Internet Appendix

Corporate R&D and Stock Returns: International Evidence

Table 1: Two-way sorted portfolio returns based on R&D_ME*: controlling for size

Panel A: Equal-weighted portfolios						
	Low R&D_ME*	2	3	4	High R&D_ME*	High−Low
Small	1.954	1.800	1.842	2.273	2.576	0.622
	(6.12)	(6.45)	(6.87)	(8.09)	(7.69)	(2.32)
	1.068	1.119	1.152	1.375	1.872	0.804
	(3.62)	(4.11)	(4.35)	(5.05)	(5.57)	(3.14)
	0.821	1.076	1.192	1.362	1.488	0.667
	(2.75)	(3.64)	(4.12)	(4.78)	(4.6)	(2.48)
	0.626	0.784	1.095	1.282	1.539	0.913
	(2.16)	(2.74)	(4.02)	(4.73)	(5.12)	(4.17)
Large	0.876	0.832	1.027	1.202	1.286	0.409
	(3.53)	(3.43)	(4.31)	(4.88)	(4.88)	(2.44)
						0.683***
						(3.59)
Panel B: Value-weighted portfolios						
	Low R&D_ME*	2	3	4	High R&D_ME*	High−Low
Small	1.701	1.578	1.609	2.079	2.329	0.629
	(5.29)	(5.66)	(5.91)	(7.2)	(7.03)	(2.4)
	1.053	1.126	1.129	1.382	1.826	0.773
	(3.54)	(4.12)	(4.23)	(5.06)	(5.45)	(2.99)
	0.795	1.068	1.166	1.334	1.480	0.684
	(2.64)	(3.59)	(4.02)	(4.65)	(4.57)	(2.52)
	0.641	0.778	1.109	1.250	1.590	0.949
	(2.22)	(2.74)	(4.08)	(4.6)	(5.39)	(4.45)
Large	0.780	0.871	0.962	1.079	1.166	0.386
	(3.34)	(3.94)	(4.4)	(4.67)	(4.34)	(2.13)
						0.684***
						(3.69)

This table reports the monthly returns (in percentage) on two-way sorted portfolios, which measure the R&D effect after controlling for firm size. We use an alternative R&D intensity (R&D_ME*), in which the numerator is defined as the sum of R&D expenditure (item01201) and capitalized R&D (which is sum of change in development cost - net (item02504) and amortization of R&D asset (item01153)). At the end of June of each year, we conduct sequential sorts by grouping all stocks by firm size quintiles first and then grouping all stocks into R&D_ME* quintiles within each size quintile. We then compute the equal-weighted (Panel A) and value-weighted (Panel B) returns on the resulting 25 portfolios and the return spreads between the top and bottom R&D_ME* quintiles (High - Low) within each size group. Finally, we average these return spreads and report this average and associated t-statistics in the last column. Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 2: Time series regression with the factors of Hou, Karolyi, and Kho (2011): R&D_ME*

	Global		Country-neutral		Country-neutral (Non-U.S.)	
Weighting	Equal	Value	Equal	Value	Equal	Value
Alpha	0.803***	0.327**	0.617***	0.351**	0.553***	0.436***
	(3.316)	(2.151)	(4.622)	(2.280)	(3.904)	(2.828)
Rm_rf	-0.008	0.077*	0.052*	0.123***	0.052	0.082*
	(-0.173)	(1.674)	(1.870)	(3.234)	(1.527)	(1.795)
F_{MOM}	0.136	0.024	0.01	-0.008	-0.01	-0.041
	(1.338)	(0.362)	(0.239)	(-0.130)	(-0.232)	(-0.704)
$F_{C/P}$	0.295***	0.315***	0.018	0.145**	0.021	0.156**
	(2.727)	(4.377)	(0.399)	(2.310)	(0.426)	(2.446)
R^2	8.773	10.74	0.978	4.666	0.796	2.99

This table examines the risk-based models' explanatory ability of R&D intensity for portfolio returns. We use an alternative R&D intensity (R&D_ME*), in which the numerator is defined as the sum of R&D expenditure (item01201) and capitalized R&D (which is sum of change in development cost - net (item02504) and amortization of R&D asset (item01153)). We conduct factor regressions of equal- and value-weighted return spreads separately, using the Hou, Karolyi, and Kho (2011) factor pricing model. These return spreads are High–Low from the previous table and are constructed by using global sorts, country-neutral sorts, and country-neutral sorts that exclude U.S. firms. Returns are computed from July of year t to June of year t+1. The model of Hou, Karolyi, and Kho (2011) includes a global market factor (Rm_rf), a global cash flow-to-price factor ($F_{C/P}$), and a global momentum factor (F_{MOM}). The sample period is from July of 1981 to June of 2018. The t-statistics based on Newey-West (1987) adjusted for time-series autocorrelation are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 3: Fama-MacBeth regressions based on R&D_ME*

Panel A: OLS Fama-MacBeth regressions – All countries					
R&D_ME*	0.064***	0.061***	0.057***	0.042***	0.038***
	(4.903)	(5.085)	(5.316)	(4.299)	(3.996)
ME				-0.001***	-0.001***
				(-2.654)	(-2.591)
BM				0.007***	0.007***
				(7.043)	(7.087)
MOM				0.003	0.002
				(1.340)	(1.195)
ROE					0.000
					(0.235)
AG					-0.003***
					(-4.822)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
R^2	0.007	0.095	0.114	0.123	0.126
Panel B: OLS Fama-MacBeth regressions – Non-U.S.					
R&D_ME*	0.042***	0.046***	0.041***	0.032***	0.028***
	(3.793)	(4.950)	(5.555)	(4.168)	(3.648)
ME				-0.001**	-0.001**
				(-2.234)	(-2.383)
BM				0.008***	0.008***
				(7.901)	(8.137)
MOM				0.007***	0.006***
				(3.201)	(3.194)
ROE					0.002
					(0.889)
AG					-0.007***
					(-3.913)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
R^2	0.008	0.143	0.173	0.181	0.186
Panel C: WLS Fama-MacBeth regressions – All countries					
R&D_ME*	0.083***	0.077***	0.078***	0.045**	0.039**
	(3.589)	(3.310)	(3.152)	(2.551)	(2.185)
ME				-0.006***	-0.005***
				(-7.098)	(-6.446)
BM				0.004	0.005
				(0.906)	(1.093)

