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Venture Capital Backing and Overvaluation: Evidence from the High-Tech Bubble

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Abstract

We investigate the association between venture capital (VC) backing and the likelihood of firm overvaluation in the high-tech bubble period. We find strong evidence that a VC-backed firm is more likely than a non-VC-backed firm to be overvalued during the bubble period. A further investigation suggests that such an association exists only for VC-backed firms that have gone public recently and VC-backed firms over which venture capitalists (VCs) have high ownership or control. But outside the bubble period, all the differences in overvaluation between VC-backed and non-VC-backed firms disappear. Our findings provide additional evidence supporting VC opportunism in boom periods.

Keywords: venture capital, overvaluation, bubble

JEL Classfications: G14, G24, G31, G32

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1. Introduction

Venture capital (VC) plays a dominant role in financing startups in high-tech industries (Sahlman, 1990; Kaplan and Stromberg, 2003; Gompers, Kovner, Lerner, and Scharfstein, 2008). The literature indicates that, besides financing, venture capitalists (VCs) are extensively involved in a number of value-adding activities. For example, they sit on the boards of directors, hire key executives, formulate strategies and modernize firms (Barry, Muscarella, Peavy, and Vetsuypens, 1990; Hellmann and Puri, 2002; Baker and Gompers, 2003; Bottazzi, Rin, and Hellmann, 2008; Campbell and Frye, 2009; Yung, 2009; Deli and Santhanakrishnan, 2010; Boulton, 2011). VCs' active involvement in their chosen portfolios has been shown in theory to reduce information asymmetry and agency problems (Admati and Pfleiderer, 1994; Bergemann and Hege, 1998; Neher, 1999; Casamatta, 2003; Wang and Zhou, 2004; Dessi, 2005) and in empirical analysis to create public companies (Barry, Muscarella, Peavy, and Vetsuypens, 1990), spur innovations (Kortum and Lerner, 2000), improve information quality (Morsfield and Tan, 2006) and enhance performance (Hochberg, Ljungqvist, and Lu, 2007; Gompers, Kovner, Lerner, and Scharfstein, 2008; Bottazzi, Rin, and Hellmann, 2008; Nahata, 2008).

However, the value-added role of VCs is dependent on market conditions (Kortum and Lerner, 2000; Cumming and MacIntosh, 2001; Gompers and Lerner, 2002; Kanniainen and Keuschnigg, 2003; Cumming and MacIntosh, 2004; Cumming, Fleming, and Schwienbacher, 2005; Cumming, 2006). Moreover, VCs have also been shown to be opportunistic during periods of asset bubbles. Lerner (1994) documents that VC-backed firms go public when equity valuations are high and conduct private financings when equity valuations are low. Gompers and Lerner (1998) find that VC distributions occur after substantial increases in share value, which leads to a substantial price reaction immediately before and after the sales event. Gompers, Kovner, Lerner and Scharfstein (2008) suggest that VCs react positively to public market signals as proxied by industry Tobin-Q or IPO activity, and that VCs with more industry experience react more positively. As suggested by Cumming and MacIntosh (2004), many immature firms take to the market during boom periods with run-ups of IPO exits and IPO valuations. Also, in boom periods, VCs switch their investment away from early-stage to later-stage firms, employ less due diligence, engage in sub-optimal contracting, provide less

monitoring and strategic advice, and perform fewer and less-effective staged financings. Gompers (1996) finds that IPOs backed up by young VCs are younger and more underpriced than those backed up by established VCs. Lee and Wahal (2004) extend the study of Gompers (1996) and find that VC-backed IPOs experience larger IPO underpricing than their non-VC-backed counterparts, after controlling for the endogeneity problem in receiving VC financing. Such a difference in first-day returns is much larger during bubble periods than during normal periods. Loughran and Ritter (2004) find that VCs tolerate large underpricing if the underwriter's analyst is expected to be bullish. They reveal that underwriters make use of future hot IPOs to reward VCs who tolerate underpricing, which creates incentives for even more underpricing. Hoberg and Seyhun (2009) indicate that a potential collaboration between VCs and underwriters hurts the firm's valuation. On the one hand, VCs who tolerate large underpricing today may receive long-term marketing support and favorable analyst reports from collaborating underwriters, allowing them to exit at relatively high prices later. On the other hand, collaborating underwriters may receive repeat business and more profits from distributing underpriced shares. However, exits by these VCs are typically followed by large negative abnormal returns, leading to an inverse-U-shaped price pattern centered on the lockup expiration date. The bubble period of 1998–2000 explains much of this effect.

