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Carbon Risk and Financial Markets

Energieforschungsgespräche Disentis

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World Economic Forum Davos 2019

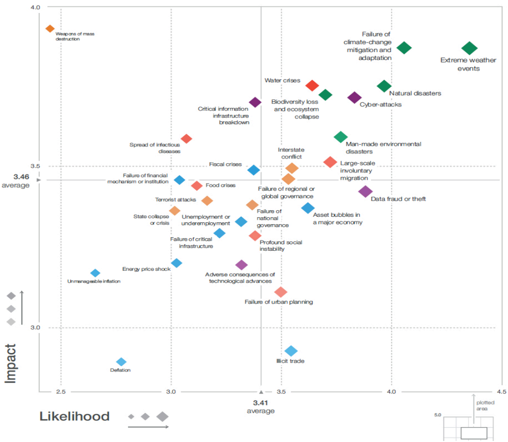

Figure: Source: World Economic Forum Global Risks Perception Survey 2018–2019

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Do you know Greta Thunberg?

Greta Thunberg Facts

- Greta Thunberg was born on 3 January 2003
- On 20 August 2018, she decided not attend school until the 2018 Sweden general election on 9 September after heat waves and wildfires in Sweden. She demands that the Swedish government reduce carbon emissions as per the Paris Agreement.
- By the end of 2018 more than 20,000 students held strikes in more than 250 cities in countries including Australia, Austria, Belgium, Canada,the Netherlands, Germany, Finland, Denmark, Japan, Switzerland, the United Kingdom and the United States.

Greta Thunberg Quote at COP24

- Instead, I will ask the people around the world to realize that our political leaders have failed us.
- Because we are facing an existential threat and there is no time to continue down this road of madness.

International Climate Negotiations: Conference of the Parties (COP)

Rio	Berlin	Kyoto	Bali	C'hagen	Cancún	Durban	Doha
1992	1995	1997	2007	2009	2010	2011	2012

Kyoto 1997:

- Agreement over Kyoto protocol (entered into force in 2005)
- Implementation of the Clean Development Mechanism (CDM) that introduces emission certificates as a policy mean to reduce carbon emissions

C'hagen 2009:

- Failure to agree on an all-encompassing global treaty
- As a response carbon prices dropped to a six-month low

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and even more COPs

Warsaw	Lima	Paris	Marrakech	Bonn	Katowice
2013	2014	2015	2016	2017	2018

- Adoption of the Paris Agreement as a replacement for the Kyoto Protocol - in force on 4 November 2016 as 55 countries responsible for at least 55% of the world's GHG emissions ratified
- Introduction of "nationally determined contributions" (NDCs) with a report on them every five years -without consequences when target is missed
- Revision of the CDM due to the failed success of certified emissions reductions (CER) in the past

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IPCC 2018 Special Report on Climate Change

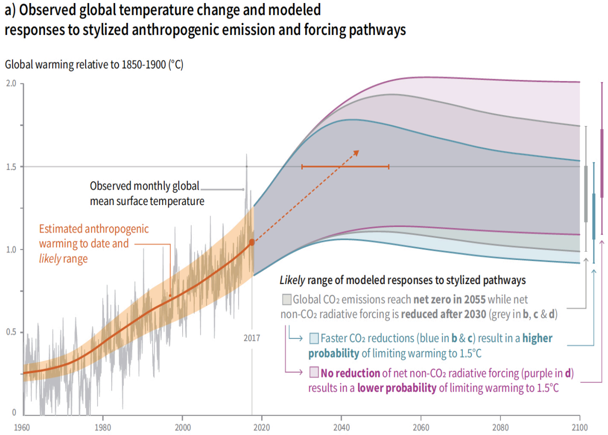

Figure: IPCC2018 Temperature Projection, source IPCC, 2018

IPCC2018 Special Report on Climate Change

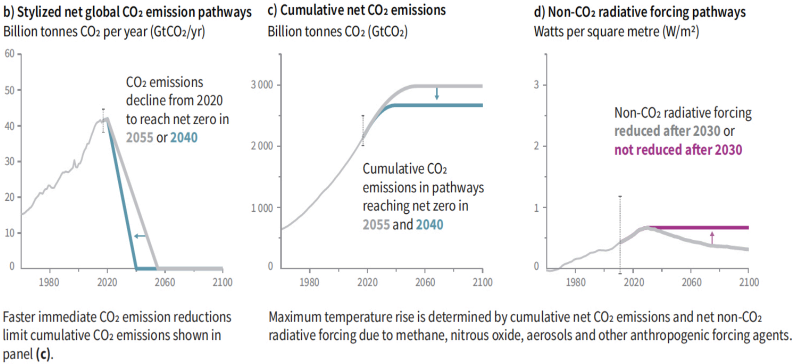

Figure: IPCC2018 CO2 emissions, source IPCC, 2018

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Characteristics of EU ETS (CO_2)

- EU ETS is split up into three phases
  - **Phase I (2005-07)**
  - **Phase II (2008-12)** coinciding with commitment period of Kyoto protocol
  - **Phase III (2013-20)** inducing significant changes compared to the two previous periods, according to Directive 2009/29/EC
- Scheme covers approximately 12,000 large emitters in the EU that are responsible for 50% of total CO_2 emissions. Regulated sectors include energy industry, combustion, cement, etc.
- Emission allowances are traded mostly OTC (approx 60%), bilateral (approx 10%) and on eight different exchanges (approx 30%): ECX in London, Nord Pool in Oslo, Powernext in Paris, EEX in Leipzig, The Green Exchange (NYMEX), Sende CO_2, EXAA, New Values Climex.