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MOM				-0.010	-0.011
				(-1.016)	(-1.089)
ROE					0.001
					(0.162)
AG					-0.009*
					(-1.891)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
R^2	0.009	0.069	0.140	0.152	0.165
	Panel D: WLS Fama-MacBeth regressions – Non-U.S.				
R&D_ME*	0.047***	0.037**	0.035***	0.029**	0.028**
	(2.832)	(2.366)	(2.792)	(2.236)	(2.197)
ME				-0.005***	-0.004***
				(-5.825)	(-5.002)
BM				0.009***	0.009***
				(5.498)	(4.657)
MOM				0.003	0.002
				(0.768)	(0.385)
ROE					0.001
					(0.169)
AG					-0.007**
					(-2.511)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
R^2	0.018	0.148	0.276	0.284	0.301

This table reports the time series averages and t-statistics of the coefficients from cross-sectional regressions of individual stock returns on R&D intensity, control variables, and country and industry fixed effects. We use an alternative R&D intensity (R&D_ME*), in which the numerator is defined as the sum of R&D expenditure (item01201) and capitalized R&D (which is sum of change in development cost - net (item02504) and amortization of R&D asset (item01153)). Panel A reports the OLS regression results for all countries, Panel B reports the OLS regression results for all countries excluding the U.S., Panel C reports the WLS regression results for all countries, and Panel D reports the WLS regression results for all countries excluding the U.S. The dependent variable, monthly stock return, is measured during the first year holding horizon after June of year t. The control variables include ME (the natural logarithm of June-end market value of year t), BM (the natural logarithm of the year $t-1$ fiscal year-end book-to-market ratio), MOM (the year t January-to-May returns), ROE (return on equity of fiscal year $t-1$), and AG (asset growth of fiscal year $t-1$). The coefficients on country/industry fixed effects are suppressed to save space. The Newey-West t-statistics are adjusted for time-series autocorrelation and reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 4: Two-way sorted portfolio returns based on R&D_ME**: controlling for size

Panel A: Equal-weighted portfolios						
	Low R&D_ME**	2	3	4	High R&D_ME**	High−Low
Small	1.936	1.790	1.857	2.225	2.557	0.622
	(6.03)	(6.39)	(6.92)	(7.95)	(7.67)	(2.32)
	1.079	1.145	1.192	1.340	1.831	0.751
	(3.69)	(4.21)	(4.49)	(4.96)	(5.48)	(2.94)
	0.799	1.040	1.142	1.337	1.450	0.651
	(2.66)	(3.54)	(3.92)	(4.72)	(4.49)	(2.41)
	0.662	0.775	1.091	1.248	1.480	0.818
	(2.27)	(2.73)	(4.01)	(4.66)	(4.92)	(3.79)
Large	0.850	0.818	1.033	1.191	1.265	0.415
	(3.48)	(3.42)	(4.36)	(4.84)	(4.83)	(2.44)
						0.651***
						(6.10)
Panel B: Value-weighted portfolios						
	Low R&D_ME**	2	3	4	High R&D_ME**	High−Low
Small	1.693	1.583	1.608	2.019	2.321	0.628
	(5.25)	(5.66)	(5.9)	(7.06)	(7.01)	(2.39)
	1.062	1.161	1.200	1.343	1.800	0.738
	(3.6)	(4.25)	(4.5)	(4.96)	(5.41)	(2.85)
	0.764	1.033	1.124	1.320	1.444	0.680
	(2.52)	(3.52)	(3.84)	(4.64)	(4.49)	(2.52)
	0.686	0.765	1.086	1.239	1.503	0.817
	(2.35)	(2.71)	(4.01)	(4.61)	(5.09)	(3.9)
Large	0.721	0.875	0.957	1.080	1.127	0.405
	(3.12)	(4.14)	(4.39)	(4.73)	(4.16)	(2.17)
						0.654***
						(6.10)

This table reports the monthly returns (in percentage) on two-way sorted portfolios, which measure the R&D effect after controlling for firm size. The R&D intensity is based on R&D_ME**, in which the numerator denotes the sum of R&D expenditure (item01201) and change in development cost – gross (item02505). At the end of June of each year, we conduct sequential sorts by grouping all stocks by firm size quintiles first and then grouping all stocks into R&D_ME** quintiles within each size quintile. We then compute the equal-weighted (Panel A) and value-weighted (Panel B) returns on the resulting 25 portfolios and the return spreads between the top and bottom R&D_ME** quintiles (High - Low) within each size group. Finally, we average these return spreads and report this average and associated t-statistics in the last column. Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 5: Time series regression with the factors of Hou, Karolyi, and Kho (2011): R&D_ME**

	Global		Country-neutral		Country-neutral (Non-U.S.)	
Weighting	Equal	Value	Equal	Value	Equal	Value
Alpha	0.789***	0.338**	0.584***	0.381**	0.526***	0.425***
	(3.260)	(2.193)	(4.382)	(2.534)	(3.814)	(2.892)
Rm_rf	-0.007	0.1**	0.052*	0.13***	0.055*	0.102**
	(-0.156)	(2.097)	(1.957)	(3.256)	(1.697)	(2.237)
F_{MOM}	0.135	0.009	0.009	0	-0.011	-0.034
	(1.315)	(0.131)	(0.207)	(-0.003)	(-0.257)	(-0.578)
$F_{C/P}$	0.286***	0.259***	0.014	0.136**	0.02	0.157**
	(2.652)	(3.617)	(0.326)	(2.195)	(0.434)	(2.536)
R^2	8.263	7.121	0.942	4.292	0.909	3.563

