Is "Being Green" Rewarded in the Market? An Empirical Investigation of Decarbonization Risk and Stock Returns

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See footnote at end of text.

OVERVIEW

While investors are increasingly prioritizing climate finance and looking for investment opportunities of "yield with impact," they seem still reluctant. It is mainly because they need more clear understanding on the return-risk relationship related to investing for a clean energy economy. To shed more light on the market evaluation of decarbonization, this study empirically investigates the relationship among firm-level decarbonization, financial characteristics, and stock returns by analyzing 75,638 observations of 739 U.S. firms during the period of January 2005 to December 2015. The main research questions include: (1) what types of firms are more likely to take decarbonization actions; (2) whether carbon-efficient firms' stocks are likely to outperform carbon-intensive firms' stocks; (3) and if so, whether these excess returns on decarbonization are from a pure alpha or market compensation from bearing additional risk.

We define firm-level carbon intensity as the actual amount of greenhouse gas (GHG) divided by company revenue, construct EMI ("efficient-minus-inefficient") portfolio based on carbon intensity, and find that EMI portfolio exhibits a large positive cumulative return from 2009. By applying multi-factor asset pricing models using factor-mimicking portfolios of market, size, value, operating profitability, investment, and momentum, we find that those well-known risk factors cannot fully explain EMI portfolio return and the estimated positive alphas of EMI portfolio amount to 7.7~8.9 percent of abnormal returns per year. In addition, estimating factor loadings on industry portfolios, we also find that EMI portfolio has explanatory power that is independent from well-known risk factors. We discuss how carbon intensity is related to other firm-level characteristics concerning corporate governance and financial performance, along with implications for climate finance in the viewpoints of investors, firms and policymakers.

DATA AND METHODOLOGY

We mainly use four databases: Trucost for carbon emission data; KLD (Kinder, Lydenberg, Domini and Company) for measures on ESG (environmental, social, governance) data; Compustat for financial variables; and CRSP for stock prices/returns. As proxy measures of firms' carbon emission, we use the actual amounts of GHG emissions reported by companies in tCO2e that include direct emissions from operations (Scope 1), indirect emission from purchased electricity (Scope 2) and other supply chain emissions (Scope 3). Then we define carbon intensity as the amount of GHG emissions divided by million USD of revenue.

Based on firm-level carbon intensity, we name a firm with relatively low intensity "efficient" and a firm with relatively high intensity "inefficient," and construct an EMI ("[carbon] efficient-minus-inefficient") portfolio in a similar way to the Fama-French procedure used for the construction of SMB ("small-minus-big") and HML ("high-minus-low") factors:

EMI = 0.5 x (small efficient + big efficient) - 0.5 (small inefficient + big inefficient)

where small firms and big firms consist of the bottom 10% and top 10% in terms of market capitalization and efficient and inefficient firms represent the bottom 33% and top 33% in terms of carbon-emissions intensity. We double-sort EMI portfolio on size and carbon efficiency to reduce the size and industry-specific effect of carbon emissions. Then we apply multi-factor asset-pricing models to test whether the observed returns on EMI portfolio can be explained by well-known risk factors such as market, size, value, profitability, investment, and momentum. Next, we use EMI portfolio as additional risk factors and test if EMI portfolio can price industry portfolios.

RESULTS AND DISCUSSION

EMI Portfolio and its Market Performance

Figure 1 demonstrates that EMI portfolio exhibits a large positive cumulative return and this pattern is more pronounced during the period of January 2009—December 2015. We show four time-series of cumulative returns on: (1) EMI portfolio when we use the sum of Scopes 1 and 2, divided by a firm's revenue as carbon intensity, (2) EMI portfolio when we use returns without dividends, (3) EMI portfolio when we use the sum of Scopes 1, 2, and 3, divided by a firm's revenue as carbon intensity, and (4) EMI portfolio when small firms and big firms consist of the bottom 20% and top 20% in terms of market capitalization and efficient and inefficient firms represent the bottom 20% and top 20% in terms of carbon-emissions intensity.

Pricing EMI Portfolio with Risk Factors

We perform GRS tests to see if well-known risk factors can price EMI portfolio. We consider four models: (1) CAPM model, (2) Fama-French 3-factor model, (3) Fama-French 3-factor model with momentum factor, and (4) Fama-French 5-factor model. Our results in table 1 show that, while it shares some characteristics of HML, WML, and RMW, EMI portfolio still has its own characteristics that cannot be fully explained by these factors during the period after 2009. We also note that alphas are all positive and statistically significant during the period of January 2010–December 2015.[1] It suggests that the return on EMI portfolio cannot be priced with standard risk factors, implying a positive alpha. The magnitudes of alpha's suggest that an investment strategy that purchases shares of carbon-efficient firms and sells shares of carbon-inefficient firms earns abnormal returns of 7.7~8.9 percent per year.