Structural Reform of the EU ETS

- At the start of phase III in 2013 the surplus of allowances stood at almost two billion, double its level in early 2012.
- As a short-term measure, the Commission has postponed the auctioning of 900 million allowances until 2019-2020 to allow demand to pick up.
- As back-loading is only a temporary measure, the Commission proposes to establish a market stability reserve at the beginning of the next trading period in 2021. http://ec.europa.eu/clima/policies/ets/reform/index_en.htm

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EUA Spot Prices – Policy Impact

N. Koch et al. / Journal of Environmental Economics and Management 78 (2016) 121–139 1

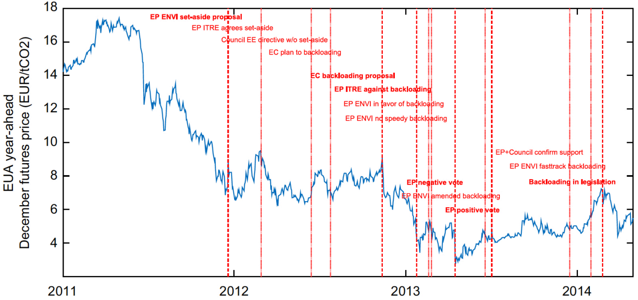

Fig. 1. EU Allowance price and news related to backloading. *Note*: This figure shows the commonality in the timing of price jumps with respect backloading policy announcements.

Figure: Source: Koch et. al. (2016)

EUA Spot Prices

Figure: EUA spot prices (in €/ton) (Source: EEX spot prices based on data from Montel)

In 2018 reports claimed that EU carbon prices are set to double by 2021 and could quadruple to €55 a tonne by 2030 if policy action of EU come in line with the Paris climate agreement.

Appropriate Price? Ask Asset Pricing Theory

- Litterman et al (2017) formulate an optimisation problem for an agent who trades off the (known) costs of climate mitigation against the uncertain future benefits associated with mitigation.
- The agent has to solve the dynamic optimization problem to determine the optimal mitigation stragegy to maximize lifetime utility at each time and for each state in future.
- Litterman et al. use Epstein-Zin preferences to separate risk aversion and time preferences and find that the Carbon Emission Price should rise from 35 $ to 60 $ by 2050.
- In Fischbach, Kiesel, Mahayni (2018) we extend Litterman et al. (2017) by introducing ambiguity aversion in the optimisation problem.
- The resulting carbon price is around 110 Euro for the year 2050 for the model with ambiguity.

Electricity Stocks and EUAs

- Tian et al. (2016) apply a multifactor model to address the impact of the EUA prices on the stocks of electricity companies during Phase I and II.
- They show that stock prices tend to positively respond to EUA price changes for those producers that use predominately green energy in their generation.
- For carbon intensive producers, they find an inverse relationship between stock returns and EUA price changes during Phase II.
- The conditional correlations between EUA returns and electricity stock volatility are found to be significant in Phase II and insignificant in Phase I.

Credit Default Spreads and EUAs

- A simple regression reveals the relation of CDS spreads of electricity producers and EUA prices.
- The EUA price is positively correlated with the CDS spread. An increase of the EUA price by one euro increases on average the CDS spread of electricity providers by about 3 basis points.
- To assess the default riskiness of a company often the expected loss ist calculated. As the expected loss is given as the exposure-at-default times the credit spread the linear relationship of EUA price and CDS spread has a direct effect on the default riskiness.

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Climate Change

Data sets from National Oceanic and Atmospheric Administration (NOAA, partly closed by the Trump administration) and NASA show

- The five warmest years in the global record have all come in the 2010s
- The 10 warmest years on record have all come since 1998
- The 20 warmest years on record have all come since 1995

Effect of annual average temperature on economic production

- Deryugina,Hsiang, NBER, WP 20750 show that a weekday with temperatures above 30C costs an average US county $20 per person in lost output.
- Burke et al. Nature (2015) show rate of change in productivity decreases with increasing temperature.

Number of Loss Events

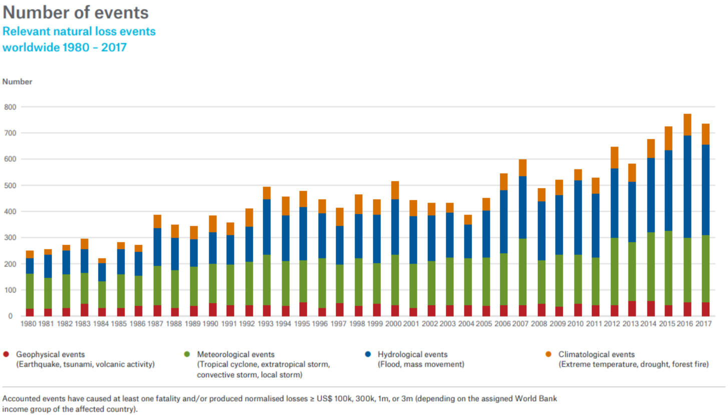

Figure: Number of loss events from 1980 to 2017 (Source: Munich Re)

Overall and Insured Losses

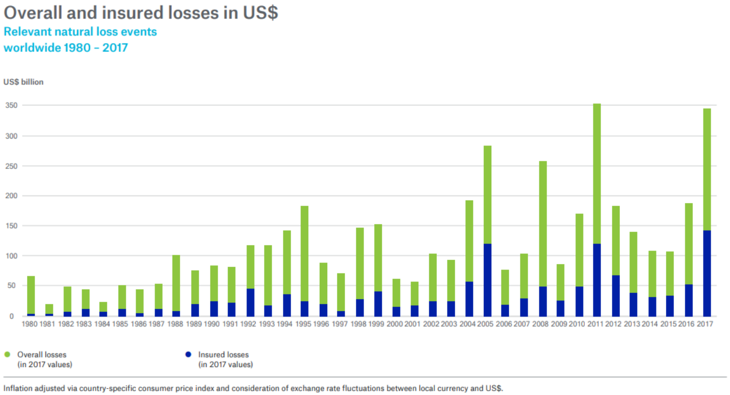

Figure: Overall and insured losses (in $) from 1980 to 2017 (Source: Munich Re)

Insurers and Climate Change I

Frankfurter Allgemeine | 08.01.2019 - Aktualisiert: 08.01.2019, 11:47 Uhr
https://www.faz.net/-gqi-9igsb

Indiz für Klimawandel

Munich Re nennt Waldbrände als schwerste Naturkatastrophe 2018

Der Rückversicherer Munich Re dokumentiert Naturkatastrophen rund um den Globus. 2018 starben dabei weltweit 10.400 Menschen – deutlich weniger als in anderen Jahren. Doch eine Katastrophe fiel aus dem Rahmen.

