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ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rael20

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To cite this article: Phuong Lan Le & Tan Do (30 Jun 2024): Heterogeneity in bubble experience across firms: an examination of the tech bubble, Applied Economics Letters, DOI: 10.1080/13504851.2024.2372405

To link to this article: https://doi.org/10.1080/13504851.2024.2372405

Published online: 30 Jun 2024.

APPLIED ECONOMICS LETTERS
https://doi.org/10.1080/13504851.2024.2372405

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Heterogeneity in bubble experience across firms: an examination of the tech bubble

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ABSTRACT

We study heterogeneity in bubble experience across individual stocks. Applying the date-stamping technique and using the tech bubble in late 1990s as our laboratory, we find that tech firms vary in whether, when and how long they experience bubbles. In multivariate regressions, we find that bubbles are more likely to happen and they on average last longer in more liquid stocks, in smaller firms, in fast-growing firms and in firms with higher ownership by institutional non-blockholders rather than blockholders.

KEYWORDS

Stock market; bubble; heterogeneity; tech bubble

JEL CLASSIFICATION

G12; G14; G41

Introduction

Date-stamping procedure developed by Phillips, Wu, and Yu (2011, 2015) has spurred a big strand of literature on financial market bubbles. While many studies apply this technique to document bubbles in long *time series* of stock indexes, little is known about how bubbles manifest at the constituent stock level. In this paper, we study the *cross-sectional variation* in bubble experience across individual stocks. Specifically, we examine how tech firms differ in whether, when and how long they experience bubbles during the tech (dot com) bubble in the late 1990s. Its sheer magnitude and its causes likely varying across firms make it a perfect setting to answer our question.

Theories offer several explanations for what causes bubbles, namely limits to arbitrage due to irrational noise traders (de Long et al. 1990), synchronization risk (Abreu and Brunnermeier 2002, 2003), or heterogeneous beliefs generated by overconfidence (Scheinkman and Xiong 2003). Shiller (2000) propose a number of specific factors that contribute to the tech bubble, some of which vary across firms, including the new information technology, analysts' optimism, the growth of mutual funds, lower transaction costs among others. As firms differ in one or some of those dimensions under the above theories and conjectures, we expect that they would have varying bubble experience.

Indeed, applying Phillips et al. (2015)'s method to a sample of tech firms from 1997 to 2002, we document heterogeneity in incidence, duration and timing of bubbles across firms. For example, within the tech industry, more than one fifth of firms in our sample did not experience any bubbles between 1997–2002. Among those that did, the amount of time experiencing bubbles varies substantially, ranging from one week per year to virtually a -whole year. Timing also differs among firms with a significant number of firms experiencing bubbles as early as mid-1997 and a peak in early 2000. To the best of our knowledge, we are the first to study bubbles at the individual stock level and document heterogeneity in bubble experience across firms, contributing to the literature on financial market bubbles (e.g. Do and Le 2024; Phillips, Wu, and Yu 2011; Zhao, Wen, and Li 2021).

We next explore which firm characteristics are correlated with such bubble experience. Using multivariate regressions, we find that bubbles are more likely to happen and they on average last longer in smaller firms, in fast-growing firms and in more liquid stocks. Analyst coverage is negatively correlated with the time length experiencing bubbles. This result suggests that this information intermediary may help stock prices converge more quickly to its fundamental. Lastly, the bubble experience is positively correlated with institutional investors

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who each hold a small share of ownership but not with institutional blockholders who are typically long-term investors. This finding is consistent with and complements previous studies on the role of mutual funds' herding (Dass, Massa, and Patgiri 2008) and hedge fund's aggressive trading (Griffin et al. 2011) in the tech bubble.

Method and data

Bubble identification

We follow the procedure in Phillips et al. (2015) to identify bubbles and their duration. Central to this test is the BSADF statistic, defined as the sup value of an ADF statistic sequence:

$$BSADF_{r_1}(r_0) = \sup_{r_1 \in [0, r_2 - r_1]} ADF_{r_1}^{r_2} \quad (1)$$

In our application, the start (end) of a bubble is defined as the first observation whose BSADF statistic exceeds (falls below) the 95% critical value. We apply this procedure to the weekly stock price series of each firm.