We are interested in VC opportunism during boom periods. We investigate this opportunism by identifying an association between VC backing and firm overvaluation in different periods. Given the fact that VCs' profitability is highly related to equity market conditions (Ljungqvist and Richardson, 2003; Cumming and MacIntosh, 2004; Cochrane, 2005; Kaplan and Schoar, 2005), VCs have incentives to take advantage of a bubble. We expect that it is more likely for a VC-backed firm, especially one that has recently gone public, to be overvalued during bubble periods than during normal periods. Further, this opportunistic behavior should be more prominent for VCs with high ownership and control over their portfolio firms. The high-tech bubble during 1998–2000 provides a good setting to investigate this problem. The NASDAQ index rose rapidly during the late 1990s and peaked in March 2000. The high-tech bubble, as the name suggests, is closely related to high-tech firms which are the focus of VC investments. The context is perfect for investigating VC opportunism. During this so-called internet or high-tech bubble period, many early-stage high-tech firms achieved

extraordinary market valuation with little or no earnings. Our study investigates the association between VC backing and firm overvaluation in and around this internet bubble period.

We employ a large sample of 14,364 firm-year observations of firms listed on NASDAQ from the databases of COMPUSTAT, SDC global new issues, Jay Ritter's IPO data, SDC VentureXpert and SEC EDGAR. We consider three periods: the pre-bubble period of 1994–1997, the bubble period of 1998–2000, and the post-bubble period of 2001–2004. We focus on the question of whether or not VC-backed firms are more likely to be overvalued during the bubble period than during other periods. From our regression analysis, we find that a VC-backed firm is more likely than a non-VC-backed firm to be overvalued in the bubble period after controlling for market- and firm-level characteristics, as well as the year and industry fixed effects. However, this relationship is only significant in the bubble period (1998–2000) and is generally insignificant in the pre- and post-bubble periods. By decomposing our sample into two subsamples with one containing recently public firms and the other containing seasoned public firms based on the time since IPO, we further find that the association between VC backing and the likelihood of overvaluation during the bubble period is only present in recently public firms, consistent with the evidence that VCs exit from the firms they back several years after the corresponding IPOs. Further analysis on VCs' ownership and control provides evidence that VCs are more likely to ride the bubble if they have more ownership and control over the recently public firms they back. We will deal with the endogeneity problem arising from omitted variables in a two-stage probit model.

Our main contribution to the literature is that we provide further firm-level evidence on the changes in VC behavior under different market conditions. Although prior literature suggests that the extent to which VC behavior changes over the business cycle depends on the extent to which IPOs are overvalued during boom periods, there was a lack of direct evidence on the difference in the likelihood of being overvalued between VC-backed and non-VC-backed firms. Our study tries to address this gap in the literature. Our study also contributes to the literature on the behavior of financial institutions in a bubble period, as discussed by Brunnermeier and Nagel (2004), Sharma, Easterwood and Kumar (2006), Gonzalez and James (2007), Dass, Massa and Patgiri (2008), Bradley, Jordan and Ritter (2008) and Greenwood and Nagel (2009).

The remainder of this paper is organized as follows. Section 2 develops hypotheses. Section 3 describes research design. Sections 4 and 5 respectively provide empirical analyses and robustness checks. Section 6 concludes the paper.

2. Hypothesis development

VC investment activity fluctuates dramatically over time and appears to be closely tied to valuation in public markets (Cumming and MacIntosh, 2004; Gompers, Kovner, Lerner, and Scharfstein, 2008). During a bubble period, investors' decisions about what stocks to buy may not be based on what they think the stocks are worth, but on what others think the stocks are worth. Valuations become divorced from fundamentals. Profit-driving incentives make it rational for VCs to ride the bubble. In addition, as short-term owners, VCs benefit from overvaluation but bear little cost from it. Since VC investments are usually not compensated by dividends, the bulk of a venture capitalist's profits comes from IPOs. As expected, the returns of VC funds appear to be highly correlated with the returns from the stock market. Cumming and MacIntosh (2004) indicate that the average return on VC investments in the U.S. was approximately 20% in 1998, 150% in 1999, 35% in 2000, and -10% in 2001. Further, there is also a rapid increase in VC fund inflows, which is no doubt driven by the increase in VC profitability. The capital under the management of VC funds grew from $2 billion in 1978 to $200 billion in 1998. Due to "too much money chasing too few deals", the competition for a limited number of attractive investments is responsible for rising stock prices. Gompers and Lerner (2000) provide strong evidence that increasing capital inflows have led to higher security prices. This effect is robust to firm characteristics and public market valuations using first differences and instrumental variables.