© dpa

Glut fliegt über einen Feuerwehrmann, während er am im Shasta-Trinity National Forest in Kalifornien ein Feuer zu kontrollieren versucht.

Für die Versicherungsbranche waren die Waldbrände in Kalifornien im vergangenen Jahr die schwersten Feuer aller Zeiten. Der weltgrößte Rückversicherer Munich Re hat die gesamtwirtschaftliche Schadensumme am Dienstag auf 24 Milliarden Dollar beziffert, ein Vielfaches der bei Feuern üblichen Summe. Davon waren 18 Milliarden Dollar versichert. Der Analyse zufolge sehen die Klimaforscher von Munich Re darin ein Indiz für den Klimawandel.

Insurers and Climate Change II

- A report by Swiss Re found the total economic loss from natural catastrophes and man-made disasters nearly doubled to $337bn in 2017, from $180bn the year before.
- Lloyd's of London posted in 2018 its first loss in six years, citing the impact of a series of natural disasters.
- Axa, the large insurer, has warned that more than 4°C of warming this century would make the world uninsurable.

Climate Risks

Types of climate related risks

- the scientific environmental uncertainty – Earth's climate sensitivity,
- the economic climate risk – economic impact and damages from climate change
- the climate policy risk – which and how regulation is enforced

Climate Risks specific

- Physical climate risks: Physical changes in climate lead to modifications of climate pattern and extreme weather events. These may alter supply and demand pattern of many industries and lead to physical damages of assets, which may trigger adaption costs and economic loss of value.
- Carbon risks: The translation into a low-carbon economy will alter the financial viability of a part of the capital stock and business models. The associated financial risks and opportunities will alter the performance of assets and portfolios.
- In the following we focus on economic and financial risks – carbon risk

Carbon Bubble

- to avoid uncontrollable climate change needs a limit on the rise in global surface temperature to 1.5°C (compared to the pre-industrial age)
- to reach this target needs a limit on future carbon dioxide (CO_2) emissions
- a major part (in the order of 30% to 50 %) of global reserves of fossil fuels can't be burned so that the majority of fossil fuel reserves are stranded assets
- over-evaluation of fossil fuel reserves and associated assets, which can become stranded assets when limiting climate change

Stranded Assets

- that reduces the value of private companies owner of fossil fuels and their ability to repay their debt
- a transition driven by technological developments could cause a negative shock to electricity producers, while reducing production costs for some other sectors
- apart from the energy sector, broader economic changes related to energy use will also impact a range of other high-carbon and climate-related sectors, notably utilities, transport, and manufacturing sectors.
- governments owning fossil fuel reserves would be faced with a fall in revenues, reducing the value of the sovereign bonds they have issued

Climate Value at Risk; Dietz et al. (2016)

- They use an extended version of Nordhaus's Dynamic Integrated Climate-Economy (DICE) model to estimate the impact of climate change on GDP growth
- They find that the expected climate Value-at-Risk (climate VaR) of global financial assets today along the busines-as-usual emission path is 1.8% of global financial assets. However, much of the risk is in the tail; for example the 99% percentile is 16.9 % of global financial assets.
- Under the 2° pathway the expected climate VaR is 1.2% of global financial assets and the 99% percentile is 9.2 % of global financial assets.

The Carbon Bubble and the European Financial System

Weyzig et al. (2014). *The Price of Doing Too Little Too Late: The impact of the carbon bubble on the EU financial system.*

- measurement of the carbon bubble's impact on the European financial system (pension funds, banks, insurances)
- estimation of the exposure to fossil fuel extracting firms (equities, bonds and loans) and fossil fuel commodities
- approx. €260-330 billion, €460-480 billion and €300-400 billion exposure for pension funds, insurances and banks, resp.
- assuming a fast and definite transition to a low-carbon economy may result in a 3%, 2% and 0.4% average loss for pension funds, insurances and banks, resp.
- a slow and uncertain transition leads to more investments in future stranded assets and become more costly

The move out of coal, FT 28th December 2018

- Mr Carney (Govenor of BoE) played a major role in setting up the Task Force on Climate-related Financial Disclosures (TCFD), an initiative to help companies quantify the risks so they can communicate them to investors.
- Most global banks have signed up to the TCFD, but five lenders went a step further last month by pledging to “progressively align” their corporate loan book with the goals of the Paris agreement, which seeks to keep global warming to well below 2C.
- Ralph Hamers, chief executive of ING, said that failing to realign the bank’s portfolio might mean it ended up with "stranded assets” — loans that have turned sour because the borrower has been put out of business by new climate policies. “You could be stuck with a client that doesn’t get [operating] licences any more,” he added.