Multivariate regressions

We are also interested in which firm characteristics are correlated with bubble incidence and bubble duration. Specifically, we examine: (i) firm fundamentals such as size, growth, profitability and financial leverage; (ii) stock characteristics such as return, volatility and liquidity; and (iii) market participants including institutional ownership and financial analyst coverage.

$$\begin{aligned} Bubble_{i,t}(N\_weeks_{i,t}) = {} & \alpha_0 + \beta_1 Size_{i,t} + \beta_2 MTB_{i,t} \\ & + \beta_3 ROA_{i,t} + \beta_4 Leverage_{i,t} \\ & + \beta_5 Return_{i,t} \\ & + \beta_6 Volatility_{i,t} \\ & + \beta_7 Ln\_spread_{i,t} \\ & + \beta_8 Ln\_analysts_{i,t} \\ & + \beta_9 InstOwnership_{i,t} + \delta_t \\ & + \varepsilon_{i,t} \end{aligned} \quad (2)$$

When the dependent variable is *Bubble*, equal to 1 if firm *i* has at least one week of bubbles in year *t*, we employ a logistic regression to estimate this model. When it is *N weeks*, the number of weeks of bubbles in firm *i*'s stock in year *t*, we employ Poisson pseudo-maximum-likelihood estimator.

Data and sample

As explained in the introduction, we use the tech bubble as our laboratory. Similar to Griffin et al. (2011), we focus on tech firms defined as those with SIC between 7370 and 7379 from 1997 to 2002. We collect data from CRSP, Compustat, Thomson Reuters and IBES. Merging these data yields a final sample of 1,925 observations corresponding to 471 firms.

Results

We first document bubble heterogeneity across tech firms during the dot com bubble. Figure 1 illustrates bubble identification in three example firms. XIOX Corp experienced.

This figure plots bubbles in the stock price series of three example firms. Bubbles, identified using Phillips et al. (2015) procedure on weekly price series, are periods when the BSADF statistic exceeds the 95% critical value.

49 weeks of bubbles in 1999, followed by a short-lived turbulence episode in 2001. GO2NET Inc had 6 weeks and 11 weeks of bubbles in 1998 and 1999, respectively. By contrast, the Phillips et al. (2015) procedure detects no explosive behaviour in SunGard Data Systems Inc's stock prices during the sample period. These examples demonstrate the heterogeneity in bubble incidence, during and timing across tech firms.

This figure plots distribution of bubble time experienced by firms in a given year conditional on bubble occurrence. On the horizontal axis is the number of weeks of bubbles, the vertical axis the number of firms.

Formally, we find that 361 firms experienced bubbles at some point during our sample period from 1997–2002 while 110 firms experienced none. This corresponds to 612 firmyear observations with bubbles, accounting for 31.8% of the sample. Firms differ not just in whether they experienced bubbles but also time length and timing. Figure 2 depicts the distribution of the

