THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

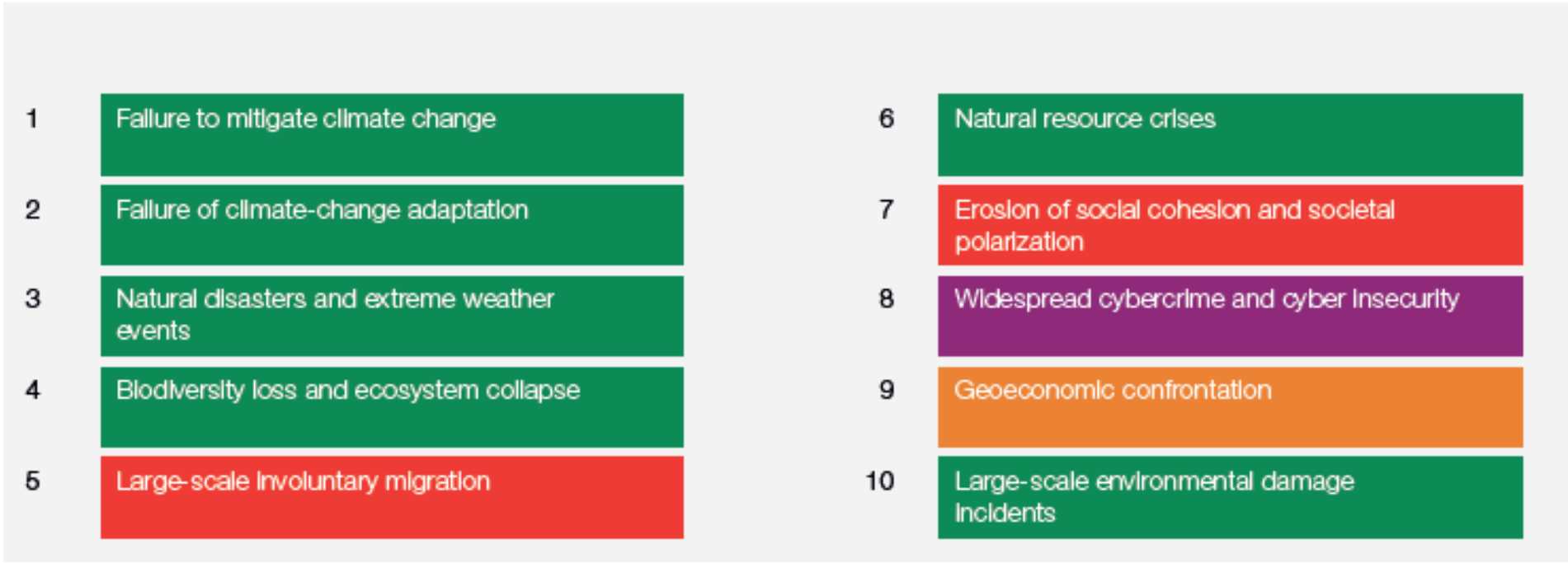
Climate Change, Asset Pricing and Expected Returns