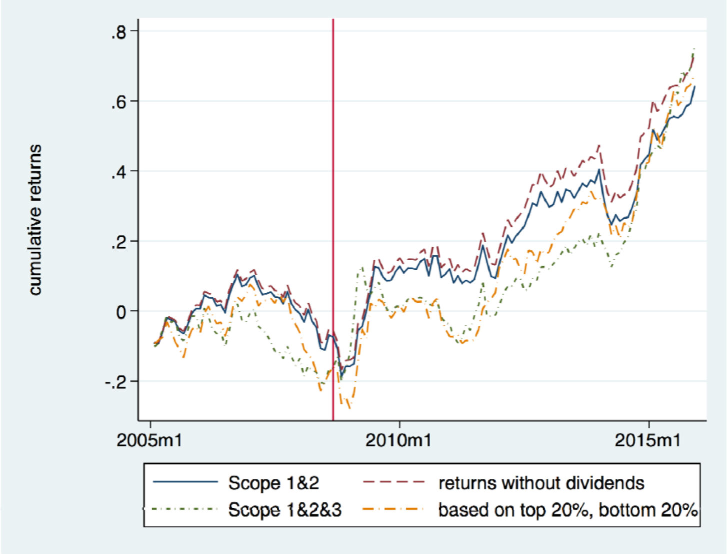

Figure 1. Cumulative Returns of EMI Portfolios
This figure shows the cumulative returns of EMI portfolios, defined in various ways. A red vertical line denotes September 2008, when Lehman Brothers filed for bankruptcy.

Industry Portfolios and Bivariate-Sorted Portfolios

To see whether EMI portfolio has an independent explanatory power, we estimate the factor loadings of 12 industry portfolios, including sectors of consumer nondurables, consumer durables, manufacturing, energy, chemicals, telephone and TV transmission, utilities, wholesale and retail, health care, finance, and others. In terms of the number of statistically significant factor loadings, we find that EMI portfolio is the second to market excess return portfolio, and has an independent explanatory power that other risk factors do not have.

Carbon-Emissions Intensity and Firm Characteristics

To examine what types of firms show lower or higher carbon intensity, we analyze the average values of firm-level characteristics by quartiles defined by four proxy measures of firms' decarbonization. Our results suggest that carbon-efficient firms are more likely to be firms with lower book-to-market ratio, higher ROA (return on assets), higher Tobin's q, higher free cash flows and cash holdings, higher coverage ratios, lower leverage ratios, and higher dividend payout ratios. Note that ROA and Tobin'q are the frequently-used measure of financial performance.

CONCLUSION

To sum, we measure firm-level carbon intensity using the actual amounts of GHG emissions available from Trucost database, and construct EMI portfolio based on firm-level carbon intensity. We find that carbon-efficient firms tend to be those with lower book-to-market ratios, higher ROA, higher Tobin's q, higher free cash flows and cash holdings, higher coverage ratios, lower leverage ratios, and higher dividend payout ratios. Most surprisingly, we find that EMI portfolio exhibits a large positive cumulative return after 2009, suggesting that carbon-efficient firms outperform carbon-inefficient firms in the stock market. In addition, we find that this extra return is not priced by well-known risk factors of size, value, momentum, operating profitability, and investment. When estimating factor loadings on industry portfolios, we also find that EMI portfolio has explanatory power that is independent from well-known risk factors.

Our findings will provide additional information on how the market evaluates firms' decarbonization activities, and raising the understanding of investors and policy makers on mobilizing capital toward corporate environmental investments.

Footnote

[1] Figure 1 shows that EMI portfolio start to earn positive returns from 2009:1. We estimate the same regressions during the period of 2009:1-2015:12 and find that alphas become larger with higher statistical significance.

	(1)	(2)	(3)	(4)
	CAPM	FF 3-factor	With momentum	FF 5-factor
	Sample period: 2005m1-2015m12			
Market excess return	0.176**	0.194**	0.140**	0.111
	-2.46	-2.63	-2.11	-1.64
SMB (size)		0.027	0.044	-0.053
		-0.25	-0.39	(-0.48)
HML (B/M)		-0.135	-0.265**	-0.145
		(-1.36)	(-2.51)	(-1.02)
WML (momentum)			-0.196**	
			(-2.13)	
RMW (profitability)				-0.573**
				(-3.07)
CMA (investment)				-0.034
				(-0.12)
Alpha	0.172	0.151	0.208	0.347
	-0.69	-0.6	-0.86	-1.45
R^2	0.064	0.075	0.151	0.138
N	132	132	132	132
	Sample period: 2010m1-2015m12			
Market excess return	-0.018	0.043	0.032	0.016
	(-0.21)	-0.510	-0.380	-0.190
SMB (size)		-0.096	-0.057	-0.156
		(-0.71)	(-0.43)	(-1.03)
HML (B/M)		-0.380**	-0.450**	-0.469**
		(-2.66)	(-3.04)	(-2.16)
WML (momentum)			-0.165**	
			(-2.25)	
RMW (profitability)				-0.268*
				(-1.77)
CMA (investment)				0.163
				-0.480
Alpha	0.588**	0.451*	0.543**	0.459*
	-2.050	-1.670	-2.000	-1.710
R^2	0.001	0.098	0.135	0.117
N	72	72	72	72

Table 1. GRS Test
*This table shows the results of GRS test, based on two sample periods, January 2005-December 2015 and January 2010-December 2015. *, **, *** denote p-value<0.10, p-value<0.05, and p-value<0.01, respectively.*