**Master of Science**
**Sustainable Management and Technology**

# SUSTAINABLE AND ENTREPRENEURIAL FINANCE

**Eric Jondeau and Shema Mitali**

# SUSTAINABLE FINANCE

## *Lecture 4: Portfolio Construction under Climate Risks*

**Eric Jondeau**

# Objectives of the lecture

There are two main topics related to **decarbonization**:

- portfolio management with climate risk
- portfolio alignment with low-carbon trajectories.

Questions addressed in this lecture:

- Metrics for a portfolio

- Carbon factors

- Portfolio decarbonization based on current carbon intensity

- Portfolio decarbonization based on carbon beta – market perception – factors

# Objectives of the lecture

## Readings

**Bolton P., and M. Kacperczyk** (2021), "Do investors care about carbon risk?", *Journal of Financial Economics*, 142(2), 517-549

**Bolton, P., M. Kacperczyk, and F. Samama** (2021), "Net-Zero Carbon Portfolio Alignment", https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3922686

**Fahlenbrach, R., and E. Jondeau** (2021), "Greening the Swiss National Bank's Portfolio", https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3906654

**Görgen, M., A. Jacob, M. Nerlinger, R. Riordan, M. Rohleder, and M. Wilkens** (2019), "Carbon risk", https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2930897

**Institut Louis Bachelier et al.** (2020), "The Alignment Cookbook - A Technical Review of Methodologies Assessing a Portfolio's Alignment with Low-carbon Trajectories or Temperature Goal", https://www.louisbachelier.org/wp-content/uploads/2020/10/cookbook.pdf

**Jondeau E., B. Mojon, and L.A. Pereira da Silva** (2021), "Building Benchmarks Portfolios with Decreasing Carbon Footprints", Swiss Finance Institute Research Paper No. 21-91

**Roncalli, T., T. Le Guenedal, F. Lepetit, T. Roncalli, and T. Sekine** (2020), "Measuring and Managing Carbon Risk in Investment Portfolios" https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3681266

# Objectives of the lecture

➔ **Assessing the Climate Performance of a Portfolio**

- **Financial Risk of Climate Change**
- **Building a Decarbonized Portfolio**
- **Portfolio Temperature Alignment**

# Concepts – Carbon Metrics

Several ways to measure the carbon impact of a portfolio:

1- Carbon footprint

alternative ways to evaluate the carbon footprint of a portfolio

exposure =/ fooprint

2- Proportion invested in “green” and “brown” sectors

3- Avoided emissions

exposure: how climate change impact your business.

4- Green-brown metrics

5- Benchmark

# Carbon Exposure Measures

Recommendation of the Task Force on Climate-related Financial Disclosures to evaluate the carbon exposure of a portfolio (TCFD, 2017):

**(1) Weighted-average carbon intensity:** measures the portfolio's exposure to carbon-intensive companies, expressed in tonnes of CO2 equivalents per million dollars of revenue (tCO2e/mln $):

$$WACI_t^{(p)} = \sum_{i=1}^{N_t} w_{i,t}^{(p)} \frac{E_{i,t}}{Rev_{i,t}}$$

where

- $E_{i,t}$ is the amount of carbon emitted by firm *i* in year *t*
- $Rev_{i,t}$ is the revenue (sales) generated by the firm
- $w_{i,t}^{(p)}$ is the weight of firm *i* in the portfolio: $w_{i,t}^{(p)} = V_{i,t}^{(p)} / V_t^{(p)}$ weight of company i in the portfolio
- $V_{i,t}^{(p)}$ is the dollar value invested in firm *i*
- $V_t^{(p)} = \sum_{i=1}^{N_t} V_{i,t}^{(p)}$ is the dollar value of the portfolio,
- $N_t$ the number of firms available in year *t*

# Carbon Exposure Measures

Of the portfolio, not the firm

**(2) Carbon intensity:** measures the volume of carbon emissions per million dollars of revenue (carbon efficiency of the portfolio), again expressed in tonnes of CO2 equivalents per million dollars of revenue (tCO2e/mln $):

how much of the share do i own as an investor

$$CI_t^{(p)} = \frac{\sum_{i=1}^{N_t} o_{i,t}^{(p)} E_{i,t}}{\sum_{i=1}^{N_t} o_{i,t}^{(p)} Rev_{i,t}}$$

My share is my responsebility
If i own 1% i have response. of 1% of the company.

where $o_{i,t}^{(p)} = V_{i,t}^{(p)} / Cap_{i,t}$ is the fraction of the equity of the firm held in the portfolio, where $Cap_{i,t}$ is the market capitalization of firm $i$ in year $t$.

**(3) Carbon footprint:** measures the total carbon emissions for a portfolio normalized by the market value of the portfolio (financed emissions). It expresses the amount of annual carbon emissions that can be allocated to the investor per million dollars invested in the portfolio (tCO2e/mln $):

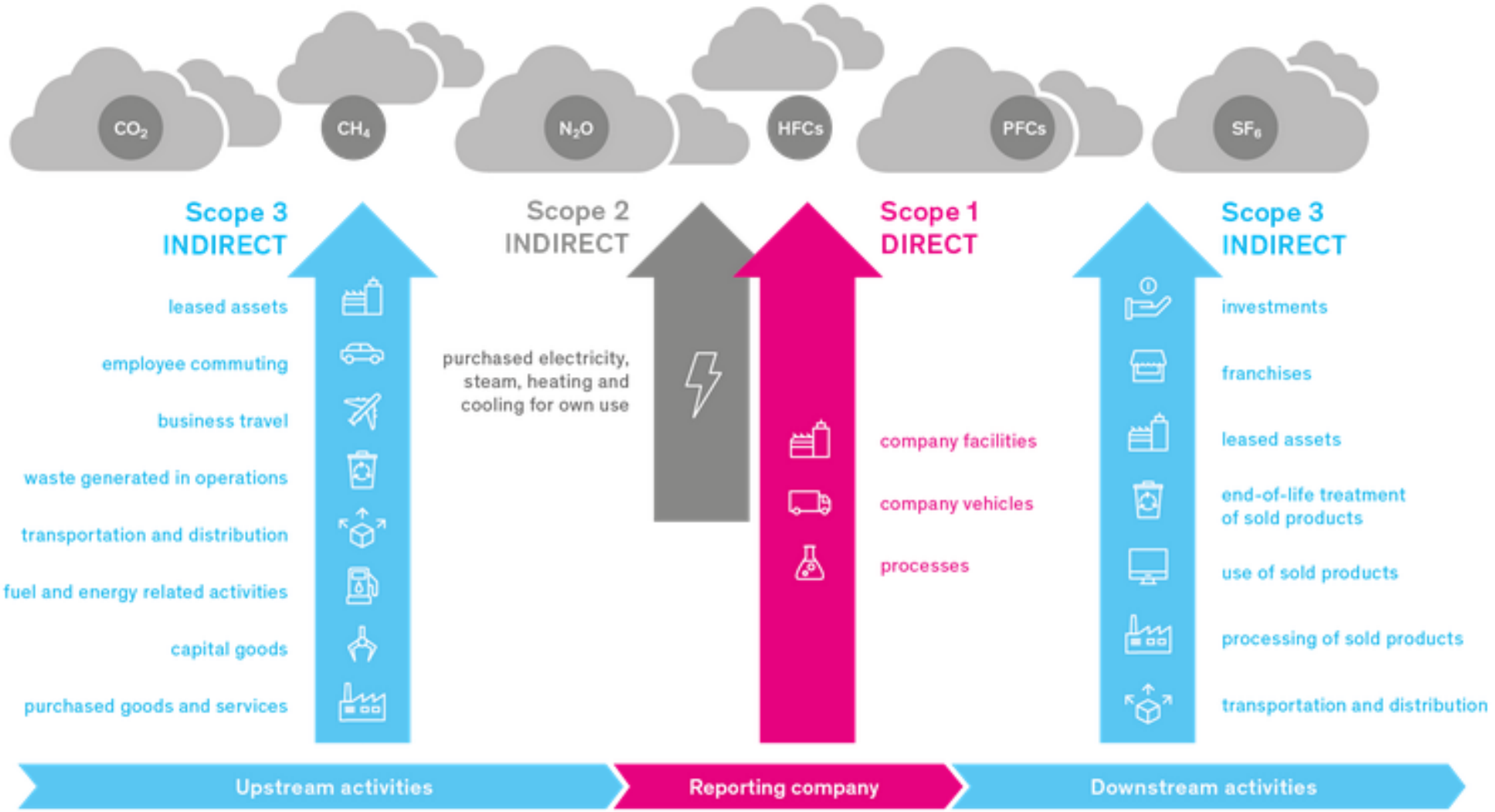
Same as before
Weight the same way
But use M.Cap

$$CF_t^{(p)} = \sum_{i=1}^{N_t} w_{i,t}^{(p)} \frac{E_{i,t}}{Cap_{i,t}} = \frac{1}{V_t^{(p)}} \sum_{i=1}^{N_t} o_{i,t}^{(p)} E_{i,t}$$

Co2_eq/$

V_t: Value of portfolio

# Carbon Indicators




Source: https://www.myclimate.org

# Which Scope to Use?

Scopes 1 and 2 are mandatory to report and should be included in any portfolio construction

Scope 3: It matters for some industries

- Banks emit little carbon directly, but they finance polluting firms (Scope 3)
- Car producers have a large influence on the emissions of their cars (Tesla vs. Ford)

Problem: most companies do not disclose Scope 3 emissions. They are estimated by data providers (CDP, Trucost) but estimates include some uncertainty.