Bank exposure to coal

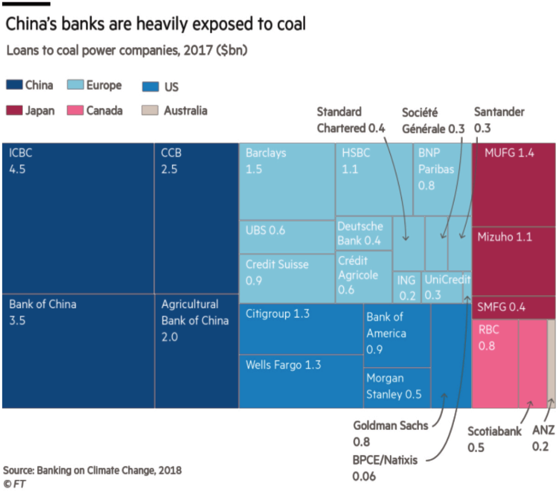

Figure: Source: FT 28th December 2018

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Carbon Risk - Definition

Carbon risk reflects the risks "correlated with GHG-emissions"

- industrial carbon-related policy risk: GHG emission caps or taxes
- market constraints: changes in the demand and prices for energy linked to an energy transition
- climate litigation: lawsuits can create liabilities due to past emissions for targeted companies
- investment regulatory frameworks: mechanisms that impact the cost and availability of capital; capital requirements, taxes on capital
- fiduciary duty related litigation: claims of negligence for institutional investors if carbon bubble bursts

So carbon risk relates to regulation, litigation, competition, production, reputational risk

Difficulties in Capturing Carbon Risk for Financial Institutions

- **Risk & Uncertainty** The decarbonization pathway of the global economy is uncertain and there are different choices at national level, in terms of levels of GHG emission constraints and technology options that will be incentivized.
- **Data** There are no historical data for models available.
- **Distribution** The climate forecasts are skewed and have fat tails
- **Time horizon** Financial actors usually think in 1 to 3 years terms, which is far shorter than the materialisation of climate risks. Mark Carney speaks of 'the tragedy of the horizon'.

Greta Thunberg Quote– Public Opinion

- So we have not come here to beg the world leaders to care for our future. They have ignored us in the past and they will ignore us again.
- We have come here to let them know that change is coming whether they like it or not. The people will rise to the challenge. And since our leaders are behaving like children, we will have to take the responsibility they should have taken long ago.

Carbon Tracker

- Carbon Tracker is an independent financial think tank that carries out in-depth analysis on the impact of the energy transition on capital markets and the potential investment in high-cost, carbon-intensive fossil fuels (from their webpage).
- `https://www.carbontracker.org`

Carbon Disclosure Project (CDP)

- CDP is a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts (from their webpage).
- https://www.cdp.net/en

Carbon Market Data

- To help regulators and investors to identify and assess the risks and opportunities created by the new carbon-constraining policies Carbon Market Data offers the EU ETS Company Database.
- https://carbonmarketdata.com/en/hom

Changing attitude of investors

- Norway state pension funds stops investing in more than 60 companies because of climate change; Norges Bank (2017)
- Mark Carney, governor of the Bank of England, has suggested the risks arising from climate change should form part of its annual stress tests for banks from 2019 (Financial Times, Dec 2018)
- Investors overseeing more than $11tn in assets, including Schroders, Legal & General Investment Management and two of the biggest US pension funds, have called on power companies to commit to ending coal use by 2030 and spell out preparations for a global shift towards low-carbon fuels (Financial Times, Dec 2018).

Changing attitude of investors/companies II

- Climate Action 100+ is a five-year initiative led by investors to engage systemically important greenhouse gas emitters and other companies across the global economy that have significant opportunities to drive the clean energy transition and help achieve the goals of the Paris Agreement. Investors are calling on companies to improve governance on climate change, curb emissions and strengthen climate-related financial disclosures.
- It was launched in December 2017 and has more than 310 members by today.
- In 2018 a growing number of companies have announced their own emissions targets against the backdrop of bruising climate negotiations at the international level, including IKEA, MAERSK, Schneider, BT.

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Recent Headline – FT 14.01.2019

- Larry Fink urged to make BlackRock tougher on climate change – Campaigners say world's biggest fund manager lags behind peers in challenging companies
-
  - BlackRock (the world biggest money manager with assets worth \$6.4tn) was also one of the worst performers in a report examining the voting record of 24 global asset managers on climate proposals at carbon-intensive companies in 2017.
  - 'BlackRock has legal obligations as a fiduciary for the investments of millions of people around the world. If it does not take stronger action to protect investors from climate risk in 2019, it will be failing to fulfil those duties', said James Thornton, chief executive of ClientEarth, an environmental legal group involved in the campaign.

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Carbon Risk (Görgen et al. 2017): Results

- construct a common capital market-based carbon risk factor to capture firm's sensitivity to transition to low carbon economy
- shows that the factor enhances the explanatory power of common factor models for a large validation sample of firms
- various asset pricing test and different model specifications are used to show the robustness of results

Carbon Risk Score (CRS)

- utilises carbon related company level data from Thomson Reuter ESG database such as CO2e-score, climate change risk/opportunities etc.
- sort companies into terciles for each variable $ES^k_{i,t}$. Assign $2, 1, 0$ for high, medium, low tercile
- define Carbon Risk Score (CSR)

$$CRS_{i,t} = 0.9CO2e_{i,t} + 0.1\sum_{k=1}^{1} 0ES^k_{i,t}$$

- Following Fama, French (1993) six portfolios, based on size (median) and CRS (tercile) are build

CRS Portfolios

Figure 1

CRS portfolio matrix

	Upper *CRS* tercile		Lower *CRS* tercile
Size Median	Big/High *CRS* (*BH*)	Big/Medium *CRS* (*BM*)	Big/Low *CRS* (*BL*)
	Small/High *CRS* (*SH*)	Small/Medium *CRS* (*SM*)	Small/Low *CRS* (*SL*)

This matrix shows the annual unconditional sorting of the stocks in our training sample into portfolios based on carbon risk score (*CRS*) and market equity (Size).