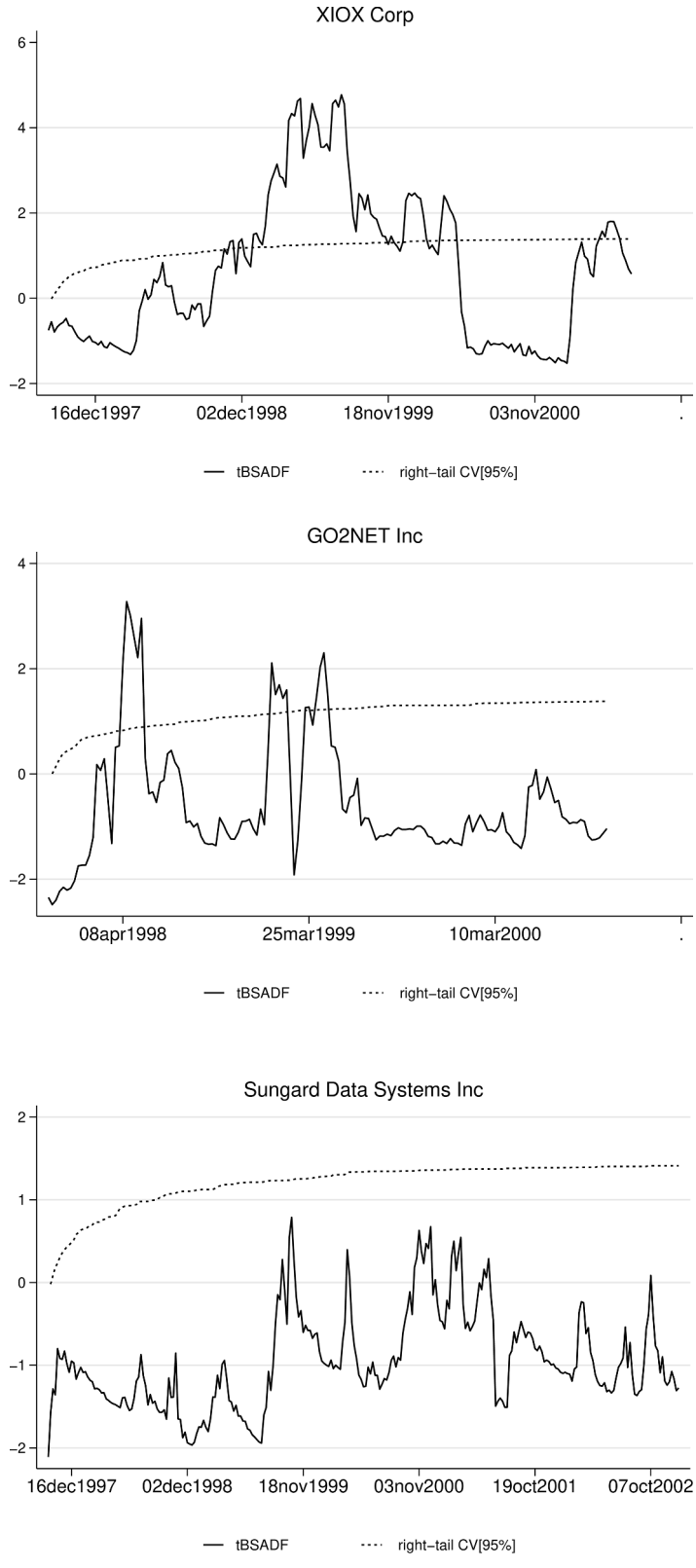

Figure 1. Date-stamping bubbles of three example firms.

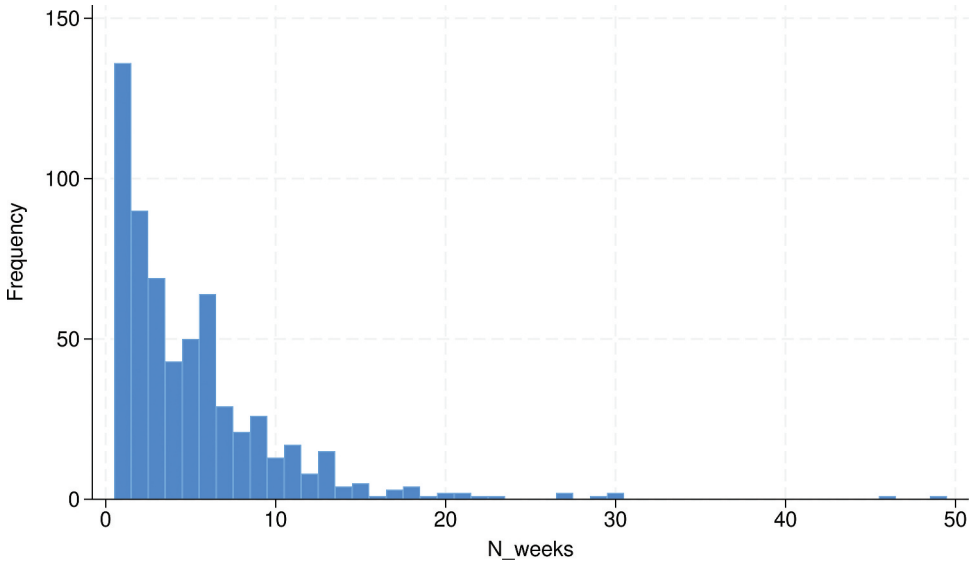

Figure 2. Distribution of bubble time experienced by firms in a given year.

bubble time experienced by firms in a given year for these 612 observations. It shows a significant variation in the number of weeks of bubbles across firm-years with an average of 5.2 weeks. The top 10% of firm-years experienced at least 11 weeks of bubbles with the longest being virtually the whole year (XIOX Corp – 49 weeks).

This figure plots the number of firms subject to bubbles week by week. On the horizontal axis is the week time, the vertical axis the number of firms.

