Scope 3 capital design for carbon-emissions-facilitation tax risk

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Context

- Climate change is a problem recognized among the majority of policymakers and officially by governments (e.g. "Fit for 55", NZBA). It requires actions in the short term, Net Zero 2050.
- Despite recent progress, current rates of implementation are too slow. Emissions in 2030 implied by governments in 2021 make it likely [1] that warming will **exceed** 1.5°C before 2100 (IPCC 2023 report [11]).
- Currently implemented CPIs are not insufficient. Their impact still dwarfs the impact of excise taxes and subsidies: USD 102 billion against USD 1 trillion (World Bank 2023 report [12]).

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- To limit global warming all sectors of society need to decarbonize and collectively reach net-zero emissions by 2050 (PCAF [9]).
- In the Euro area, carbon taxes are largely focused on specific fuels and industrial emissions. ETSs mostly focus on stationary energy and large industrial facilities (see [8]).
- In line with Net Zero 2050 governments might introduce a carbon tax hitting indirect emissions. This is a climate policy risk. Could financials be affected?
- The 15^{th} category of Scope 3 emissions is about investment activities.
- Partnership for Carbon Accounting Financials (PCAF) provides accounting and reporting standards to be applied in the financial industry for GHG.
- Should financial institutions and regulators be worried about this event? How big are the Risk-Weighted-Assets of climate policy risk?

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Mathematical model (see [10])

- A pricing model that combines the theory of markets with dividends of [4, Ch. 6] and the ideas of [3] and [6].
- A timeline $[T_0, T]$ and a probability space $(\Omega, \mathcal{F}, Q)$

$$\Omega = \Omega^M \times \Omega^{co} \longleftrightarrow \omega = (\omega^M, \omega^{co})$$

Market risks:

- Brownian $W_t(\omega^M)$ for IR risk. Single jump process $J_t^B(\omega^M)$ and $J_t^C(\omega^M)$ for defaults risks.
- $(\mathcal{F}_t^M)_{t\in[T_0,T]}$ information generated by these noises.

CPI tax-risks:

- Tax size risk: $W_t^F(\omega^{co})$ and $W_t^S(\omega^{co})$ Brownian motions that drive the size of the tax. Single jump process $J_t^{co}(\omega^{co})$ for tax introduction risk.

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Scope 3 tax

- To a risky contract $\widehat{V}$ we associate a process, the instantaneous tax rate $\mathcal{T}$.

$$\mathcal{T}_t := g(V_t, \mathrm{BS}_t, F_t) J_t^{co}, \qquad g = x_t \beta_t \frac{\max(V(r_t), 0)}{\mathrm{BS}(S_t)} E_t F_t$$

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- $dF_t / F_t = \mu_t^F dt + \sigma_t^F dW_t^F$: mitigation cost for one tonne of CO2e emissions.
- E_t: C's emissions per year (generally Scope 1 plus Scope 2).
- Net participation in counterparty's balance sheet:
  - V risk-free value of the contract.
  - BS equals EVIC (enterprise value including cash).

$$\mathrm{BS}_t := S_t \times (\#\text{ outstanding shares}), \qquad S_t : W^S\text{-driven positive Itô dynamic.}$$

- x_t, β_t: scaling factors. Gradual introduction and progressive emissions reduction.

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$$\widehat{V}(t, P, \omega^{co}) = V'(t, P) - G(t, T, P, \omega^{co})$$

with V' CVA-DVA-FVA adjusted price and

$$G(t, T, P_t(\omega^M), \omega^{co}) = \mathbb{E}\left[\int_t^T e^{-\int_t^u r_s^B + \lambda_s^C \, ds} \mathcal{T}_u(P_u(\omega^M), \omega^{co}) \, du \,\middle|\, \sigma(\mathcal{F}_t^M, \mathcal{F}_T^{co})\right].$$

- Mathematically : $\widehat{V}_t$ is predictable wrt $(\sigma(\mathcal{F}_t^M, \mathcal{F}_T^{co}))_{t \in [T_0, T]}$. Information available about climate risks is incomplete (see [5]).
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Climate policy RWA

- Expected tax-loss accruing between t and T:

$$\mathrm{EL}(t,T) = \mathbb{E}\left[\int_t^T e^{-\int_{T_0}^u r_s^B+\lambda_s^C ds} g(V_u, \mathrm{BS}_u, F_u) J_u^{co} du \middle| \mathcal{F}_t\right].$$

- We defined the climate policy risk RWA as

$$\boxed{\mathrm{CPIC}(T_0,T) := \alpha \int_{T_0}^{(T_0+1y)\wedge T} \max_{t\in[T_0,s]} \mathbb{E}\left[\mathrm{EL}(t,T)\middle|\mathcal{F}_{T_0}\right] ds}$$

where α is a universal constant (e.g. $\alpha = 1.4$ in CCR capital). See [1, CRE 53.12] for a similar methodology.

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A numerical example

- In arrears IRS with annual transactions and maturity $T = 5, 10, 20$ years. Formulas taken from [7]
- Very ambitious policy:
  - x_t is deterministic and it equals 100% in 2040. Immediately high tax for later introduction.
  - The cost of carbon is random and **time-dependent** (unusual). Carbon tax based on ETS allowances price.

