Internet Appendix with Supplement Results for

"Bubbles for Fama"

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Last Updated: Sep. 2017

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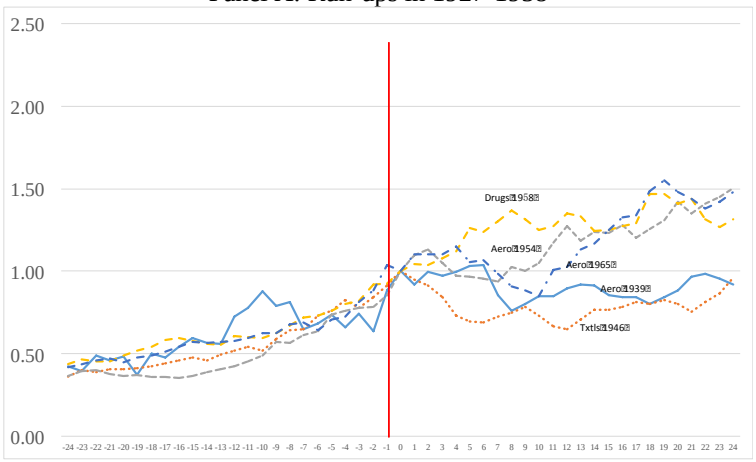
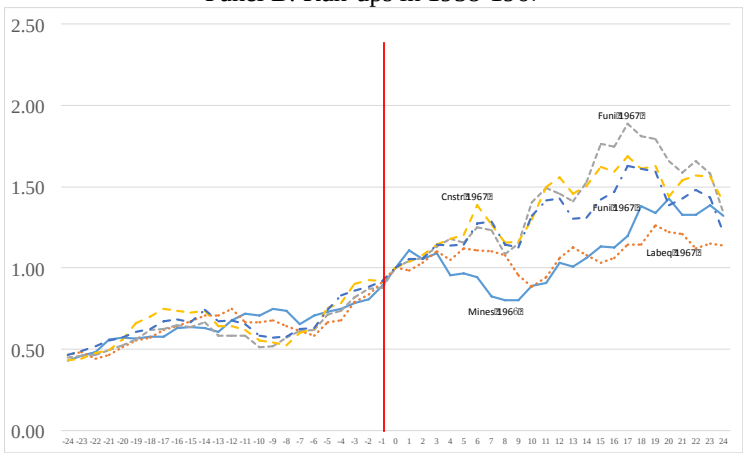
Appendix Figure 1. Price Run-ups without crash

The figure shows cumulative returns for the 19 episodes without a subsequent crash following an industry price run-up. Event time of 0 denotes the month when the price run-up is first identified. The vertical axis denotes a cumulative return index. All price run-ups have been normalized to have a total return index of 1 at the time 0. We separate the episodes into four figures for visibility.

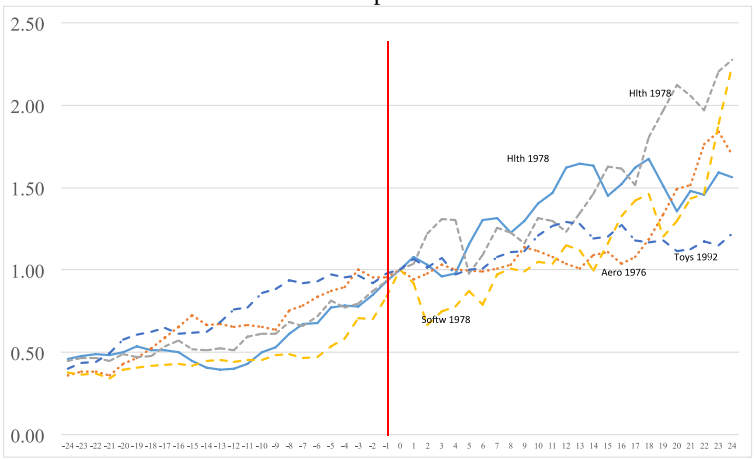
Panel A: Run-ups in 1927-1958



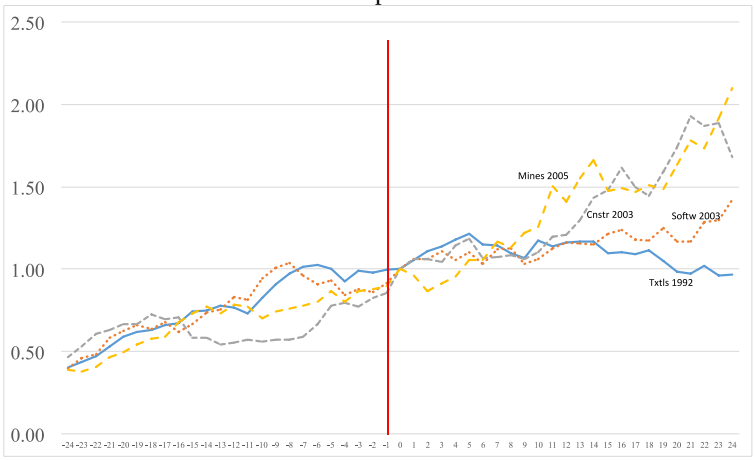
Panel B: Run-ups in 1958-1967



Panel C: Run-ups in 1967-1992



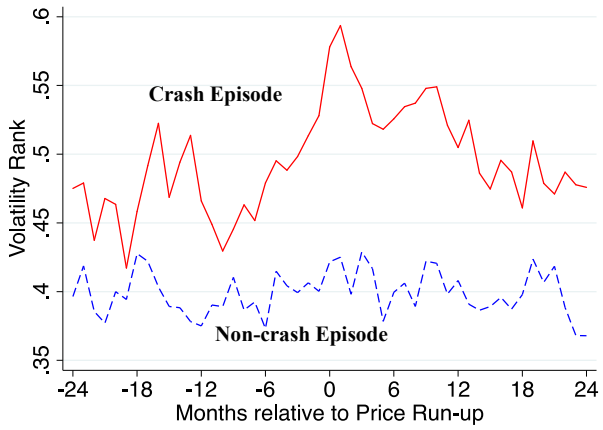
Panel D: Run-ups in 1992-2012



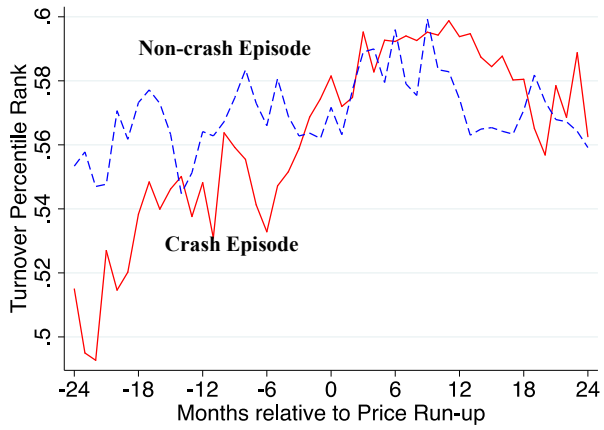
Appendix Figure 2. Features of Price Run-ups: International Sectors

The figure shows the characteristics for 107 international sector price run-ups, separated by those that crash (solid line) and those that do not (dashed). The figures show event-time plots of these characteristics, which include volatility, turnover, age, age tilt, issuance, the book-to-market ratio, sales growth, and the market cyclically adjusted P/E from Shiller. Construction of the characteristics and their aggregation to the industry level is described in the text.