Figure 3 demonstrates the variation in bubble timing by displaying the number of firms subject to bubbles week by week. We can see that there was already quite substantial number of firms experiencing bubbles by the end of 1997. The figure climbed rapidly towards the end of 1999, peaking at more than 100 firms in early 2000 before dropping dramatically to an unnoticeable level afterwards. This is in line with the boom and burst of the stock market when the Nasdaq index rose 86%

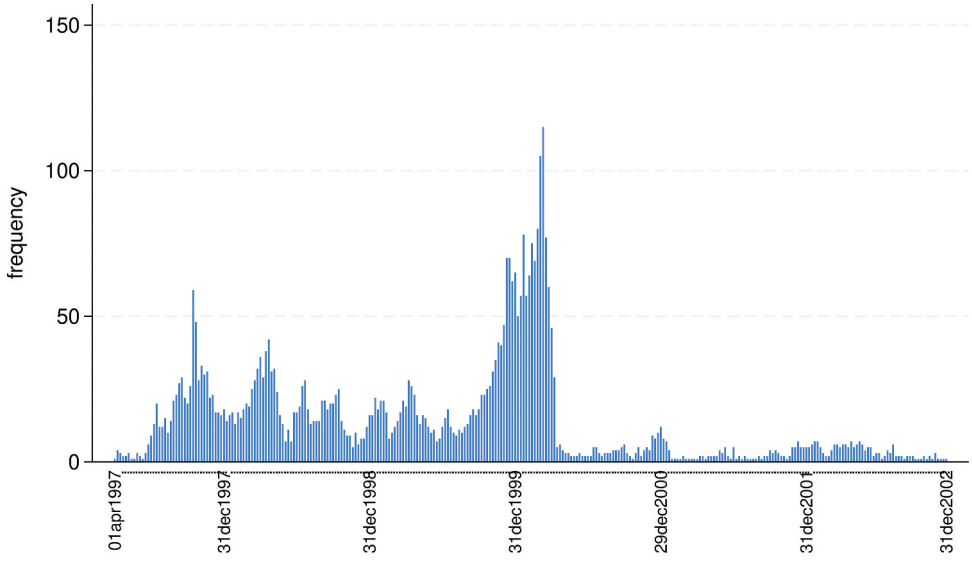

Figure 3. Distribution of bubble timing.

Table 1. Summary statistics.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	N	mean	sd	min	p5	p25	p50	p75	p95	max
Bubble	1,925	0.318	0.466	0.000	0.000	0.000	0.000	1.000	1.000	1.000
N_weeks	1,925	1.660	3.813	0.000	0.000	0.000	0.000	1.000	9.000	49.000
Size	1,925	4.936	2.027	0.720	1.804	3.463	4.806	6.333	8.429	10.391
MTB	1,925	2.789	2.295	0.537	0.747	1.292	2.016	3.404	7.880	12.645
ROA	1,925	−0.153	0.423	−2.392	−0.924	−0.215	−0.008	0.071	0.174	0.272
Leverage	1,925	0.100	0.167	0.000	0.000	0.000	0.011	0.137	0.463	0.840
Return	1,925	0.177	1.176	−0.938	−0.829	−0.498	−0.141	0.400	2.130	6.831
Volatility	1,925	0.951	0.420	0.310	0.445	0.668	0.860	1.140	1.717	2.670
Ln_spread	1,925	1.181	0.652	0.085	0.226	0.655	1.124	1.631	2.348	2.838
Ln_analysts	1,925	1.237	0.932	0.000	0.000	0.693	1.179	1.910	2.876	3.676
InstOwnership	1,925	0.330	0.273	0.000	0.002	0.081	0.272	0.536	0.832	0.937

This table reports summary statistics. The sample consists of 1,925 firm-year observations from 471 US tech firms between 1997–2002.

Table 2. Bubbles experience and firm characteristics.