This table examines the risk-based models' explanatory ability of R&D intensity for portfolio returns. The R&D intensity is based on R&D_ME**, in which the numerator denotes the sum of R&D expenditure (item01201) and change in development cost – gross (item02505). We conduct factor regressions of equal- and value-weighted return spreads separately, using the Hou, Karolyi, and Kho (2011) factor pricing model. These return spreads are High–Low from the previous table and are constructed by using global sorts, country-neutral sorts, and country-neutral sorts that exclude U.S. firms. Returns are computed from July of year t to June of year t+1. The model of Hou, Karolyi, and Kho (2011) includes a global market factor (Rm_rf), a global cash-to-price factor ($F_{C/P}$), and a global momentum factor (F_{MOM}). The sample period is from July of 1981 to June of 2018. The t-statistics based on Newey-West (1987) adjusted for time-series autocorrelation are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 6: Fama-MacBeth regressions based on R&D_ME**

Panel A: OLS Fama-MacBeth regressions – All countries					
R&D_ME**	0.064***	0.060***	0.057***	0.042***	0.037***
	(4.884)	(5.078)	(5.321)	(4.321)	(4.015)
ME				-0.001***	-0.001***
				(-2.661)	(-2.595)
BM				0.007***	0.007***
				(7.032)	(7.075)
MOM				0.003	0.002
				(1.358)	(1.213)
ROE					0.000
					(0.226)
AG					-0.003***
					(-4.827)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
R^2	0.007	0.095	0.114	0.123	0.126
Panel B: OLS Fama-MacBeth regressions – Non-U.S.					
R&D_ME**	0.042***	0.046***	0.041***	0.032***	0.028***
	(3.759)	(4.936)	(5.535)	(4.160)	(3.637)
ME				-0.001**	-0.001**
				(-2.238)	(-2.387)
BM				0.008***	0.008***
				(7.902)	(8.138)
MOM				0.007***	0.006***
				(3.204)	(3.197)
ROE					0.002
					(0.886)
AG					-0.007***
					(-3.917)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
R^2	0.008	0.143	0.173	0.181	0.186
Panel C: WLS Fama-MacBeth regressions – All countries					
R&D_ME**	0.083***	0.077***	0.078***	0.045**	0.039**
	(3.592)	(3.303)	(3.159)	(2.575)	(2.202)
ME				-0.006***	-0.006***
				(-6.965)	(-6.380)
BM				0.004	0.005
				(0.906)	(1.094)

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MOM				-0.010	-0.011
				(-1.016)	(-1.090)
ROE					0.001
					(0.161)
AG					-0.009*
					(-1.877)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
R^2	0.009	0.069	0.140	0.152	0.165
	Panel D: WLS Fama-MacBeth regressions – Non-U.S.				
R&D_ME**	0.047***	0.036**	0.035***	0.029**	0.028**
	(2.826)	(2.337)	(2.790)	(2.241)	(2.198)
ME				-0.005***	-0.004***
				(-5.831)	(-5.006)
BM				0.009***	0.009***
				(5.501)	(4.659)
MOM				0.003	0.002
				(0.765)	(0.382)
ROE					0.001
					(0.167)
AG					-0.007**
					(-2.510)
Cty		Y	Y	Y	Y
Ind			Y	Y	Y
R^2	0.018	0.148	0.276	0.284	0.301

This table reports the time series averages and t-statistics of the coefficients from cross-sectional regressions of individual stock returns on R&D intensity, control variables, and country and industry fixed effects. The R&D intensity is based on R&D_ME**, in which the numerator denotes the sum of R&D expenditure (item01201) and change in development cost – gross (item02505). Panel A reports the OLS regression results for all countries, Panel B reports the OLS regression results for all countries excluding the U.S., Panel C reports the WLS regression results for all countries, and Panel D reports the WLS regression results for all countries excluding the U.S. The dependent variable, monthly stock return, is measured during the first year holding horizon after June of year t. The control variables include ME (the natural logarithm of June-end market value of year t), BM (the natural logarithm of the year $t-1$ fiscal year-end book-to-market ratio), MOM (the year t January-to-May returns), ROE (return on equity of fiscal year $t-1$), and AG (asset growth of fiscal year $t-1$). The coefficients on country/industry fixed effects are suppressed to save space. The Newey-West t-statistics are adjusted for time-series autocorrelation and reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 7: Two-way sorted portfolio returns based on RD_TA: controlling for size

Panel A: Two-way sorted portfolios: Equal-weighted						
	Low R&D_TA	2	3	4	High R&D_TA	High−Low
Small	2.035	2.030	2.049	2.212	2.550	0.516
	(6.89)	(7.86)	(8.08)	(7.51)	(6.57)	(2.61)
	1.168	1.225	1.172	1.371	1.687	0.519
	(4.03)	(4.78)	(4.70)	(5.02)	(4.41)	(1.96)
	1.008	1.048	1.149	1.187	1.432	0.424
	(3.68)	(4.1)	(4.24)	(4.09)	(3.79)	(1.33)
	0.859	0.800	0.964	1.124	1.306	0.447
	(3.23)	(3.08)	(3.69)	(3.94)	(3.62)	(1.57)
Large	0.927	0.904	0.902	1.073	1.318	0.391
	(4.12)	(4.01)	(3.65)	(4.31)	(4.32)	(1.72)
						0.459**
						(2.03)
Panel B: Two-way sorted portfolios: Value-weighted						
	Low R&D_TA	2	3	4	High R&D_TA	High−Low
Small	1.778	1.714	1.852	1.969	2.258	0.480
	(5.94)	(6.52)	(7.21)	(6.66)	(5.87)	(1.99)
	1.137	1.215	1.198	1.353	1.646	0.509
	(3.92)	(4.74)	(4.78)	(4.94)	(4.33)	(1.52)
	0.980	1.044	1.123	1.164	1.431	0.450
	(3.58)	(4.03)	(4.13)	(3.96)	(3.81)	(1.42)
	0.860	0.810	0.958	1.104	1.308	0.448
	(3.26)	(3.12)	(3.68)	(3.87)	(3.62)	(1.77)
Large	0.838	0.841	0.830	0.976	1.235	0.397
	(3.84)	(4.07)	(3.47)	(4.23)	(4.91)	(2.11)
						0.457**
						(2.28)