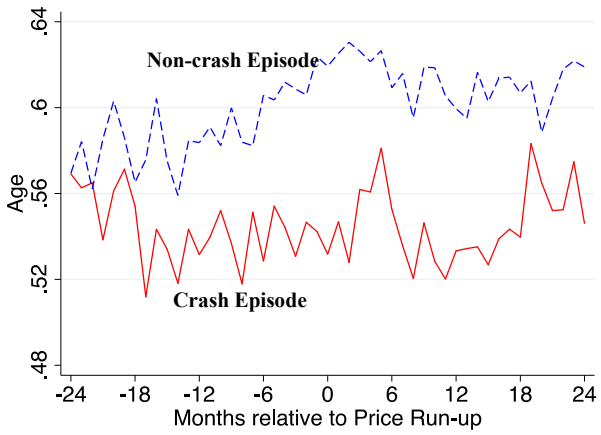
Panel A: Volatility



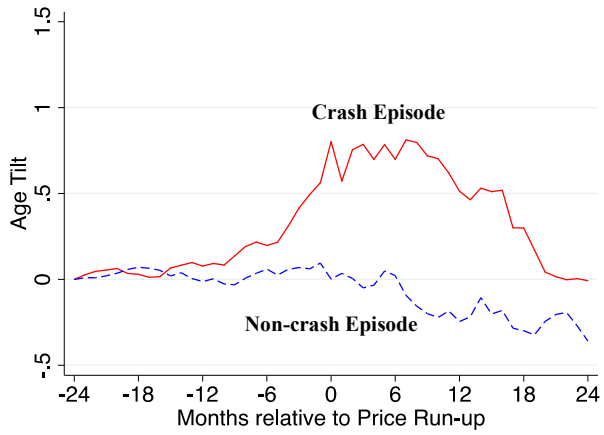
Panel B: Turnover



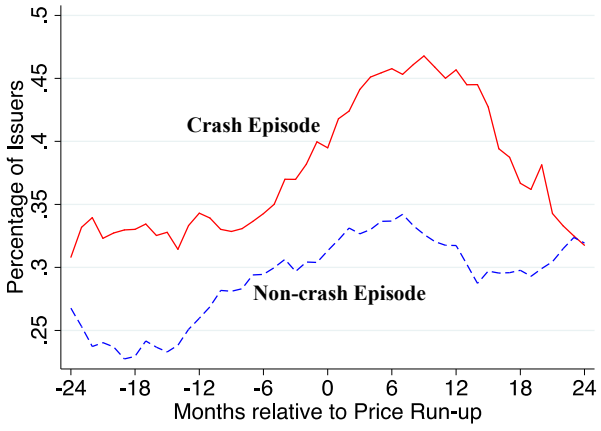
Panel C: Company Age



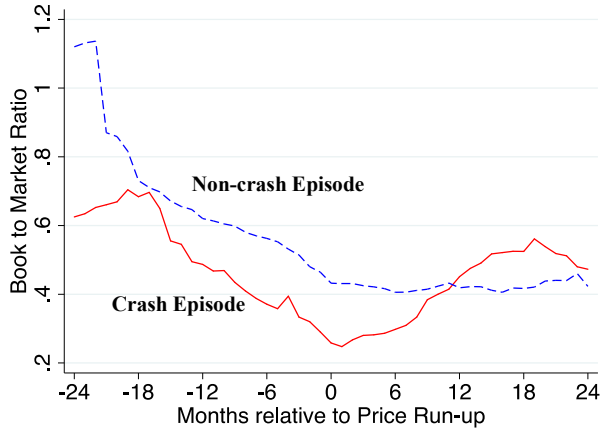
Panel D: Age Tilt



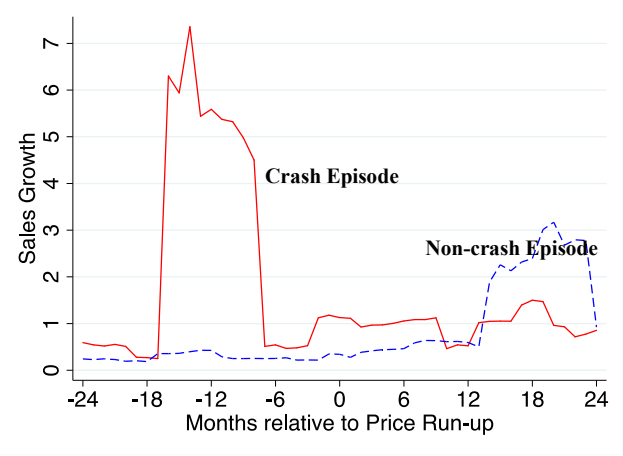
Panel E: Issuer Percentage



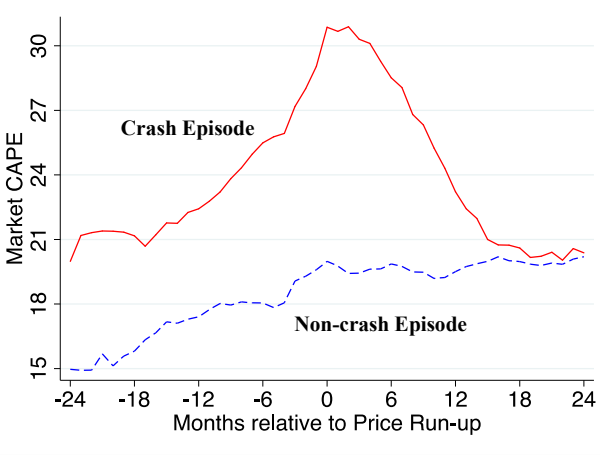
Panel F: Book-to-Market Ratio



Panel G: Sales Growth



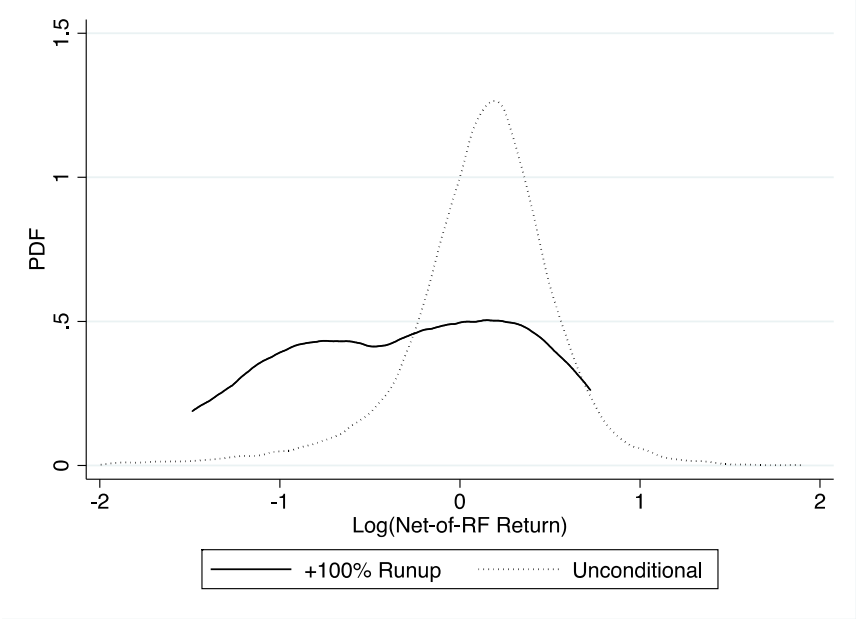
Panel H: Market CAPE Ratio



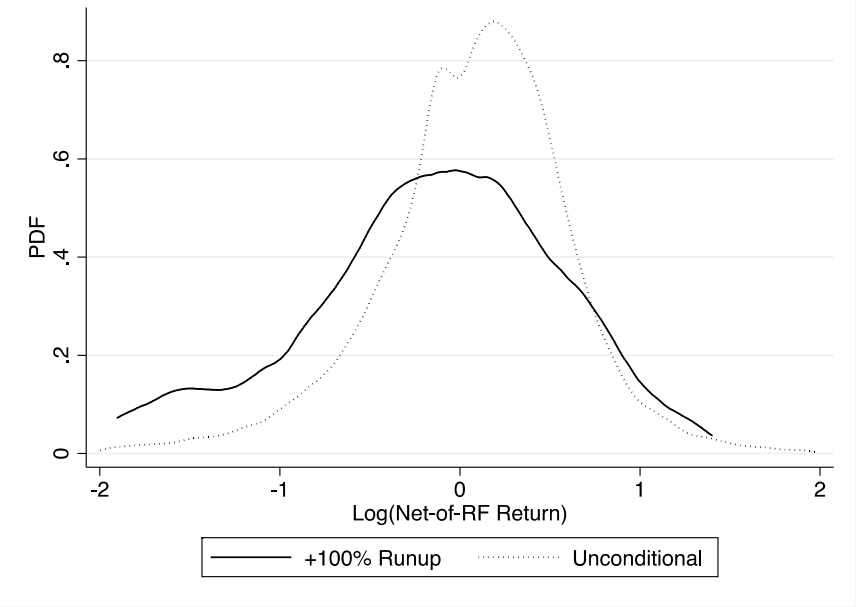
Appendix Figure 3. The Distribution of Log-Returns after a Price Run-up

Using our sample of 40 large industry price run-ups in the U.S. and 107 sector price run-ups internationally, the figure plots the non-parametric kernel density of subsequent24-month log excess returns. Panel A shows the distribution for the US sample; Panel B shows the distribution for the international sample. For comparison, each figure also shows the unconditional distribution of log excess returns.

Panel A. US Sample: Distribution of Log- Excess Returns after a Price Run-up



Panel B. International Sample: Distribution of Log-Excess Returns after a Price Run-up



Appendix Table 1. Returns after Industry Price Run-ups, International Sectors 1987-2012

We list all price run-ups of international country-sectors, defined as any incident with (1) 100% raw and value-weighted return over the past two years (2) 100% net of market returns over the past two years, and (3) 100% raw return over the past five years. A crash is defined as a 40% drawdown from any point in the two years after the initial price run-up. We document subsequent performance for all price run-ups, including raw/net-to-risk-free/net-to-market return, maximal price drawdown within 24 months, number of months to price peak (for crashes only) and raw return to price peak (for crashes only).

Panel A. Run-ups that Subsequently Experienced a Crash

Country	Industry Name	Number of Firms	Price Run-up first observed：	Subsequent Performance & Maximal Drawdown over next 2-years								
				12mo Raw Return (%)	24mo Raw Return (%)	12mo net of Risk-Free (%)	24mo net of Risk-Free (%)	12mo net of Market Return (%)	24mo net of Market Return (%)	24mo Maximal Drawdown	Months to Price Peak	Return to Peak
Brazil	Telecomm	11	199702	5%	-50%	0%	-60%	9%	10%	-64%	5	39%
Taiwan	IT	65	199707	-41%	-23%	-46%	-33%	-2%	17%	-50%	0	0%
Germany	IT	15	199803	-14%	81%	-19%	71%	-15%	45%	-48%	23	107%
Greece	Consumer Discretionary	28	199903	113%	3%	108%	-8%	84%	34%	-82%	7	396%
India	IT	26	199906	227%	18%	222%	7%	202%	34%	-78%	8	436%