Sectors for which Scope 3 is likely to be material

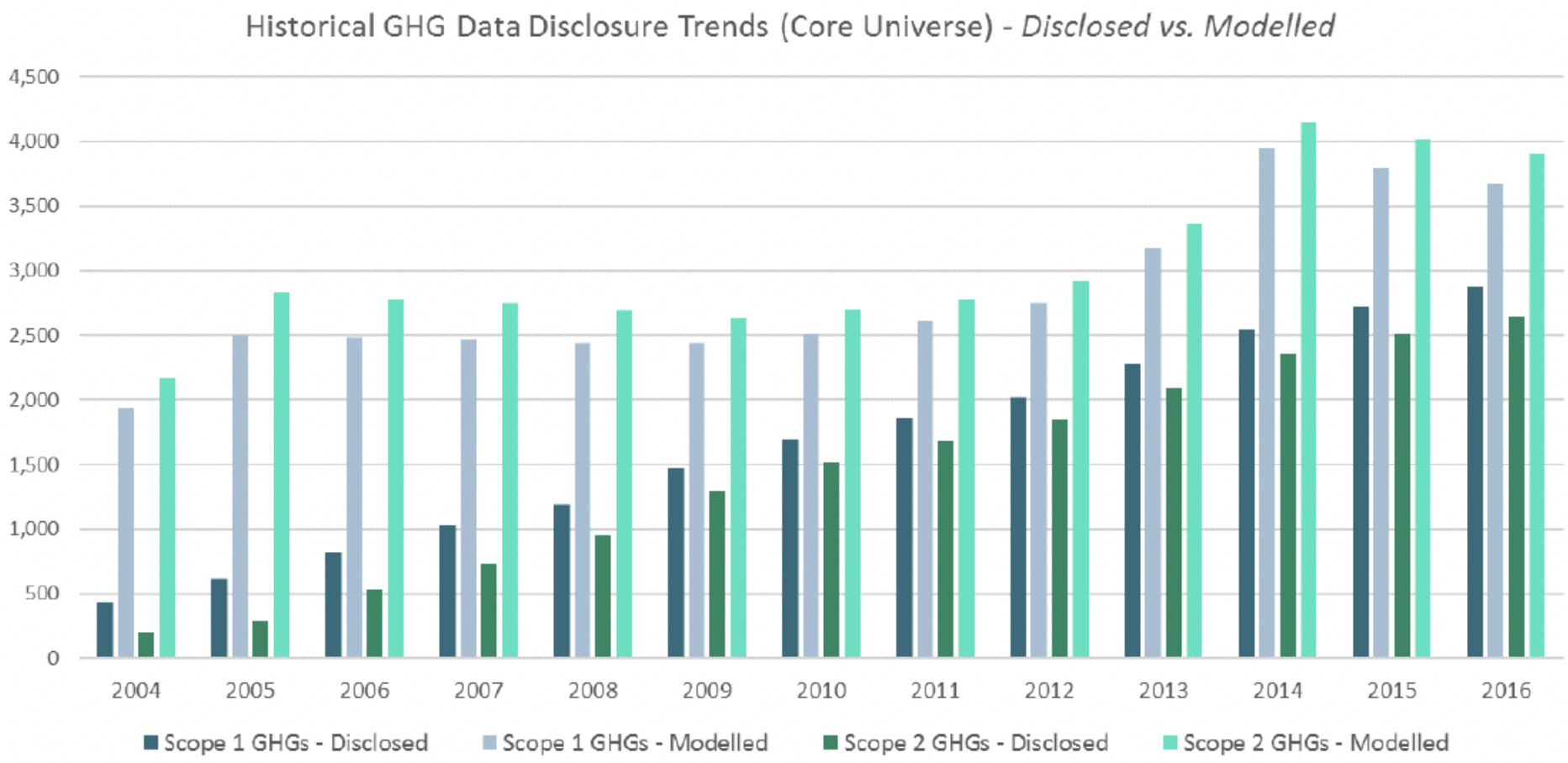
Should be taken into account.
But relies on poor estimates

Credit Suisse down 24% one day
Usually a level of defualt.

- Upstream Scope 3:
  - Energy, utilities, materials, chemicals, industrials, consumer goods

- Downstream Scope 3:
  - Sold products: oil and gas, automobiles, technology, apparel, chemicals
  - Financed emissions: financials

# Which Scope to Use?

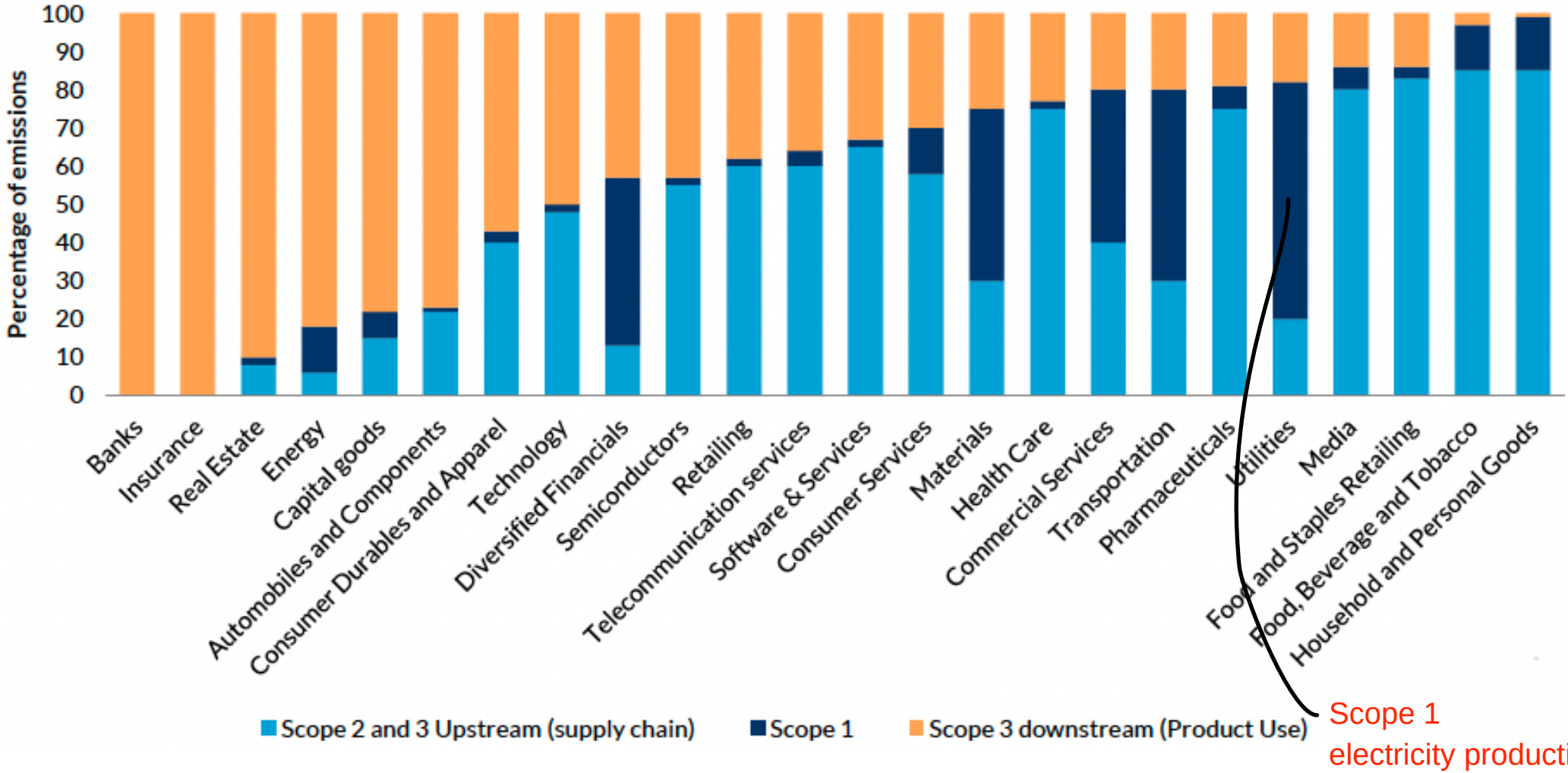



Source: Trucost (2021)

Modelled and Disclosed closing in due to compulsory disclosure.

# Which Scope to Use?

numbers normalized




Scope 1
electricity production

Source: Based on Inrate data

Useful for DNB?

Large differences

Double-counting:
no way to fix this problem...
-> perfect knowlegde and transparenncy of whole pipeline

~~100% sure that the it will be an overestimate whenc~~

# Double Counting

Double counting: case where the same tonne of carbon is counted multiple times within a portfolio.

if you invest in two companies you will be punished twice.

**Examples:**

| Category | Scope | Example |
|---|---|---|
| Electricity producer/user | Scope 2 | Company A produces the electricity (Scope 1) purchased by company B (Scope 2) |
| Supplier/user | Scope 3 | Company A uses the energy-consuming goods (Scope 1) produced by company B (Scope 3) |
| Product/energy | Scope 3 | The petrol produced by company A (Scope 3) is burnt by the vehicles operated by (Scope 1) or produced by (Scope 3) company B |
| Producer/retailer | Scope 3 | Company A is a retailer (product in use Scope 3) of goods purchased by company B (Scope 3) |

Large and diversified portfolios are more prone to double counting.

