A Scenario-Based Quantification of Portfolio Financial Loss From Climate Transition Risks

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Outline

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Sources of Transition Risks in the Cash Flows Channel

- When transition concerns increase unexpectedly, market expectations about future cash flows may shift
- Markets may revise their assumptions from a continuation of current policies to a stricter transition towards a low-carbon economy
- In such a scenario, "brown" firms could see diminished future cash flows due to declining demand and rising carbon costs, while "green" firms may benefit

Sources of Transition Risks in the Cash Flows Channel

- We adopt a model-based approach using climate scenarios to investigate the potential losses in firm value due to changes in expectations about future cash flows
- With a free cash flows model, we decompose the likely sources of changes in expected cash flows, offering insights into how an unexpected strengthening in climate transition concerns could lead to value losses

This decomposition allows us to understand the repricing effects of unexpected changes in transition concerns through two main dimensions:

- The net carbon tax effect
- The revenue effect

The Importance of the Revenue Dimension

The last column in Table 1 shows that the revenue dimension is the main source of transition risks in 8 out of 10 TRBC sectors.

- Sectors such as Utilities, Energy, Basic Materials, and Industrials exhibit the highest overall losses.
- Utilities face the largest potential value loss, up to 57.85% (see Table 1).

The Importance of the Revenue Dimension

Sector	Total (%)	From net carbon tax (%)	From revenue (%)	Revenue / carbon tax ratio
Utilities	57.85	22.24	35.6	1.60
Energy	33.09	12.36	20.73	1.68
Basic Materials	21.96	20.99	0.97	0.05
Industrials	9.81	4.85	4.96	1.02
Non-Cyclical Consumer	4.74	2.9	1.84	0.63
Financials	3.08	1.22	1.86	1.53
Healthcare	2.45	0.71	1.74	2.45
Telecoms	2.08	0.29	1.8	6.29
Technology	1.83	0.33	1.51	4.58
Cyclical Consumer	-1.57	1.68	-3.25	1.93
MSCI World	5.90	2.91	2.99	1.03

Table 1: Loss per sector

Green (Brown) Stocks Outperformance (Underperformance)

- Unexpected changes in transition concerns may lead to "winners" (stocks with negative losses) and "losers" (stocks with positive losses)
- Particularly visible in the Energy and Utilities sectors where both "winners" (stocks with negative losses) and "losers" can be found (see Table 2)
- While carbon dimension (Table 3) consistently has a negative impact (with positive losses), the revenue dimension distinctly separates "winners" from "losers" (Table 4)

Green (Brown) Stocks Outperformance (Underperformance)

Sector	Nber of stocks	Mean	Std dev	Min	Max	Q1	50%	Q3
Utilities	69	51.76	27.37	-97.51	71.09	49.54	58.92	67.28
Energy	59	30.77	22.06	-84.63	57.05	27.40	33.28	43.80
Basic Materials	88	21.97	20.22	-0.68	66.70	5.13	15.19	32.95
Industrials	215	8.40	13.06	-13.66	65.06	1.90	2.48	7.82
MSCI World	1287	9.23	16.97	-97.51	71.09	1.83	2.17	5.32

Table 2: Summary statistics by sector: total loss

Green (Brown) Stocks Outperformance (Underperformance)

Sector	Nber of stocks	Mean	Std dev	Min	Max	Q1	50%	Q3
Utilities	69	22.43	25.44	0.03	138.02	5.05	16.86	30.17
Energy	59	12.74	10.34	0.14	33.87	4.89	9.47	18.40
Basic Materials	88	20.34	20.29	0.09	64.37	4.03	13.56	32.01
Industrials	215	4.24	10.61	0.00	63.42	0.27	0.67	1.5
MSCI World	1287	4.66	11.74	0.00	138.02	0.08	0.43	2.26

Table 3: Summary statistics by sector: loss from net carbon tax

Green (Brown) Stocks Outperformance (Underperformance)