Greece	Consumer Staples	19	199908	-63%	-74%	-68%	-85%	-19%	-14%	-80%	3	13%
India	HealthCare	32	199908	-27%	-37%	-32%	-47%	-19%	-1%	-49%	4	18%
Greece	Industrials	31	199908	-58%	-71%	-64%	-82%	-15%	-11%	-78%	3	16%
UK	IT	137	199911	-34%	-73%	-40%	-83%	-21%	-50%	-87%	3	52%
Australia	IT	27	199911	-53%	-79%	-59%	-89%	-40%	-71%	-84%	4	19%
Thailand	Telecomm	11	199911	-36%	-39%	-42%	-49%	6%	1%	-58%	2	33%
Japan	IT	350	199911	-30%	-60%	-36%	-70%	-8%	-15%	-73%	3	27%
Sweden	IT	39	199912	-33%	-68%	-39%	-78%	-10%	-27%	-85%	2	47%
Thailand	Materials	58	199912	-58%	-45%	-63%	-54%	-6%	3%	-55%	0	0%
Malaysia	Financials	127	200001	-31%	-29%	-37%	-39%	-7%	-7%	-50%	1	8%
Hong Kong	IT	44	200001	-37%	-60%	-43%	-70%	-29%	-26%	-80%	2	45%
Malaysia	IT	22	200001	-43%	-46%	-49%	-55%	-18%	-24%	-75%	2	51%
Italy	Telecomm	10	200002	-47%	-59%	-53%	-69%	-25%	-20%	-56%	0	0%
Italy	Consumer	66	200002	-48%	-63%	-54%	-72%	-26%	-24%	-62%	0	0%

	Discretionary											
France	IT	80	200002	-44%	-72%	-50%	-81%	-29%	-42%	-79%	6	5%
Swizerland	IT	17	200002	-42%	-70%	-48%	-79%	-50%	-58%	-77%	0	0%
Portugal	Consumer Discretionary	15	200002	-79%	-90%	-85%	-100%	-51%	-42%	-88%	0	0%
Brazil	Consumer Staples	15	200009	-34%	-45%	-39%	-52%	12%	14%	-57%	4	28%
Canada	Telecomm	22	200009	-41%	-52%	-46%	-59%	-11%	-18%	-56%	1	1%
Brazil	Materials	58	200308	29%	3%	28%	0%	28%	19%	-52%	18	88%
Brazil	Industrials	32	200310	-15%	-95%	-16%	-99%	3%	-75%	-96%	5	32%
Austria	Consumer Discretionary	17	200504	46%	5%	42%	-4%	-2%	-95%	-56%	12	46%
Brazil	Utilities	49	200602	23%	-66%	18%	-75%	0%	14%	-79%	15	53%
Hong Kong	Telecomm	15	200610	142%	11%	137%	4%	49%	33%	-54%	12	142%
Brazil	Consumer Discretionary	59	200611	-91%	-97%	-96%	-103%	-13%	-2%	-98%	7	57%
China	Consumer Staples	93	200705	12%	-13%	9%	-17%	17%	11%	-60%	7	40%
Hong Kong	Materials	51	200707	-44%	-47%	-47%	-51%	-34%	-34%	-79%	2	4%
China	Consumer Discretionary	259	200707	-35%	-12%	-38%	-15%	-6%	-2%	-68%	2	13%
China	Materials	270	200708	-58%	-42%	-61%	-45%	-10%	-3%	-76%	1	10%
Korea	Materials	242	200709	-42%	-35%	-44%	-37%	-2%	-1%	-68%	1	3%
Taiwan	Consumer Staples	38	200709	-27%	0%	-30%	-2%	9%	16%	-43%	7	8%
Singapore	Energy	18	200710	-75%	-32%	-77%	-35%	-27%	-14%	-75%	0	0%
Brazil	IT	10	200710	-51%	-18%	-53%	-20%	34%	47%	-51%	0	0%
France	Utilities	21	200710	-39%	-38%	-41%	-41%	4%	-9%	-59%	1	4%
China	Energy	30	200710	-71%	-54%	-73%	-56%	-4%	-15%	-66%	0	0%
India	Materials	246	200710	-72%	-37%	-74%	-39%	-9%	-4%	-78%	2	10%
Korea	Energy	11	200711	-67%	-50%	-69%	-52%	-4%	-15%	-67%	0	0%
Singapore	Consumer Staples	42	200712	-57%	2%	-58%	0%	-13%	9%	-63%	5	5%
Switzerland	Utilities	10	200803	-41%	-33%	-42%	-34%	0%	-26%	-50%	2	18%