Example	million tonnes / year	Balance Sheet (milions USD)
Airline	2.7	2,600
Shipping	10.8	3,700

- Mean value $x_t\beta_t \simeq 47\%$ in the timeline $[2023, 2050]$.
- $\lambda^{co}_{2030} = 1042$ bps or $\lambda^{co}_{2040} = 413$ bps.

- 1% one-year counterparty's probability of default.
- Counterparty balance sheet: GBM with $\mu^S = 10\%$ and $\sigma^S = 20\%$.
- HW model: 3.2% flat initial curve, 4% volatility, 2% mean-reversion speed, and 4% long term mean. See e.g. [2].

Mitigation cost

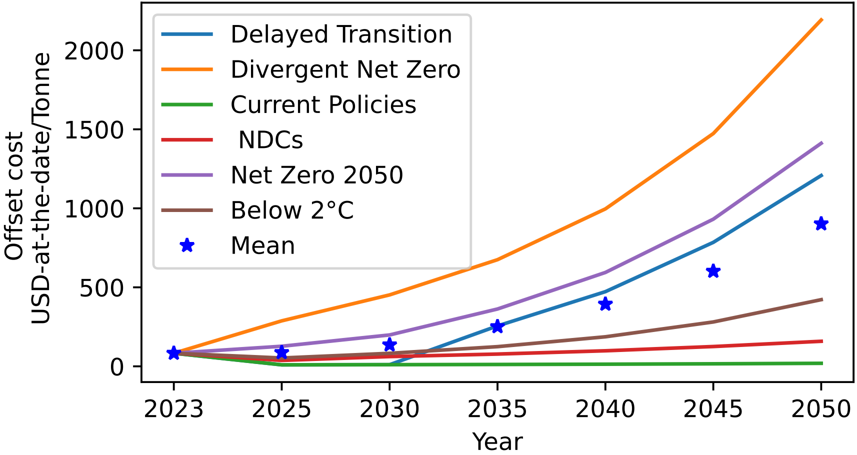

Figure: NGFS inflation adjusted carbon mitigation price projections using REMIND-MAgPIE 3.0-4.4 and standard scenarios. For these data, region = World, and the initial value is set as 82.91 USD. Mitigation cost per year has order 10% of count.'s BS.

Results

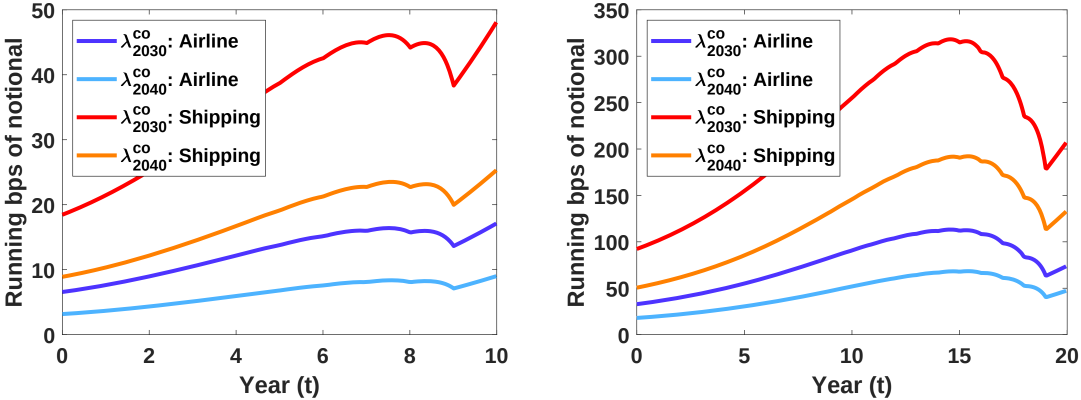

Figure: Expected-unexpected loss for IRS with different maturities. For 20-year maturity, at around $\frac{3}{4}$ of the life of the contract, the bank has the impression to pay up 3% the value of the notional in Scope 3 taxes every year.

How big α should be?

Example	Maturity (Years)	CPIC (bps of not.)	(CPIs $\leq$ CPIC) (probability)	97.5-perc. (bps of not.)	ratio to get to 97.5-perc.
A	5	2	91%	25	13
A	10	33	86%	319	10
A	20	379	82%	2990	8
S	5	6	90%	70	12
S	10	92	86%	897	10
S	20	1066	82%	8404	8

Table: Given future histories we consider whether CPIC is sufficient to absorb the CPI-introduction losses. For $\alpha = 1$ the CPIC is effective over 80% of the times. To increase CPIC effectiveness to 97.5% the value of α would need to be roughly 10. Hazard rate is $\lambda^{co}_{2040} = 413$ bps.

Climate policy risk capital against SA-CCR capital

Example	Maturity (Years)	CPIC (bps of not.)	CPIC (run. bps of not.)	SA-CCR (bps of not.)	SA-CCR (run. bps of not.)	ratio CPIC / SA-CCR
A	5	2	0	25	5	0.08
A	10	33	3	44	4	0.75
A	20	379	19	71	4	5.35
S	5	6	1	25	5	0.24
S	10	92	9	44	4	2.09
S	20	1066	53	71	4	15.06

Table: CPIC-capital compared with SA-CCR capital (i.e. SA-CCR RWA x 8% with 100% risk weight, so roughly BBB rating with AIRB). Hazard rate is $\lambda^{co}_{2040} = 413$ bps, and the capital scaling factor for CPI capital is set to $\alpha = 12.5$.

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Thank you for your attention!