Sector	Nber of stocks	Mean	Std dev	Min	Max	Q1	50%	Q3
Utilities	69	29.33	31.89	-97.85	49.01	20.15	46.49	48.88
Energy	59	18.03	16.10	-85.03	39.93	23.16	23.25	23.27
Basic Materials	88	1.62	3.06	-17.35	21.89	1.62	1.63	1.63
Industrials	215	4.16	6.45	-15.21	18.35	1.65	1.65	1.65
MSCI World	1287	4.57	11.34	-97.85	49.01	1.65	1.74	1.81

Table 4: Summary statistics by sector: loss from revenue

Green (Brown) Stocks Outperformance (Underperformance)

We present the five stocks in the Utilities sector with the highest loss from revenue and the five stocks with the lowest loss (i.e., potential opportunity) in Table 5.

- The "browner" stocks (100% of revenue coming from brown technologies) all face a potential loss of 49% (due to the exposition to the same technology)
- On the other side of the revenue dimension, "greener" stocks represent a sizeable source of opportunities, with up to 97.85% of value gain for example
- Green (brown) stocks perform better (worse) than expected if transition concerns strengthen unexpectedly

Green (Brown) Stocks Outperformance (Underperformance)

Stock	From revenue (%)	Rank	Green revenue (%)	Brown revenue (%)
Elia Group SA/NV	49.01	Top 5	0.00	100.00
Redeia Corporación, S.A.	49.01		0.00	100.00
Exelon Corporation	49.01		0.00	100.00
Eversource Energy	49.01		0.00	100.00
Hydro One Limited	49.01		0.00	100.00
EDP Renováveis, S.A.	-97.85	Bottom 5	99.48	0.52
Chubu Electric Power Company, Inc.	-70.80		79.00	21.00
Northland Power Inc.	-60.51		71.16	28.84
Mercury NZ Limited	-53.91		66.26	33.74
Orsted A/S	-52.15		65.00	35.00

Table 5: Top 10 MSCI World constituents in the Utilities sector based on revenue impact

Carbon Intensity Doesn't Tell the Whole Story

- The (log of) Scope 1 carbon intensity relates – at least partially – to the loss from the net carbon tax (see Figure 1)
- We find out no relationship between Scope 1 carbon intensity and the loss from revenue
- Scope 1-2 carbon intensity displays a similar pattern (see the relationship in Figure 2)
- The relationship almost disappears when considering the Scope 3 emissions (see Figure 3)