Sri Lanka	Consumer Discretionary	52	201002	60%	-5%	60%	-5%	-49%	-44%	-41%	12	60%
Sri Lanka	Financials	58	201009	-9%	-37%	-9%	-37%	-4%	-9%	-53%	5	9%
Sri Lanka	Industrials	25	201009	-14%	-35%	-14%	-35%	-9%	-6%	-48%	0	0%
Norway	Consumer Staples	16	201010	-37%	-11%	-37%	-11%	-38%	-22%	-52%	6	25%
Hong Kong	HealthCare	36	201010	-42%	-35%	-42%	-35%	-31%	-34%	-49%	1	1%
China	IT	222	201010	-20%	-35%	-20%	-36%	-7%	-10%	-41%	1	5%
Canada	Materials	1253	201010	-12%	-20%	-12%	-21%	-9%	-21%	-40%	2	13%
Belgium	Industrials	13	201011	-46%	-53%	-46%	-53%	-37%	-73%	-63%	5	21%
Korea	Energy	14	201103	-22%	-23%	-22%	-23%	-19%	-24%	-42%	1	9%
	Crash Mean	**85**	**NA**	**-23%**	**-38%**	**-27%**	**-44%**	**-5%**	**-13%**	**-65%**	**4.1**	**38%**
	All Run-up Mean	**74**	**N/A**	**1%**	**7%**	**-1%**	**2%**	**3%**	**0%**	**-43%**	**N/A**	**N/A**

[Appendix Table 1 Continued]

Panel B. Run-ups without a Crash in the next 2 years

Country	Industry Name	Number of Firms	Price Run-up first observed:	Subsequent Performance & Maximal Drawdown over next 2-years						
				12mo Raw Return (%)	24mo Raw Return (%)	12mo net of Risk-Free (%)	24mo net of Risk-Free (%)	12mo net of Market Return (%)	24mo net of Market Return (%)	24mo Maximal Drawdown
Malaysia	Financials	107	199603	26%	-67%	21%	-78%	11%	-7%	0%
France	HealthCare	19	199612	14%	68%	8%	58%	2%	14%	-12%
Spain	Consumer Discretionary	12	199806	-19%	-18%	-24%	-28%	-14%	-16%	-38%
UK	Telecomm	12	199807	23%	33%	18%	23%	17%	24%	-29%
Greece	Financials	20	199807	71%	22%	67%	12%	21%	-1%	-40%
Belgium	Consumer Discretionary	10	199902	-30%	-39%	-35%	-50%	-1%	-13%	-34%
New Zealand	Consumer Staples	10	200008	40%	39%	35%	32%	40%	22%	-10%
Danmark	HealthCare	12	200107	-31%	-20%	-33%	-23%	-17%	-27%	-32%
Canada	Real Estate	30	200111	13%	48%	11%	46%	20%	32%	-4%
South Africa	Materials	59	200205	-1%	11%	-3%	9%	-17%	-54%	-20%
Thailand	Materials	50	200211	139%	145%	138%	142%	43%	19%	-21%
Austria	Consumer Staples	15	200301	97%	156%	96%	153%	23%	-1%	-6%
Thailand	HealthCare	12	200301	155%	308%	154%	305%	39%	169%	-12%
Thailand	Industrials	46	200308	34%	30%	33%	27%	6%	-26%	-22%
India	Energy	19	200308	16%	68%	15%	64%	-12%	-50%	-28%
India	Industrials	115	200310	34%	135%	33%	132%	8%	54%	-22%
Finland	Industrials	32	200311	43%	106%	42%	102%	37%	85%	-8%
India	Financials	50	200312	43%	87%	42%	82%	17%	19%	-26%
Finland	Consumer Staples	11	200312	48%	76%	47%	72%	39%	44%	-6%
South Africa	Consumer Discretionary	65	200401	94%	179%	93%	175%	47%	47%	-13%
Finland	Consumer	29	200401	37%	52%	35%	47%	45%	34%	-17%

	Discretionary									
Singapore	Consumer Staples	22	200402	17%	38%	15%	34%	2%	1%	-9%
Swizerland	Utilities	14	200403	41%	60%	40%	55%	22%	12%	-11%
Brazil	Consumer Discretionary	42	200408	26%	151%	24%	144%	43%	135%	-19%
Thailand	Telecomm	10	200409	18%	14%	16%	7%	-5%	-21%	-19%
Finland	Financials	18	200410	37%	93%	34%	85%	13%	29%	-5%
Brazil	Consumer Staples	20	200412	26%	66%	23%	58%	39%	39%	-30%
Neitherlands	Industrials	40	200501	33%	53%	30%	45%	13%	11%	-14%
India	Materials	190	200502	35%	76%	32%	68%	-9%	3%	-24%
Thailand	HealthCare	16	200505	77%	187%	73%	177%	57%	136%	-4%
Australia	Energy	108	200508	27%	71%	22%	62%	6%	4%	-11%
Singapore	HealthCare	12	200509	17%	96%	12%	86%	-5%	-4%	-19%
Danmark	Consumer Discretionary	24	200510	50%	66%	46%	56%	16%	-26%	-11%
Korea	HealthCare	70	200510	7%	55%	3%	45%	-22%	-49%	-22%
Korea	Industrials	284	200603	40%	98%	35%	89%	28%	74%	-39%
Malaysia	HealthCare	20	201003	4%	9%	4%	9%	-30%	-34%	-22%
Thailand	Consumer Staples	55	201003	65%	169%	65%	169%	20%	98%	-13%
China	HealthCare	141	201008	2%	-15%	1%	-15%	-3%	2%	-38%
Hong Kong	IT	154	201010	-20%	-18%	-20%	-18%	-9%	-18%	-33%
Singapore	Consumer Discretionary	103	201010	-7%	-2%	-7%	-2%	-2%	-12%	-20%
Singapore	Energy	25	201010	-18%	-8%	-18%	-9%	-14%	-18%	-34%
Singapore	HealthCare	19	201010	14%	8%	14%	8%	19%	-2%	-18%
Singapore	Consumer Staples	45	201010	-10%	-11%	-10%	-11%	-5%	-21%	-24%
China	Consumer Discretionary	314	201010	-17%	-33%	-17%	-34%	-3%	-8%	-34%
Hong Kong	Consumer Discretionary	310	201010	-8%	-6%	-8%	-6%	3%	-5%	-27%
Finland	Industrials	41	201010	-14%	1%	-14%	1%	5%	24%	-38%

Thailand	Materials	105	201011	-17%	-3%	-17%	-3%	-15%	-41%	-31%
UK	Materials	158	201011	-12%	-16%	-12%	-16%	-11%	-30%	-33%
Mexico	Materials	12	201011	-7%	21%	-7%	21%	-2%	4%	-26%
Switzerland	Consumer Discretionary	33	201011	-4%	24%	-4%	24%	-1%	10%	-28%
Belgium	Consumer Discretionary	12	201011	-12%	-9%	-12%	-9%	-3%	-28%	-36%
India	IT	222	201012	-27%	-23%	-27%	-24%	10%	-1%	-28%
Thailand	HealthCare	23	201112	50%	59%	50%	59%	6%	27%	-27%
Thailand	Telecomm	19	201203	57%	42%	57%	42%	16%	25%	-31%
	Non-Crash Mean	**63**	**NA**	**24%**	**51%**	**23%**	**46%**	**10%**	**13%**	**-22%**
	All Run-up Mean	**74**	**NA**	**1%**	**7%**	**-2%**	**2%**	**2%**	**0%**	**-43%**

Appendix Table 2. Predicting Major Industry Drawdowns

The table presents the predictive power of raw 24-month past return on crash occurrence in the next 24 months with or without the volatility control. Regressions take the form:

$$Crash_{it} = a + b(R_{t-1} > 100\%) + c\sigma_{t-1} + u_{it}$$

Volatility is measured as the standard deviation of the past 12 months of industry or sector returns. *t*-statistics are reported in the parenthesis based on the standard errors clustered by industry and time following Thompson (2006). * p<0.05, ** p<0.01, *** p<0.001.