This table reports the monthly returns (in percentage) on R&D intensity (R&D_TA) sorted portfolios. R&D_TA denotes an alternative R&D intensity in which the denominator is total assets. Panel A reports one-way sorted portfolio analysis. At the end of June of each year, we sort stocks into five R&D intensity quintiles by their R&D intensity in year $t-1$ by using three approaches: global sorting, country-neutral, and country-neutral excluding the U.S. For country-neutral sorting, we rank all sample firms in one country by their R&D intensity measures in year $t-1$. We first compute the quintile equal- or value-weighted returns within each country and then calculate the average to obtain the country-neutral portfolio returns. We then compute the equal-weighted and value-weighted returns on the resulting 5 portfolios and the return spreads between the top and bottom R&D_TA quintiles (High – Low). Equal- and value-weighted returns are computed from July of year t to June of year $t+1$. The rows labeled "t-stat" show t-statistics for the High – Low return spreads. Panel B and C reports two-way sorted portfolio analysis. At the end of June of each year, we conduct sequential sorts by grouping all stocks by firm size quintiles first and then grouping all stocks into R&D_TA quintiles within each size quintile. We then compute the equal-weighted (Panel B) and value-weighted (Panel C) returns on the resulting 25 portfolios and the return spreads between the top and bottom R&D_TA quintiles (High - Low) within each size group. Finally, we average these return spreads and report this average and associated t-statistics in the last column. Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 8: Two-way sorted portfolio returns based on R&D_BE: controlling for size

Panel A: Equal-weighted portfolios						
	Low R&D_BE	2	3	4	High R&D_BE	High−Low
Small	2.038	2.012	2.033	2.148	2.539	0.501
	(7.18)	(7.61)	(7.69)	(7.3)	(7.01)	(1.80)
	1.094	1.186	1.294	1.404	1.604	0.510
	(3.89)	(4.83)	(5.09)	(4.94)	(4.48)	(1.75)
	0.970	1.076	1.054	1.262	1.425	0.454
	(3.68)	(4.12)	(3.86)	(4.24)	(4.07)	(1.66)
	0.832	0.809	0.938	1.142	1.324	0.492
	(3.23)	(3.09)	(3.5)	(4.08)	(3.93)	(2.16)
Large	0.936	0.783	0.979	1.044	1.238	0.302
	(4.17)	(3.54)	(3.91)	(4.29)	(4.63)	(1.83)
						0.452**
						(2.02)
Panel B: Value-weighted portfolios						
	Low R&D_BE	2	3	4	High R&D_BE	High−Low
Small	1.794	1.711	1.825	1.966	2.241	0.447
	(6.23)	(6.43)	(6.79)	(6.71)	(6.11)	(1.57)
	1.059	1.176	1.299	1.385	1.574	0.515
	(3.78)	(4.8)	(5.05)	(4.89)	(4.42)	(1.77)
	0.929	1.072	1.031	1.242	1.415	0.486
	(3.52)	(4.06)	(3.76)	(4.14)	(4.07)	(1.8)
	0.843	0.810	0.904	1.155	1.334	0.492
	(3.29)	(3.11)	(3.38)	(4.14)	(3.97)	(2.18)
Large	0.851	0.789	0.825	1.011	1.126	0.275
	(3.87)	(3.81)	(3.43)	(4.49)	(4.86)	(1.82)
						0.443**
						(1.97)

This table reports the monthly returns (in percentage) on two-way sorted portfolios, which measure the R&D effect after controlling for firm size. We use an alternative R&D intensity (R&D_BE), in which the denominator is book equity (stockholders' equity minus value of preferred stock plus deferred taxes and investment tax credit). At the end of June of each year, we conduct sequential sorts by grouping all stocks by firm size quintiles first and then grouping all stocks into R&D_BE quintiles within each size quintile. We then compute the equal-weighted (Panel A) and value-weighted (Panel B) returns on the resulting 25 portfolios and the return spreads between the top and bottom R&D_BE quintiles (High - Low) within each size group. Finally, we average these return spreads and report this average and associated t-statistics in the last column. Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 9: One-way sorted portfolio returns based on R&D_S

	Global		Country-neutral		Country-neutral (Non-U.S.)	
Weighting	Equal	Value	Equal	Value	Equal	Value
Low R&D_S	1.269	0.927	1.294	1.170	1.356	1.256
	(5.09)	(4.24)	(5.54)	(4.84)	(5.61)	(5.)
	1.207	0.814	1.233	1.039	1.298	1.136
	(5.3)	(3.92)	(5.35)	(4.33)	(5.48)	(4.63)
	1.245	0.912	1.340	1.058	1.420	1.148
	(5.25)	(4.07)	(5.6)	(4.37)	(5.76)	(4.6)
	1.363	0.923	1.345	1.073	1.405	1.144
	(5.17)	(3.81)	(5.42)	(4.25)	(5.58)	(4.41)
High R&D_S	1.639	1.144	1.436	1.213	1.511	1.267
	(4.61)	(4.4)	(5.27)	(4.51)	(5.49)	(4.59)
High−Low	0.370	0.217	0.148	0.047	0.161	0.015
t-stat	(1.36)	(1.16)	(1.22)	(0.34)	(1.33)	(0.12)