In principle, the same emissions could be counted 3 times

Eliminating all double counting is virtually impossible (requires input-output models)

It may reach up to 30-40% of total emissions.

Big emitters will be the same
even though you include Scope 3 emissions!

Hence not impact the investments and construction of your portfolio.

# Carbon Exposure Measures

## Example of a Portfolio's Scope 1–3 Carbon Metrics (2019)

Portfolio value: $100 billion
Market weights: based on market cap, Portfolio weights: my choice

| | Walmart | Southern Company | Exxon Mobil | Portfolio |
|---|---|---|---|---|
| Scope 13 emissions (mln tonnes) ($E_{i,t}$) | 59.8 | 96.6 | 227.3 | |
| Revenue (bln \$) ($Rev_{i,t}$) | 514.4 | 20.7 | 255.6 | |
| Scope 13 intensity (tonnes/mln \$ rev) | 116.3 | 4673.8 | 889.3 | |
| Market cap (bln \$) ($Cap_{i,t}$) | 337.2 | 66.8 | 295.3 | |
| Relative market weight (%) | 48.2 | 9.6 | 42.2 | 100.0 |
| Ptf market value (mln \$) ($V_{i,t}^{(p)}$) | 31.9 | 12.5 | 55.6 | 100.0 |
| Ptf weight ($w_{i,t}^{(p)}$) (%) | 31.9 | 12.5 | 55.6 | 100.0 |
| Ownership ($o_{i,t}^{(p)}$) | 9.5 | 18.7 | 18.8 | |
| Ptf WA intensity (tonnes/mln \$ rev) | 37.1 | **584.5** | **494.1** | 1115.8 |
| Ptf intensity (tonnes/mln \$ rev) | -- | -- | -- | 660.7 |
| Ptf footprint (tonnes/mln \$ invested) | 56.6 | **180.8** | **427.7** | 665.2 |

Source: Trucost (2021).

# Avoided Emissions

Avoided emissions are emission reductions that occur outside of a product's life cycle or value chain, but as a result of the use of that product.

Examples of products (goods and services) that avoid emissions

- low-temperature detergents
- fuel-saving tires
- teleconferencing services

Tesla

Scope 1 and 2 emission reductions due to energy-saving and energy-mix process, do not qualify as "avoided emissions"

Emissions avoided by a company through the sale of low-carbon products / services lead to the reduction of the direct (Scope 1 and 2) emissions of the user or client.

Avoided emissions contribute to the overall objective of reducing total emissions at the macroeconomic level

Difficult to include in a carbon footprint measure

# Objectives of the lecture

- Assessing the Climate Performance of a Portfolio

➔ **Financial Risk of Climate Change**

- Building a Decarbonized Portfolio

- Portfolio Alignment

# Financial Risk of Climate Change

Climate-related market risk of a firm: measured by current carbon intensity

Market perception of climate change may be different. Measuring the market perception is of course more complicated.

**Görgen, Jacob, Nerlinger, Riordan, Rohleder, and Wilkens** (2019), "Carbon risk" Working Paper University of Augsburg (CARIMA approach)

**Roncalli, Le Guenedal, Lepetit, Roncalli, and Sekine** (2020), "Measuring and Managing Carbon Risk in Investment Portfolios"

**Bolton and Kacperczyk** (2021), "Do investors care about carbon risk?"

Shares of small firms are harder to sell
"I want a premium to invest in small firms".

Investors are more reluctant to invest in companies with a big co2 footprint, polluting firms will have to pay a premium to get investors. -> Higher return. Takes risk by investing in this. This is costly from the companies' perspective.

Ex: 2022 bad year for clean portfolio.

If you don't invest in polluting firms you will "lose" this premium.

# Market Measure of Carbon Risk (Görgen et al., 2019)

Three-step approach:

- Define a brown – green score (BGS) for each stock (scoring model)
- Build a brown minus green factor (Fama-French approach)
- Estimate the carbon beta of a stock with respect to the BMG factor (multi-factor regression analysis)

Carbon beta = market measure of carbon risk
≠
Carbon intensity = fundamental measure of carbon risk

Market perception of carbon risk depends on several dimensions: sector, country…

How is the firm exposed to this carbon risk?

**Systematic carbon risk**
Common risk
Carbon beta

Market measure (general carbon risk exposure, e.g., market repricing risk)

What is special to the company we are talking about. "Physics"

**Idiosyncratic carbon risk**
Specific risk
Carbon intensity

Fundamental measure (specific carbon risk exposure, e.g., reputational risk)

# Step 1: Construction of the Brown Green Score

## CARIMA Approach

Görgen et al. (2019) use 55 proxy variables from 4 ESG databases (CDP, Refinitiv, Sustainalytics, MSCI) to define 3 broad indicators:

What is it doing in the production process?

- Value chain ($VC_{i,t}$) captures current emissions related to the production of goods and services – based on Carbon emissions / Energy Efficiency / Renewable Energy Use metrics…

What do we know about the company? Is it disclosing its emissions? Cleaning?

- Public perception ($PP_{i,t}$) represents how the public views a firm with respect to carbon emissions – based on Disclosure Score / Environmental Score / Performance Band…

Reflects what the company is trying to implement.

- Adaptability ($A_{i,t}$) is related to the ability of firms to transition from a brown to a green economy – based on Environ. Innovation / Environ. Expenditures / Preparedness Score…

A Brown Green Score (BGS) is created for each stock:

$$BGS_{i,t} = 0.70\, VC_{i,t} + 0.30\, PP_{i,t} + 0.15\, A_{i,t}$$

Classify all firms G or B

Based on BGS, 1,108 firms (624 "brown" and 484 "green" firms) are assigned to one of two mimicking (Brown and Green) portfolios, used to compute the BMG Factor return

# Step 2: Construction of the BMG Factor

Two different portfolios split on Green and Brown
What is best?

## Fama-French Approach

We take all firms.

We form 2 subsamples with equal size, based on market cap (Small/Big)

For each subsample, we form 3 subsamples with equal size, based on a Brown Green Score (Green/Neutral/Brown)

| | Green | Neutral | Brown |
|---|---|---|---|
| Small | SG | SN | SB |
| Big | BG | BN | BB |

The "Brown-Minus-Green" (BMG) Factor return $R_{bmg,t}$ is obtained as:

Performance of BMG= $$R_{bmg,t} = \frac{1}{2}\left(R_{SB,t} + R_{BBg,t}\right) - \frac{1}{2}\left(R_{SG,t} + R_{BGg,t}\right)$$

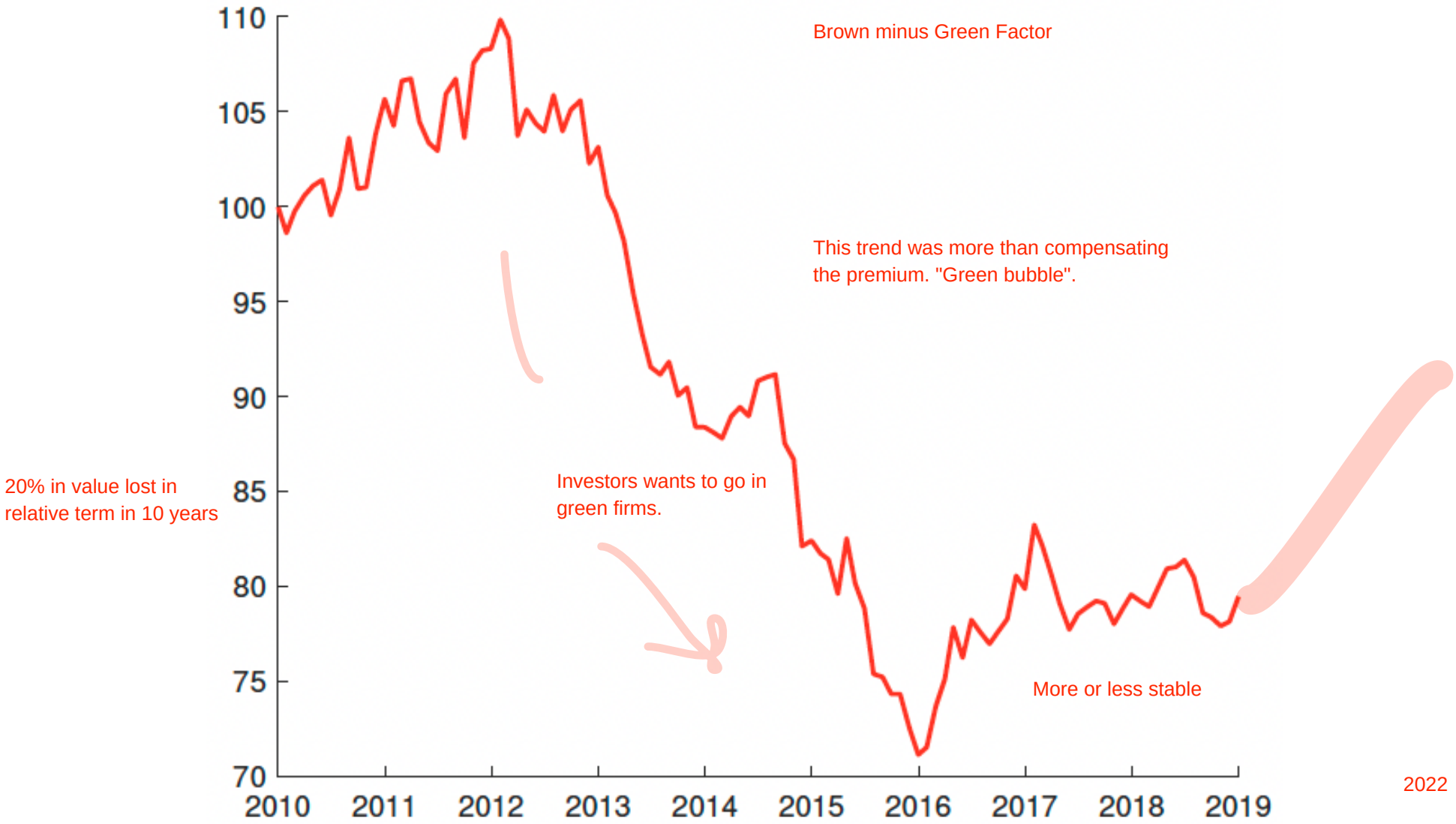
Small Brown + Big Brown

Small Green + Big Green

*We take B-G because the risk is to be brown

where $R_{SB,t}$ (small brown portfolio) is value-weighted by the market cap.