Panel A. US Industries

	Dependent Variable = Crash Occurrence in the next 24 months									
R>50%	0.224*** [3.58]	0.262*** [3.99]								
R>75%			0.444*** [5.95]	0.418*** [5.48]						
R>100%					0.712*** [7.93]	0.621*** [6.67]				
R>125%							0.923*** [8.32]	0.762*** [6.52]		
R>150%									1.079*** [7.91]	0.855*** [5.93]
σ_{t-1}		7.239*** [8.35]		7.006*** [8.19]		6.792*** [7.97]		6.709*** [7.90]		6.727*** [7.90]
N	47,701	47,701	47,701	47,701	47,701	47,701	47,701	47,701	47,701	47,701

[Appendix Table 2 Continued]

Panel B. International Sectors

	Dependent Variable = Crash Occurrence in the next 24 months									
R>50%	0.240***	0.277***								
	[3.63]	[4.09]								
R>75%			0.319***	0.295***						
			[4.80]	[4.23]						
R>100%					0.376***	0.296***				
					[5.59]	[4.15]				
R>125%							0.433***	0.300***		
							[6.05]	[3.95]		
R>150%									0.498***	0.312***
									[6.37]	[3.77]
σ_{t-1}		5.174***		5.001***		4.916***		4.887***		4.875***
		[11.00]		[10.25]		[9.92]		[9.83]		[9.83]
N	90,633	90,633	90,633	90,633	90,633	90,633	90,633	90,633	90,633	90,633

Appendix Table 3. Predicting Crashes

The table reports panel regressions forecasting future crashes and maximal drawdown with the identified features controlling for the past 2-year raw return.

$$Crash_{it} = a + bX_{it-1} + cR_{t-1} + dZ_{t-1} + u_{it}, \text{ and}$$
$$drawdown_{it} = a + bX_{it-1} + cR_{t-1} + dZ_{t-1} + u_{it},$$

where X denotes a characteristic of firms in the industry experiencing a price run-up, *R* denotes the past return and *Z* denotes additional controls. All regressions include a control for volatility (Standard deviation of monthly returns in past 12 months). *t*-statistics are based on standard errors clustered by time and industry/country-sector. * p<0.05, ** p<0.01, *** p<0.001

Panel A: US Industries

	Probit: Predicting a Crash				OLS: Predicting Maximum Drawdown				
	b	**[*t*]**	***c***	**[*t*]**	***b***	**[*t*]**	***c***	**[*t*]**	R^2
Turnover and Volatility:									
Volatility (VW)	0.954***	[6.94]	0.168**	[2.56]	0.150***	[7.96]	0.026**	[2.91]	0.132
Volatility (VW)- 1-yr change	0.355**	[3.06]	0.199**	[2.98]	0.045***	[3.34]	0.030***	[3.40]	0.115
Turnover (VW)	0.526**	[2.99]	0.193**	[2.83]	0.070***	[4.13]	0.029**	[3.28]	0.121
Turnover (VW)- 1-yr change	0.590**	[3.03]	0.205**	[3.04]	0.089***	[3.88]	0.031***	[3.48]	0.117
Age:									
Firm Age (VW)	0.590**	[3.03]	0.205**	[3.04]	-0.064***	[-2.92]	0.030***	[3.34]	0.119
Age "tilt"	-0.085	[-0.27]	0.199**	[2.95]	0.002	[0.04]	0.031***	[3.39]	0.113
Issuance:									
% Issuers	0.921***	[6.41]	0.167*	[2.38]	0.112***	[5.73]	0.025**	[2.86]	0.133
Fundamentals vs. Price:									
Book to Market Ratio (VW)	-0.671***	[4.88]	0.145	[1.51]	-0.038***	[-3.33]	0.043***	[4.30]	0.079
Sales Growth	0.417*	[1.97]	0.271**	[3.10]	0.014	[0.66]	0.050***	[5.68]	0.094
CAPE	0.043***	[9.95]	0.161*	[2.34]	0.052***	[9.78]	0.025**	[3.02]	0.165
Acceleration:									
Acceleration	-0.245*	[-2.11]	0.336***	[3.57]	-0.028	[-1.71]	0.046***	[3.54]	0.115

[Appendix Table 3 Continued]

Panel B: International Sectors

	Probit: Predicting a Crash				OLS: Predicting Maximum Drawdown				
	b	**[*t*]**	***c***	**[*t*]**	***b***	**[*t*]**	***c***	**[*t*]**	R^2
Turnover and Volatility:									
Volatility (VW)	1.157***	[11.19]	0.130**	[2.99]	0.211***	[12.60]	0.022**	[3.26]	0.131
Volatility (VW)- 1-yr change	0.382***	[4.76]	0.127**	[2.89]	0.070***	[5.26]	0.022**	[3.14]	0.104
Turnover (VW)	-0.167	[-1.62]	0.126**	[2.89]	-0.028	[-1.62]	0.022**	[3.15]	0.099
Turnover (VW)- 1-yr change	0.067	[0.66]	0.127**	[2.91]	0.023	[1.43]	0.022**	[3.16]	0.099
Age:									
Firm Age (VW)	-0.107	[-1.11]	0.239***	[4.31]	-0.195	[-1.29]	0.036***	[4.21]	0.110
Age "tilt"	-0.055	[-1.33]	0.253***	[4.33]	-0.006	[-0.90]	0.031***	[3.39]	0.109
Issuance:									
% Issuers	0.242***	[6.81]	0.125*	[2.87]	0.032***	[4.87]	0.021**	[3.02]	0.108
Fundamentals vs. Price:									
Book to Market Ratio (VW)	-0.030	[-1.08]	0.207***	[4.17]	-0.003	[-0.83]	0.033***	[4.21]	0.104
Sales Growth	0.052	[0.56]	0.212***	[4.31]	0.011	[0.83]	0.034***	[4.49]	0.105
CAPE	0.024***	[6.88]	0.153***	[3.33]	0.004	[7.55]	0.023***	[3.58]	0.153
Acceleration:									
Acceleration	-0.040	[-0.58]	0.153**	[2.92]	-0.004	[-0.32]	0.024**	[2.92]	0.099

Appendix Table 4. Price Run-ups & Crashes: Ex-ante Criterion Robustness

We experiment using different ex-ante price criteria to identify price run-ups for Table 3. The ex-ante criterion for Table 4a: Net-of-Market 100% in a two-year period and a raw return of 50% or more in a five-year period. The ex-ante criterion for Table 4b: Raw 100% in a two-year period and a raw return of 50% or more in a five-year period. The ex-ante criterion for Table 4c: Net-of-Market and Raw 100% in a two-year period. Our data samples include (1) Panel A: US Industry 1928-2012 (2) Panel B: International sectors 1986-2012. Standard errors are clustered by calendar year in Panel A, by sector-calendar year in Panel B.