Henk Berkman

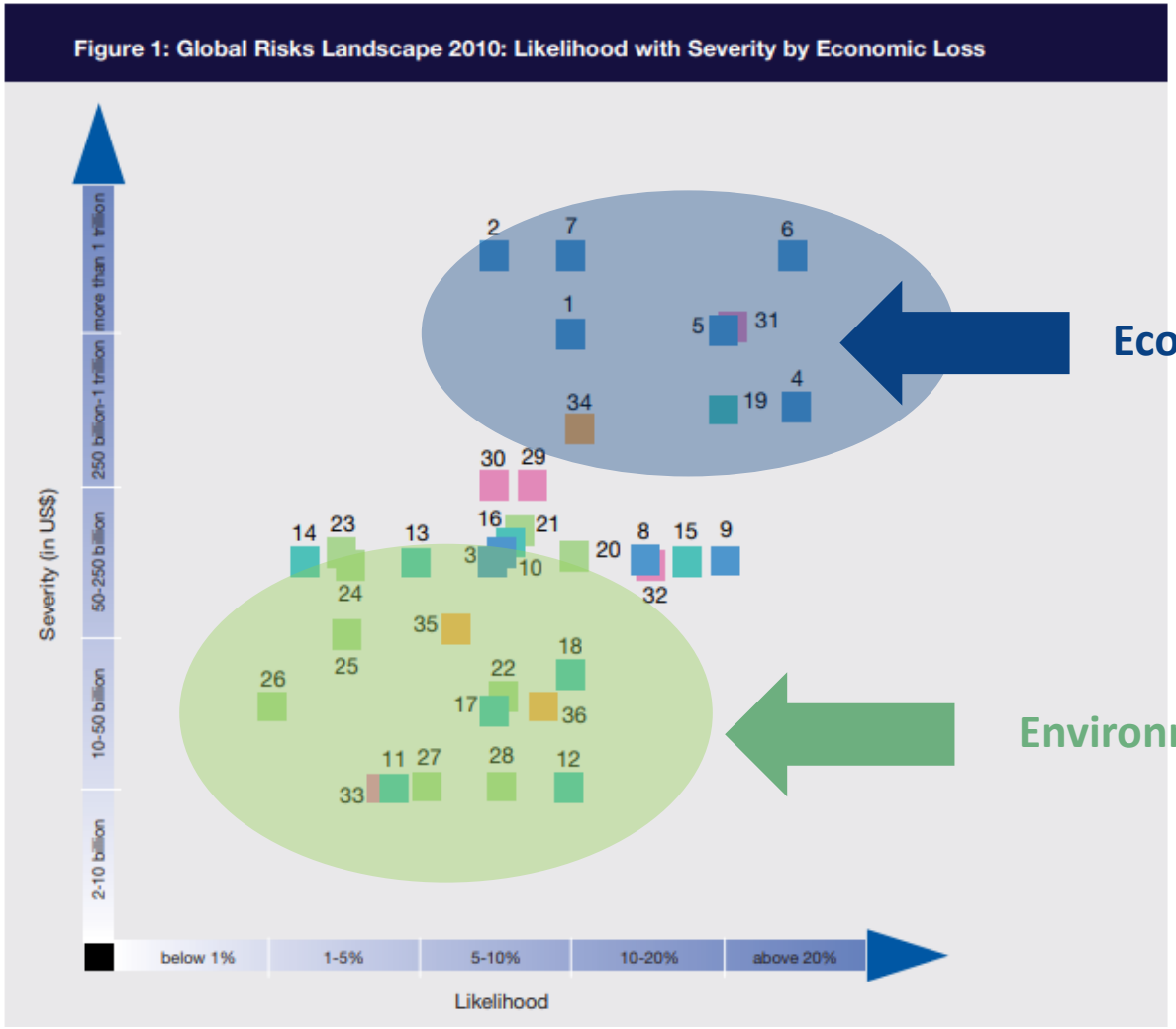
World Economic Forum *Risk Survey* 2023

What risk will have the most severe impact over next 10 years?

Choose from 32 risks from 5 categories:
Economic, Environmental, Geopolitical, Societal, Technological



World Economic Forum
Global Risks Survey 2010



Last decade saw emergence of *Sustainable Investors*

Consider *ESG* criteria (**environmental**, social, and governance) in addition to *Financial* criteria (risk and return)

Strong growth in ESG Investing

Growth ESG investments last 6 years
>40% pa (PwC)

Assets under Management with ESG considerations = 36% of total global AuM
(Global Sustainable Investment Alliance)

Climate Change concerns and growth in in ESG investing

What are the implications for

Asset Prices and Expected Returns?

What do *you* think?