Figure: CRS Portfolio Matrix (Görgen et al. 2017)

Define the Brown Minus Green Factor

$$BMG_t = 0.5(SH_t + BH_t) - 0.5(SL_t + BL_t)$$

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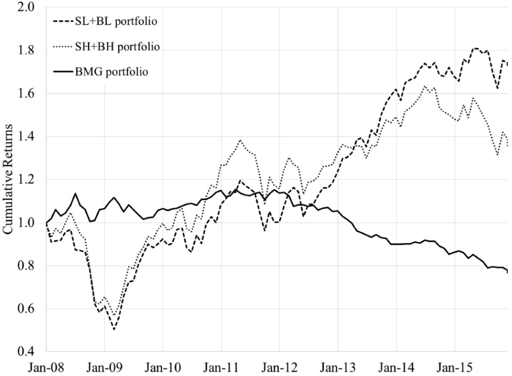
BMG Performance

Figure 2
Cumulative returns of carbon risk portfolios



This figure shows cumulative returns of the *BMG* factor and the underlying long (*SH+BH*) and short positions (*SL+BL*) for the sample period from January 2008 to December 2015.

Figure: (Görgen et al. 2017)

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Carbon Risk and Cost of Equity Capital in Korea

Kim, et. al.(2015). *The effect of carbon risk on the cost of equity capital* show that

- carbon intensity (CO2 emissions/sales) and the cost of equity capital are positively related
- this effect decreases for companies in highly GHG emitting sectors
- sustainability report disclosure has no positive effect on the cost of equity capital
- a 10% cut in carbon intensity (CO_2 emissions/sales) is associated with a 8 basis points lower cost of equity for a given sales level
- Similar results by for cost of equity capital for Germany and Austria (Fichtner, Masterthesis LEF, 2018)

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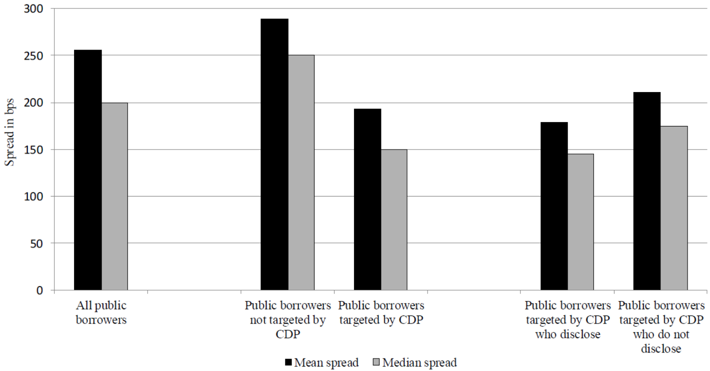
Carbon Disclosure, Emission Levels, and Cost of Debt

Kleimeier, S., Viehs, M. (2018). *Carbon disclosure, emission levels, and the cost of carbon.*

- higher transparency with respect to carbon emissions leads to more favorable loan conditions for firms with high levels of information uncertainty
- Opaque firms which answer the annual Carbon Discloser Project (CDP) questionnaire and voluntarily reveal their carbon emission pay significantly lower loan spreads as compared to firms which do not disclose their emissions data
- financial markets and in particular lenders take into account information on firms environmental status when assessing creditworthiness.

Carbon Disclosure, Emission Levels, and Cost of Debt

Cost of debt for different borrower types



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Data

- CDS spreads of European Energy and German companies available at Bloomberg's CDX with one, three and five years maturity
- rolling EUA futures prices with one, three and five years maturity
- interest rate on listed Federal securities with one, three and five years maturity published by Deutsche Bundesbank
- stock prices available at Bloomberg
- stock return volatility measured as the annualized volatility over a 250 days window

Data

- market condition measured as the median spread change of equally rated companies considering the rating groups (1) AAA/AAs, (2) As, (3) BBBs and (4) BBs and lower and the maturities one, three and five years. The company ratings were derived from the companies' annual reports, Moody's website and Standard & Poor's website
- carbon intensity data and sector information from EU ETS Company Database by Carbon Market Data
- daily data from 01/2013 - 8/2018

Data

Carbon intensity is measured by

- yearly absolute emissions
- yearly change in emissions
- yearly emissions-to-cap ratio (=(verified emissions-allocated allowances)/allocated allowances)

We divide the sample into terciles per category and allocate $-1, 0, 1$ to green, gray and brown companies, resp. Finally, we sum up the scores per category and define

- brown companies: score < 0
- gray companies: score $= 0$
- green companies: score > 0

Data

green	gray	brown
Bayer	BASF	E.ON
BMW	BP	EDP
Centrica	EnBW	EDF
Continental	Fortum	Endesa
Daimler	Iberdrola	Enel
Henkel	Linde	Engie
Lanxess	LUKOIL	Eni
Merck	Repsol	HeidelbergCement
National Grid	Suedzucker	Shell
Siemens	Veolia	thyssenkrupp
United Utilities	Volkswagen	TOTAL

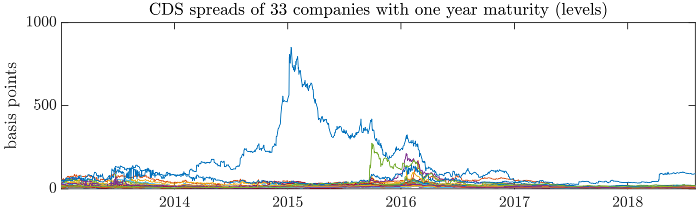
Table: Carbon intensity of companies under consideration.

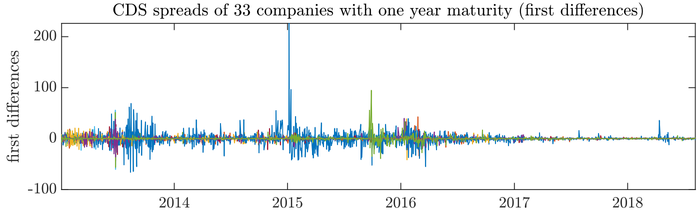
Data

sector	#	examples
Heat & Power	11	e.g. E.ON, EnBW, Endesa, Enel, Veolia
Oil & Gas	6	e.g. Eni, LUKOIL, Shell, Repsol, TOTAL
Chemicals	5	BASF, Bayer, Henkel, Lanxess, Linde
Motor Industry	4	BMW, Continental, Daimler, Volkswagen
mixed	7	e.g. HeidelbergCement, National Grid, Siemens

Table: Sectors under consideration.