Table 4a: Identifying Run-ups using Net-of-Market Return and Non-recovery Conditions

	Return Statistics							Probability of a Subsequent Crash & Drawdown				
Pick-up Threshold	12-month Net of Risk-Free Return (%)	24-month Net of Risk-Free Return (%)	12-month Net of Market Return (%)	24-month Net of Market Return (%)	SD of 24-mo Net of Risk-Free Return	Skewness of 24-mo Net of Risk-Free Return	Kurtosis of 24-mo Net of Risk-Free Return	Number of Run-ups Identified	Number of Crashes	% Crashes	Drawdown of Crashes (%)	Average Drawdown (%)
Panel A: US Industries 1926-2012												
Unconditional	10%	21%	2%	4%	25%	2.0	17.9					
50%	6%	11%	3%	3%	0.46	1.09	5.50	173	35	0.20	-0.52	-0.27
	[2.39]	[2.70]	[1.43]	[1.02]							[-35.42]	[-20.12]
75%	5%	1%	3%	2%	0.44	0.58	2.96	79	28	0.35	-0.54	-0.34
	[1.16]	[0.27]	[1.14]	[0.60]							[-30.88]	[-15.48]
100%	1%	-11%	4%	-2%	0.52	0.68	2.50	42	22	0.52	-0.59	-0.41
	[0.15]	[-1.24]	[0.73]	[-0.31]							[-30.54]	[-10.19]
125%	-11%	-30%	-6%	-14%	0.54	1.73	5.21	21	16	0.76	-0.60	-0.51
	[-1.36]	[-2.35]	[-1.06]	[-1.43]							[-16.81]	[-10.54]
150%	-17%	-28%	-9%	-10%	0.63	1.55	3.96	15	12	0.80	-0.62	-0.55
	[-2.36]	[-1.63]	[-1.52]	[-0.77]							[-18.29]	[-12.84]
Panel B: International Sectors 1987-2012												
Unconditional	11%	24%	2%	5%	68%	5.9	93.5					
50%	9%	17%	5%	6%	0.64	1.14	5.07	243	87	36%	-62%	-35%
	[2.83]	[3.58]	[2.41]	[2.06]							[-33.96]	[-20.63]
75%	4%	9%	4%	5%	0.65	1.17	5.31	155	65	42%	-62%	-38%
	[0.90]	[1.67]	[1.69]	[1.36]							[-29.15]	[-17.58]
100%	-2%	2%	3%	0%	0.70	1.30	5.59	109	53	49%	-65%	-43%

	[-0.29]	[0.28]	[0.77]	[0.02]							[-28.33]	[-15.63]
125%	-6%	-6%	-1%	-5%	0.70	1.28	4.98	76	40	53%	-68%	-47%
	[-1.03]	[-0.71]	[-0.31]	[-1.11]							[-27.99]	[-14.37]
150%	-18%	-21%	-5%	-11%	0.70	1.43	5.08	53	35	66%	-70%	-53%
	[-2.23]	[-2.08]	[-0.98]	[-1.98]							[-27.03]	[-12.96]

[Appendix Table 4 Continued]

Table 4b: Identifying Run-ups using Raw Return and Non-recovery Conditions

	Return Statistics							Probability of a Subsequent Crash & Drawdown				
Pick-up Threshold	12-month Net of Risk-Free Return (%)	24-month Net of Risk-Free Return (%)	12-month Net of Market Return (%)	24-month Net of Market Return (%)	SD of 24-mo Net of Risk-Free Return	Skewness of 24-mo Net of Risk-Free Return	Kurtosis of 24-mo Net of Risk-Free Return	Number of Run-ups Identified	Number of Crashes	% Crashes	Drawdown of Crashes (%)	Average Drawdown (%)
Panel A: US Industries 1926-2012												
Unconditional	10%	21%	2%	4%	25%	2.0	17.9					
50%	7%	13%	1%	2%	0.40	0.63	4.53	439	59	13%	-54%	-23%
	[3.68]	[4.56]	[0.54]	[0.89]							[-37.23]	[-21.40]
75%	4%	7%	-1%	-3%	0.38	0.33	3.01	312	49	16%	-52%	-25%
	[1.76]	[2.38]	[-0.65]	[-1.32]							[-34.13]	[-19.46]
100%	4%	2%	0%	-4%	0.38	0.65	3.75	178	44	25%	-53%	-29%
	[1.48]	[0.56]	[-0.26]	[-1.90]							[-42.55]	[-18.07]
125%	-2%	-8%	-1%	-4%	0.44	1.27	5.53	90	38	42%	-55%	-36%
	[-0.34]	[-1.51]	[-0.47]	[-1.29]							[-40.95]	[-14.42]
150%	-3%	-18%	1%	-4%	0.51	1.12	3.57	45	30	67%	-58%	-46%
	[-0.53]	[-2.19]	[0.18]	[-0.71]							[-33.54]	[-14.21]
Panel B: International Sectors 1987-2012												
Unconditional	11%	24%	2%	5%	0.68	5.9	93.5					
50%	11%	17%	4%	4%	0.56	1.01	4.99	529	143	0.27	-59%	-30%
	[5.17]	[6.11]	[3.30]	[2.56]							[-46.95]	[-27.08]
75%	10%	16%	4%	4%	0.58	1.01	4.79	466	152	0.33	-59%	-33%

	[3.71]	[4.79]	[2.18]	[2.29]							[-50.73]	[-26.20]
100%	6%	13%	3%	3%	0.59	1.06	5.06	367	126	0.34	-61%	-34%
	[2.39]	[3.41]	[1.72]	[1.40]							[-45.44]	[-21.31]
125%	7%	11%	4%	2%	0.61	0.99	4.47	268	97	0.36	-62%	-35%
	[1.99]	[2.51]	[1.82]	[0.61]							[-38.46]	[-19.61]
150%	0%	7%	-1%	-1%	0.60	0.91	4.52	207	80	0.39	-64%	-38%
	[0.11]	[1.43]	[-0.30]	[-0.41]							[-36.25]	[-17.30]

[Appendix Table 4 Continued]

Table 4c: Identifying Run-ups using Net-of-Market Return and Raw Return Conditions

	Return Statistics							Probability of a Subsequent Crash & Drawdown				
Pick-up Threshold	12-month Net of Risk-Free Return (%)	24-month Net of Risk-Free Return (%)	12-month Net of Market Return (%)	24-month Net of Market Return (%)	SD of 24-mo Net of Risk-Free Return	Skewness of 24-mo Net of Risk-Free Return	Kurtosis of 24-mo Net of Risk-Free Return	Number of Run-ups Identified	Number of Crashes	% Crashes	Drawdown of Crashes (%)	Average Drawdown (%)
Panel A: US Industries 1926-2012												
Unconditional	10%	21%	2%	4%	0.25	2.0	17.9					
50%	5%	14%	2%	4%	0.46	0.89	4.87	193	32	17%	-52%	-26%
	[2.07]	[3.84]	[0.98]	[1.56]							[-33.67]	[-20.92]
75%	4%	8%	3%	3%	0.48	0.82	3.93	90	26	29%	-54%	-31%
	[1.08]	[1.47]	[1.10]	[0.78]							[-29.68]	[-15.57]
100%	3%	2%	4%	0%	0.57	0.65	3.10	52	22	42%	-59%	-37%
	[0.42]	[0.20]	[1.01]	[-0.03]							[-28.94]	[-10.31]
125%	-9%	-12%	-6%	-12%	0.67	1.31	3.88	27	16	59%	-59%	-44%
	[-1.20]	[-0.81]	[-1.27]	[-1.29]							[-15.52]	[-8.51]
150%	-18%	-19%	-9%	-9%	0.65	1.13	2.83	17	12	71%	-62%	-52%
	[-2.78]	[-1.13]	[-1.73]	[-0.71]							[-18.29]	[-11.16]
Panel B: International Sectors 1987-2012												
Unconditional	11%	24%	2%	5%	0.68	5.9	93.5					
50%	7%	16%	5%	4%	0.61	0.88	3.95	287	95	0.33	-62%	-35%

