European Commission

The Greenium matters: evidence on the pricing of climate risk

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The views in this presentation are those of the authors and do not necessarily reflect those of the EC.

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Introduction

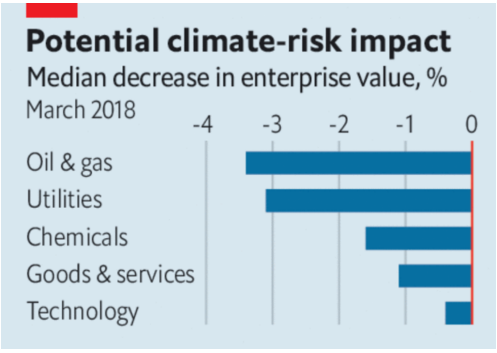
Paris Agreement, December 2015

- "*Holding the increase in the global average temperature to well below 2 Celsius degrees above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 Celsius degrees*"
- " *[...] and low greenhouse gas emission development*"

Implications of climate change:

- Physical risk: the direct impacts of climate and weather-related events (typhoons, hurricanes, droughts, ...);
- Transition risk: the risks that arise from the process of mitigation and adjustment towards a low-carbon economy. Negative (positive) impact on polluting (environmentally friendly) firms.

The Economist: Firms urgently need to rethink how they approach climate risk.



Building blocks (1)

1. How to distinguish greener and browner firms?
   - Transparent and non-transparent companies.
   - Firm-level synthetic indicator of greenness based on the quality of the environmental disclosure and the level GHG emissions.

Building blocks (2)

2. Does climate risk affect the cross-section of stocks returns?
   - We identify a priced green risk factor and the associated Greenium.
3. How exposed are financial firms to climate risk?
   - Climate change and financial stability: We develop a carbon stress test on equity holdings.

Related literature

Environmental and financial performances are positively correlated:

- Ambec and Lanoie (2008), Margolis (2009), Porter (1991), Gore (1993), and Porter and VanDerLinde (1995).

Sustainability and asset pricing:

- sustainability is associated with higher financial returns (Derwall et al., 2005), and predicting future performance (Trinks et al. 2018);
- divesting in carbon does not affect portfolios performances (Hartzmark and Sussman, 2018).
- climate risk hedging portfolios: Engle et al. (2019), Goergen et al. (2019).

Climate change and financial stability:

- gradual vs abrupt transition (Gros et al., 2016);
- carbon stress test (Battiston et al., 2017).

Data

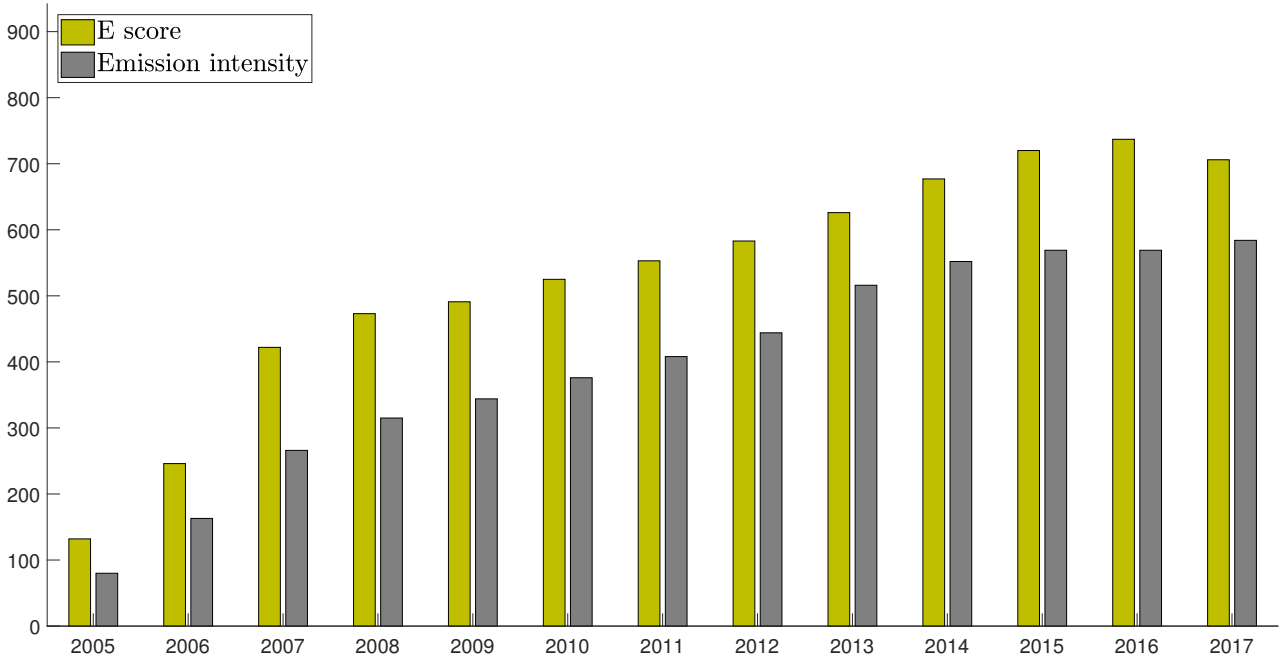
Stocks returns: 942 companies listed on the STOXX Europe Total Market Index (TMI). (Source Bloomberg)