Looking back over last 10 years, did

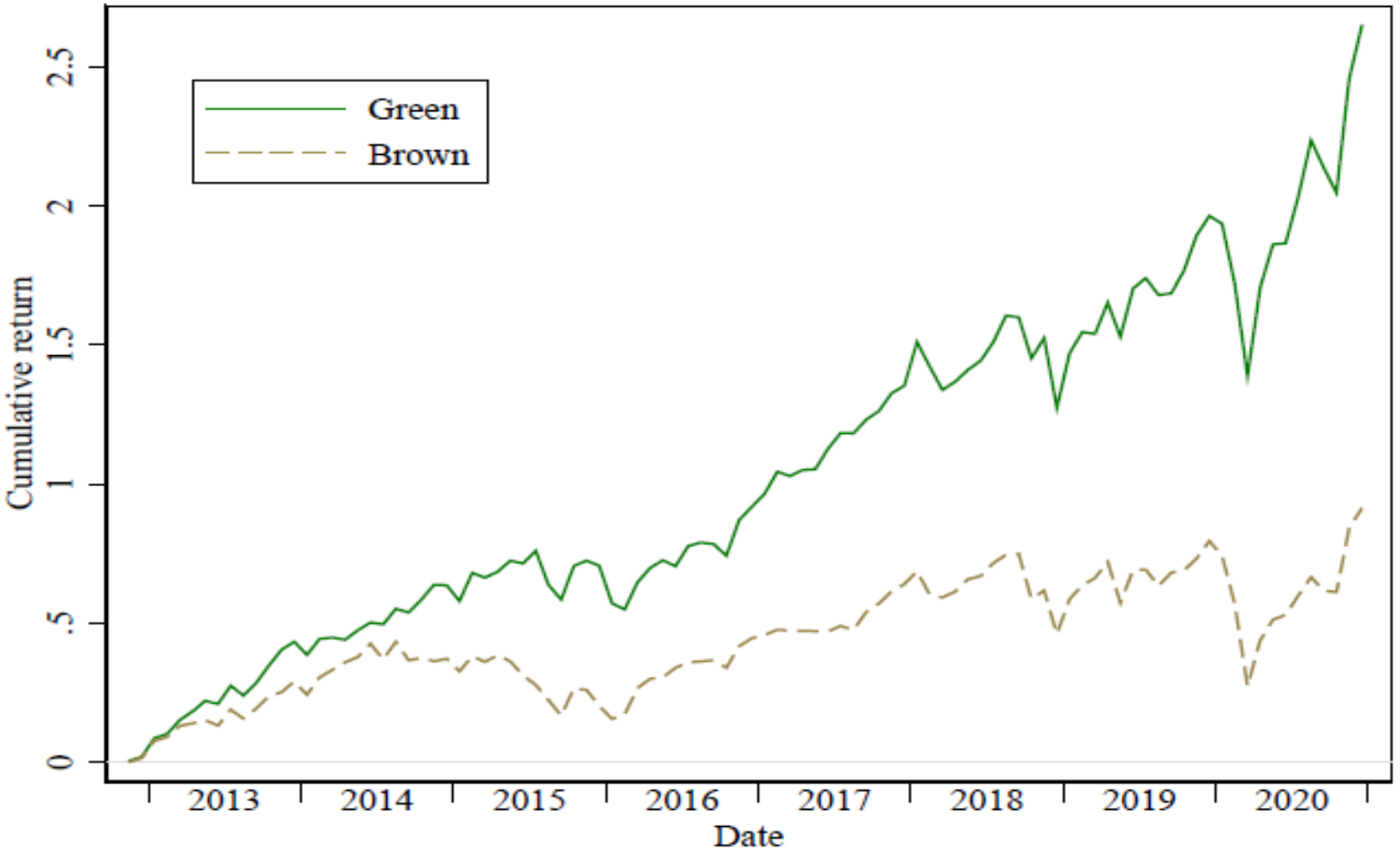
Green stocks *outperform* Brown stocks?

Green stocks = low exposure to CC (IT, biotech, Finance, Health care, Pharma)

Brown stocks *outperform* Green stocks?

Brown stocks = high exposure to CC (Oil&Gas, Steel, Construction, Mining, Transport)

Green outperformed brown



What do *you* think?

Looking forward over the next 10 years, will..

Green stocks *outperform* Brown stocks?

Green stocks = low exposure to CC (IT, biotech, Finance, Health care, Pharma)

Brown stocks *outperform* Green stocks?

Brown stocks = high exposure to CC (Oil&Gas, Steel, Construction, Mining, Transport)