Carbon Intensity Doesn't Tell the Whole Story

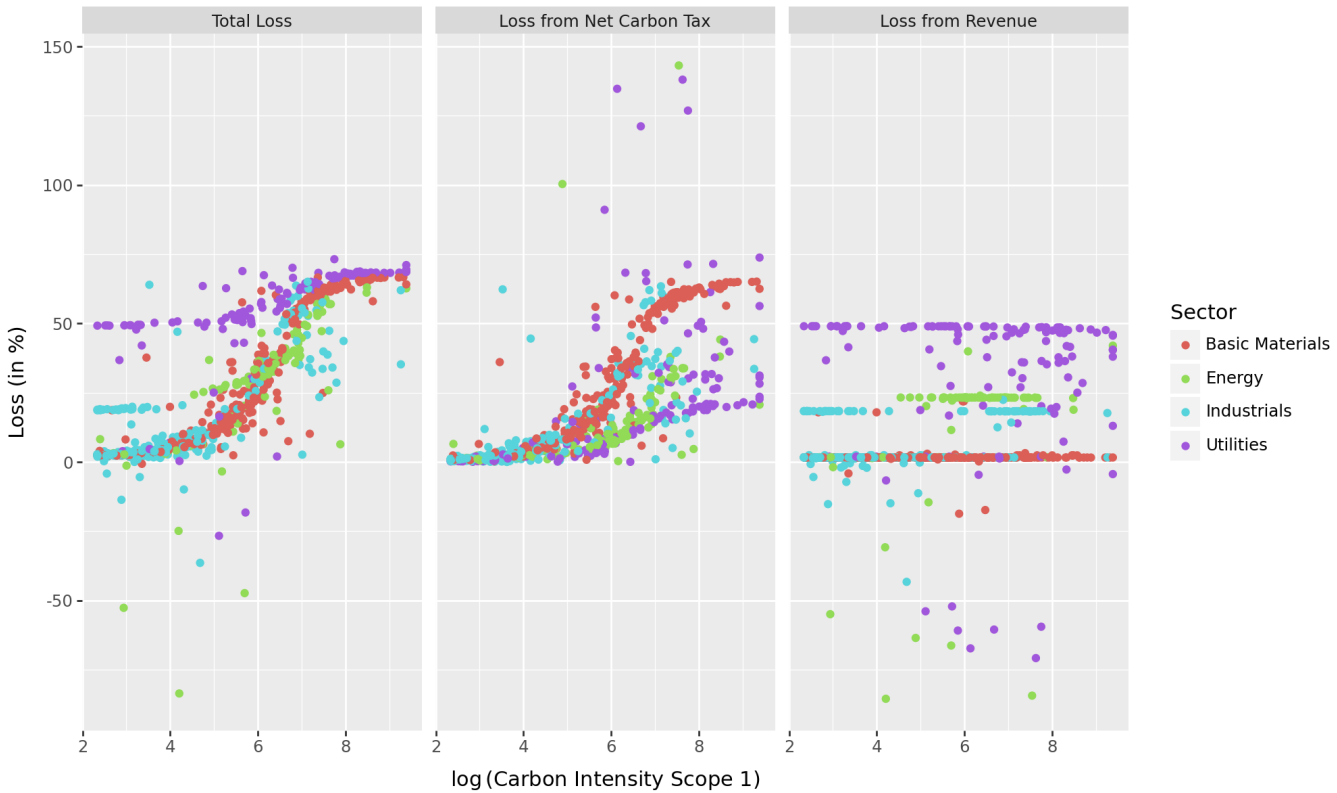

Figure 1: Relationship between carbon intensity and transition risks. Scope 1.