# Cumulative Performance of the BMG Factor




Source: Roncalli, Le Guenedal, Lepetit, Roncalli and Sekine (2020).

# Step 3: Multi-Factor Analysis

are you exposed to the risk of being a brown firm?
individually as company

## CAPM

$$R_{i,t} = \alpha_i + \beta_{mkt,i} R_{mkt,t} + \varepsilon_{i,t}$$

sensitivity of your return to the factor

Regression on my return

## Fama-French 3 Factor model

$$R_{i,t} = \alpha_i + \beta_{mkt,i} R_{mkt,t} + \beta_{smb,i} R_{smb,t} + \beta_{hml,i} R_{hml,t} + \varepsilon_{i,t}$$

## Market + BMG model

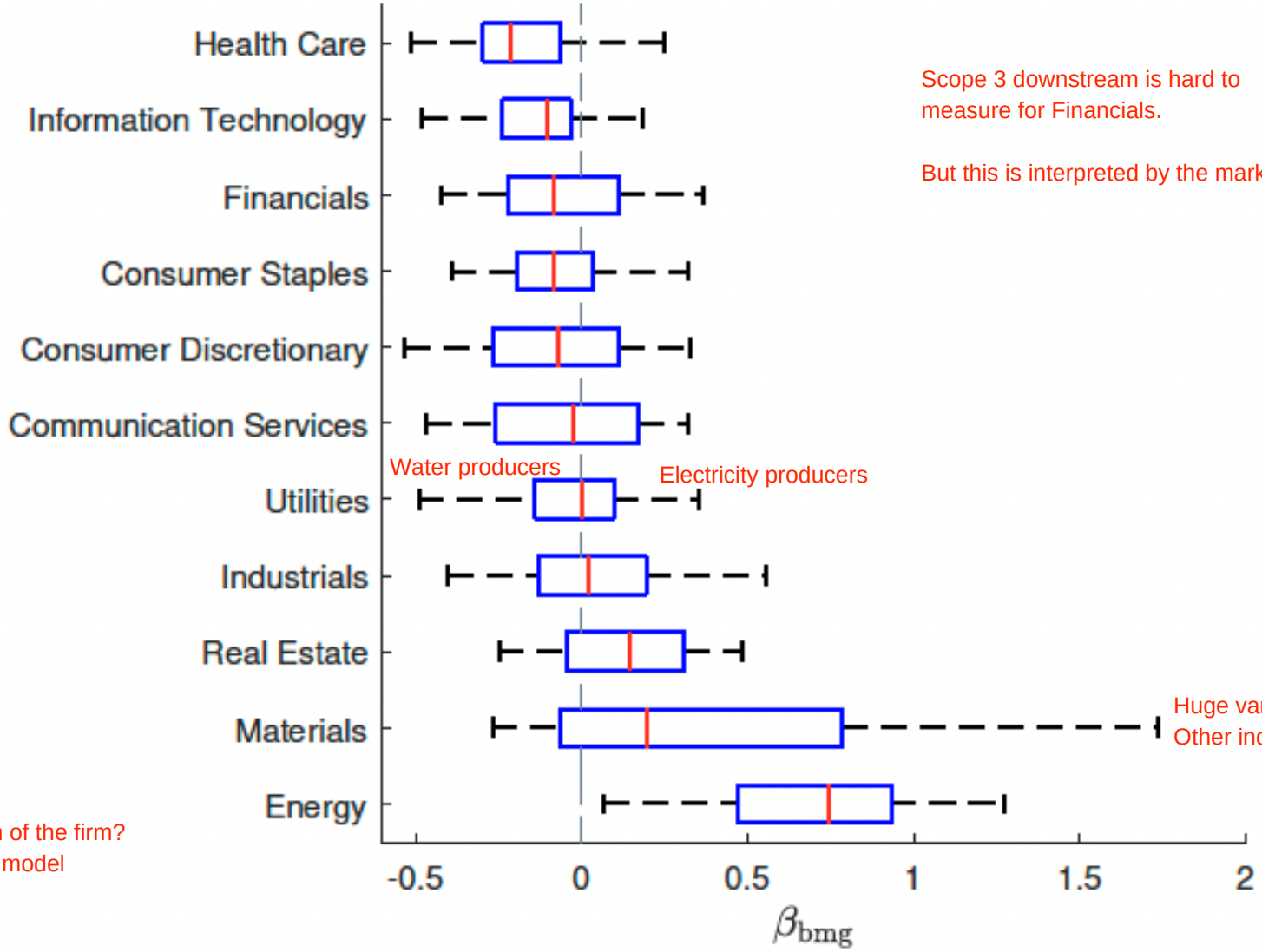
$$R_{i,t} = \alpha_i + \beta_{mkt,i} R_{mkt,t} + \beta_{bmg,i} R_{bmg,t} + \varepsilon_{i,t}$$

Imagine high Bmgi (1) = highly exposed becuase im brown
Low value: -1 negativley exposed to this factor. (renewables)
Market exposure to the risk. Is the company considered a brown or green firm?

## Fama-French 3 Factor model

$$R_{i,t} = \alpha_i + \beta_{mkt,i} R_{mkt,t} + \beta_{smb,i} R_{smb,t} + \beta_{hml,i} R_{hml,t} + \beta_{bmg,i} R_{bmg,t} + \varepsilon_{i,t}$$

# Carbon Sensitivities across Sectors (Market+BMG Model)




Scope 3 downstream is hard to measure for Financials.

But this is interpreted by the market.

Water producers

Electricity producers

Huge variation. Cement and steel(++)
Other industries unrelated.

What is the perception of the firm?
Can predict using this model

Source: Roncalli, Le Guenedal, Lepetit, Roncalli and Sekine (2020). Estimation based on stocks from MSCI World from 2010 to 2018.

# Advantages and Limits of BMG Approach

**Advantages**

- Biases in the databases are offset because the BGS scores are derived from several databases
- No significant country-specific and sector-specific effects
- No problem of extreme values
- Encompass a lot of climate change-relevant information

**Limits**

- No differentiation between values near and far the median of a variable
- No rebalancing schemes
- Correlation between BMG factor and some other factors
- Double counting problems
- Not only carbon risk dimension

Capturing the way the firm is perceived - not measured.

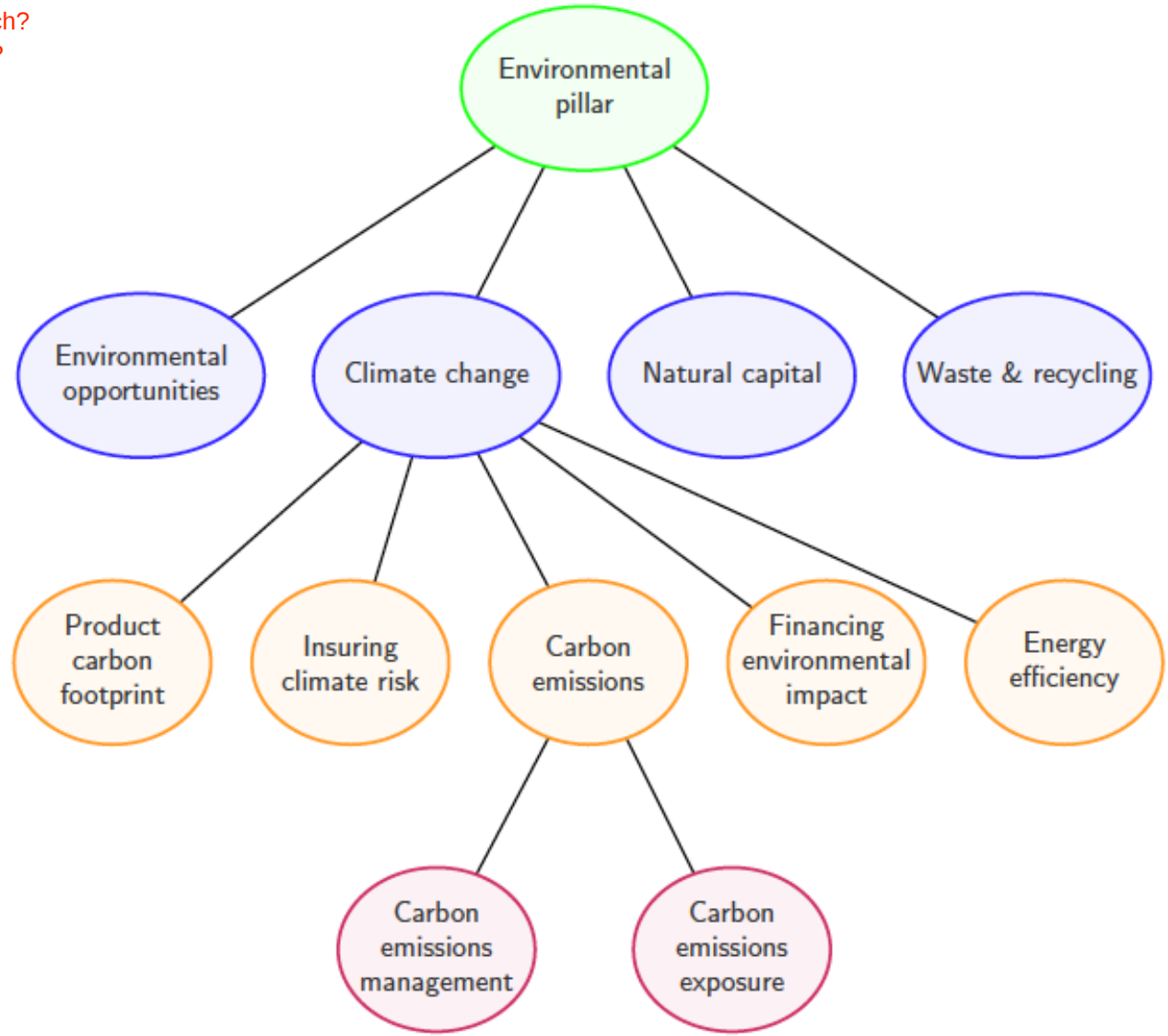
Some variables can create more noise than information

