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Additional results

• Table SM.9: Pairwise correlation matrix

	(1)	(2)	(3)	(4)	(5)
	CAPM	FF3	Carhart	FF5	FF5 + Industry factors
Panel A: Car	bon intensity				
Alpha	-0.0042*	-0.0027	-0.0028	-0.0025	-0.0042
	(0.0025)	(0.0025)	(0.0025)	(0.0027)	(0.0030)
MktRF	-0.0737	-0.1558*	-0.1743**	-0.1566*	-2.4806
	(0.0689)	(0.0798)	(0.0789)	(0.0805)	(1.5581)
SMB		-0.1133	-0.1164	-0.1650	-0.1050
		(0.1115)	(0.1135)	(0.1223)	(0.1626)
HML		0.4071***	0.3653***	0.3094**	0.7685***
		(0.1200)	(0.1200)	(0.1470)	(0.2396)
WML			-0.0748		
			(0.0873)		
RMW				-0.2101	-0.3622
				(0.1997)	(0.2313)
CMA				0.2587	-0.2939
				(0.2490)	(0.2887)
Adj. R ²	0.0107	0.1355	0.1487	0.1547	0.8005
Panel B: Sect	or-adjusted carbor	intensity			
Alpha	-0.0024	-0.0021	-0.0021	-0.0021	0.0012
	(0.0019)	(0.0018)	(0.0019)	(0.0019)	(0.0024)
MktRF	0.0839*	0.0701	0.0522	0.0718	0.5246
	(0.0498)	(0.0538)	(0.0558)	(0.0537)	(1.4273)
SMB		-0.0475	-0.0505	-0.0416	-0.1197
		(0.0778)	(0.0753)	(0.0800)	(0.1377)
HML		0.0953	0.0547	0.1006	-0.0978
		(0.0787)	(0.0896)	(0.0972)	(0.2071)
WML			-0.0727**		
			(0.0353)		
RMW				0.0292	-0.1030
				(0.1211)	(0.2150)
CMA				-0.0111	0.0312
				(0.1425)	(0.2304)
Adj. R ²	0.0364	0.0554	0.0880	0.0559	0.5904

Table SM.1: U.S. factors and Industry factors (2009–2017, N=108).

Notes: The estimated equation is: $R(High \ carbon \ intensity)_t - R(Low \ carbon \ intensity)_t = \alpha + \beta' Risk \ factors_t + \varepsilon_t$ (Equation (1)). The dependent variable is the monthly return on a portfolio long in stocks of firms with high one-year lagged carbon intensity and short in low-carbon intensity firms. Carbon intensity is measured as Scopes 1 and 2 CO₂e emissions divided by net sales. *High carbon intensity* and *Low carbon intensity* are determined by the 90th and 10th percentile values. Portfolios a re formed based on absolute carbon intensity in Panel A or sector-adjusted carbon intensity in Panel B. Sector-adjusted carbon intensity is defined as carbon intensity minus the average carbon intensity in the associated sector and year, scaled by the standard deviation of carbon intensity. The coefficients of MktRF, SMB, HML, WML, RMW, and CMA are the loadings on the *Risk factors*, which are the U.S. market, size, book-to-market, momentum, profitability, and investment factors respectively (Sharpe, 1966; Fama and French, 1993; Carhart, 1997; Fama and French, 2015). In column (5), the Fama-French 49 industry factors are included (but for brevity not reported). Alpha captures the return differential between high - and low-carbon assets unexplained by the systematic risk factors. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
	CAPM	FF3	Carhart	FF5
Panel A: Carbon	intensity			
Alpha	-0.0056**	-0.0049**	-0.0031	-0.0046
	(0.0026)	(0.0024)	(0.0046)	(0.0028)
MktRF	0.1052	0.0421	0.0432	0.0074
	(0.0665)	(0.0792)	(0.0790)	(0.0718)
SMB		0.3266	0.3290	0.2863
		(0.2212)	(0.2216)	(0.2472)
HML		0.4890***	0.4951***	0.6110***
		(0.1565)	(0.1540)	(0.2266)
WML			-0.0882	
			(0.2164)	
RMW			× ,	-0.0132
				(0.3176)
CMA				-0.3605
				(0.4036)
Adj. R ²	0.0247	0.1355	0.1381	0.1510
Panel B: Sector-	adjusted carbon intensity			
Alpha	-0.0006	-0.0003	-0.0007	-0.0008
	(0.0015)	(0.0015)	(0.0030)	(0.0017)
MktRF	-0.0074	-0.0308	-0.0310	-0.0088
	(0.0376)	(0.0384)	(0.0380)	(0.0374)
SMB		0.0102	0.0097	0.0539
		(0.1131)	(0.1144)	(0.1393)
HML		0.1683*	0.1669*	0.1436
		(0.0866)	(0.0877)	(0.1107)
WML			0.0208	
			(0.1348)	
RMW			. ,	0.0967
				(0.1722)
CMA				0.1532
				(0.1666)
Adi. R ²	0.0004	0.0357	0.0362	0.0472