Carbon Intensity Doesn't Tell the Whole Story

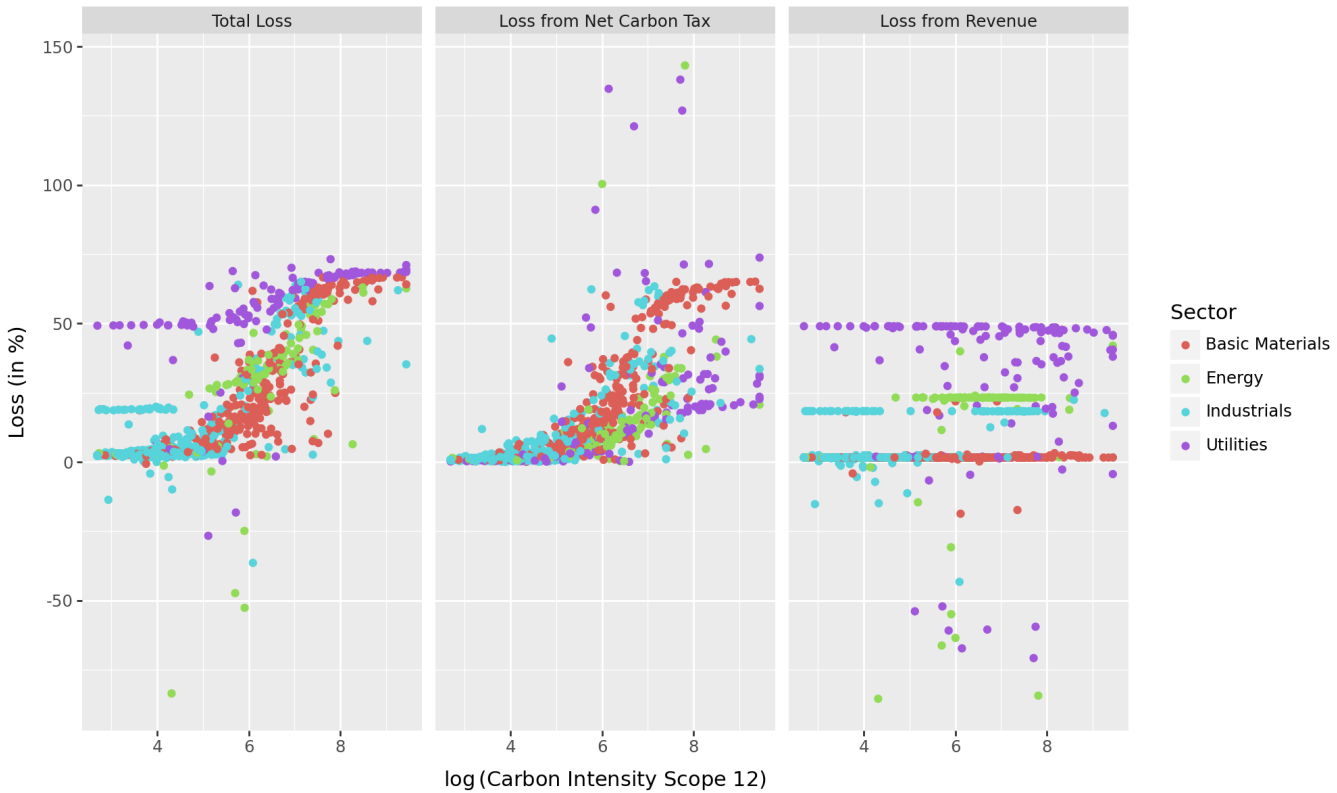

Figure 2: Relationship between carbon intensity and transition risks. Scope 1 and 2.