This table reports the monthly returns (in percentage) on R&D intensity (R&D_S) sorted portfolios. R&D_S denotes an alternative R&D intensity in which the denominator is sales. At the end of June of each year, we sort stocks into five R&D intensity quintiles by their R&D intensity in year $t-1$ by using three approaches: global sorting, country-neutral, and country-neutral excluding the U.S. For country-neutral sorting, we rank all sample firms in one country by their R&D intensity measures in year $t-1$. We first compute the quintile equal- or value-weighted returns within each country and then calculate the average to obtain the country-neutral portfolio returns. We then compute the equal-weighted and value-weighted returns on the resulting 5 portfolios and the return spreads between the top and bottom R&D_S quintiles (High – Low). Equal- and value-weighted returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. The rows labeled "t-stat" show t-statistics for the High – Low return spreads. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 10: Two-way sorted portfolio returns based on R&D_S: controlling for size

Panel A: Equal-weighted portfolios						
	Low R&D_S	2	3	4	High R&D_S	High−Low
Small	2.209	1.989	2.129	2.286	2.398	0.188
	(7.67)	(7.85)	(8.43)	(7.6)	(6.)	(0.58)
	1.195	1.225	1.180	1.439	1.595	0.400
	(4.2)	(5.03)	(4.73)	(5.11)	(4.13)	(1.22)
	1.024	1.077	1.157	1.168	1.399	0.375
	(3.91)	(4.24)	(4.39)	(3.92)	(3.63)	(1.21)
	0.892	0.888	0.971	1.003	1.236	0.344
	(3.47)	(3.63)	(3.73)	(3.45)	(3.32)	(1.2)
Large	1.014	0.898	0.925	0.989	1.236	0.221
	(4.56)	(4.09)	(3.86)	(3.96)	(3.87)	(0.93)
						0.306
						(1.28)
Panel B: Value-weighted portfolios						
	Low R&D_S	2	3	4	High R&D_S	High−Low
Small	1.936	1.652	1.949	2.055	2.099	0.163
	(6.69)	(6.47)	(7.52)	(6.88)	(5.29)	(0.51)
	1.151	1.226	1.167	1.432	1.577	0.426
	(4.05)	(5.03)	(4.66)	(5.1)	(4.09)	(1.29)
	1.001	1.068	1.115	1.155	1.383	0.382
	(3.83)	(4.18)	(4.18)	(3.84)	(3.61)	(1.24)
	0.892	0.880	0.976	0.998	1.227	0.335
	(3.48)	(3.61)	(3.75)	(3.44)	(3.29)	(1.16)
Large	0.956	0.794	0.883	0.908	1.142	0.185
	(4.42)	(3.79)	(3.93)	(3.78)	(4.54)	(0.99)
						0.298
						(1.29)

This table reports the monthly returns (in percentage) on two-way sorted portfolios, which measure the R&D effect after controlling for firm size. We use an alternative R&D intensity (R&D_S), in which the denominator is sales. At the end of June of each year, we conduct sequential sorts by grouping all stocks by firm size quintiles first and then grouping all stocks into R&D_S quintiles within each size quintile. We then compute the equal-weighted (Panel A) and value-weighted (Panel B) returns on the resulting 25 portfolios and the return spreads between the top and bottom R&D_S quintiles (High - Low) within each size group. Finally, we average these return spreads and report this average and associated t-statistics in the last column. Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 11: Two-way sorted portfolio returns based on R&D_ME and industry-adjusted return: controlling for size

Panel A: Two-way sorted portfolios: Equal-weighted						
	Low R&D_ME	2	3	4	High R&D_ME	High−Low
Small	0.201	0.189	0.191	0.542	0.858	0.657
	(1.48)	(1.67)	(1.76)	(4.92)	(7.11)	(3.98)
	0.022	0.033	0.116	0.423	0.910	0.888
	(0.26)	(0.36)	(1.21)	(4.33)	(6.79)	(5.79)
	-0.100	0.098	0.130	0.269	0.446	0.547
	(-1.30)	(1.09)	(1.30)	(2.59)	(2.73)	(3.22)
	-0.179	0.145	0.290	0.319	0.510	0.690
	(-2.10)	(1.65)	(3.01)	(2.91)	(3.24)	(4.25)
Large	0.050	0.168	0.394	0.674	0.542	0.492
	(0.53)	(1.87)	(3.93)	(5.94)	(3.75)	(3.31)
						0.655***
						(6.37)
Panel B: Two-way sorted portfolios: Value-weighted						
	Low R&D_ME	2	3	4	High R&D_ME	High−Low
Small	0.075	0.297	0.214	0.551	0.945	0.870
	(0.51)	(2.12)	(1.67)	(4.47)	(6.75)	(4.74)
	-0.051	-0.049	0.090	0.461	0.942	0.993
	(-0.51)	(-0.46)	(0.78)	(4.12)	(6.24)	(6.0)
	-0.185	0.114	0.129	0.342	0.433	0.618
	(-2.04)	(1.07)	(1.14)	(2.86)	(2.62)	(3.56)
	-0.137	0.159	0.305	0.368	0.656	0.793
	(-1.25)	(1.60)	(3.03)	(3.07)	(4.03)	(4.49)
Large	-0.033	0.071	0.254	0.600	0.417	0.449
	(-0.29)	(0.72)	(2.22)	(5.02)	(2.56)	(2.61)
						0.745***
						(6.77)

This table reports the monthly industry-adjusted returns (in percentage) on R&D intensity (R&D_ME) sorted portfolios. A portfolio stock's industry-adjusted returns is its stock return minus the stock return on its control firm (i.e., a firm that has the closest book-to-market ratio, is in the same industry based on Industry Classification Benchmark (ICB), does not positive R&D expenses, and has market values of equity between 70% and 130% of the market value of equity of the portfolio stock). We then compute the equal-weighted and value-weighted returns on the resulting 5 portfolios and the return spreads between the top and bottom R&D_ME quintiles (High – Low). Equal- and value-weighted returns are computed from July of year t to June of year $t+1$. The rows labeled "t-stat" show t-statistics for the High – Low return spreads. Panel B and C reports two-way sorted portfolio analysis. At the end of June of each year, we conduct sequential sorts by grouping all stocks by firm size quintiles first and then grouping all stocks into R&D_ME quintiles within each size quintile. We then compute the equal-weighted (Panel B) and value-weighted (Panel C) industry-adjusted returns on the resulting 25 portfolios and the return spreads between the top and bottom R&D_ME quintiles (High - Low) within each size group. Finally, we average these return spreads and report this average and associated t-statistics in the last column. Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 12: Time series regression with the factors of Hou, Karolyi, and Kho (2011): R&D_ME and industry-adjusted return