Table SM.2: Carbon intensity measure: 'High' and 'low' carbon intensity determined by the 80th and 20th percentile values (2009–2017, N=108).

Notes: The estimated equation is: $R(High \ carbon \ intensity)_t - R(Low \ carbon \ intensity)_t = \alpha + \beta' Risk \ factors_t + \varepsilon_t$ (Equation (1)). The dependent variable is the monthly return on a portfolio long in stocks of firms with high one-year lagged carbon intensity and short in low-carbon intensity firms. Carbon intensity is measured as Scopes 1 and 2 CO₂e emissions divided by net sales. *High carbon intensity* and *Low carbon intensity* are determined by the 80th and 20th percentile values. Portfolios are formed based on absolute carbon intensity in Panel A or sector-adjusted carbon intensity in Panel B. Sector-adjusted carbon intensity is defined as carbon intensity minus the average carbon intensity in the associated sector and year, scaled by the standard deviation of carbon intensity. The coefficients of MktRF, SMB, HML, WML, RMW, and CMA are the loadings on the *Risk factors*, which are the global market, size, book-to-market, momentum, profitability, and investment factors respectively (Sharpe, 1966; Fama and French, 1993; Carhart, 1997; Fama and French, 2015). Alpha captures the return differential between high- and low-carbon assets unexplained by the systematic risk factors. Robust standard errors are in parentheses.*** p<0.01,** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
	CAPM	FF3	Carhart	FF5
Panel A: Carbor	ı intensity			
Alpha	-0.0023	-0.0022	0.0009	-0.0021
•	(0.0019)	(0.0018)	(0.0026)	(0.0020)
MktRF	0.0578	0.0174	0.0193	-0.0234
	(0.0552)	(0.0512)	(0.0505)	(0.0571)
SMB	× ,	0.4654***	0.4694***	0.4391***
		(0.1383)	(0.1409)	(0.1589)
HML		0.3433***	0.3537***	0.5484***
		(0.1074)	(0.1080)	(0.1359)
WML			-0.1502*	
			(0.0868)	
RMW				0.0879
				(0.1967)
CMA				-0.5121**
				(0.2070)
A 1: D ²	0.0145	0 1022	0.2080	0.2572
Adj. K	0.0145	0.1933	0.2080	0.2572
Panel B: Sector-	adjusted carbon intensity	r		
Alpha	0.0026	0.0015	0.0025	0.0029*
	(0.0018)	(0.0016)	(0.0026)	(0.0017)
MktRF	-0.0197	0.0237	0.0243	-0.0219
	(0.0445)	(0.0371)	(0.0371)	(0.0427)
SMB		0.3476***	0.3489***	0.2268*
		(0.1247)	(0.1251)	(0.1339)
HML		-0.2690***	-0.2657***	-0.3051***
		(0.0819)	(0.0835)	(0.1004)
WML			-0.0482	
			(0.0844)	
RMW				-0.3479*
				(0.1980)
CMA				-0.1937
				(0.1434)
Adi. R ²	0.0023	0.1523	0.1543	0 1900