What if we consider alternative risk factors: Carbon intensity (Trucost), Carbon emissions exposures (MSCI), Carbon emissions management (MSCI), etc.?

# Alternative Risk Factors

## Hierarchy in the environmental pillar (MSCI methodology)

What is the best approach?
Measured or perception?




What is the best predictor of the firm performance?

Source: MSCI (2020), Roncalli, Le Guenedal, Lepetit, Roncalli and Sekine (2020).

# Alternative Risk Factors: Explanatory Power

## Comparison of Explanatory Power of Alternative Factors

**Difference in $R^2$ between the Market + BMG Model and the CAPM**

| | Full period % | First period (2010-2014) | Second period (2014-2018) |
|---|---|---|---|
| CARIMA | 1.74 | 1.16 | 2.21 |
| Carbon intensity 1-3 (Trucost) | 1.77 | 1.43 | **2.53** |
| Carbon emissions (MSCI) | 2.00 | **2.18** | 2.39 |
| Climate change (MSCI) | 1.58 | 1.98 | 1.83 |
| Environment (MSCI) | 1.63 | 1.35 | 2.17 |
| Carbon intensity[1] | 2.06 | 1.25 | 3.13 |
| Carbon emissions[1] | 1.91 | 1.41 | 2.42 |

Should be very deep

Trucost better than perception

Source: Roncalli, Le Guenedal, Lepetit, Roncalli and Sekine (2020). 1: The carbon factor is based on the quintile methodology Q5-Q1.

Looks like relying on carbon emissions and intensity is best

Carbon emissions and intensity are better climate change-related factors to explain stock price fluctuations

# Objectives of the lecture

- Assessing the Climate Performance of a Portfolio
- Financial Risk of Climate Change

➔ **Building a Decarbonized Portfolio**

- Portfolio Alignment

# Portfolio Optimization with Carbon Risk

## Minimum Variance Portfolio

We consider the Global Minimum Variance (GMV) Portfolio, which solves the program

$$\min_{\alpha} \frac{1}{2} \alpha' \, \Sigma \, \alpha$$
$$s.t. \; e' \, \alpha = 1$$

a' : portfolio weight ' = Ta

such that?

The solution is:

$$\alpha^* = \frac{\Sigma^{-1} e}{e' \Sigma^{-1} e}$$

a* optimal weight

Carbon risk can be introduced in this problem through the covariance matrix $\Sigma$ using a factor model.

Variance: V(R_it) = B_mkt,i^2 * sigma_mkt^2 + sigma*errorterm_i^2

Cov(R_ib, R_Rjt) = B_mki * B_mkj * omega_mkt^2

CAPM: Market $R_{i,t} = \alpha_i + \beta_{mkt,i} \, R_{mkt,t} + \varepsilon_{i,t}$

Market + BMG model: $R_{i,t} = \alpha_i + \beta_{mkt,i} \, R_{mkt,t} + \beta_{bmg,i} \, R_{bmg,t} + \varepsilon_{i,t}$

With carbon risk

# Portfolio Optimization with Carbon Risk

## Minimum Variance Portfolio

We define: $D = diag(\sigma_{\varepsilon,1}^2, \ldots, \sigma_{\varepsilon,N}^2)$

**CAPM:**

$$\Sigma = \beta_{mkt}\beta'_{mkt}\sigma^2_{mkt} + D$$

**Market + BMG model:**

$$\Sigma = \beta_{mkt}\beta'_{mkt}\sigma^2_{mkt} + \beta_{bmg}\beta'_{bmg}\sigma^2_{bmg} + D$$

Less restrictive

# Portfolio Optimization with Carbon Risk

## Adding Restrictions

Two different logic

**Market-based risk management:** We restrict the exposure of the portfolio to (systematic) carbon risk

**Fundamental-based risk management:** We restrict the exposure of the portfolio to carbon intensity (idiosyncratic carbon risk)

- Individual threshold: $\alpha_i = 0 \quad \text{if} \quad CI_i \geq CI^+$
- Portfolio threshold: $CI(\alpha) = \sum_{i=1}^{N} CI_i \, \alpha_i \leq CI^+$

CI: carbon intensity

CI^+ : c intensity treshold

Weighted carbon intensity

where $CI(\alpha)$ is the weighted average carbon intensity of the portfolio

Optimization program: Objective function

The program to solve is:

$$\min_{\alpha} \frac{1}{2} \alpha' \, \Sigma \, \alpha$$

Depends on weights will reflect these restrictions

$$s.t. \begin{cases} e'\alpha = 1 \\ \beta'_{bmg} \, \alpha \leq \beta^+_{bmg} \\ CI(\alpha) \leq CI^+ \end{cases}$$

sum(alpha_i*B_bmg_i) = measring your exposure to carbon risk

Pushing towards greener companies

smaller than a given level

MinVar Portfolio : variance will be higher
Risk will increase

where $\beta^+_{bmg}$ is the maximum tolerance of the investor with respect to carbon risk

# Exclusion/Best-in-Class Strategies based on Carbon Intensity

We assume an investor who does not want to invest in highly polluting firms. We define a highly polluting firm as a firm with a high carbon intensity.

- We first define a threshold of the carbon intensity above which a given firm is excluded

- We define the threshold as corresponding to a given number of firms to exclude or, preferably, to a fraction of the market value of the portfolio that is excluded

What do we do with the money you get from selling the brown assets?

- We need to decide what we do with the proceeds of the exclusion:

  - We reinvest proportionately in the remaining firms (**exclusion approach**)

  - We reinvest in the same countries or sectors as excluded firms (**exclusion approach with same region-sector exposures**)

  - We reinvest in the firms with the lowest carbon intensity in the same countries or sectors as excluded firms (**best-in-class approach with same region-sector exposures**)

Best in class = Selling dirty and buying in green companies
"Overweight the good firms". same sector exposure

# Exclusion/Best-in-Class Strategies based on Carbon Intensity

Reduction of the portfolio carbon reduction (2005-2020) – Scope 1+2+3 upstream

Exclude 1% ofmarket c

10%

25%

| | All firms | Exclusion approach | | | Best-in-class approach | | |
|---|---|---|---|---|---|---|---|
| | | 99% | 90% | 75% | 99% | 90% | 75% |
| Weighted avg carbon intensity | 440 | 362.5 | 222.8 | 139.9 | 364.2 | 243.2 | 168.1 |
| Reduction (in %) | (–) | (17.6) | (49.3) | (68.0) | (17.2) | (44.6) | (61.9) |
| Carbon footprint | 535 | 425.6 | 263.3 | 161.6 | 426.6 | 284.7 | 184.9 |
| Reduction (in %) | (–) | (20.7) | (51.2) | (70.0) | (20.6) | (47.2) | (65.7) |
| Carbon intensity | 422.2 | 356.2 | 218 | 128.4 | 356.9 | 245.4 | 160.2 |
| Reduction (in %) | (–) | (16.4) | (49.7) | (70.7) | (16.2) | (42.6) | (62.8) |
| Annual. return (in %) | 8.67 | 8.69 | 8.93 | 9.15 | 8.68 | 8.69 | 8.69 |
| Annual. volatility (in %) | 16.3 | 16.3 | 16.1 | 16.4 | 16.2 | 16.1 | 16.3 |
| Sharpe ratio | 0.53 | 0.53 | 0.55 | 0.56 | 0.53 | 0.54 | 0.53 |
| Tracking error (in %) | (–) | 0.09 | 0.71 | 1.71 | 0.07 | 0.44 | 1.06 |

Tons / mill $ invested

Huge impact in terms of C

Super interesting! Clean portfolio

Source: Jondeau, Mojon, and Pereira da Silva (2021). Intensity and footprint are in tonnes $CO_2e$/million $.