	Global		Country-neutral		Country-neutral (Non-U.S.)	
Weighting	Equal	Value	Equal	Value	Equal	Value
Alpha	0.665***	0.365**	0.536***	0.364**	0.553***	0.421***
	(5.575)	(2.535)	(5.196)	(2.498)	(4.196)	(2.692)
Rm_rf	0.057**	0.13***	0.037	0.043	0.067***	0.076
	(2.434)	(3.183)	(1.537)	(1.110)	(2.629)	(1.633)
F_{MOM}	0.022	-0.013	0.018	0.024	0.019	0.043
	(0.606)	(-0.297)	(0.659)	(0.513)	(0.663)	(0.802)
$F_{C/P}$	0.024	0.12***	0.018	0.08*	0.008	0.05
	(0.677)	(2.760)	(0.598)	(1.734)	(0.211)	(0.929)
R^2	1.545	4.88	0.672	1.04	1.235	0.972

This table examines the risk-based models' explanatory ability of R&D intensity for industry-adjusted portfolio returns. We conduct factor regressions of equal- and value-weighted industry-adjusted return spreads separately, using the Hou, Karolyi, and Kho (2011) factor pricing model. These return spreads are High–Low from Table 9 and are constructed by using global sorts, country-neutral sorts, and country-neutral sorts that exclude U.S. firms. Returns are computed from July of year t to June of year t+1. The model of Hou, Karolyi, and Kho (2011) includes a global market factor (Rm_rf), a global cash flow-to-price factor ($F_{C/P}$), and a global momentum factor (F_{MOM}). The sample period is from July of 1981 to June of 2018. The t-statistics based on Newey-West (1987) adjusted for time-series autocorrelation are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 13: One-way sorted portfolio returns based on R&D_ME* and industry-adjusted return

	Global		Country-neutral		Country-neutral (Non-U.S.)	
Weighting	Equal	Value	Equal	Value	Equal	Value
Low R&D_ME*	-0.015	-0.026	0.118	0.107	0.109	0.102
	(-0.28)	(-0.27)	(1.57)	(0.96)	(1.12)	(0.67)
	0.125	0.083	0.252	0.274	0.291	0.290
	(2.16)	(1.01)	(3.33)	(2.77)	(3.)	(2.36)
	0.219	0.241	0.263	0.255	0.287	0.261
	(3.44)	(2.56)	(3.25)	(2.47)	(2.93)	(2.12)
	0.468	0.532	0.422	0.406	0.386	0.377
	(6.76)	(5.21)	(5.26)	(3.63)	(4.01)	(2.88)
High R&D_ME*	0.707	0.483	0.714	0.613	0.741	0.690
	(7.57)	(3.55)	(7.23)	(4.45)	(6.73)	(4.6)
High−Low	0.721***	0.509***	0.596***	0.506***	0.631***	0.588
t-stat	(7.73)	(3.72)	(6.28)	(3.51)	(5.25)	(3.35)

This table reports the monthly industry-adjusted returns (in percentage) on R&D intensity sorted portfolios. We use an alternative R&D intensity (R&D_ME*), in which the numerator is defined as the sum of R&D expenditure (item01201) and capitalized R&D (which is sum of change in development cost - net (item02504) and amortization of R&D asset (item01153)). At the end of June of each year, we sort stocks into five R&D intensity quintiles by their R&D intensity in year $t-1$ by using three approaches: global sorting, country-neutral, and country-neutral excluding the U.S. For country-neutral sorting, we rank all sample firms in one country by their R&D intensity measures in year $t-1$. We first compute the quintile equal- or value-weighted industry-adjusted returns within each country and then calculate the average to obtain the country-neutral portfolio returns. A portfolio stock's industry-adjusted returns is its stock return minus the stock return on its control firm (i.e., a firm that has the closest book-to-market ratio, is in the same industry based on Industry Classification Benchmark (ICB), does not positive R&D expenditure, and has market values of equity between 70% and 130% of the market value of equity of the portfolio stock). We exclude Financials and Oil & Gas. industries. We then compute the equal-weighted and value-weighted returns on the resulting 5 portfolios and the return spreads between the top and bottom R&D_ME* quintiles (High – Low). Equal- and value-weighted returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. The rows labeled "t-stat" show t-statistics for the High – Low return spreads. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 14: Two-way sorted portfolio returns based on R&D_ME* and industry-adjusted return: controlling for size

Panel A: Equal-weighted portfolios						
	Low R&D_ME*	2	3	4	High R&D_ME*	High−Low
Small	0.203	0.186	0.188	0.569	0.855	0.652
	(1.5)	(1.67)	(1.73)	(5.22)	(7.07)	(3.97)
	-0.004	0.033	0.124	0.440	0.894	0.898
	(-0.05)	(0.36)	(1.3)	(4.44)	(6.65)	(5.88)
	-0.104	0.103	0.124	0.279	0.462	0.566
	(-1.36)	(1.14)	(1.23)	(2.67)	(2.83)	(3.34)
	-0.161	0.131	0.307	0.325	0.512	0.674
	(-1.89)	(1.48)	(3.19)	(2.96)	(3.25)	(4.17)
Large	0.045	0.163	0.388	0.675	0.567	0.522
	(0.48)	(1.82)	(3.85)	(5.9)	(3.95)	(3.53)
						0.662***
						(6.46)
Panel B: Value-weighted portfolios						
	Low R&D_ME*	2	3	4	High R&D_ME*	High−Low
Small	0.063	0.306	0.197	0.575	0.944	0.881
	(0.43)	(2.21)	(1.53)	(4.7)	(6.74)	(4.85)
	-0.070	-0.039	0.098	0.468	0.920	0.990
	(-0.69)	(-0.36)	(0.86)	(4.14)	(6.09)	(6.01)
	-0.183	0.120	0.128	0.356	0.449	0.632
	(-2.03)	(1.11)	(1.13)	(2.97)	(2.72)	(3.64)
	-0.117	0.147	0.319	0.372	0.667	0.784
	(-1.07)	(1.47)	(3.16)	(3.09)	(4.1)	(4.47)
Large	-0.035	0.067	0.249	0.607	0.442	0.477
	(-0.31)	(0.68)	(2.16)	(5.07)	(2.69)	(2.76)
						0.753***
						(6.87)