Carbon Intensity Doesn't Tell the Whole Story

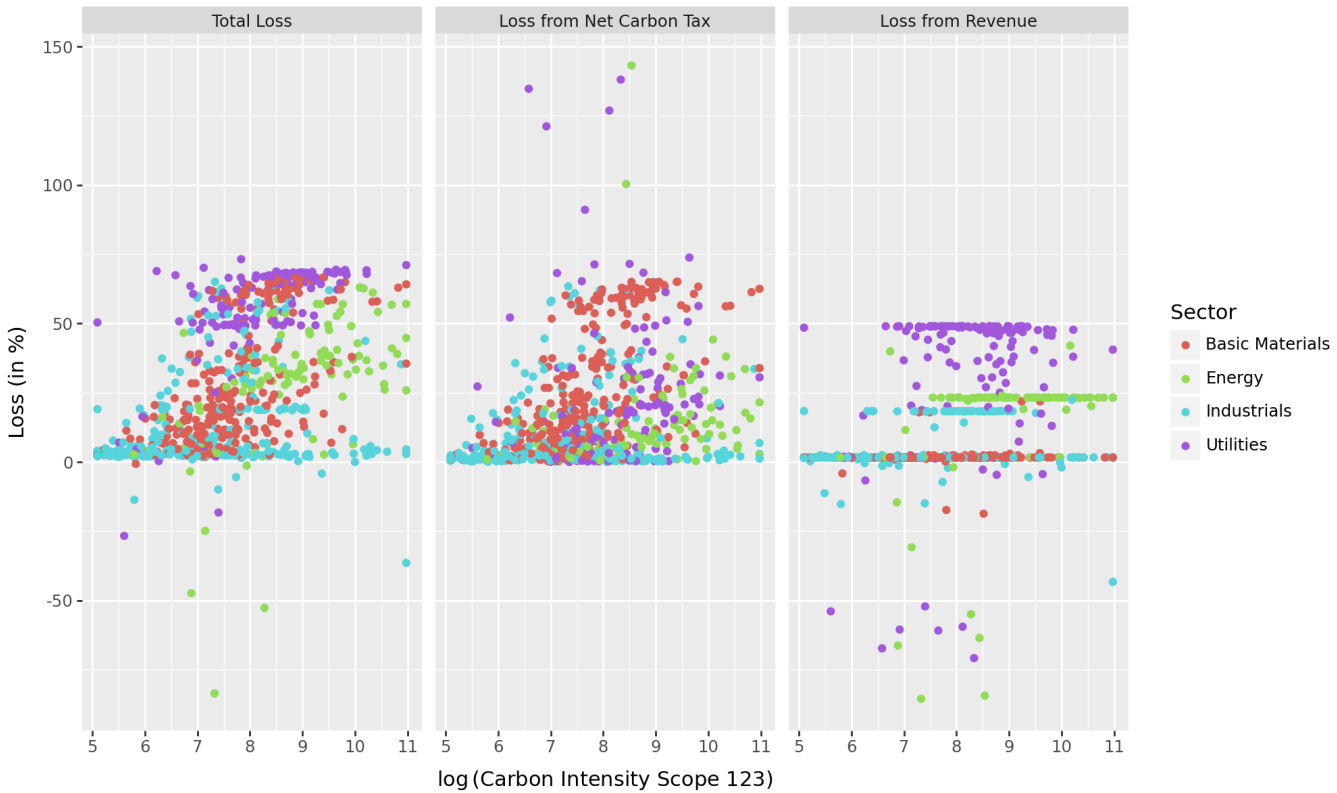

Figure 3: Relationship between carbon intensity and transition risks. Scope 1, 2 and 3.

Carbon Intensity Doesn't Tell the Whole Story

If traditional carbon intensity indicators fail to capture the revenue dimension of transition risks, what alternative can be used?

- Figure 4 explores the relationship between net green revenue (calculated as green revenue minus brown revenue) and the revenue dimension for the Energy, Utilities, and Industrials sectors
- Colours in Figure 4 identify the technology constituting the main source of revenue
- We observe a clear an intuitive relationship. In the Utilities sector for instance, stocks with the higher net green revenue are the clear "winner" of the transition (and vice versa)