# Objectives of the lecture

- **Assessing the Climate Performance of a Portfolio**
- **Financial Risk of Climate Change**
- **Building a Decarbonized Portfolio**

➔ **Portfolio Temperature Alignment**

Becoming Net Zero in 2050

# Portfolio Temperature Alignment

Paris Agreement (2015): hold the increase in the global average temperature to well below 2°C above preindustrial levels, and pursue efforts to limit the temperature increase to 1.5°C.

Achieving this objective comes with drastically limiting GHG emissions, down to a "net-zero" level. The sooner we reach zero, the closer we will be to the +1.5°C limit.

About 130 countries have set a target to become carbon neutral by 2050, and China by 2060.

Following the One Planet Summit in 2017, eight central banks and supervisors launched the Network for Greening the Financial System (NGFS) to strengthen the necessary global response to meet the Paris Agreement goals. NGFS includes 90 members and 14 observers.

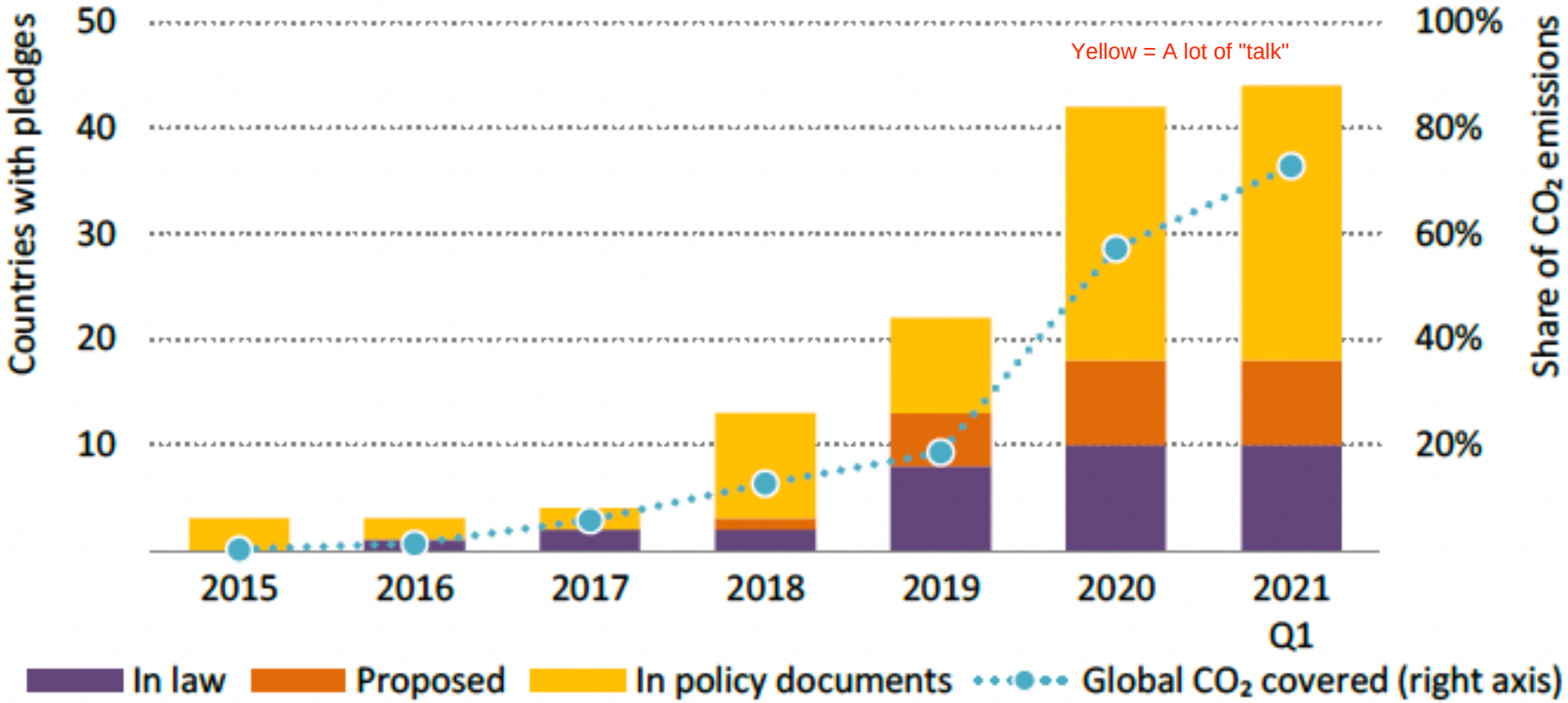
Some part is greenwashing...

Private sector financial institutions are also beginning to mobilize. Through the UN-convened Asset Owners Net-Zero Alliance launched in September 2019, 37 institutional investors, representing $5.7 trillion, have committed to align their portfolios with a 1.5°C consistent decarbonization trajectory by setting science-based targets by 2050.

# National Net Zero Pledges

Country level pledges.

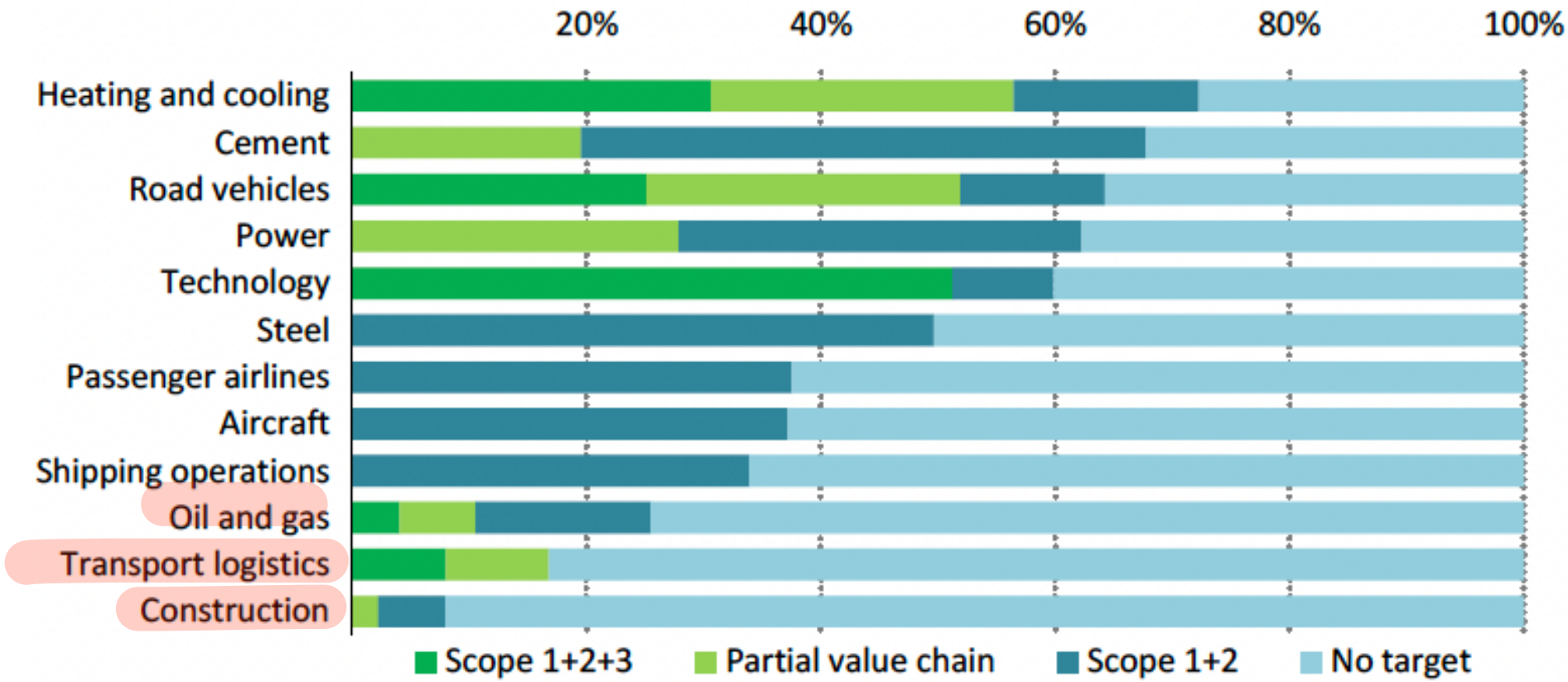
Number of national net zero pledges and share of global $CO_2$ emissions covered




