmark:

+8 bps over 3y US Treasury bond



Transition bonds

Used to fund a firm's transition towards a reduced environmental impact or to reduce their carbon emissions

– E.g., a coal-mining firm wants to shift to more sustainable business practices

Enables firms that do not qualify to issue green bonds to obtain sustainable-related financing

Questioning on do we need a separate transition bond framework?

Overall green debt financing challenges

No universally accepted standards have been adopted which raises the concern for greenwashing

- In China, which accounted for 39 % of total issuance in 2016, the definition (green bonds) is more lax; E.g., can use up to half of proceeds to repay bank loans and in general working capital¹

Slowdown in green transition

1) Morgan Stanley, 2024, "Behind the Green Bond Boom"

Private Equity (PE) & Venture Capital (VC)

- For green projects

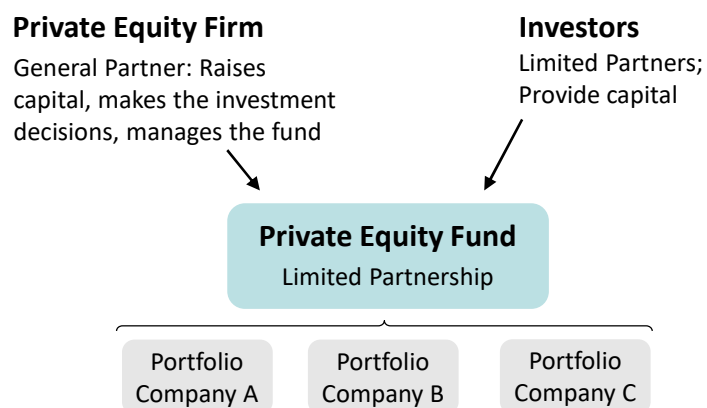
What is private equity?

Controlling stake equity investment in companies that are not publicly listed

Active ownership to increase target's value

Often use debt financing to leverage ROE (Leveraged buyouts: LBOs)

Private equity fund structure



What is venture capital?

Minority stake equity investment in early-stage companies

Active participation in target company

Evidence on venture capital performance is mixed, it varies based on sample period and dataset used

Do private equity / VC investors accept lower expected returns in exchange for impact?

[Last time we talked about public equity investors]

Theory: Ex ante, in random utility/willingness-to-pay models, investors accept 2.5-4 pp. lower internal rates of return (IRRs) for impact funds

Empirics: Ex post, impact funds earn 5 pp. lower IRRs than traditional VC funds

*“Investors derive nonpecuniary utility from investing in dual-objective Venture Capital (VC) funds, thus sacrificing returns” **

* Barber, Brad M., Adair Morse, and Ayako Yasuda, 2021, “Impact investing”, *Journal of Financial Economics* 139, 162-185.

Conclusion

End of lecture series on green transition investment appraisal and financing

Now you see how green transition projects are similar to, or different from, other projects

- You have taken the first steps to the readiness to do investment appraisal and assess financing instruments

Next, important to develop your own example of a green transition project and submit for evaluation

In the meantime, any questions are welcome!