This table reports the monthly industry-adjusted returns (in percentage) on two-way sorted portfolios, which measure the R&D effect after controlling for firm size. We use an alternative R&D intensity (R&D_ME*), in which the numerator is defined as the sum of R&D expenditure (item01201) and capitalized R&D (which is sum of change in development cost - net (item02504) and amortization of R&D asset (item01153)). At the end of June of each year, we conduct sequential sorts by grouping all stocks by firm size quintiles first and then grouping all stocks into R&D_ME* quintiles within each size quintile. We then compute the equal-weighted (Panel A) and value-weighted (Panel B) industry-adjusted returns on the resulting 25 portfolios and the return spreads between the top and bottom R&D_ME* quintiles (High - Low) within each size group. Finally, we average these return spreads and report this average and associated t-statistics in the last column. Returns are computed from July of year t to June of year $t+1$. The sample period is from July of 1981 to June of 2018. t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 15: Time series regression with the factors of Hou, Karolyi, and Kho (2011): R&D_ME* and industry-adjusted return

	Global		Country-neutral		Country-neutral (Non-U.S.)	
Weighting	Equal	Value	Equal	Value	Equal	Value
Alpha	0.666***	0.375***	0.56***	0.424***	0.58***	0.487***
	(5.54)	(2.59)	(5.51)	(2.92)	(4.44)	(3.12)
Rm_rf	0.059**	0.143***	0.031	0.045	0.06**	0.079
	(2.48)	(3.44)	(1.23)	(1.13)	(2.24)	(1.64)
F_{MOM}	0.023	-0.023	0.019	0.036	0.020	0.055
	(0.65)	(-0.53)	(0.71)	(0.78)	(0.71)	(1.05)
$F_{C/P}$	0.021	0.131***	0.017	0.073	0.007	0.043
	(0.6)	(3.02)	(0.55)	(1.56)	(0.17)	(0.79)
R^2	1.655	5.941	0.523	1.071	1.016	1.094

This table examines the risk-based models' explanatory ability of R&D intensity for industry-adjusted portfolio returns. We use an alternative R&D intensity (R&D_ME*), in which the numerator is defined as the sum of R&D expenditure (item01201) and capitalized R&D (which is sum of change in development cost - net (item02504) and amortization of R&D asset (item01153)). We conduct factor regressions of equal- and value-weighted industry-adjusted return spreads separately, using the Hou, Karolyi, and Kho (2011) factor pricing model. These return spreads are High–Low from the previous table and are constructed by using global sorts, country-neutral sorts, and country-neutral sorts that exclude U.S. firms. Returns are computed from July of year t to June of year t+1. The model of Hou, Karolyi, and Kho (2011) includes a global market factor (Rm_rf), a global cash-to-price factor ($F_{C/P}$), and a global momentum factor (F_{MOM}). The sample period is from July of 1981 to June of 2018. The t-statistics based on Newey-West (1987) adjusted for time-series autocorrelation are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 16: PVGO vs. limits-to-arbitrage and sentiments

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Panel A: Equal-weighted SPREAD as dependent variable						
PVGO	0.298***	0.286***	0.277***	0.289***	0.281***	0.272***
	(3.795)	(3.668)	(3.494)	(3.681)	(3.556)	(3.503)
SHORT	0.120					0.174
	(0.559)					(0.903)
IRISK		0.155***				0.169**
		(2.377)				(2.269)
DVOL			0.055			0.045
			(1.048)			(0.984)
NIPO				-0.041		-0.120
				(-0.241)		(-0.626)
PVOL					-0.002	-0.008
					(-0.022)	(-0.105)
R^2	0.054	0.056	0.054	0.054	0.054	0.057
Panel B: Value-weighted SPREAD as dependent variable						
PVGO	0.359***	0.348***	0.355***	0.367***	0.364***	0.363***
	(2.650)	(2.652)	(2.672)	(2.598)	(2.587)	(2.548)
SHORT	0.039					0.016
	(0.190)					(0.122)
IRISK		0.189**				0.177**
		(2.157)				(2.330)
DVOL			0.112**			0.090*
			(2.147)			(1.769)
NIPO				0.217		-0.007
				(0.782)		(-0.027)
PVOL					0.328**	0.314
					(2.225)	(1.943)
R^2	0.064	0.066	0.066	0.064	0.066	0.069
Panel C: OLS SLOPE as dependent variable						
PVGO	0.507	0.493	0.462	0.410	0.492	0.177
	(0.568)	(0.588)	(0.539)	(0.513)	(0.580)	(0.207)
SHORT	-1.807					-2.332
	(-0.991)					(-1.165)
IRISK		0.709				0.684
		(1.412)				(1.408)
DVOL			0.205			0.362
			(0.704)			(1.269)
NIPO				-2.807***		-3.847*
				(-2.807)		(-1.948)
PVOL					-0.431	-0.411
					(-0.429)	(-0.425)