Table SM.3: Carbon intensity	measure: Carbon	emissions divided	bv market value	(2009-2017, N=108).
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Notes: The estimated equation is: $R(High \ carbon \ intensity)_t - R(Low \ carbon \ intensity)_t = \alpha + \beta' Risk \ factors_t + \varepsilon_t$ (Equation (1)). The dependent variable is the monthly return on a portfolio long in stocks of firms with high one-year lagged carbon intensity and short in low-carbon intensity firms. Carbon intensity is measured as Scopes 1 and 2 CO₂e emissions divided by market value. *High carbon intensity* and *Low carbon intensity* are determined by the 90th and 10th percentile values. Portfolios are formed based on absolute carbon intensity in Panel A or sector-adjusted carbon intensity in Panel B. Sector-adjusted carbon intensity is defined as carbon intensity. The coefficients of MktRF, SMB, HML, WML, RMW, and CMA are the loadings on the *Risk factors*, which are the global market, size, book-to-market, momentum, profitability, and investment factors respectively (Sharpe, 1966; Fama and French, 1993; Carhart, 1997; Fama and French, 2015). Alpha captures the return differential between high- and low-carbon assets unexplained by the systematic risk factors. Robust standard errors are in parentheses.*** p<0.01,** p<0.05, * p<0.1.

	<u> </u>	č		
	(1)	(2)	(3)	(4)
	CAPM	FF3	Carhart	FF5
Panel A: Carbon	intensity			
Alpha	-0.0070***	-0.0060***	-0.0051	-0.0067**
1	(0.0025)	(0.0022)	(0.0035)	(0.0026)
MktRF	0.0450	-0.0457	-0.0452	-0.0492
	(0.0597)	(0.0599)	(0.0602)	(0.0612)
SMB		0.3600**	0.3612**	0.4071*
		(0.1789)	(0.1801)	(0.2088)
HML		0.6909***	0.6938***	0.8517***
		(0.1232)	(0.1224)	(0.1551)
WML			-0.0427	
			(0.1525)	
RMW				0.2484
				(0.2768)
CMA				-0.2484
				(0.3022)
Adj. R ²	0.0052	0.2377	0.2384	0.2538
Panel B: Sector-	adjusted carbon intensity			
Alpha	-0.0021	-0.0018	-0.0041*	-0.0029*
	(0.0018)	(0.0018)	(0.0022)	(0.0017)
MktRF	0.1065**	0.0929*	0.0915*	0.0963*
	(0.0529)	(0.0511)	(0.0501)	(0.0530)
SMB		-0.0973	-0.1002	-0.0180
		(0.1290)	(0.1301)	(0.1372)
HML		0.0853	0.0777	0.2926**
		(0.1020)	(0.1040)	(0.1301)
WML			0.1107	
			(0.1061)	
RMW				0.3695**
				(0.1855)
CMA				-0.2779
				(0.1801)
Adj. R ²	0.0657	0.0790	0.0896	0.1399

Table SM 4. Carbon intensit	v measure: Scone 1	-only carbon emissions	divided by sales	$(2009_{2017} N=108)$
Table SNI.4. Carbon meensi	y measure. Scope i	-omy carbon conssions	uiviucu by sales	(2009-2017, 19-100)