Carbon Intensity Doesn't Tell the Whole Story

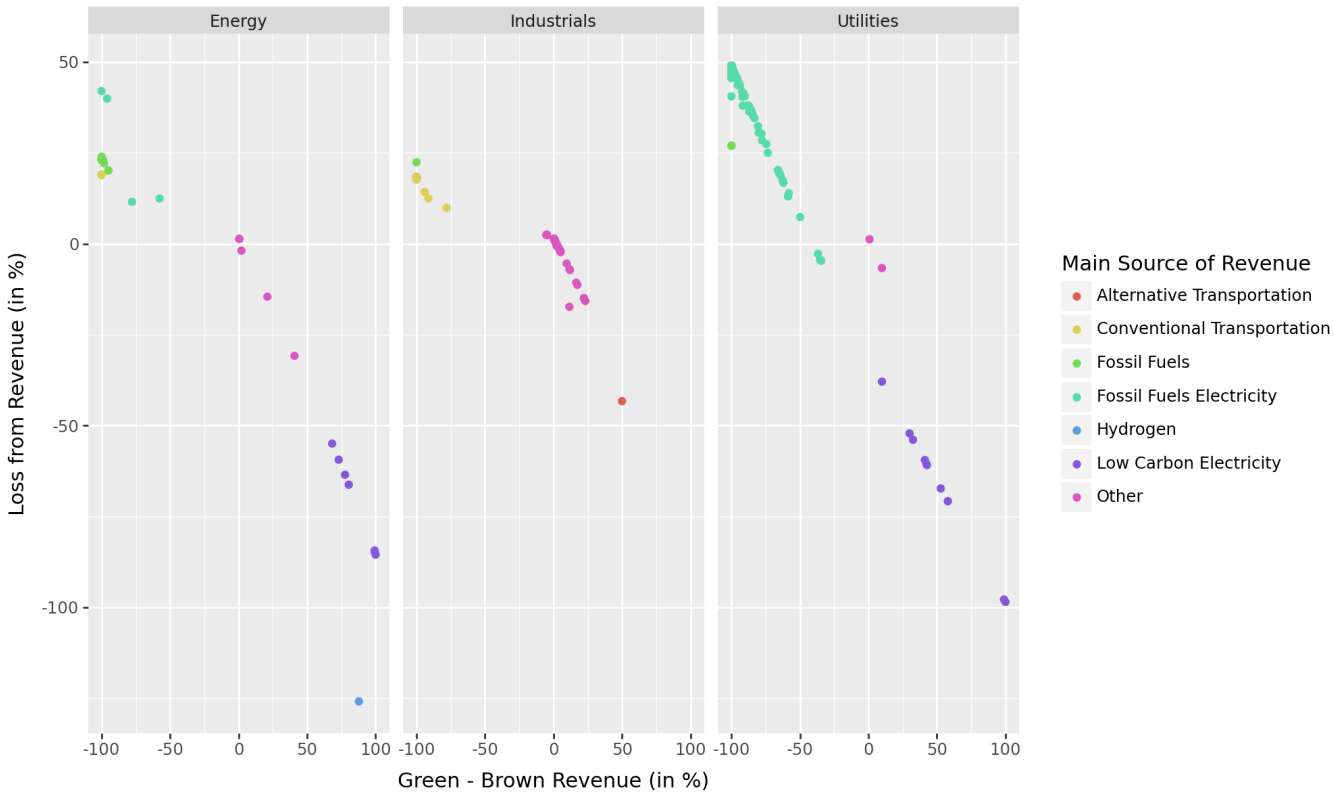

Figure 4: Relationship between net green revenue and transition risks.

Conclusion

- Unexpected changes in transition concerns can lead to significant value losses for firms
- The revenue dimension is the main source of transition risks in most sectors
- Green stocks outperform brown stocks in terms of revenue impact
- Carbon intensity alone does not capture the full story of transition risks

Thank You!
Any Questions?

Appendix: Cash Flow Model Overview

To model firm-level cash flows, let $\mathrm{CF}_{i,t}$ denote the cash flows of firm i at time t, under an expected transition scenario. We assume the following cash flow structure:

$$\mathrm{CF}_{i,t} = Y_{i,t}(1 - \omega_{i,t} - \theta - \tau - \rho) \tag{1}$$

where:

- $Y_{i,t}$ represents sales,
- $\omega_{i,t}$ is the carbon cost rate,
- θ is the operating cost rate,
- τ is the tax rate,
- ρ is the net investment rate.

Appendix: Carbon Cost Rate

The carbon costs rate, $\omega_{i,t}$, is modeled as:

$$\omega_{i,t} = \min(\sigma_i \times \Lambda_t, 1 - \tau - \theta - \rho) \tag{2}$$

where:

- σ_i is the carbon intensity of stock i,
- Λ_t is the carbon price.

Appendix: Sales Dynamics

Firm sales $Y_{i,t}$ are the sum of sales from individual products s:

$$Y_{i,t} = \sum_{s} Y_{i,s,0} \times \frac{Y_{s,t}}{Y_{s,0}} \tag{3}$$

where:

- $Y_{i,s,0}$ is the initial sales of product s for stock i,
- $\frac{Y_{s,t}}{Y_{s,0}}$ is the growth factor of the product's demand over time.

Appendix: Discounting Cash Flows

We discount the cash flows using the weighted average cost of capital (WACC):

$$\text{DCF}_{i,t} = \frac{\text{CF}_{i,t}}{(1 + \text{WACC})^t} \tag{4}$$

Assuming WACC remains constant, we focus on identifying the impact of transition risks on the discounted cash flows (DCF).