Source: IEA (2021), Net Zero by 2050 A Roadmap for the Global Energy Sector

# Industry-level Net Zero Pledges

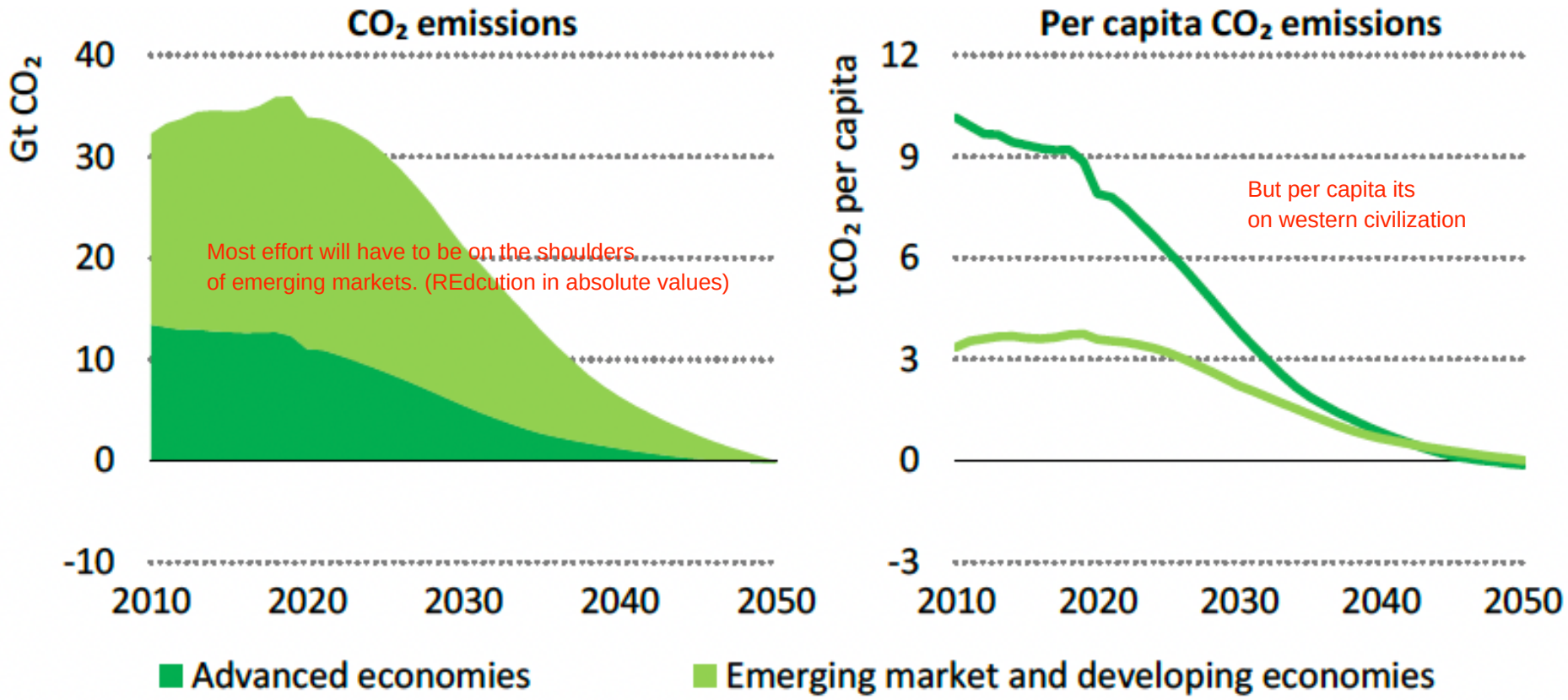
Sectoral activity of large energy-related companies with announced pledges to reach net-zero emissions by 2050




Source: IEA (2021), Net Zero by 2050 A Roadmap for the Global Energy Sector

# $CO_2$ Emissions in the Net-Zero Emission Scenario

Global net $CO_2$ emissions in the Net-Zero Emission scenario of the IEA




Source: IEA (2021), Net Zero by 2050 A Roadmap for the Global Energy Sector

Switzerland: 12 tons per capita per year

# Remaining Carbon Budget

Use 40gt per year atm

Estimates of IPCC (6th Assessment Report): the remaining carbon budget to limit global warming to 1.5°C is equal to 300 $GtCO_2$ with an 83% probability, 400 $GtCO_2$ with a 67% probability, and 500 $GtCO_2$ with a 50% probability (at the beginning of 2020).

The economic effects of Covid-19 pandemic caused fossil fuel emissions to decrease by 7% in 2020, but this effect is likely to be short lasting.

Estimates of International Energy Agency (IEA): global energy-related $CO_2$ emissions amount to 31.5 $GtCO_2$ in 2020.

Therefore, if we assume a remaining carbon budget of 300 $GtCO_2$, initial annual carbon emissions of 31.5 $GtCO_2$, and a target of net-zero emission in 2050, $CO_2$ emissions should decrease between 9% and 10% per annum on average over the next 30 years.

Several caveats: non-$CO_2$ emissions can increase or decrease the remaining budget by 220 $GtCO_2$ or more.

# Portfolio Temperature Alignment

**Bolton, Kacperczyk, and Samama** (2021), "Net-Zero Carbon Portfolio Alignment"

**Approach 1:** Minimize the tracking error of the portfolio w.r.t. the benchmark

$$\min_{\alpha_p} \sigma_p[TE] = std(R_{p,t} - R_{b,t})$$

$$s.t. \begin{cases} \alpha_{p,i} = 0 \text{ for all } i = 1, \dots, k \\ \alpha_{p,i} \geq 0 \text{ for all } i = k+1, \dots, N \end{cases}$$

Given a BM.

Want to ble as close as the BM as possible
But reduce the C emissions as much as possible
With a trajectory to reach Zero.

where the $k$ most polluting firms are excluded. The number $k$ is set such that the sum of carbon emissions of all the remaining constituents satisfies the carbon budget

**Approach 2:** Minimize the tracking error of the portfolio w.r.t. the benchmark

$$\min_{\alpha_p} \sigma_p[TE] = std(R_{p,t} - R_{b,t})$$

$$s.t. \begin{cases} \sum_{i=1}^{N} \alpha_{p,i} E_{i,t} \leq \bar{E} \\ \alpha_{p,i} \geq 0 \text{ for all } i = k+1, \dots, N \end{cases}$$

where $\bar{E}$ is the carbon budget for year $t$ to reach the net-zero carbon budget in 2050

# Portfolio Temperature Alignment

## Additional Features

- The tracking error is: $\sigma_p^2[TE] = V\left(R_{p,t} - R_{b,t}\right) = \left(\alpha_p - \alpha_b\right)' \Sigma \left(\alpha_p - \alpha_b\right)$

where $\Sigma = \beta\ \Omega_f\ \beta' + D$ is based on a factor model and $D$ is the matrix of idiosyncratic variances

- There are constraints on sectoral exposures: $\left|\alpha_p - \alpha_b\right| \leq \delta \qquad (\delta = 2\%)$

Restriction on how far you can be in sector exposure
Not more than 2% away from the BM in each industry.

**Two scenarios:**

- a 25% initial reduction followed by an 8% annual reduction over 29 years
- a 10% reduction over 30 years

**Remarks:**

- Exclusion is based on Scope 1-2-3 upstream total emissions instead of carbon intensity
- There is no constraint on regional/country exposures
- Carbon emissions are supposed constant over time

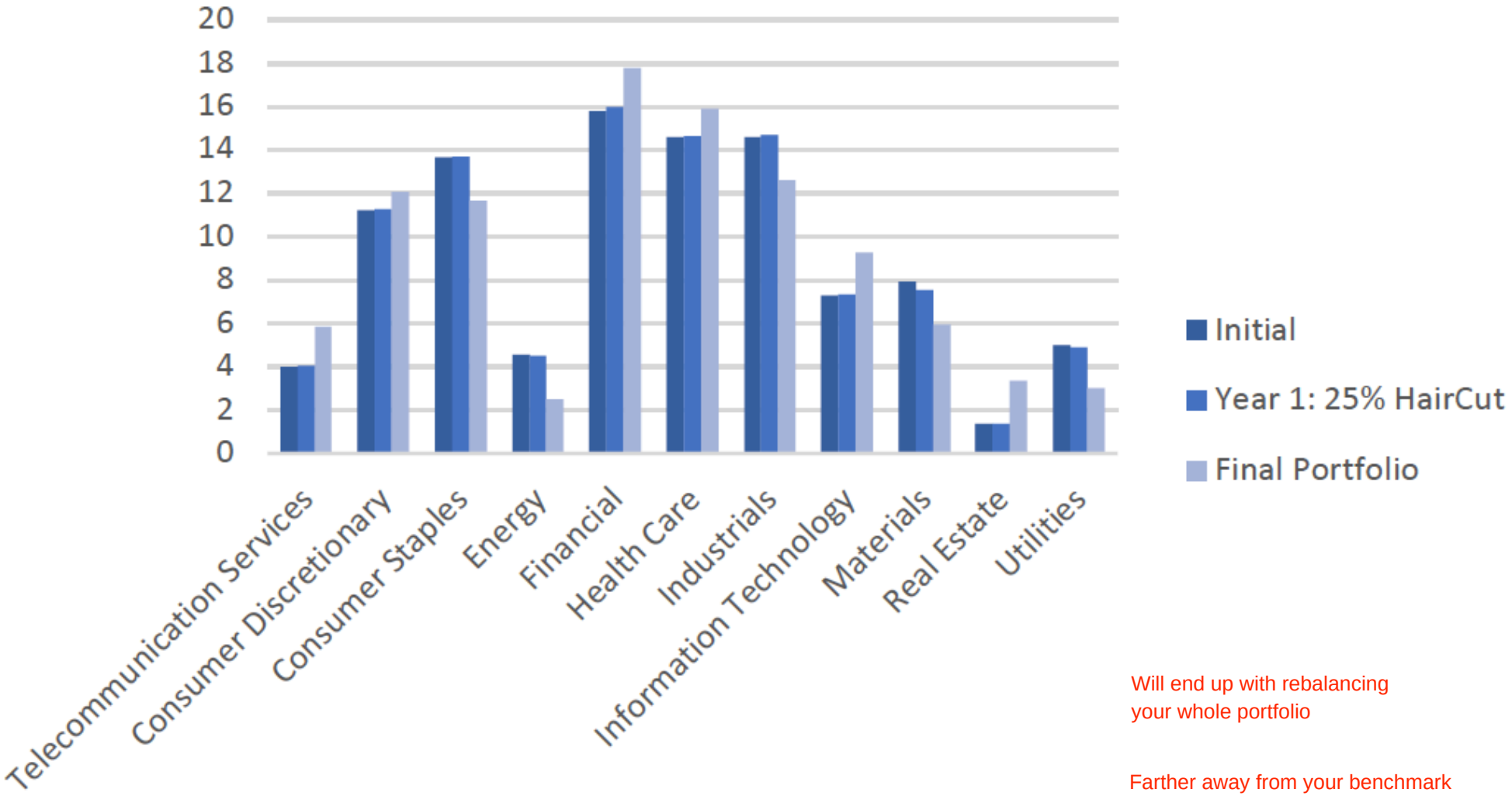
# Portfolio Temperature Alignment: Results