Data


CDS spreads of 33 companies with one year maturity (levels)
basis points
1000
500
0
2014
2015
2016
2017
2018


CDS spreads of 33 companies with one year maturity (first differences)
first differences
200
100
0
-100
2014
2015
2016
2017
2018

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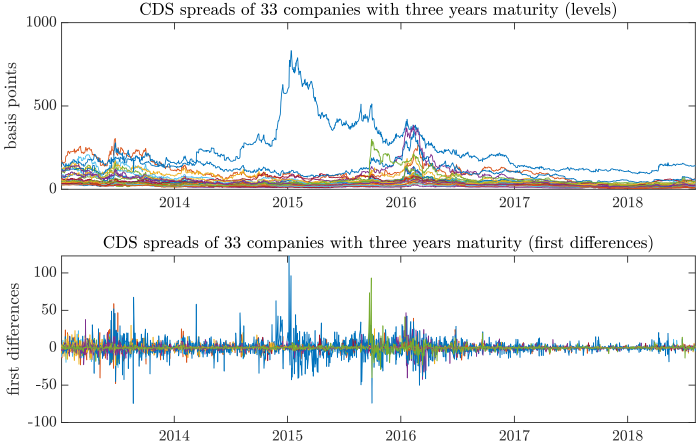
Data



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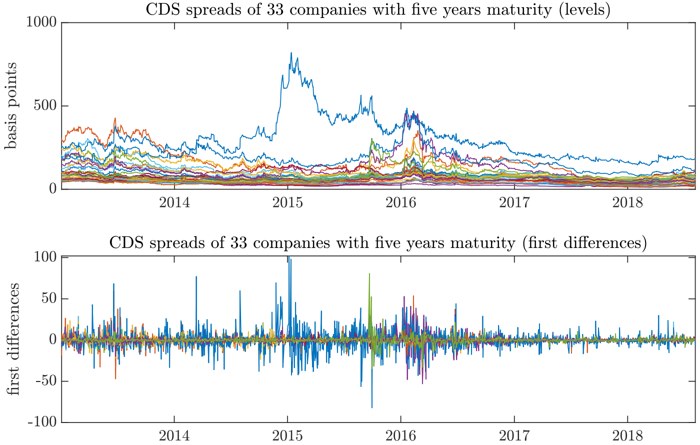
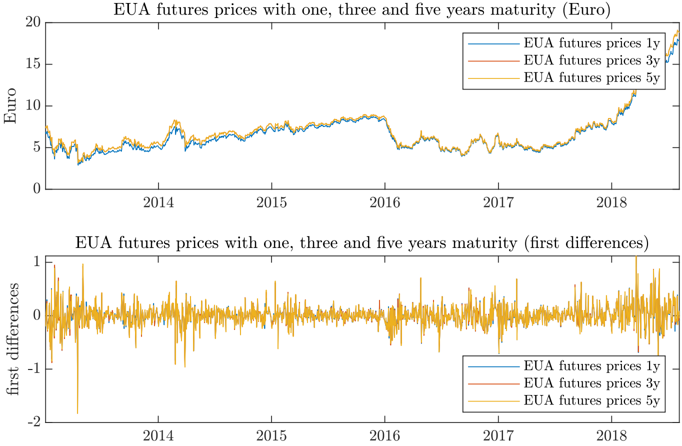

CDS spreads of 33 companies with five years maturity (levels)
basis points
1000
500
0
2014
2015
2016
2017
2018
CDS spreads of 33 companies with five years maturity (first differences)
first differences
100
50
0
-50
-100
2014
2015
2016
2017
2018