Appendix: DCF Sensitivity Analysis

We calculate the sensitivity of DCF to changes in the carbon cost rate $\omega_{i,t}$ and projected sales $Y_{i,t}$:

$$\frac{\partial \text{DCF}_{i,t}}{\partial \omega_{i,t}} = -\frac{Y_{i,t}}{(1+\text{WACC})^t} \tag{5}$$

$$\frac{\partial \text{DCF}_{i,t}}{\partial Y_{i,t}} = \frac{(1-\omega_{i,t}-\tau-\theta-\rho)}{(1+\text{WACC})^t} \tag{6}$$

These partial derivatives represent the sensitivity of the discounted cash flows to the carbon cost rate and sales.

Appendix: Cross Sensitivity of DCF

The cross-sensitivity of DCF with respect to both the carbon cost rate and projected sales is:

$$\frac{\partial^2 \mathrm{DCF}_{i,t}}{\partial \omega_{i,t}\, \partial Y_{i,t}} = -\frac{1}{(1+\mathrm{WACC})^t} \tag{7}$$

This captures the combined impact of changes in both $\omega_{i,t}$ and $Y_{i,t}$ on the discounted cash flows.

Appendix: Impact of Climate Scenarios on DCF

The impact on firm i's discounted cash flows due to climate scenarios can be expressed as:

$$\Delta \text{DCF}_{i,t}^{Y} = \frac{\partial \text{DCF}_{i,t}}{\partial Y_{i,t}} \times \Delta Y_{i,t} \tag{8}$$

$$\Delta \text{DCF}_{i,t}^{\omega} = \frac{\partial \text{DCF}_{i,t}}{\partial \omega_{i,t}} \times \Delta \omega_{i,t} \tag{9}$$

$$\Delta \text{DCF}^{Y \times \omega} = \frac{\partial^2 \text{DCF}_{i,t}}{\partial \omega_{i,t} \, \partial Y_{i,t}} \times \Delta \omega_{i,t} \, \Delta Y_{i,t} \tag{10}$$

where $\Delta Y_{i,t}$ and $\Delta \omega_{i,t}$ are the differences in projected sales and carbon cost rate between the initial scenario and the new expectations.

Appendix: Total Impact on Discounted Cash Flows

The total impact of the transition scenario on firm i's discounted cash flows is:

$$\Delta \text{DCF}_{i,t} = \Delta \text{DCF}^{Y}_{i,t} + \Delta \text{DCF}^{\omega}_{i,t} + \Delta \text{DCF}^{Y \times \omega}_{i,t} \tag{11}$$

Appendix: Translating DCF into Stock Value

We translate the discounted cash flows into the stock value, where the total firm value V_i is the sum of discounted cash flows over time:

$$V_i = \sum_{t=1}^{T} \text{DCF}_{i,t} \tag{12}$$

The change in stock value due to unexpected transition concerns is:

$$\Delta V_i = \Delta V_i^Y + \Delta V_i^\omega + \Delta V_i^{Y \times \omega} \tag{13}$$

Appendix: Computing Losses from Transition Risks

The loss from each factor is computed as a ratio to the baseline stock value V_i^{baseline}:

$$L_i^Y = -\frac{\Delta V_i^Y}{V_i^{\text{baseline}}} \quad L_i^\omega = -\frac{\Delta V_i^\omega}{V_i^{\text{baseline}}} \quad L_i^{Y\times\omega} = -\frac{\Delta V_i^{Y\times\omega}}{V_i^{\text{baseline}}} \tag{14}$$

Appendix: Total Loss Computation

The loss from net carbon tax is computed as the sum of losses from carbon and the interaction term:

$$L_i^{\omega^{\text{net}}} = L_i^{\omega} + L_i^{Y \times \omega} \tag{15}$$

The total loss of stock i is:

$$L_i = L_i^{Y} + L_i^{\omega^{\text{net}}} \tag{16}$$

Appendix: Calibration of Growth Factors and Carbon Price

To calibrate the growth factors of product demand $\frac{Y_{s,t}}{Y_{s,0}}$ and the carbon price Λ_t, we use data from the Network for Greening the Financial Systems (NGFS) scenarios database.