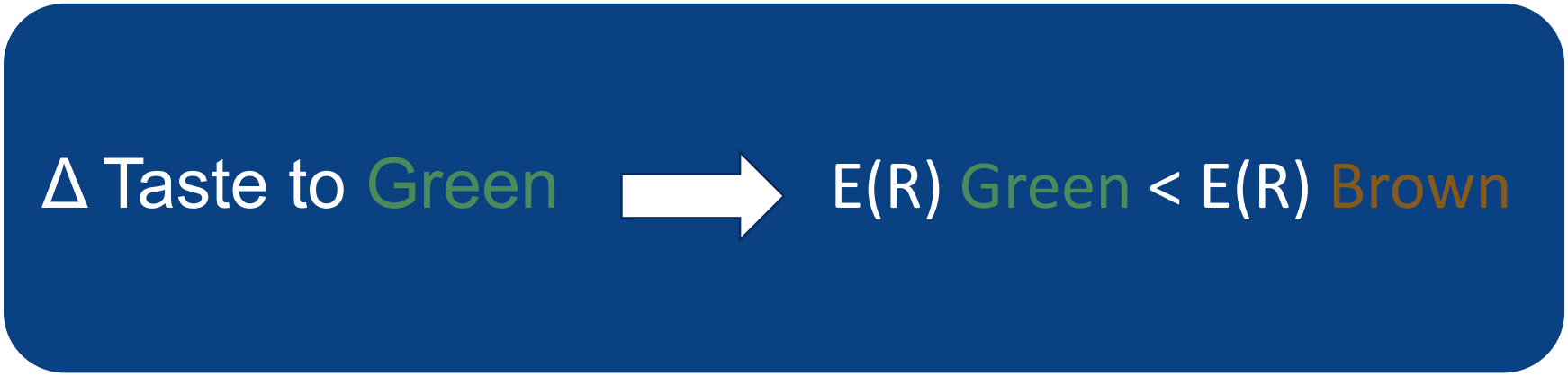
Sustainable Investing in Equilibrium

Pastor, Stambaugh and Taylor (2021, JFE)

Δ Taste: Many investors tilt to Green, away from Brown

This is OK, b/o of preference for Green, 'social returns'

Sustainable Investing: Negative screening



Climate Change is special

Weather disasters are costly & lower E (Consumption)

If climate disasters turn out worse than expected, **Green** retains value better than **Brown**

Because **Green** stocks provide *climate disaster insurance*, they require a lower return

Sustainable Investing: Theory

Δ Taste to green → E(R) **Green** < E(R) **Brown**

Climate disaster insurance → E(R) **Green** < E(R) **Brown**

Empirical Evidence

1. Is CC risk reflected in Asset Values?

2. Is CC risk affecting Expected Returns?

Climate risk and Real Estate

Initial evidence:
Physical Climate Risk and assets with fixed location

Bernstein, Gustafson and Lewis (JFE, 2019)

Houses inundated with 1 foot Sea Level Rise, sell at 15% discount

For similar properties *no* discount in rental rates

Physical Climate risk and Bonds

Painter (2020, JFE)

Bonds issued by US Counties that are more exposed to wildfire, floods or SLR have a higher yield

Only for LT bonds

Only for counties with low credit ratings

Climate Risk and *Equity Value*

Transition risk, Supply chain, consumer reactions, new technologies

Firms can adapt to climate risk at relatively low cost

Weather risks are insurable & costs passed on to customers

Low probability of direct impact and only in distant future

Firm-Specific Climate Risk and Market Valuation

Berkman, Jona, Soderstrom (2024, AOS)

Introduce Textual Climate Risk measure based on 10Ks

Compare to alternative firm-specific measures in explaining firm value

Different CC exposure measures

Scope 1 and 2 emissions scaled by sales

Environmental (ESG) databases e.g. MSCI & Sustainalytics

Conference call-based Climate Exposure measure

Sautner et al. (2023, JoFinance)

10-K disclosure-based measure

10K-based measure proposed in our paper

Covers Russell 3000 and Publicly Available

Reflects *length* of relevant CC disclosures and *relevance* of the language used

Climate Risk Measure

Using key-words, ML techniques find CC-relevant excerpts in 10K
Then assign a *score*, depending on *length* of excerpt as well as a *relevance* of words.

MACQUARIE INFRASTRUCTURE (FY 2015, reporting date: Feb., 2016)

"Policies at the national, regional and state levels to **regulate Greenhouse Gas emissions**, as well as **climate change**, could adversely impact CP&E's results of operations, financial condition and cash flows. Hazards customary to the power production industry include the potential for **unusual weather conditions**, which could affect fuel pricing and availability, as well as route to market or access to customers through transmission and distribution lines or to critical plant assets. To the extent that **climate change** contributes to the **frequency** or **intensity of weather-related events**, CP&E's operations could be affected. CP&E operates generating units in New Jersey that are not subject to the **Regional Greenhouse Gas Initiative (RGGI)**, which is a regional cap and trade system. Future state-level legislative changes may result in generating units in New Jersey being subject to **RGGI**. These new rules could adversely impact CP&E's results of operations, financial condition and cash flows. CP&E competes with both conventional **power industries and renewable power industries**, which could limit our returns and materially adversely affect our financial condition. The **power industry faces intense** competition from both conventional and renewable energy providers."