House of Energy Markets & Finance

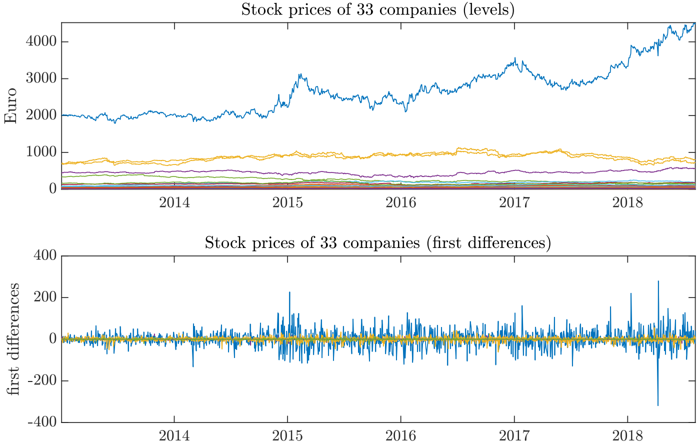
UNIVERSITÄT DUISBURG ESSEN

Offen im Denken

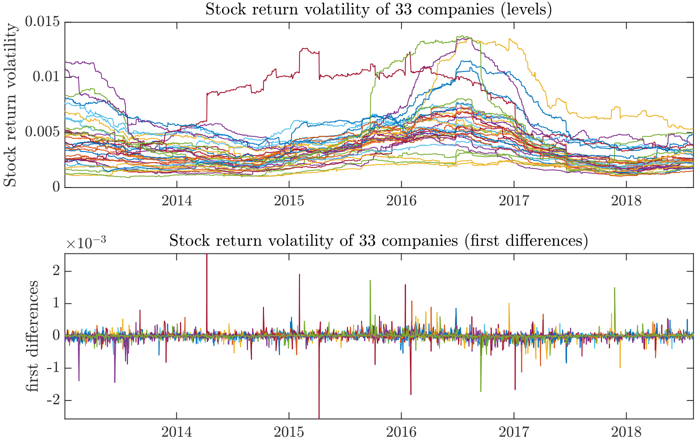
Data



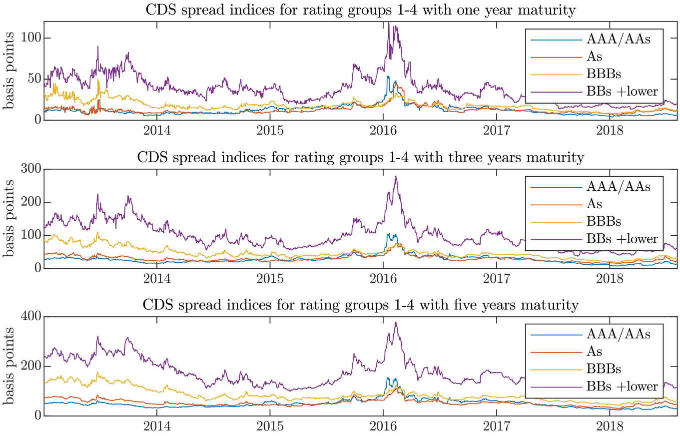
Data


Stock prices of 33 companies (levels)
Euro
4000
3000
2000
1000
0
2014
2015
2016
2017
2018
Stock prices of 33 companies (first differences)
first differences
400
200
0
-200
-400
2014
2015
2016
2017
2018

Data


Stock return volatility of 33 companies (levels)
Stock return volatility
0.015
0.01
0.005
0
2014
2015
2016
2017
2018
Stock return volatility of 33 companies (first differences)
×10^-3
first differences
2
1
0
-1
-2
2014
2015
2016
2017
2018

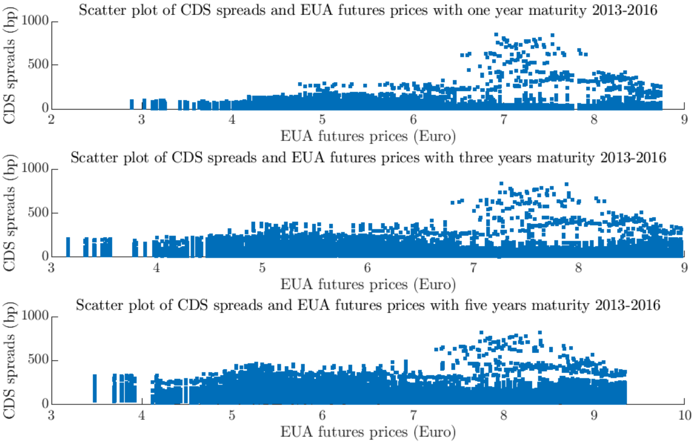
Data


CDS spread indices for rating groups 1-4 with one year maturity
basis points
100
50
0
2014
2015
2016
2017
2018
AAA/AAs
As
BBBs
BBs +lower
CDS spread indices for rating groups 1-4 with three years maturity
basis points
300
200
100
0
2014
2015
2016
2017
2018
AAA/AAs
As
BBBs
BBs +lower
CDS spread indices for rating groups 1-4 with five years maturity
basis points
400
200
0
2014
2015
2016
2017
2018
AAA/AAs
As
BBBs
BBs +lower

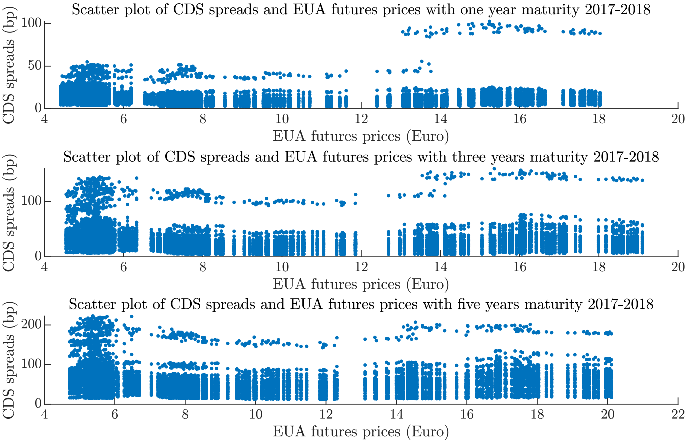
Data


Scatter plot of CDS spreads and EUA futures prices with one year maturity
CDS spreads (bp)
1000
500
0
2
4
6
8
10
12
14
16
18
20
EUA futures prices (Euro)
Scatter plot of CDS spreads and EUA futures prices with three years maturity
CDS spreads (bp)
1000
500
0
2
4
6
8
10
12
14
16
18
20
EUA futures prices (Euro)
Scatter plot of CDS spreads and EUA futures prices with five years maturity
CDS spreads (bp)
1000
500
0
2
4
6
8
10
12
14
16
18
20
22
EUA futures prices (Euro)

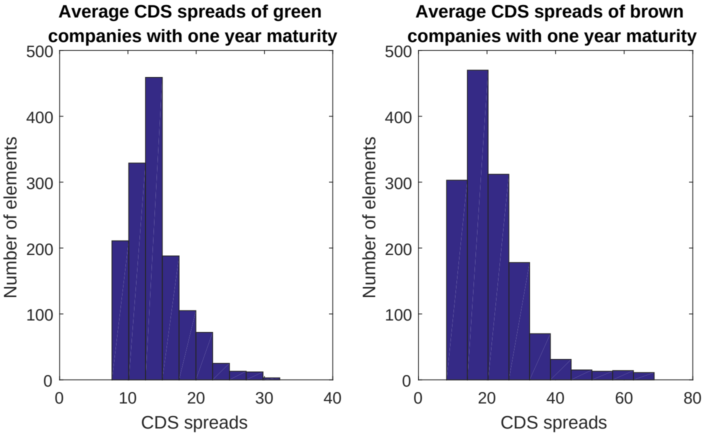
Data


Scatter plot of CDS spreads and EUA futures prices with one year maturity 2013-2016
CDS spreads (bp)
1000
500
0
2
3
4
5
6
7
8
9
EUA futures prices (Euro)
Scatter plot of CDS spreads and EUA futures prices with three years maturity 2013-2016
CDS spreads (bp)
1000
500
0
3
4
5
6
7
8
9
EUA futures prices (Euro)
Scatter plot of CDS spreads and EUA futures prices with five years maturity 2013-2016
CDS spreads (bp)
1000
500
0
3
4
5
6
7
8
9
10
EUA futures prices (Euro)