- TMI covers approximately 95% of the market capitalisation of European companies, including large, mid and small caps;
- time horizon: January 2006 to August 2018, monthly frequency;
- unbalanced panel of individual stocks returns;
- firm level information (e.g., market capitalization).

Observable factors: market, size, value and momentum factors from French's website.

Environmental data

- Transparency: Bloomberg Environmental disclosure score (E score);
- Emission intensity: total GHG emission normalized by revenues (source: Bloomberg).



Greenness indicator

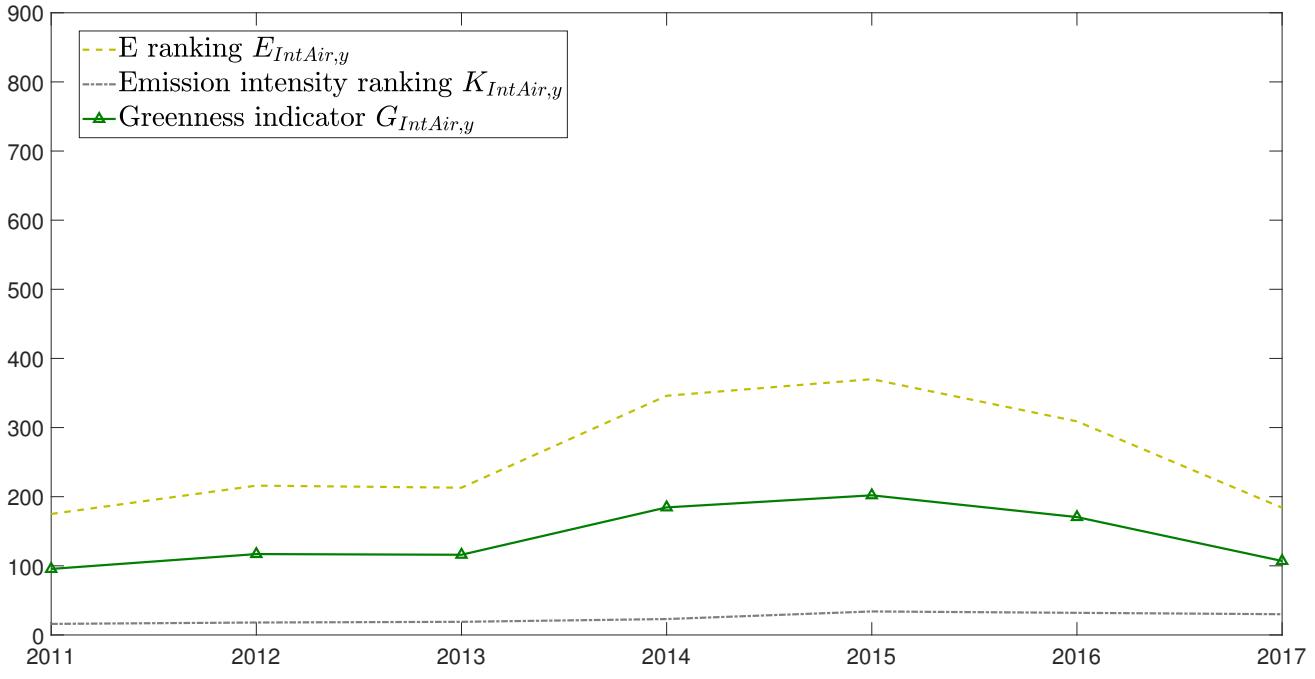
The synthetic greenness indicator of company i at year y is:

$$G_{i,y} = \gamma K_{i,y} + (1-\gamma)E_{i,y}, \text{ with } \gamma \in [0,1],$$