Notes: The estimated equation is: $R(High \ carbon \ intensity)_t - R(Low \ carbon \ intensity)_t = \alpha + \beta' Risk \ factors_t + \varepsilon_t$ (Equation (1)). The dependent variable is the monthly return on a portfolio long in stocks of firms with high one-year lagged carbon intensity and short in low-carbon intensity firms. Carbon intensity is measured as Scope 1 CO₂e emissions divided by net sales. *High carbon intensity* and *Low carbon intensity* are determined by the 90th and 10th percentile values. Portfolios are formed based on absolute carbon intensity in Panel A or sector-adjusted carbon intensity in Panel B. Sector-adjusted carbon intensity is defined as carbon intensity minus the average carbon intensity in the associated sector and year, scaled by the standard deviation of carbon intensity. The coefficients of MktRF, SMB, HML, WML, RMW, and CMA are the loadings on the *Risk factors*, which are the global market, size, book-to-market, momentum, profitability, and investment factors respectively (Sharpe, 1966; Fama and French, 1993; Carhart, 1997; Fama and French, 2015). Alpha captures the return differential between high- and low-carbon assets unexplained by the systematic risk factors. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
	CAPM	FF3	Carhart	FF5
Panel A: Carbon in	ıtensity			
Alpha	-0.0028	-0.0033	0.0009	-0.0025
	(0.0024)	(0.0023)	(0.0035)	(0.0026)
MktRF	0.0158	0.0342	0.0367	0.0243
	(0.0832)	(0.0813)	(0.0797)	(0.0843)
SMB		0.1535	0.1588	0.0995
		(0.1657)	(0.1633)	(0.1782)
HML		-0.1134	-0.0996	-0.2023
		(0.1260)	(0.1217)	(0.2002)
WML			-0.1987	
			(0.1279)	
RMW				-0.2114
				(0.2851)
CMA				0.0741
				(0.3536)
Adj. R ²	0.0009	0.0182	0.0394	0.0263
Panel B: Sector-ad	justed carbon intensity			
Alpha	-0.0032*	-0.0037*	-0.0023	-0.0034
	(0.0019)	(0.0020)	(0.0033)	(0.0021)
MktRF	0.0346	0.0565	0.0573	0.0508
	(0.0643)	(0.0662)	(0.0663)	(0.0615)
SMB		0.1161	0.1178	0.0941
		(0.1493)	(0.1499)	(0.1780)
HML		-0.1426	-0.1380	-0.1675
		(0.1145)	(0.1149)	(0.2115)
WML			-0.0651	
			(0.1511)	
RMW				-0.0775
				(0.2655)
CMA				0.0053
				(0.3266)
Adj. R ²	0.0053	0.0275	0.0304	0.0287

Table SM.5: Carbon intensity measure: Scopes 1, 2, and 3 carbon emissions divided by sales (2009-2017, N=108).

Notes: The estimated equation is: $R(High \ carbon \ intensity)_t - R(Low \ carbon \ intensity)_t = \alpha + \beta' Risk \ factors_t + \varepsilon_t$ (Equation (1)). The dependent variable is the monthly return on a portfolio long in stocks of firms with high one-year lagged carbon intensity and short in low-carbon intensity firms. Carbon intensity is measured as Scopes 1, 2, and 3 CO₂e emissions divided by net sales. *High carbon intensity* and *Low carbon intensity* are determined by the 90th and 10th percentile values. Portfolios are formed based on absolute carbon intensity minus the average carbon intensity in the associated sector and year, scaled by the standard deviation of carbon intensity. The coefficients of MktRF, SMB, HML, WML, RMW, and CMA are the loadings on the *Risk factors*, which are the global market, size, book-to-market, momentum, profitability, and investment factors respectively (Sharpe, 1966; Fama and French, 1993; Carhart, 1997; Fama and French, 2015). Alpha captures the return differential between high- and low-carbon assets unexplained by the systematic risk factors. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
	CAPM	FF3	Carhart	FF5
Panel A: Carbon	intensity			
Alpha	0.0010	0.0002	0.0017	-0.0009
	(0.0035)	(0.0033)	(0.0053)	(0.0033)
MktRF	0.0298	-0.0330	-0.0350	-0.1181
	(0.0855)	(0.0926)	(0.0939)	(0.0829)
SMB		0.4497*	0.4560*	0.4757*
		(0.2660)	(0.2605)	(0.2779)
HML		0.5824***	0.5841***	1.2490***
		(0.2115)	(0.2114)	(0.2699)
WML			-0.0691	
			(0.2345)	
RMW				0.8157*
				(0.4547)
CMA				-1.0726***
				(0.3865)
Adj. R ²	0.0007	0.0560	0.0566	0.1588
Panel B: Sector-	adjusted carbon intensity			
Alpha	-0.0007	-0.0008	0.0010	-0.0006
	(0.0020)	(0.0020)	(0.0039)	(0.0023)
MktRF	0.0251	0.0187	0.0163	-0.0133
	(0.0520)	(0.0560)	(0.0591)	(0.0694)
SMB		0.0732	0.0813	0.0621
		(0.1537)	(0.1583)	(0.1658)
HML		0.0394	0.0417	0.1765
		(0.1387)	(0.1407)	(0.2143)
WML			-0.0857	
			(0.1796)	
RMW				0.0823
				(0.2633)
CMA				-0.2801
				(0.2197)
Adj. R ²	0.0014	0.0033	0.0062	0.0161

Table SM.6: Sample period: include carbon emission data before 2008 (2003-2017, N=178).