R^2	0.053	0.053	0.052	0.054	0.052	0.057
Panel D: WLS SLOPE as dependent variable						
PVGO	3.866**	3.764**	3.928***	3.827**	3.895**	3.731**
	(2.228)	(2.233)	(2.282)	(2.210)	(2.224)	(2.194)
SHORT	-2.352					-3.269
	(-0.599)					(-0.988)
IRISK		1.710				1.473
		(1.285)				(1.255)
DVOL			1.414*			1.543**
			(1.805)			(2.108)
NIPO				-0.848		-3.096
				(-0.196)		(-0.692)
PVOL					2.433	2.495
					(1.162)	(1.127)
R^2	0.070	0.071	0.070	0.069	0.070	0.074

This table reports the results of panel regressions that examine the relation between the dispersion in growth option value and the R&D effect on stock returns, after controlling for limits-to-arbitrage and investor sentiment. The dependent variables are the monthly equal- and value-weighted spread (SPREAD) and OLS- and WLS-based slope (SLOPE). SPREAD is the equal-weighted or value-weighted average of the monthly return difference between the top and bottom R&D_ME quintile, and their returns are cumulated from July of year t to June of year $t+1$. The value-weighting of SPREAD is based on firms' market capitalizations in June of year t. SLOPE is given by regressing buy-and-hold stock returns from July of year t to June of year $t+1$ on R&D_ME measured over year $t-1$. The regressions are either OLS or WLS. The WLS version of SLOPE is based on weighted-least-squares regressions, for which the weights are proportional to market capitalizations in June of year t. Panel A reports the regression results for which the equal- or value-weighted SPREAD is used as the dependent variable. Panel B presents the regression results for which the OLS- or WLS-based SLOPE is used as the dependent variable. The explanatory variable is the dispersion in present value of growth options (PVGO), and the control variables include the idiosyncratic stock return volatility (IRISK), dollar trading volume scaled by total market capitalization (DVOL), and permission for equity short-sale (SHORT), number of newly-listed equities (NIPO), and volatility premium (PVOL). The t-statistics reported in parentheses are computed using two-way clustered standard errors by country and year. Year fixed effects are included. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table 17: PE vs. limits-to-arbitrage and sentiments

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Panel A: Equal-weighted SPREAD as dependent variable						
PE	0.010*	0.009*	0.009*	0.011***	0.011**	0.008*
	(1.944)	(1.884)	(1.722)	(2.381)	(2.268)	(1.681)
SHORT	0.066					0.074
	(0.297)					(0.325)
IRISK		0.037				0.085
		(1.010)				(1.590)
DVOL			0.040			0.051
			(1.043)			(1.394)
NIPO				-0.217		-0.280
				(-1.446)		(-1.561)
PVOL					-0.068	-0.033
					(-0.682)	(-0.323)
R^2	0.054	0.056	0.055	0.054	0.054	0.057
Panel B: Value-weighted SPREAD as dependent variable						
PE	0.009	0.008**	0.009**	0.011***	0.009**	0.002
	(1.609)	(2.225)	(2.001)	(2.566)	(2.115)	(0.402)
SHORT	-0.010					-0.017
	(-0.048)					(-0.412)
IRISK		0.073				0.120*
		(1.456)				(1.904)
DVOL			0.082**			0.090**
			(2.451)			(2.280)
NIPO				-0.017		-0.078
				(-0.071)		(-0.280)
PVOL					0.170	0.223
					(1.185)	(1.393)
R^2	0.061	0.063	0.062	0.061	0.062	0.065
Panel C: OLS SLOPE as dependent variable						
PE	0.119**	0.098*	0.102*	0.110*	0.106*	0.119*
	(2.207)	(1.775)	(1.876)	(1.799)	(1.839)	(1.933)
SHORT	-2.645					-3.210
	(-1.329)					(-1.484)
IRISK		0.163				0.392
		(0.479)				(1.027)
DVOL			0.019			0.250
			(0.066)			(1.155)
NIPO				-3.272**		-4.489***
				(-1.999)		(-2.580)
PVOL					-0.768	-0.581
					(-0.627)	(-0.563)

R^2	0.058	0.056	0.055	0.057	0.056	0.062
Panel D: WLS SLOPE as dependent variable						
PE	0.065	0.010	0.004	0.043	0.023	-0.010
	(0.542)	(0.079)	(0.033)	(0.319)	(0.163)	(-0.077)
SHORT	-3.799					-4.802
	(-0.968)					(-1.292)
IRISK		0.921				1.109
		(1.070)				(1.186)
DVOL			0.918			1.251*
			(1.294)			(1.739)
NIPO				-2.093		-4.642
				(-0.553)		(-1.071)
PVOL					0.903	1.457
					(0.411)	(0.643)
R^2	0.068	0.068	0.067	0.066	0.066	0.071

This table reports the results of panel regressions that examine the relation between the dispersion in growth option value and the R&D effect on stock returns, after controlling for limits-to-arbitrage and investor sentiment. The dependent variables are the monthly equal- and value-weighted spread (SPREAD) and OLS- and WLS-based slope (SLOPE). SPREAD is the equal-weighted or value-weighted average of the monthly return difference between the top and bottom R&D_ME quintile, and their returns are cumulated from July of year t to June of year $t+1$. The value-weighting of SPREAD is based on firms' market capitalizations in June of year t. SLOPE is given by regressing buy-and-hold stock returns from July of year t to June of year $t+1$ on R&D_ME measured over year $t-1$. The regressions are either OLS or WLS. The WLS version of SLOPE is based on weighted-least-squares regressions, for which the weights are proportional to market capitalizations in June of year t. Panel A reports the regression results for which the equal- or value-weighted SPREAD is used as the dependent variable. Panel B presents the regression results for which the OLS- or WLS-based SLOPE is used as the dependent variable. The explanatory variable is the dispersion in price-to-dividend ratios (PE), and the control variables include the idiosyncratic stock return volatility (IRISK), dollar trading volume scaled by total market capitalization (DVOL), and permission for equity short-sale (SHORT), number of newly-listed equities (NIPO), and volatility premium (PVOL). The t-statistics reported in parentheses are computed using two-way clustered standard errors by country and year. Year fixed effects are included. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.