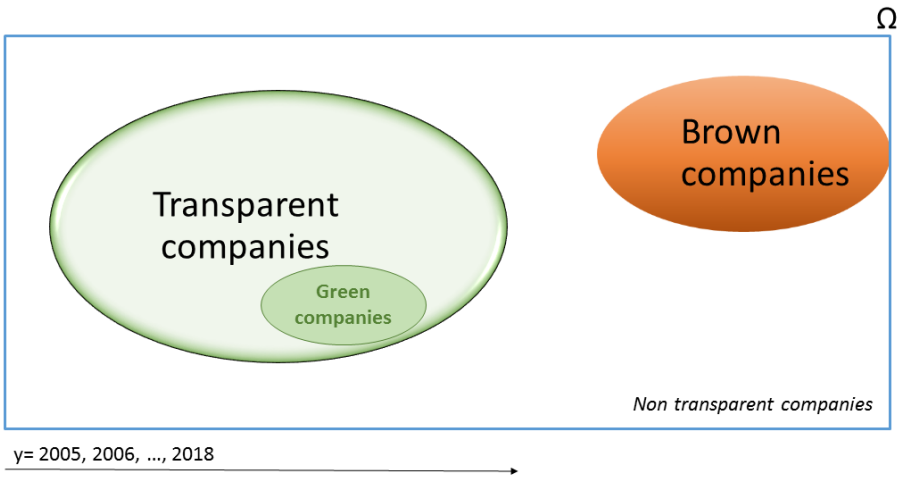
where

- $K_{i,y}$ is the inverse of the ranking of firm i in terms of emission intensity;
- $E_{i,y}$ is the ranking of firm i in terms of E score;
- γ controls for the relative importance of the two components of the index (benchmark case $\gamma = 0.5$).

Greenness indicator: International Airline Group



Green and brown portfolios



- Value weighted portfolios based on previous year greenness indicator.
- Green portfolio includes the top 20% transparent companies in term of greenness indicator.
- Brown portfolio includes the non-transparent firms active in highest emitting sectors.

The green factor

$$f_{g,t} = \tilde{r}_t^g - \tilde{r}_t^b$$

Factor	Mean	Std	Kurt	Skewn	f_m	f_{smb}	f_{hml}	f_{mom}
f_m	6.035	1.885	4.690	-0.642	1			
f_{smb}	1.671	0.641	3.195	-0.129	-0.034	1		
f_{hml}	-1.378	0.788	3.582	0.519	0.533	-0.062	1	
f_{mom}	9.398	1.313	19.610	-2.546	-0.439	-0.009	-0.506	1
f_g	-4.350	1.291	4.563	0.103	-0.224	-0.483	-0.206	0.268

Linear factor model

The excess return $R_{i,t}$ of asset i at date t satisfies

$$R_{i,t} = a_i + b_i' f_t + \varepsilon_{i,t},$$

$$a_i = b_i' \nu \Leftrightarrow E[R_{i,t}] = b_i' \lambda$$

where

- f_t is a vector of K observable factors;
- $\varepsilon_{i,t}$ is s.t. $E_{t-1}[\varepsilon_{i,t}] = 0$, and $Cov_{t-1}[\varepsilon_{i,t}, f_t] = 0$;
- approximate factor structure;
- $\lambda = E[f_t] + \nu$ is the vector of risk premia.

Empirical results

Carhart model + Green factor			
$\hat{\lambda}_m$	10.659**	$\hat{\nu}_m$	4.625**
	(0.662, 20.657)		(4.144, 5.105)
$\hat{\lambda}_{smb}$	3.326**	$\hat{\nu}_{smb}$	1.655**
	(0.321, 6.331)		(1.030, 2.279)
$\hat{\lambda}_{hml}$	-4.582*	$\hat{\nu}_{hml}$	-3.203**
	(-8.525, -0.639)		(-4.042, -2.364)
$\hat{\lambda}_{mom}$	8.986**	$\hat{\nu}_{mom}$	-0.412
	(2.277, 15.695)		(-2.148, 1.325)
$\hat{\lambda}_g$	-9.860**	$\hat{\nu}_g$	-4.076**
	(-14.455, -5.265)		(-5.453, -2.699)

Investors accept lower compensation, *ceteris paribus*, to hold greener assets.

Robustness checks

- Tuning the parameter γ: $G_{i,t}$ with $\gamma = 0.2$ and 0.8;
- Alternative specification for the indicator:

$$G^*_{i,y} = \frac{E^*_{i,y}}{K^*_{i,y}} = E^*_{i,y} \left(\frac{Sales}{Emissions} \right)_{i,y},$$

  where $E^*_{i,y}$ is the E score and $K^*_{i,y}$ is the ratio of total GHG emissions over sales.
- Extension of the sample including all listed European companies which do some environmental disclosure ($n = 2,154$).
- Alternative definitions of the green factor:
  - green portfolio - non transparent portfolio;
  - green portfolio - less-green portfolio.

