

Asset Pricing
Econ 70427
Carbon Risk

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Some introductory points

- Construct brown-minus-green factor from 1600 firms. Compute carbon betas
- Firms can understand their own carbon risk. Regulators can gauge impact of policy. Investors can manage carbon risk in their portfolios
- Paris agreement (2015) limits global warming to $2^{\circ}C$. World agreement on transition from brown high-carbon world to green.
- Associated risks
 - Policy risk: introduction, repeal of carbon taxes. Trump's support fo brown industries
 - Stranded assets
 - Develop a carbon-risk mimicking portfolio. The brown-minus-green (BMG) portfolio. Long in brown firms, short green firms.
- Identify brown and green firms using an annual brown-green score (BGS), which is composite of sensitivity of firms value chains, public perception and adaptability to carbon risk.
- Paper has good citations for climate change finance.

Brown-Green Scoring

- For each firm, look at 55 variables with firm-specific information relating to value chains vc , public perception pp , and adaptability ad . $ad = 0$ means you in good shape to adapt.
- for each variable, determine whether firm is above or below the median.
- Average the 55 values assigned to the firm in a given year. Combine the scores as

$$BGS_{i,t} = (0.7vc_{i,t} + 0.3pp_{i,t}) \left(1 - \frac{1 - ad_{i,t}}{3} \right)$$

- BMG idea, same as the Fama-French size and book-to-market factors.
- Double sort into 6 size and 2 BGS portfolios. SH (small/high) BH (big/high), SL (small/low), SH (small/high). The BMG factor is

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

Figure 2
Cumulative returns of BMG and the long and short portfolios



GMG factor

- Regress firm excess return on the market excess return, FF's SMB, HML factors, a Global momentum factor, and BMG. Slope on BMG is the carbon beta.
- ESG Environmental, social and (corporate) governance data sets, from MSCI, Thomson Reuters, Sustainalytics, Carbon Disclosure Project, Climate Change questionnaire dataset. (see fn 14, on exposure of financial sector to BGS).

Table 2

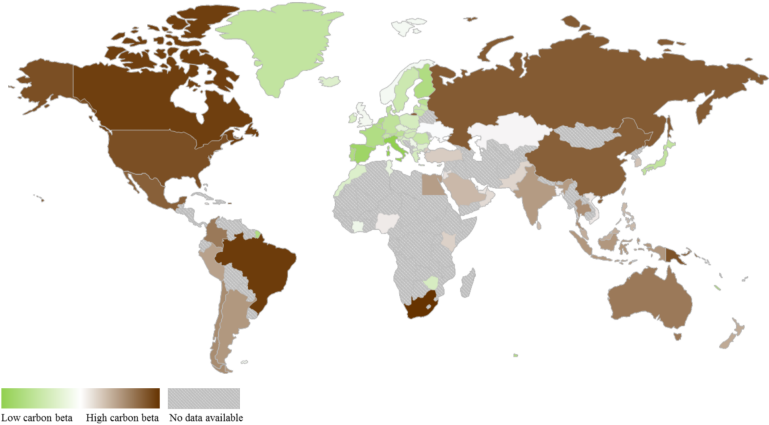
Factor descriptive statistics and correlations

Factor	Mean return (%)	SD (%)	T-stat.	Correlations				
				BMG	cr _M	SMB	HML	WML
BMG	-0.25	1.95	-1.17	1.00				
cr _M	0.76	4.02	1.74	0.09	1.00			
SMB	0.06	1.39	0.37	0.20	-0.02	1.00		
HML	-0.00	1.68	-0.02	0.27	0.19	-0.06	1.00	
WML	0.57	2.53	2.06	-0.24	-0.20	0.00	-0.41	1.00

- In Table 3 (not reproduced here) Annual sort of firms into BGS deciles from green to brown. Run these 10 portfolio excess returns on the 4 factors. The BMG betas on low BGS firms are negative, and on high BGS firms are positive. Most are significant. The alphas are generally insignificant.
 - BGS has explanatory value beyond the Carhart model, for these portfolios.
- Table 4 (not reproduced here). 39,000 individual stock regressions. Assess the incremental explanatory power of BMG over Fama-French. Compare it to additional explanatory power of momentum. They find that BMG contributes more than momentum.

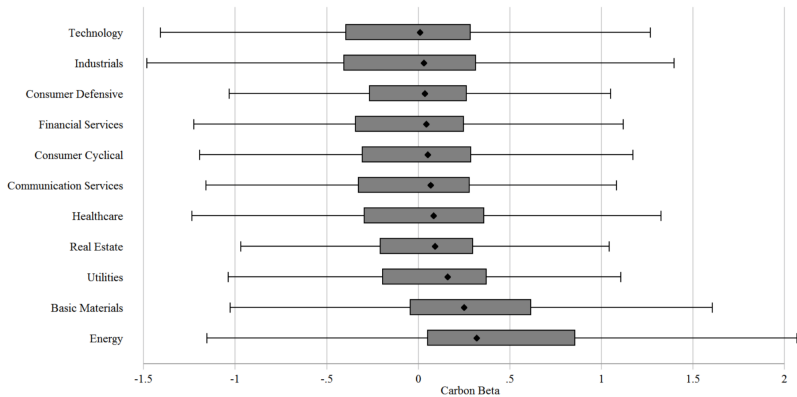
Carbon Betas by Country

Figure 3
Carbon beta landscape



Carbon Betas by Industry

Figure 4
Carbon beta industry breakdown



Risk Decomposition (Campbell)

- Decomposition done with Campbell VAR
- Variables in the VAR: (1) The BMG. (2) Global versions of the PE ratio, the term-spread, small stock value spread.
- Results based on variance decomposition of BMG. 88% of BMG variance due to expectations of future cash flows. Only 12% due to discount-factor news.
- There's also a Campbell-Vuolteenaho (2004) paper that decomposes betas in to cash-flow and discount-rate components. Here, they find similar results.