- The reference scenario is "Current Policies."
- The default transition scenario is "Net Zero 2050."
- Products particularly exposed to changes in mitigation policies were identified, with non-specific products grouped under the "Other" category.
- Growth factors are mapped to NGFS variables.

Appendix: Product and NGFS Variable Mapping

Product	**NGFS Variable**
Other	GDP—MER—Counterfactual without damage
Fossil Fuels Electricity	Secondary Energy—Electricity—Coal
	Secondary Energy—Electricity—Gas
	Secondary Energy—Electricity—Oil
Low Carbon Electricity	Secondary Energy—Electricity—Biomass
	Secondary Energy—Electricity—Geothermal
	Secondary Energy—Electricity—Hydro
	Secondary Energy—Electricity—Solar
	Secondary Energy—Electricity—Wind
	Secondary Energy—Electricity—Nuclear
Fossil Fuels	Primary Energy—Coal
	Primary Energy—Gas
	Primary Energy—Oil
	Secondary Energy—Gases
	Secondary Energy—Liquids
Hydrogen	Secondary Energy—Hydrogen
Alternative Transportation	Final Energy—Transportation—Electricity
	Final Energy—Transportation—Hydrogen
Conventional Transportation	Final Energy—Transportation—Electricity
	Final Energy—Transportation—Liquids

Appendix: Calibration of Initial Revenue per Product

To determine the initial revenue per product $Y_{i,s,0}$:

1. We use Moody's data and NACE codes to map products.
2. Non-mapped NACE activities are assigned to "Other."

Algorithm:

- For each stock i, assign a percentage of revenue based on available data.
- Deduct assigned percentage from 100% and assign the remaining to the NACE-mapped category.

Appendix: Calibrated Parameters by TRBC Sector

Sector	WACC	Tax Rate (τ)	Operating Costs Rate (θ)	Net Investments Rate (ρ)
Industrials	0.091	0.201	0.116	0.071
Basic Materials	0.094	0.140	0.090	0.038
Cyclical Consumer	0.091	0.138	0.308	-0.005
Energy	0.086	0.136	0.068	0.022
Financials	0.075	0.036	0.232	-0.032
Non-Cyclical Consumer	0.073	0.174	0.241	0.122
Technology	0.107	0.079	0.270	0.026
Telecoms	0.077	0.178	0.309	0.016
Utilities	0.082	0.141	0.190	0.116
Total	0.064	0.125	0.221	0.032

Table 7: Calibrated parameters by TRBC sector
Note: The table presents the Weighted-Average Cost of Capital (WACC), Tax Rate (τ), Operating Costs Rate (θ), and Net Investments Rate (ρ) for each sector, calibrated using data from Damodaran Online.

Appendix: Explanation of Parameter Calibration

We used various financial fields for calibration:

- **WACC**: Calibrated using the Cost of Capital field.
- **Tax Rate (τ)**: Derived from the Tax Rate field.
- **Operating Costs Rate (θ)**: Calculated as the difference between Gross Margin and Pre-tax, Pre-stock compensation Operating Margin.
- **Net Investments Rate (ρ)**: Calibrated with the Net Capex/Sales field.

Appendix: Sensitivity to Calibration Settings

Sector	Max-Min Scenario	Max-Min Model	Max-Min Horizon
Utilities	47.92	6.72	28.51
Energy	29.76	10.37	20.60
Basic Materials	20.87	9.81	12.97
Industrials	8.63	4.79	6.76
MSCI World	5.83	1.15	3.66

Table 8: Sensitivity to calibration settings
Note: The table compares loss sensitivity to scenarios, models, and horizons. Higher values indicate greater uncertainty from calibration setting choices.