- **For this excerpt, 184 total words and *ClimateRisk*=22.**
- **Scores are then summed across the excerpts to get *total score for each year-firm***
- **14 excerpts were identified with 2,528 total words and *ClimateRisk*=85.**

Results 1

Market valuations are significantly negatively associated with $ClimateRisk_{it}$

Our measure outperforms other measures in explaining firm valuations (emission intensity, MSCI, Sustainalytics)

Coefficient $ClimateRisk$ more negative after Paris Agreement

Results 2

For our text-based measure,

In reaction to *negative news about CC*:

Stocks with *high* score (i.e. brown stocks)

decrease in value relative to stocks with *low* score

MSCI & Sustainalytics: no relation

Emissions intensity: weak negative relation

Empirical Results – Asset Valuations

Climate risks are incorporated into market valuations of assets

(stocks, bonds, real estate)

2: Climate Risk and Expected Returns

Δ Taste to green

Climate disaster insurance

E(R) **Green** < E(R) **Brown**

Empirical Evidence:

Bolton and Kacperzyk (JFE, 2020)

Higher carbon-emissions ⟹ higher stock returns?

Yes for Scope 1, and scope 2 and scope 3

There is a carbon premium!

Brown outperforms Green

However … lots of issues

Only holds for *emission levels* *not* *emissions intensity*

More careful use of Emissions data - reported vs estimated & release lags – shows *no* evidence of premium (Zhang, 2023)

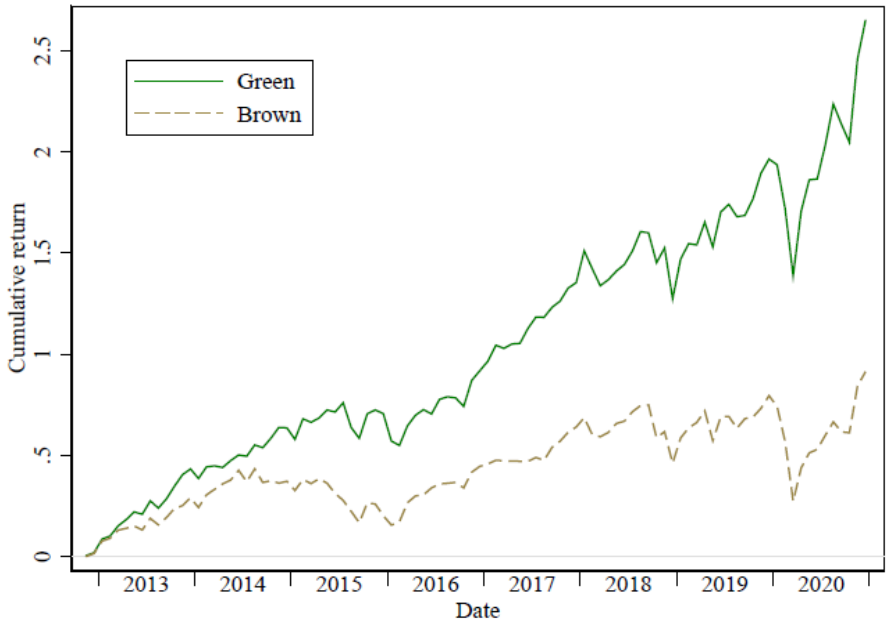
Conclusion based on *Realised* returns:

NO convincing evidence of carbon premium!

Problem with Realised returns

Realised return Green > Realised return brown … therefore ?????

E(R) Green > E(R) Brown NO!!!!!



Learning CC is real

→ $E(R)_{Green} < E(R)_{Brown}$

$$\text{Present Value (PV)} = \frac{C}{(1+r)^n}$$

→ $R_{Green} > R_{Brown}$

E(R) predictions based on Realised returns not reliable

What is Expected Return on a Stock?