	(1)	(2)	(3)	(4)
Variables	Bubble	N_weeks	Bubble	N_weeks
Size	−0.260***	−0.220***	−0.304***	−0.243***
	(0.069)	(0.069)	(0.068)	(0.069)
MTB	0.054*	0.064***	0.051*	0.061***
	(0.030)	(0.021)	(0.030)	(0.021)
ROA	0.235	0.185	0.215	0.166
	(0.165)	(0.209)	(0.163)	(0.207)
Leverage	0.321	−0.183	0.262	−0.233
	(0.339)	(0.326)	(0.339)	(0.332)
Return	0.597***	0.321***	0.598***	0.324***
	(0.080)	(0.034)	(0.080)	(0.034)
Volatility	0.082	−0.105	0.032	−0.140
	(0.169)	(0.227)	(0.168)	(0.229)
Ln_spread	−0.584***	−0.708***	−0.560***	−0.673***
	(0.173)	(0.201)	(0.170)	(0.198)
Ln_analysts	−0.059	−0.175*	−0.119	−0.217**
	(0.104)	(0.090)	(0.107)	(0.095)
InstOwnership	0.773***	0.808***		
	(0.293)	(0.291)		
InstBlock			−0.582	−0.170
			(0.513)	(0.471)
InstSmall			1.908***	1.552***
			(0.455)	(0.450)
Observations	1,925	1,925	1,925	1,925
Year FE	yes	yes	yes	yes
Pseudo R-squared	0.122	0.193	0.127	0.197

This table presents the regression results. In column (1) and (3), the dependent variable is *Bubble*. In columns (2) and (4), the dependent variable is *N weeks*. In columns (3) and (4), *InstOwnership* used in columns (1) and (2) is broken down into *InstBlock* and *InstNonBlock*. All regressions include year fixed effects. Robust standard errors are clustered at the firm level.

in 1999 alone, and peaked on 10 March 2000; then the bubble imploded.[1]

We next explore which firm characteristics explain the documented variation in bubble incidence and duration across firms. Table 1 reporting summary statistics on these characteristics. Table 2 presents the regression results.[2] Column (1) shows that *Bubble* is associated with some fundamentals such as profitability or financial structure. It is, however, significantly negatively correlated with *Size* and *Ln spread* but positively correlated with *MTB*, *Return* and *InstOwnership*.

This suggests that bubbles are more likely to happen in smaller growing firms. Besides, we observe bubbles more often in more liquid stocks (lower bid-ask spread). It might be that higher

[1]See https://www.goldmansachs.com/our-firm/history/moments/2000-dot-com-bubble.html. There is also literature on calendar effects (Bouman and Jacobsen 2002; Do and Le 2016)

[2]Our results are robust to (i) the inclusion of (4-digit) segment fixed effects, (ii) the use of bootstrap or Huber-White standard errors for inference or (iii) the use of the traditional OLS for estimation.

liquidity, i.e. lower trading costs, attracted more investors who drove markets up. The coefficient on *Ln analysts* is negative in both columns but only statistically significant in column (2). This suggests that while analysts, an important information intermediary on financial markets, were not able to stop bubbles from occurring, they seemed to help stock prices converge to its fundamental faster through information production and dissemination (Kelly and Ljungqvist 2012). Lastly, it is intriguing that firms with high institutional ownership are more likely to subject to bubbles.

We examine further this relationship by decomposing it into ownership by institutional blockholders and ownership by smaller institutions. We, therefore, construct two new variables: *InstBlock*, ownership by institutions who each hold at least 5%, and *InstNonBlock*, ownership by institutions who each hold less than 5%. Results in columns (3) and (4) show that only ownership by institutional non-blockholders is significantly positively correlated with the likelihood and the time length of experiencing bubbles while the ownership by institutional blockholders is not. It is possible that institutions holding a small share of ownership are likely frequent traders and hence associated with stock price exuberance, whereas institutional blockholders are typically long-term investors with strong incentives to monitor (Shleifer and Vishny 1986). Indeed, Griffin et al. (2011) find that during the tech bubble, hedge funds were the most aggressive among institutional investors in trading tech stocks. Dass et al. (2008) also find evidence suggesting that herding among mutual fund managers contributed to the tech bubble and managers with low incentives hold relatively more 'bubble' stocks.

Conclusions

We study bubble experience by individual stocks during the tech bubble in late 1990s. Applying Phillips et al. (2015) technique, we document heterogeneity in incidence, duration and timing of bubbles across tech firms, and these differences are linked to firm fundamentals and stock characteristics. Our findings support several conjectures by Shiller (2000) on the causes of the tech bubble. Our approach to bubbles at the individual stock level can be applied by practitioners or academics in other settings, markets and time periods such as the currently debated tech and AI 'bubble'.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research is funded by Foreign Trade University under research programme number [FTURP02-2023-02].