	[2.57]	[3.95]	[2.43]	[1.69]							[-34.43]	[-21.07]
75%	2%	9%	4%	4%	0.60	0.88	4.15	189	74	0.39	-61%	-37%
	[0.55]	[1.98]	[1.62]	[1.30]							[-33.00]	[-19.21]
100%	-2%	3%	3%	1%	0.66	1.29	5.81	126	57	0.45	-64%	-41%
	[-0.32]	[0.48]	[1.06]	[0.23]							[-29.63]	[-17.10]
125%	-6%	-3%	0%	-3%	0.67	1.24	5.16	85	41	0.48	-68%	-44%
	[-1.05]	[-0.46]	[0.07]	[-0.77]							[-29.00]	[-14.52]
150%	-17%	-18%	-4%	-10%	0.67	1.32	4.94	58	36	0.62	-69%	-50%
	[-2.25]	[-1.87]	[-0.81]	[-1.81]							[-26.95]	[-12.53]

Appendix Table 5. Features of Price Run-ups and Crashes: Sensitivity to Definition of "Run-up"

This table reports the last two columns of Table 4 and 5 in the paper with different definitions of price run-up. Consistent with Table 3, we require 50%, 75%, 100%, 125% and 150% past two-year return respectively and show the average difference of characteristics between crashes and non-crashes. Panel A corresponds to Table 4 using U.S. data and Panel B corresponds to Table 5 using international data.

Panel A: US Industries 1928-2012

	2-yr Ret>50%		2-yr Ret>75%		2-yr Ret>100%		2-yr Ret>125%		2-yr Ret>150%	
	Difference	**[*t*]**	**Difference**	**[*t*]**	**Difference**	**[*t*]**	**Difference**	**[*t*]**	**Difference**	**[*t*]**
Past 2-year Return	0.191	[3.01]	0.299	[3.95]	0.311	[3.14]	0.263	[2.30]	0.253	[1.12]
Excess Past 2-year Return	0.029	[0.91]	0.076	[2.40]	0.030	[0.64]	0.034	[0.41]	0.046	[0.56]
Turnover and Volatility:										
Volatility (VW)	0.011	[0.40]	0.011	[0.32]	0.021	[0.46]	-0.078	[-1.57]	-0.022	[-0.28]
Volatility (VW)- 1yr-Δ	-0.027	[-1.02]	0.042	[1.45]	0.113	[2.61]	-0.024	[-0.39]	0.017	[0.24]
Turnover (VW)	-0.001	[-0.04]	-0.017	[-0.41]	-0.036	[-0.67]	-0.181	[-2.98]	-0.165	[-1.7]
Turnover (VW)- 1yr-Δ	-0.026	[-1.23]	-0.002	[-0.09]	-0.005	[-0.15]	-0.063	[-0.75]	-0.066	[-0.44]
Age:										
Firm Age (VW)	-0.047	[-1.18]	0.031	[0.59]	0.150	[2.30]	0.118	[0.98]	0.167	[1.25]
Age tilt	0.022	[0.92]	0.055	[1.69]	0.075	[2.46]	0.129	[2.16]	0.210	[3.01]
Issuance:										
% Issuers	0.051	[1.39]	0.064	[1.61]	0.122	[2.17]	0.105	[1.50]	0.118	[1.04]
Fundamentals vs. Price:										
Book to Market (VW)	-0.122	[-2.30]	-0.128	[-2.36]	-0.148	[-1.75]	-0.127	[-1.13]	-0.122	[-0.80]
Sales Growth	0.093	[0.69]	0.039	[0.63]	0.061	[1.04]	0.437	[1.97]	0.294	[0.90]
CAPE	6.286	[2.92]	6.384	[2.82]	6.350	[1.87]	7.662	[1.38]	15.276	[3.30]
Acceleration:										
Acceleration	0.114	[1.70]	0.238	[3.14]	0.323	[2.99]	0.024	[0.16]	-0.087	[-0.56]
Joint F-stat	2.13		2.56		3.37		4.29		5.67	
p-value (Prob>F)	0.018		0.004		0.000		0.000		0.000	

[Appendix Table 5 Continued]

Panel B: International Sectors 1987-2012

	2-yr Ret>50%		2-yr Ret>75%		2-yr Ret>100%		2-yr Ret>125%		2-yr Ret>150%	
	Difference	**[*t*]**	**Difference**	**[*t*]**	**Difference**	**[*t*]**	**Difference**	**[*t*]**	**Difference**	**[*t*]**
Past 2-year Return	0.255	[2.40]	0.294	[2.22]	0.532	[2.98]	0.706	[3.16]	0.515	[1.85]
Excess Past 2-year Return	0.123	[1.67]	0.189	[2.04]	0.282	[2.80]	0.259	[2.01]	0.163	[1.10]
Turnover and Volatility:										
Volatility (VW)	0.141	[6.78]	0.119	[4.25]	0.154	[5.50]	0.145	[4.16]	0.124	[2.50]
Volatility (VW)- 1yr-Δ	0.041	[1.79]	0.022	[0.65]	0.061	[1.76]	0.054	[1.24]	0.097	[1.70]
Turnover (VW)	-0.013	[-0.53]	-0.018	[-0.57]	0.015	[0.44]	0.023	[0.62]	0.010	[0.20]
Turnover (VW)- 1yr-Δ	0.016	[1.11]	0.009	[0.44]	0.021	[0.93]	0.034	[1.22]	0.012	[0.40]
Age:										
Firm Age (VW)	-0.072	[-2.68]	-0.044	[-1.22]	-0.087	[-2.25]	-0.081	[-1.80]	-0.141	[-2.43]
Age tilt	0.266	[1.29]	0.485	[1.53]	0.848	[2.25]	1.003	[2.00]	1.465	[1.88]
Issuance:										
% Issuers	0.100	[1.32]	0.075	[0.89]	0.147	[1.57]	0.173	[1.57]	0.099	[0.86]
Fundamentals vs. Price:										
Book to Market (VW)	-0.222	[-5.37]	-0.137	[-3.43]	-0.174	[-4.02]	-0.191	[-3.64]	-0.212	[-4.40]
Sales Growth	0.011	[0.53]	0.023	[0.95]	0.032	[1.10]	0.046	[1.53]	0.055	[1.71]
CAPE	7.576	[5.83]	8.932	[5.20]	10.882	[4.63]	12.427	[4.52]	14.979	[4.73]
Acceleration:										
Acceleration	0.375	[4.47]	0.546	[4.34]	0.806	[5.18]	0.979	[4.96]	0.755	[3.00]
Joint F-stat	9.23		6.87		5.22		4.90		4.52	
p-value (Prob>F)	0.003		0.000		0.000		0.000		0.000	

Appendix Table 6. Betting Against Bubbles Using Bubble Features: Trading Strategy Returns

The table reports the performance of trading strategies based on the features in Table 4 and 5. "Hold" strategy denotes the benchmark for portfolio evaluation in which we hold the industry following a price run-up. Alternatively, the investor may choose to exit the industry and hold another asset, either the value-weighted market return or the risk-free rate. The "sell" signal for each strategy is to exit the industry if the feature reported in column (1) is greater (or smaller for special cases) than the corresponding mean of among crashed price run-ups. Column 2 reports the number of price run-ups identified as potential bubbles by the strategy. Column 3 reports the percentage of the identified run-ups followed by a subsequent crash. Column 4-9 report the raw returns of the strategy at the end of 1-, 2- and 4-year. Column 10-15 report the net of benchmark returns and the corresponding *t*-statistics in parenthesis. All numbers in bold are the returns of strategies beating the benchmark at 90% significance level. In Panel A, we specifically set "sell" signal as "smaller than mean" for book-to-market ratio in the spirit of Table 4. *t*-statistics are based on clustered standard errors by calendar year. In Panel B, we set "sell" signal as "smaller than mean" for book-to-market ratio and firm age in the spirit of Table 5. *t*-statistics in Panel B are based on standard errors clustered by sector and calendar year. The seemingly unrelated regressions (SUR) test the joint significance of net of benchmark returns in all trading strategies and output the F-stat and the corresponding *p*-values in the bottom two rows of both panels.