Notes: The estimated equation is: $R(High \ carbon \ intensity)_t - R(Low \ carbon \ intensity)_t = \alpha + \beta' Risk \ factors_t + \varepsilon_t$ (Equation (1)). The dependent variable is the monthly return on a portfolio long in stocks of firms with high one-year lagged carbon intensity and short in low-carbon intensity firms. Carbon intensity is measured as Scopes 1 and 2 CO₂e emissions divided by net sales. *High carbon intensity* and *Low carbon intensity* are determined by the 90th and 10th percentile values. Portfolios are formed based on absolute carbon intensity in Panel A or sector-adjusted carbon intensity in Panel B. Sector-adjusted carbon intensity is defined as carbon intensity minus the average carbon intensity in the associated sector and year, scaled by the standard deviation of carbon intensity. The coefficients of MktRF, SMB, HML, WML, RMW, and CMA are the loadings on the *Risk factors*, which are the global market, size, book-to-market, momentum, profitability, and investment factors respectively (Sharpe, 1966; Fama and French, 1993; Carhart, 1997; Fama and French, 2015). Alpha captures the return differential between high - and low-carbon assets unexplained by the systematic risk factors. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
	CAPM	FF3	Carhart	FF5
Panel A: Carbon	intensity			
Alpha	-0.0042*	-0.0027	-0.0028	-0.0025
	(0.0025)	(0.0025)	(0.0025)	(0.0027)
MktRF	-0.0737	-0.1558*	-0.1743**	-0.1566*
	(0.0689)	(0.0798)	(0.0789)	(0.0805)
SMB		-0.1133	-0.1164	-0.1650
		(0.1115)	(0.1135)	(0.1223)
HML		0.4071***	0.3653***	0.3094**
		(0.1200)	(0.1200)	(0.1470)
WML			-0.0748	
			(0.0873)	
RMW				-0.2101
				(0.1997)
CMA				0.2587
				(0.2490)
Adj. R ²	0.0107	0.1355	0.1487	0.1547
Panel B: Sector-a	djusted carbon intensity			
Alpha	-0.0024	-0.0021	-0.0021	-0.0021
	(0.0019)	(0.0018)	(0.0019)	(0.0019)
MktRF	0.0839*	0.0701	0.0522	0.0718
	(0.0498)	(0.0538)	(0.0558)	(0.0537)
SMB		-0.0475	-0.0505	-0.0416
		(0.0778)	(0.0753)	(0.0800)
HML		0.0953	0.0547	0.1006
		(0.0787)	(0.0896)	(0.0972)
WML			-0.0727**	
			(0.0353)	
RMW				0.0292
				(0.1211)
CMA				-0.0111
				(0.1425)
Adi R ²	0.0364	0.0554	0.0880	0.0559

Table SM.7: Sam	ole composition:	analysis restricted	l to high-emitting :	sectors (2009–2017, N=108).
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Notes: The estimated equation is:  $R(High \ carbon \ intensity)_t - R(Low \ carbon \ intensity)_t = \alpha + \beta' Risk \ factors_t + \varepsilon_t$  (Equation (1)). The dependent variable is the monthly return on a portfolio long in stocks of firms with high one-year lagged carbon intensity and short in low-carbon intensity firms. Carbon intensity is measured as Scopes 1 and 2 CO₂e emissions divided by net sales. *High carbon intensity* and *Low carbon intensity* are determined by the 90th and 10th percentile values. Portfolios are formed based on absolute carbon intensity in Panel A or sector-adjusted carbon intensity in Panel B. Sector-adjusted carbon intensity is defined as carbon intensity minus the average carbon intensity in the associated sector and year, scaled by the standard deviation of carbon intensity. The coefficients of MktRF, SMB, HML, WML, RMW, and CMA are the loadings on the *Risk factors*, which are the global market, size, book-to-market, momentum, profitability, and investment factors respectively (Sharpe, 1966; Fama and French, 1993; Carhart, 1997; Fama and French, 2015). Alpha captures the return differential between high - and low-carbon assets unexplained by the systematic risk factors. The sample is restricted to ICB sectors with mean carbon intensity above the full sample mean, which are: Oil & Gas Producers, Oil Equipment & Services, Chemicals, Forestry & Paper, Industrial Metals & Mining, Mining, Construction & Materials, General Industrials, Travel & Leisure, Electricity, and Gas, Water & Multiutilities. These sectors also have the highest mean absolute carbon emissions. Robust standard errors are in parentheses. ***

