The Price of Emissions: Carbon Risk in the European Equity Market

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The Three What's of this Paper

1. What is it?

Investigate the pricing of carbon risk using two novel ETS-carbon risk measures

- Forward-looking & market-based:
  Sensitivity to change in the forward convenience yield of EU ETS carbon futures
- Realized & accounting-based: Firm-level ratios of carbon expense to accounting profits

2. What is new?

- Buying high vs low carbon risk gives a significant premium for the market-based proxy
- Carbon expenses can be non-trivial
- The associated carbon risk premium is positive but not significant

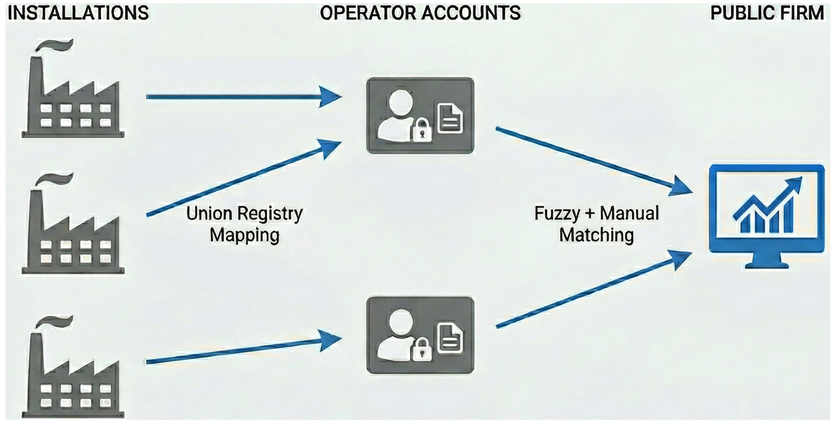
3. So what?

- Investors price the expectation of future carbon costs
- But the realized financial impact has yet to translate into a discernible risk premium

EU ETS and Data Construction

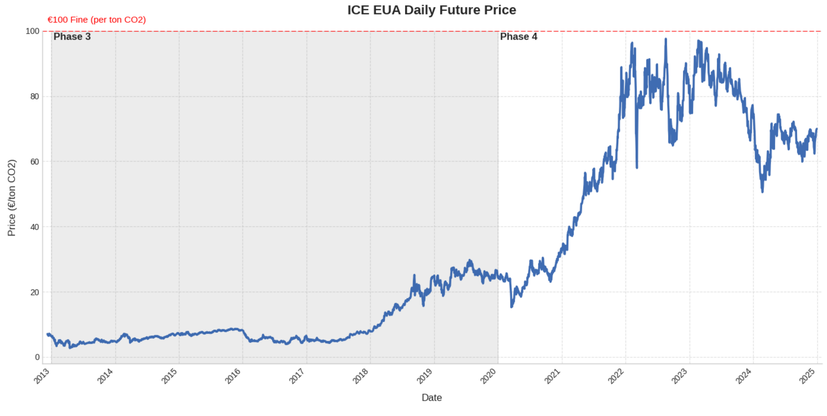
Mapping from Regulated Body (Installations) to Listed Stocks

Audited installation level emission and surrender data



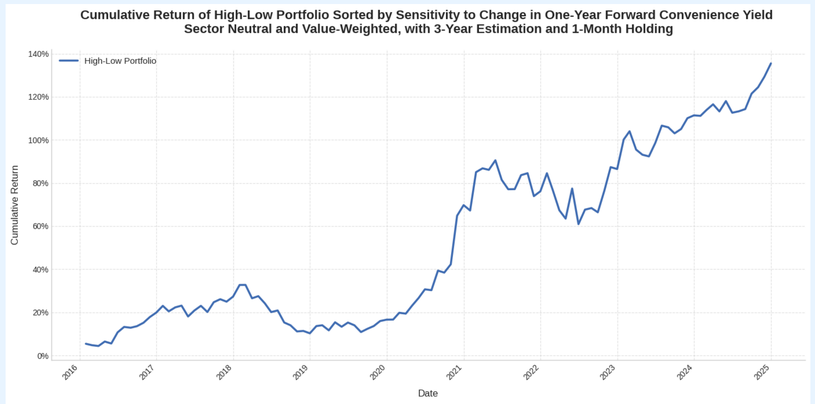
Carbon Price Movement: from single digit to over 80 in 12 years

Observable carbon price dynamics for future contracts with different maturities



Forward-looking & Market-based: Carbon Convenience Yield

Monthly Carbon Risk Premium w.r.t $\beta_i^{\Delta cy}$: 0.85% (t-stat 2.35); Alpha 1.00% (t-stat 2.70)

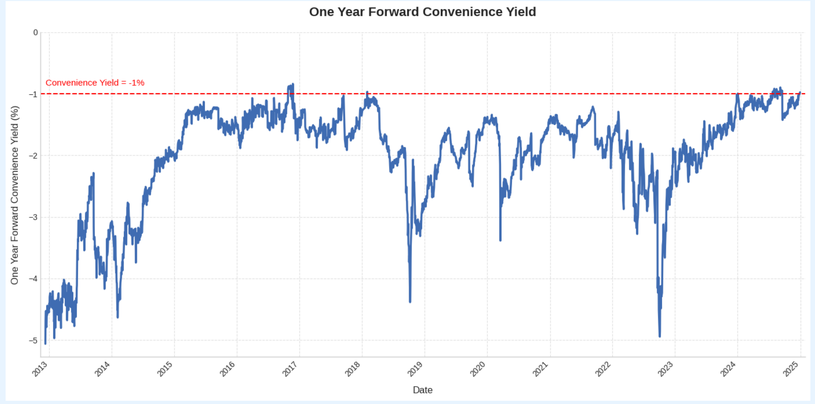


Cost of Carry Model: Linking Spot and Future Prices in Commodity Markets

$$F_{t,T} = S_t \times e^{(r_{t,T} + sc_{t,T} - \mathbf{cy_{t,T}})(T-t)}$$

Allowances are fully bankable, with no need for storage, and not tied to production.