Ex-ante tracking error for MSCI indexes 1.5°C aligned portfolios


Source: Bolton, Kacperczyk, Samama (2021)

# Portfolio Temperature Alignment: Results

Sector deviations of the MSCI Europe 1.5°C aligned portfolio




Will end up with rebalancing your whole portfolio

Farther away from your benchmark

Source: Bolton, Kacperczyk, Samama (2021)

implemented this strategy the last 11 yrs

# Exclusion Strategy based on Carbon Intensity

Dynamic reduction of the portfolio carbon footprint over 11 years (2010-2020)

| | Reduction target | | | BAU | MSCI |
|---|---|---|---|---|---|
| | **5%** | **10%** | **15%** | **bench.** | **index** |
| Starting emissions ($GtCO_2e$) | 46.8 | 46.8 | 46.8 | 46.8 | – |
| Final emissions ($GtCO_2e$) | 17.9 | 9.7 | 7.1 | 20.8 | – |
| Cumulative growth (%) | -61.8 | -79.3 | -84.7 | -55.6 | – |
| Annual growth (%) | -8.4 | -13.4 | -15.7 | -7.1 | – |
| Annual return (%) | 10.7 | 10.6 | 10.4 | 10.7 | 10.5 |
| Annual volatility (%) | 14.0 | 14.0 | 14.0 | 14.0 | 13.7 |
| Sharpe ratio | 0.76 | 0.76 | 0.74 | 0.76 | 0.77 |
| Annual tracking error (%) | 0.04 | 0.26 | 0.74 | – | – |
| Number of firms excluded | 28.5 | 210.0 | 463.7 | – | – |
| Prop. of firms excluded (%) | 1.1 | 8.0 | 18.1 | – | – |
| Prop. of market value excluded (%) | 0.4 | 5.0 | 13.0 | – | – |

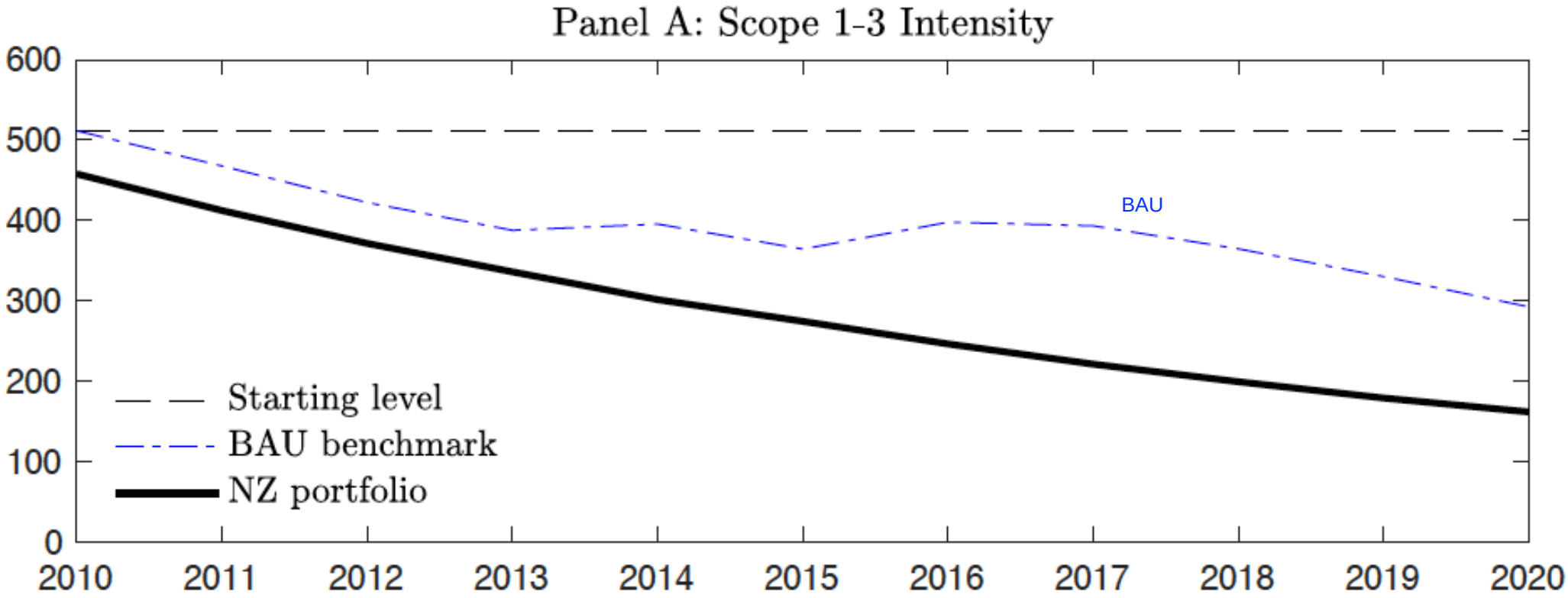
Limited change

Exclude a lot of firms

Source: Jondeau, Mojon, and Pereira da Silva (2021)

# Exclusion Strategy based on Carbon Intensity

Evolution of the carbon intensity of the BAU benchmark and the PC portfolio
($tCO_2e$/million $ of revenue)

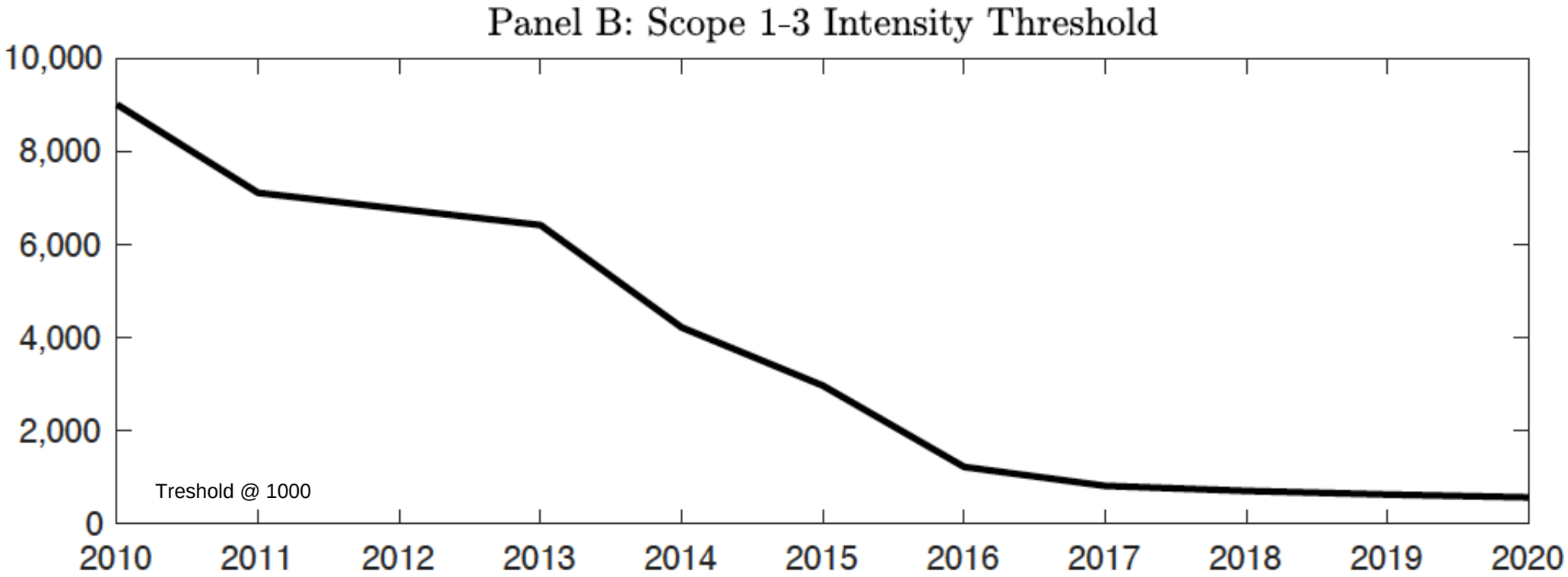



Source: Jondeau, Mojon, and Pereira da Silva (2021)

Based on World Wide portfolio

# Exclusion Strategy based on Carbon Intensity

Annual carbon intensity threshold above which firms are excluded
($tCO_2e$/m$ revenue)




Source: Jondeau, Mojon, and Pereira da Silva (2021)

## ➔ Case Study: Swiss National Bank's Portfolio