Carbon stress test

Actual equity holdings (see Battiston et al. (2017)) of :

Institutional sectors	European SIFIs
Other Credit Institutions	DEUTSCHE BANK
Governments	BPCE
Individuals	BNP PARIBAS
Banks	UNICREDIT
Insurance and Pension Funds	BARCLAYS
Other Financial Services	CREDIT SUISSE
Non-Financial Companies	BANCO SANTANDER
Investment Funds	UBS
	ING BANK
	SOCIETE GENERALE

Aggregated by climate-policy-relevant sector:
Fossil-Fuel, Energy-Intensive, Transport, Utilities, etc...

Portfolio returns

$$r_{j,t} = \sum_{\kappa=1}^{7} \omega_{j,\kappa} r_{\kappa,t}$$

where

- $r_{\kappa,t}$ is the monthly VW portfolio of climate-policy-relevant sector κ, with $\kappa = 1$ for fossil-fuel, $\kappa = 2$ for energy-intensive, ...;
- $\omega_{j,\kappa}$ is the equity exposure to the climate-policy-relevant sector κ.

Marginal expected shortfall (MES)

$$\begin{aligned} MES_{j,t} &= -E[r_{j,t} | - r_{g,t} < -q_\alpha] \\ &= -E[r_{j,t} | r_{g,t} > q_\alpha], \end{aligned}$$

where q_α is the α percentile of the distribution of the green factor.

- *Baseline scenario*: current exposure.
- *Scenario 1*: reduced exposure to carbon intensive sectors ($r_{1,t}$ is the corresponding portfolio) by 50%,

$$r_{j,t} = \frac{1}{2}\omega_{j,1} r_{1,t} + \frac{1}{2}\omega_{j,1} r_t^+ + \sum_{\kappa=2}^{7} \omega_{j,\kappa} r_{\kappa,t}.$$

- *Scenario 2*: investing only in green stocks (i.e., stocks with $b_{g,i} > 0$), $r_{j,t} = \sum_{\kappa=1}^{7} \omega_{j,\kappa} r_{\kappa,t}^+$.

MES computed for an extreme but plausible scenario ($f_{g,t} > q_{0.95}$)

- Institutional sectors' losses

	MES (%)			MES (Bn $)		
	Baseline	Scenario 1	Scenario 2	Baseline	Scenario 1	Scenario 2
OCIs	-1.592	-1.511	0.113	-8.236	-7.821	0.584
Governments	-1.411	-1.259	-0.085	-8.169	-7.286	-0.493
Individuals	-1.433	-1.383	0.245	-37.270	-35.964	6.375
Banks	-1.495	-1.411	0.062	-40.864	-38.553	1.686
IPFs	-1.434	-1.339	0.096	-46.529	-43.460	3.119
OFSs	-1.447	-1.376	0.200	-50.261	-47.791	6.931
Non-Financial Companies	-1.462	-1.355	0.095	-68.476	-63.444	4.469
Investment Funds	-1.404	-1.323	0.211	-127.646	-120.310	19.194
Average and Total	-1.460	-1.370	0.117	-387.451	-364.630	41.866

European SIFIs' losses

	MES (%)			MES (Bn $)		
	Baseline	Scenario 1	Scenario 2	Baseline	Scenario 1	Scenario 2
DEUTSCHE BANK AG via its funds	-1.455	-1.321	-0.032	-2.348	-2.131	-0.052
BPCE SA via its funds	-1.590	-1.539	0.112	-2.325	-2.251	0.164
BNP PARIBAS via its funds	-1.621	-1.518	-0.141	-1.090	-1.021	-0.095
UNICREDIT SPA via its funds	-1.482	-1.415	0.145	-0.438	-0.418	0.043
BARCLAYS PLC via its funds	-1.512	-1.394	-0.079	-0.572	-0.528	-0.030
CREDIT SUISSE GROUP AG via its funds	-1.420	-1.325	0.158	-1.300	-1.212	0.145
BANCO SANTANDER SA	-1.912	-1.904	-0.486	-0.155	-0.154	-0.039
UBS GROUP AG via its funds	-1.432	-1.314	0.097	-2.604	-2.390	0.176
ING BANK NV	-2.225	-2.049	-1.120	-0.042	-0.039	-0.021
SOCIETE GENERALE GESTION	-1.571	-1.496	0.088	-0.771	-0.734	0.043
Average and Total	-1.647	-1.552	-0.167	-6.971	-6.496	0.222

Conclusions

- Identification of a greenness indicator based on emission intensity and disclosure of environmental data.
- Evidence of the existence of a pricing factor linked to climate risk;
- Evidence of climate-related losses for institutional sectors and European SIFIs.