Martin and Wagner JoFinance 2019

- Based on current option market prices only
- No use of historical data, no parameter estimation
- Stock specific measure of Expected Return..E(Ret $_i$)
- Performs well both in and out-of-sample

High CO2 Emissions ➡ High $E(R_i)$?

$$E(R_i) = a + b1\ Beta_i + b2\ Size_i + b3\ BM_i + b4\ Scope12/Sales_i + e_i$$

Option implied expected return

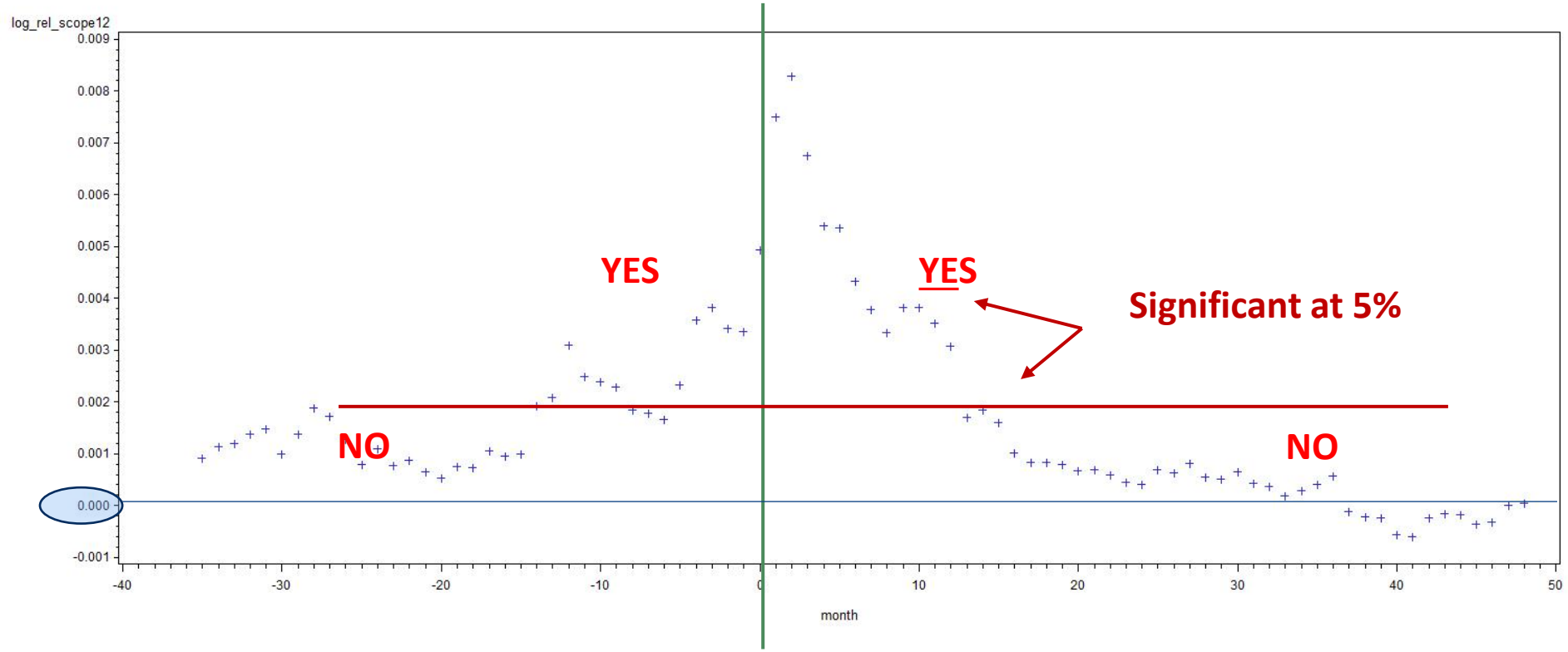
Estimate this cross-sectional model *every month*
from January 2013 to December 2019 (84 regressions)

Results

$E(R_i) = a + b1\ Beta_i + b2\ Size_i + b3\ BM_i + b4\ Scope12/Sales_i + e_i$

Variable	Mean	t-stat	N
log_rel_scope12	0.002	8.32	84
Beta	0.020	34.89	84
Size	-0.006	-42.47	84
BM	-0.004	-5.26	84

Risk Premium Emission Intensity?



Paris Dec 2015

Does ESG investing impact Expected returns?
Henk Berkman and Mihir Tirodkar

Over period 2007 -2021, for S&P 500 stocks

Expected returns (Option-Implied)

- are **not** related to *MSCI ESG scores*
- are **not** related to *E-scores* individually (or S or G)

Investors do not (yet) incorporate ESG in E(R)

Conclusions

Asset prices do reflect climate risk exposure

Expected returns, in theory, should be lower for Green stocks

- Evidence using Realised Returns is ambiguous (unreliable)
- Evidence using Expected Returns shows no relation

Investors do not (yet) incorporate climate risk in their E(R)