	· · ·	(		
	(1)	(2)	(3)	(4)
	CAPM	FF3	Carhart	FF5
Panel A: Carbon	intensity			
Alpha	-0.0048*	-0.0047*	-0.0070**	-0.0060**
	(0.0024)	(0.0025)	(0.0034)	(0.0026)
MktRF	-0.0249	-0.0252	-0.0266	-0.0092
	(0.0450)	(0.0464)	(0.0468)	(0.0551)
SMB		-0.0260	-0.0289	0.0704
		(0.1782)	(0.1798)	(0.2050)
HML		-0.0009	-0.0086	0.1691
		(0.1346)	(0.1394)	(0.1781)
WML			0.1098	
			(0.1252)	
RMW				0.3862
				(0.2740)
CMA				-0.1571
				(0.2550)
Adj. R ²	0.0019	0.0021	0.0075	0.0261
Panel B: Sector-a	djusted carbon intensity			
Alpha	-0.0045*	-0.0046*	-0.0077*	-0.0045
	(0.0027)	(0.0026)	(0.0046)	(0.0034)
MktRF	0.1880**	0.1809**	0.1791**	0.1336*
	(0.0719)	(0.0722)	(0.0694)	(0.0759)
SMB		0.1707	0.1667	0.1412
		(0.1934)	(0.1893)	(0.2118)
HML		0.0707	0.0603	0.3117
		(0.1708)	(0.1739)	(0.2441)
WML			0.1492	
			(0.2092)	
RMW				0.1070
				(0.3774)
CMA				-0.5985**
				(0.2515)
Adj. R ²	0.0797	0.0882	0.0957	0.1336

Table SM.8: Samp	le composition: anal	vsis restricted to EU	countries (	2009-2017, N=108).
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Notes: The estimated equation is:  $R(High \ carbon \ intensity)_t - R(Low \ carbon \ intensity)_t = \alpha + \beta' Risk \ factors_t + \varepsilon_t$  (Equation (1)). The dependent variable is the monthly return on a portfolio long in stocks of firms with high one-year lagged carbon intensity and short in low-carbon intensity firms. Carbon intensity is measured as Scopes 1 and 2 CO₂e emissions divided by net sales. *High carbon intensity* and *Low carbon intensity* are determined by the 90th and 10th percentile values. Portfolios are formed based on absolute carbon intensity in Panel A or sector-adjusted carbon intensity in Panel B. Sector-adjusted carbon intensity is defined as carbon intensity minus the average carbon intensity in the associated sector and year, scaled by the standard deviation of carbon intensity. The coefficients of MktRF, SMB, HML, WML, RMW, and CMA are the loadings on the *Risk factors*, which are the global market, size, book-to-market, momentum, profitability, and investment factors respectively (Sharpe, 1966; Fama and French, 1993; Carhart, 1997; Fama and French, 2015). Alpha captures the return differential between high - and low-carbon assets unexplained by the systematic risk factors. The sample is restricted to EU countries. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

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(1)	(2)	(3)	(4)	(5)		
1.00						
0.01	1.00					
0.04	0.16	1.00				
0.06	0.03	0.09	1.00			
0.10	0.05	0.18	-0.08	1.00		
	(1) 1.00 0.01 0.04 0.06 0.10	$\begin{array}{c} (1) & (2) \\ \hline 1.00 \\ 0.01 & 1.00 \\ 0.04 & 0.16 \\ 0.06 & 0.03 \\ 0.10 & 0.05 \end{array}$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		

Table SM.9: Pairwise correlations between carbon intensity, cost of equity, and control variables (2008–2016).