Not relate to operation but market's expectations of future regulatory conditions



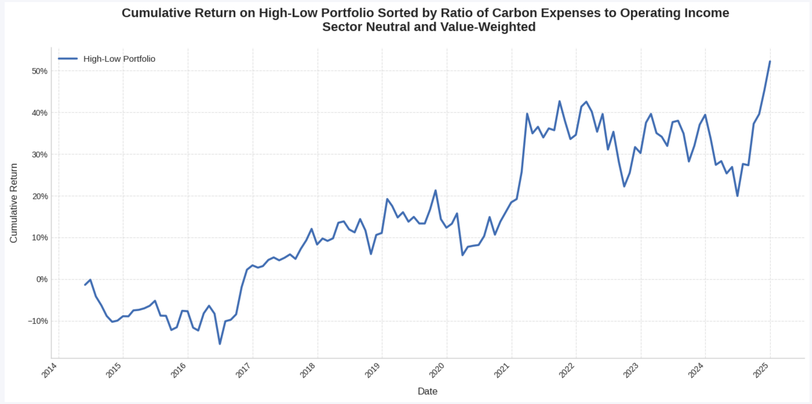
Carbon Risk Premium Portfolio w.r.t Sensitivity to Change in Carbon Convenience Yield

Estimate betas to the change in forward convenience yield, then sort into portfolios.

$Return$	α	MKT	SMB	HML	RMW	CMA	MOM	R_{Carbon}	R_{Oil}
STOXX 600									
0.85	1.00	0.29	0.03	0.32	-0.37	-0.21	-0.23	-0.06	-0.02
[2.35]	[2.70]	[3.42]	[0.20]	[1.79]	[-1.05]	[-0.49]	[-2.14]	[-3.29]	[-0.90]
STOXX 600, controlling for market return									
0.62	0.63	0.01	0.17	0.19	0.12	-0.12	-0.10	-0.02	0.04
[2.26]	[2.05]	[0.17]	[1.41]	[1.35]	[0.50]	[-0.40]	[-0.91]	[-1.14]	[1.30]
STOXX 600 with ETS Exposure									
0.89	0.96	0.23	-0.05	0.38	-0.44	-0.42	-0.08	-0.07	0.01
[1.99]	[2.36]	[2.29]	[-0.24]	[1.41]	[-1.13]	[-0.93]	[-0.52]	[-2.68]	[0.40]
Carbon Solution Providers									
1.61	2.14	-0.28	0.39	-0.19	-1.19	0.18	-0.21	-0.04	-0.02
[2.27]	[2.07]	[-1.54]	[0.95]	[-0.30]	[-1.93]	[0.27]	[-0.68]	[-0.82]	[-0.54]

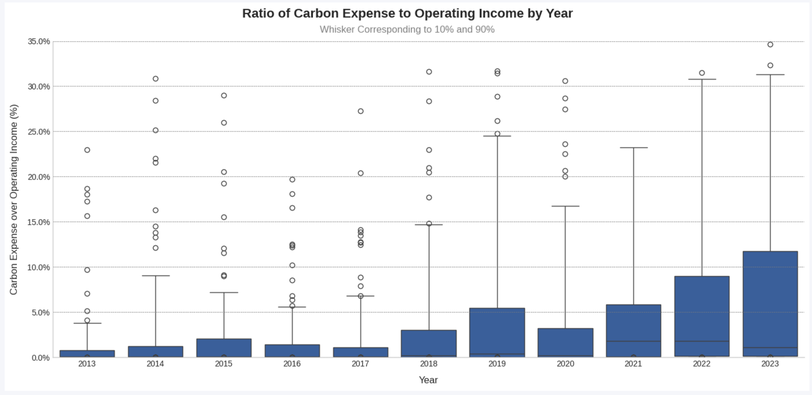
Realized & Accounting-based: Carbon Expense Ratios

Monthly Carbon Risk Premium w.r.t Carbon Expense/Operating Income: 0.38% (t-stat 1.44)



Carbon Expense/Operating Income: From to 12.4% for Top Quartile in FY 2023

In heavily regulated sectors such as Materials, this ratio could reach 50% in top quartile.



Key Takeaways

We propose two new measures of carbon risk directly implied from EU ETS:

- Forward-looking, market-based proxy from forward carbon convenience yield
- Realized, accounting-based proxy from firm-level carbon expenses

They capture different aspects of carbon exposure:

- Change in convenience yield reflects market expectations on future allowance pricing
- Carbon expense ratios reflect firm-specific direct financial carbon compliance burden

Both proxies are economically significant:

- Firm's sensitivity to the change in carbon convenience yield carries a risk premium
- Carbon expense ratios are not yet priced in the equity market

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