Panel A: US Industries 1928-2012

Strategy	# Price Run-ups Identified as potential bubbles	% Identified run-ups with a subsequent crash	Raw Returns						Net of Benchmark Returns					
			Switch to Market when "Bubble" Identified			Switch to Risk-free when "Bubble" Identified			Switch to Market when "Bubble" Identified			Switch to Risk-free when "Bubble" Identified		
			1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Hold = Benchmark	0	0	7%	0%	5%	7%	0%	5%	0%	0%	0%	0%	0%	0%
Exit based on														
Price Run-up Only	40 (All)	53%	3%	0%	16%	5%	10%	20%	-5% [-0.90]	0% [0.04]	11% [0.98]	-3% [-0.35]	10% [0.89]	15% [1.13]
Price Run-up +														
Volatility	20	60%	6%	2%	13%	7%	8%	17%	-2% [-0.51]	3% [0.53]	8% [1.22]	0% [-0.02]	8% [1.21]	**12%** **[1.68]**
Volatility 1yr-Δ	11	91%	10%	5%	10%	11%	10%	17%	3% [1.48]	5% [1.43]	5% [1.16]	4% [1.42]	**10%** **[1.88]**	12% [1.67]
Turnover	19	47%	4%	-4%	6%	4%	-2%	5%	-3% [-0.75]	-4% [-0.58]	1% [0.07]	-3% [-0.54]	-2% [-0.23]	0% [-0.01]
Turnover 1yr-Δ	18	56%	7%	-1%	8%	11%	6%	14%	0% [-0.11]	-1% [-0.15]	3% [0.32]	4% [0.84]	6% [0.77]	9% [0.84]
Age	15	80%	8%	4%	12%	12%	11%	20%	1%	5%	8%	4%	**12%**	**16%**

Strategy	# Price Run-ups Identified as potential bubbles	% Identified run-ups with a subsequent crash	Raw Returns						Net of Benchmark Returns					
			Switch to Market when "Bubble" Identified			Switch to Risk-free when "Bubble" Identified			Switch to Market when "Bubble" Identified			Switch to Risk-free when "Bubble" Identified		
			1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Age Tilt	10	70%	6%	2%	11%	7%	7%	15%	[0.49] -1%	[1.23] 3%	[1.57] **6%**	[1.21] 0%	**[2.04]** 7%	**[2.10]** **10%**
%Issuer	13	69%	7%	0%	5%	7%	0%	5%	[-0.53] 1%	[0.87] 4%	**[1.92]** **9%**	[-0.05] 3%	[1.52] 10%	**[2.27]** 13%
Book-to-Market	9	67%	7%	1%	6%	7%	4%	8%	[0.72] -1%	[1.17] 1%	**[2.34]** 1%	[1.04] 0%	[1.64] 4%	[1.61] 4%
Sales Growth	20	52%	2%	-1%	7%	0%	2%	4%	[-0.28] -6%	[0.26] -1%	[0.19] 3%	[-0.09] -7%	[0.77] 2%	[0.47] -1%
CAPE	11	82%	5%	1%	9%	7%	8%	19%	[-1.45] -3%	[-0.14] 1%	[0.26] 4%	[-1.39] 0%	[0.25] 9%	[-0.08] **15%**
Acceleration	17	76%	8%	4%	14%	9%	11%	22%	[-0.91] 0%	[0.36] 5%	[1.40] 9%	[-0.02] 2%	[1.27] **12%**	**[1.87]** **17%**
									[0.16]	[1.15]	[1.52]	[0.47]	**[1.84]**	**[2.06]**
Joint F-stat									[2.15]	[2.20]	[1.78]	[2.12]	[1.94]	[1.81]
p-value (Prob>F)									0.017	0.014	0.056	0.018	0.033	0.050

[Appendix Table 6 Continued]

Panel B: International Sectors 1987-2012

Strategy	# Price Run-ups Identified as potential bubbles	% Identified run-ups with a subsequent crash	Raw Returns						Net of Benchmark Returns					
			Switch to Market when "Bubble" Identified			Switch to Risk-free when "Bubble" Identified			Switch to Market when "Bubble" Identified			Switch to Risk-free when "Bubble" Identified		
			1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Hold = Benchmark	0	0	0%	6%	39%	0%	6%	39%	0%	0%	0%	0%	0%	0%
Exit based on														
Price Run-up Only	107 (All)	50%	-2%	6%	30%	3%	5%	9%	-2% [-0.72]	0% [-0.01]	-9% [-0.80]	3% [0.52]	-1% [-0.12]	-30% [-1.66]
Price Run-up +														
Volatility	31	84%	3%	11%	38%	10%	18%	39%	2% [1.45]	**4%** **[2.15]**	-2% [-0.26]	**9%** **[2.47]**	**12%** **[2.58]**	0% [-0.03]
Volatility 1yr-**Δ**	42	62%	4%	13%	40%	5%	12%	26%	**3%** **[1.71]**	**6%** **[2.33]**	-2% [-0.34]	5% [1.55]	6% [1.23]	-13% [-1.03]
Turnover	53	49%	2%	11%	45%	5%	10%	36%	1% [0.58]	5% [1.61]	7% [0.92]	5% [1.38]	4% [0.62]	-1% [-0.07]
Turnover 1yr-**Δ**	45	51%	1%	9%	39%	3%	9%	38%	0% [-0.09]	1% [0.36]	-3% [-0.43]	2% [0.44]	0% [0.08]	-4% [-0.42]
Age	46	61%	-2%	2%	31%	-1%	-3%	13%	1% [0.61]	**5%** **[2.09]**	1% [0.18]	5% [1.53]	7% [1.43]	-3% [-0.25]
Age Tilt	30	60%	-1%	8%	36%	2%	9%	32%	-2% [-0.89]	1% [0.60]	-3% [-0.54]	0% [0.08]	1% [0.25]	-9% [-0.84]
%Issuer	31	61%	3%	10%	44%	7%	13%	43%	2% [1.44]	3% [1.21]	5% [1.53]	6% [2.53]	5% [1.30]	3% [0.78]
Book-to-Market	46	65%	3%	12%	40%	6%	14%	35%	-2% [-0.76]	-1% [-0.21]	5% [1.20]	4% [0.89]	9% [1.65]	12% [2.10]
Sales Growth	48	60%	0%	6%	36%	4%	6%	29%	-1% [-0.31]	-1% [-0.19]	-5% [-0.64]	4% [0.93]	1% [0.14]	-9% [-0.78]
CAPE	21	76%	4%	10%	45%	8%	16%	50%	**3%** **[2.17]**	**3%** **[1.94]**	**4%** **[1.86]**	**8%** **[3.09]**	**8%** **[2.51]**	**8%** **[2.57]**
Acceleration	22	82%	0%	9%	37%	3%	14%	35%	-1% [-0.54]	2% [1.42]	-3% [-0.48]	2% [0.81]	**6%** **[1.89]**	-6% [-0.53]

Strategy	# Price Run-ups Identified as potential bubbles	% Identified run-ups with a subsequent crash	Raw Returns						Net of Benchmark Returns					
			Switch to Market when "Bubble" Identified			Switch to Risk-free when "Bubble" Identified			Switch to Market when "Bubble" Identified			Switch to Risk-free when "Bubble" Identified		
			1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret	1-yr ret	2-yr ret	4-yr ret
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Joint F-stat									[2.36]	[2.47]	[1.59]	[2.68]	[2.29]	[2.10]
p-value (Prob>F)									0.007	0.005	0.095	0.002	0.009	0.018