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References

Abreu, D., and M. K. Brunnermeier. 2002. "Synchronization Risk and Delayed Arbitrage." *Journal of Financial Economics* 66 (2–3): 341–360. https://doi.org/10.1016/S0304-405X(02)00227-1.

Abreu, D., and M. K. Brunnermeier. 2003. "Bubbles and Crashes." *Econometrica* 71 (1): 173–204. https://doi.org/10.1111/1468-0262.00393.

Bouman, S., and B. Jacobsen. 2002. "The Halloween indicator,"sell in May and Go away": Another Puzzle." *American Economic Review* 92 (5): 1618–1635. https://doi.org/10.1257/000282802762024683.

Dass, N., M. Massa, and R. Patgiri. 2008. "Mutual Funds and Bubbles: The Surprising Role of Contractual Incentives." *The Review of Financial Studies* 21 (1): 51–99. https://doi.org/10.1093/rfs/hhm033.

de Long, J. B., A. Shleifer, L. H. Summers, and R. J. Waldmann. 1990. "Noise Trader Risk in Financial Markets." *Journal of Political Economy* 98 (4): 703–738. https://doi.org/10.1086/261703.

Do, D. T., and P. L. Le. 2016. "An Empirical Test of Calendar Effects in Vietnam Stock Market." *External Economics Review* 79:28–39.

Do, D. T., and P. L. Le. 2024. "Trading Behaviours During Stock Market Bubbles: Evidence from Vietnam." *Applied Economics Letters* 31 (7): 623–629. https://doi.org/10.1080/13504851.2022.2140759.

Griffin, J. M., J. H. Harris, T. Shu, and S. Topaloglu. 2011. "Who Drove and Burst the Tech Bubble?" *The Journal of Finance* 66 (4): 1251–1290. https://doi.org/10.1111/j.1540-6261.2011.01663.x.

Kelly, B., and A. Ljungqvist. 2012. "Testing Asymmetric-Information Asset Pricing Models." *The*

Review of Financial Studies 25 (5): 1366–1413. https://doi.org/10.1093/rfs/hhr134.

Phillips, P. C., S. Shi, and J. Yu. 2015. "Testing for Multiple Bubbles: Historical Episodes of Exuberance and Collapse in the s&p 500." *International Economic Review* 56 (4): 1043–1078. https://doi.org/10.1111/iere.12132.

Phillips, P. C., Y. Wu, and J. Yu. 2011. "Explosive Behavior in the 1990s Nasdaq: When Did Exuberance Escalate Asset Values?" *International Economic Review* 52 (1): 201–226. https://doi.org/10.1111/j.1468-2354.2010.00625.x.

Scheinkman, J. A., and W. Xiong. 2003. "Overconfidence and Speculative Bubbles." *Journal of Political Economy* 111 (6): 1183–1220. https://doi.org/10.1086/378531.

Shiller, R. J. 2000. *Irrational Exuberance*. 1st ed. Princeton university press.

Shleifer, A., and R. W. Vishny. 1986. "Large Shareholders and Corporate Control." *Journal of Political Economy* 94 (3, Part 1): 461–488. https://doi.org/10.1086/261385.

Zhao, Z., H. Wen, and K. Li. 2021. "Identifying Bubbles and the Contagion Effect Between Oil and Stock Markets: New Evidence from China." *Economic Modelling* 94:780–788. https://doi.org/10.1016/j.econmod.2020.02.018.

Appendix

Table A1. Bubbles experience and firm characteristics: Segment FEs.

	(1)	(2)	(3)	(4)
Variables	Bubble	N weeks	Bubble	N weeks
Size	−0.311***	−0.229***	−0.350***	−0.249***
	(0.072)	(0.072)	(0.073)	(0.072)
MTB	0.057*	0.064***	0.053*	0.060***
	(0.031)	(0.022)	(0.031)	(0.022)
ROA	0.260	0.179	0.237	0.158
	(0.166)	(0.212)	(0.164)	(0.211)
Leverage	0.183	−0.216	0.128	−0.265
	(0.343)	(0.331)	(0.343)	(0.337)
Return	0.617***	0.323***	0.618***	0.326***
	(0.081)	(0.034)	(0.081)	(0.034)
Volatility	0.194	−0.054	0.137	−0.090
	(0.174)	(0.238)	(0.173)	(0.241)
Ln spread	−0.757***	−0.757***	−0.724***	−0.719***
	(0.184)	(0.212)	(0.183)	(0.211)
Ln analysts	−0.054	−0.179*	−0.115	−0.220**
	(0.106)	(0.093)	(0.110)	(0.098)
InstOwnership	0.737**	0.829***		
	(0.305)	(0.297)		
InstBlock			−0.587	−0.120
			(0.528)	(0.487)
InstSmall			1.850***	1.548***
			(0.470)	(0.458)
Observations	1,925	1,925	1,925	1,925
Year FEs	yes	yes	yes	yes
Segment FEs	yes	yes	yes	yes
Pseudo R-squared	0.129	0.201	0.133	0.204