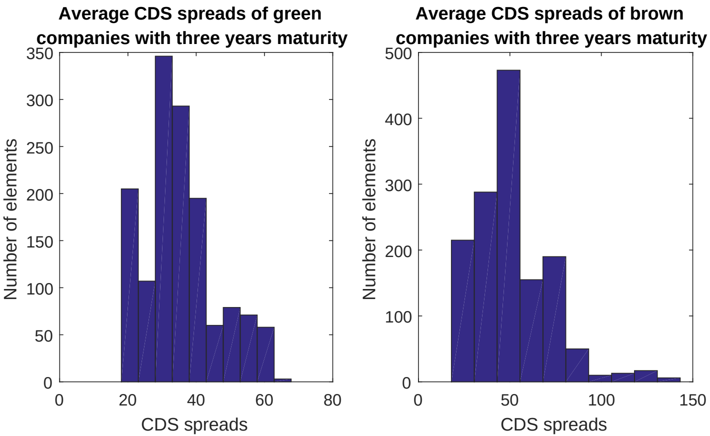
Data


Scatter plot of CDS spreads and EUA futures prices with one year maturity 2017-2018
CDS spreads (bp)
0
50
100
4
6
8
10
12
14
16
18
20
EUA futures prices (Euro)
Scatter plot of CDS spreads and EUA futures prices with three years maturity 2017-2018
CDS spreads (bp)
0
100
EUA futures prices (Euro)
Scatter plot of CDS spreads and EUA futures prices with five years maturity 2017-2018
CDS spreads (bp)
0
100
200
22
EUA futures prices (Euro)

Data


Average CDS spreads of green companies with one year maturity
Number of elements
CDS spreads
0
100
200
300
400
500
0
10
20
30
40
Average CDS spreads of brown companies with one year maturity
Number of elements
CDS spreads
0
100
200
300
400
500
0
20
40
60
80

Data


Average CDS spreads of green companies with three years maturity
Number of elements
CDS spreads
0
50
100
150
200
250
300
350
0
20
40
60
80
Average CDS spreads of brown companies with three years maturity
Number of elements
CDS spreads
0
100
200
300
400
500
0
50
100
150

Regression Equations

Panel regressions using the first-difference estimator for one, three and five years maturity:

$$\Delta CDS_{i,t}^{m} = \beta_1 \Delta r_t + \beta_2 \Delta EUA_t + \Delta \epsilon_{i,t}$$
$$\Delta CDS_{i,t}^{m} = \beta_1 \Delta s_{i,t} + \beta_2 \Delta v_{i,t} + \beta_3 \Delta mx_{i,t} + \beta_4 \Delta EUA_t + \Delta \epsilon_{i,t}$$

with $m = 1, 3, 5$, $i = 1, ..., N$, $t = 1, ..., T$ and $N = 33$, $T = 1417$.

Regressions

	Estimate	Std. Error	t value	Pr(>|t|)
β_1	-0.1107	0.0132	-8.3766	< 2.2e-16 ***
β_2	0.0496	0.0191	2.6024	0.0093 **
β_3	0.4844	0.0279	17.3695	< 2.2e-16 ***
β_4	-0.0371	0.0128	-2.9001	0.0037 **

Table: FD estimator for three years maturity. $R^2 = 0.2038$

Regressions

	Estimate	Std. Error	t value	Pr(>|t|)
β_1	-0.1208	0.0138	-8.7810	< 2.2e-16 ***
β_2	0.0248	0.0155	1.6056	0.1084
β_3	0.5758	0.0306	18.7996	< 2.2e-16 ***
β_4	-0.0316	0.0108	-2.9333	0.0034 **

Table: FD estimator for five years maturity. $R^2 = 0.3829$

Regressions - oil and gas sector

	Estimate	Std. Error	t value	Pr(>|t|)
β_1	-0.0173	0.0113	-1.5340	0.1252
β_2	0.0636	0.0544	1.1695	0.2423
β_3	0.4710	0.0462	10.1873	<2e-16 ***
β_4	0.0070	0.0184	0.3786	0.7050

Table: FD estimator for one year maturity 2017-2018. $R^2 = 0.2380$

Regressions - oil and gas sector

	Estimate	Std. Error	t value	Pr(>|t|)
β_1	-0.0240	0.0105	-2.2765	0.0230 *
β_2	0.0885	0.0442	2.0048	0.0451 *
β_3	0.3066	0.0193	15.8646	< 2e-16 ***
β_4	0.0061	0.0180	0.3422	0.7323

Table: FD estimator for three years maturity 2017-2018. $R^2 = 0.1050$

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Regressions - oil and gas sector

	Estimate	Std. Error	t value	Pr(>|t|)
β_1	-0.0005	0.0099	-0.0528	0.9579
β_2	0.0580	0.0414	1.4019	0.1611
β_3	0.3911	0.0156	25.0859	<2e-16 ***
β_4	-0.0021	0.0177	-0.1209	0.9038

Table: FD estimator for five years maturity 2017-2018. $R^2 = 0.2159$

Contact

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Thank you for your attention...