This table presents the results of a robustness test in which we include segment (4-digit SIC) fixed effects in the models.

Table A2. Bubbles experience and firm characteristics: Alternative standard errors.

	(1)	(2)	(3)	(4)
Variables	Bubble	N weeks	Bubble	N weeks
Size	−0.260***	−0.220***	−0.304***	−0.243***
	(0.077)	(0.071)	(0.077)	(0.072)
MTB	0.054*	0.064***	0.051*	0.061***
	(0.030)	(0.023)	(0.030)	(0.023)
ROA	0.235	0.185	0.215	0.166
	(0.144)	(0.177)	(0.141)	(0.175)
Leverage	0.321	−0.183	0.262	−0.233
	(0.304)	(0.303)	(0.312)	(0.312)
Return	0.597***	0.321***	0.598***	0.324***
	(0.089)	(0.035)	(0.088)	(0.035)
Volatility	0.082	−0.105	0.032	−0.140
	(0.179)	(0.209)	(0.182)	(0.211)
Ln spread	−0.584***	−0.708***	−0.560***	−0.673***
	(0.199)	(0.188)	(0.192)	(0.185)
Ln analysts	−0.059	−0.175*	−0.119	−0.217**
	(0.107)	(0.094)	(0.110)	(0.098)
InstBlock			−0.582	−0.170
			(0.546)	(0.450)
InstSmall			1.908***	1.552***

(*Continued*)

Table A2. (Continued).

	(1)	(2)	(3)	(4)
Variables	Bubble	N weeks	Bubble	N weeks
			(0.423)	(0.458)
InstOwnership	0.773***	0.808***		
	(0.272)	(0.281)		
Observations	1,925	1,925	1,925	1,925
Year FE	yes	yes	yes	yes
Pseudo R-squared	0.122	0.193	0.127	0.197

This table presents the results of a robustness test in which we use the alternative standard errors for inference. Instead of clustered standard errors reported in the main results, columns (1) and (3) report bootstrap standard errors while columns (2) and (4) report the Huber-White robust standard errors.

Table A3. Bubbles experience and firm characteristics: OLS.

	(1)	(2)	(3)	(4)
Variables	Bubble	Ln – weeks	Bubble	Ln – weeks
Size	−0.045***	−0.086***	−0.054***	−0.100***
	(0.012)	(0.021)	(0.012)	(0.022)
MTB	0.012**	0.027**	0.011**	0.026**
	(0.006)	(0.011)	(0.006)	(0.011)
ROA	0.035	0.063	0.031	0.057
	(0.027)	(0.048)	(0.026)	(0.048)
Leverage	0.056	0.011	0.045	−0.007
	(0.063)	(0.106)	(0.062)	(0.106)
Return	0.110***	0.218***	0.110***	0.219***
	(0.011)	(0.023)	(0.011)	(0.023)
Volatility	0.019	0.028	0.009	0.011
	(0.032)	(0.062)	(0.032)	(0.062)
Ln spread	−0.101***	−0.218***	−0.098***	−0.215***
	(0.030)	(0.054)	(0.029)	(0.054)
Ln analysts	−0.009	−0.031	−0.020	−0.048
	(0.019)	(0.035)	(0.019)	(0.036)
InstOwnership	0.141***	0.300***		
	(0.054)	(0.107)		
InstBlock			−0.110	−0.129
			(0.092)	(0.169)
InstSmall			0.349***	0.638***
			(0.083)	(0.163)
Observations	1,925	1,925	1,925	1,925
R-squared	0.143	0.181	0.148	0.185
Year FEs	yes	yes	yes	yes

This table presents the results of a robustness test in which we use the traditional OLS for estimation. For this reason, the dependent variable in column (2) and (4) need log-transformation of the original count data.