We are interested in the difference in the likelihood of overvaluation between VC-backed and non-VC-backed firms, and further, whether such a difference is dependent on market conditions. We consider three time periods: the pre-bubble period of 1994–1997, the bubble period of 1998–2000 and the post-bubble of 2001–2004. Based on the prior discussion of VCs' taking advantage of overvalued stocks for profits, we develop our first hypothesis:

Hypothesis 1. *VC-backed firms are more likely than non-VC-backed firms to be overvalued in the bubble period; this difference does not exist in the pre- and post-bubble periods.*

VC funds have short lifecycles of about ten years in general. They usually make investments in the first half of their lives and try to cash out in the second half. The most successful channel for VCs to exit is to take their portfolio firms public and to sell the shares gradually on stock markets or to distribute the shares directly to investors. VCs typically remain actively involved in their portfolio firms within three to four years after IPOs before exiting. Campbell and Frye (2009) provide consistent evidence that differences in governance and monitoring between VC-backed and non-VC-backed firms disappear four years after IPOs. Since VCs exit from their portfolio firms within a few years, the association between VC backing and the likelihood of being overvalued stocks should be quite different for recently and seasoned public firms. We expect this association to be driven by recently public firms instead of their seasoned counterparts. Hence, our second hypothesis is stated as:

Hypothesis 2. *The association between VC backing and the likelihood of overvaluation is stronger for recently public firms than for seasoned public firms.*

VCs are usually block shareholders and have powerful control rights over the firms they back, including the rights to put their shares to managers (Sahlman, 1990) and fire managers (Hellmann, 1998). Given our prediction in Hypothesis 2 that, during a bubble, VCs take advantage of overvalued firms that have recently gone public, we further predict that such behavior is more prominent for VCs with high ownership and control over the firms they back. If so, we should find a statistical relationship between VCs' ownership or control and overvaluation during the bubble period. Hence, we state our third hypothesis as follows:

Hypothesis 3. *VC-backed, recently public firms are more likely to be overvalued in the bubble period if the VCs concerned have higher ownership or control over them.*

3. Research design

3.1. The sample

We investigate the association between VC backing and the likelihood of overvaluation. We are also interested in how this association differs between the high-tech bubble period of 1998-2000, and the pre- and post-bubble periods. Our sample period is chosen as

1994–2004. We decompose the sample period into three sub-periods: the pre-bubble period of 1994–1997, the bubble period of 1998–2000, and the post-bubble period of 2001–2004.[1]

Our primary sample of U.S. firms listed on NASDAQ during 1994–2004 is gathered from the COMPUSTAT database. There are 36,468 firm-year observations in our primary sample. To come up with the final sample, we (1) exclude the financial sectors with SIC codes 6000–6999; (2) exclude those observations for which values for overvaluation measurement are missing; (3) drop those firms without the IPO information in the SDC global new issues database and Jay Ritter's IPO data (http://bear.warrington.ufl.edu/ritter/) needed to perform the first-stage regression of the likelihood of receiving VC funding; and (4) exclude those observations for which values for control variables are missing. This selection procedure results in a final sample of 14,364 firm-year observations over the period of 1994–2004. Those firms that had VC financing before IPOs are regarded as VC-backed firms. These firms can be found in the SDC VentureXpert database, which covers more than 90% of all VC investments in the U.S. market (Gompers and Lerner, 2004). The VC-backed subsample consists of VC-backed firms.

[Insert Table 1 here]

Table 1 presents the distributions of our sample by year. The numbers of observations and corresponding percentages are listed for the whole sample, the VC-backed subsample and the non-VC-backed subsample. We can see that the yearly distributions are quite even across the three time periods, and there are no structural differences between the VC-backed subsample and the non-VC- backed subsample. The four biggest industries—computer and data processing services, drugs, electronic components and accessories, and medical instruments and supplies—make up respectively 19.33%, 8.79%, 5.84% and 5.40% of the sample. The VC-backed subsample exhibits more industry clustering than the non-VC-backed subsample, in line with the focus of VC investments. There are more VC-backed firms than non-VC-backed firms in the high technology industries, such as computer and data processing services, drugs, electronic components and accessories, medical instruments and supplies, computer and office equipment, etc. However, there are more non-VC-backed firms than VC-backed firms in traditional industries, such as eating and drinking places, trucking

[1] We have also tried other sample periods. For example, we selected the sample period of 1995-2003 and also tried that sample period excluding the bubble bursting year 2000. All the results are similar.

and courier services (except air mail), professional and commercial equipment, motor vehicles and equipment, etc.

3.2. Variables

Our dependent variable is named as *Overvalued Stock*, a dummy variable indicating whether or not a firm's stock is overvalued. Following the literature, we use *Price-to-Sales Ratio* or *Valuation Error* to measure the extent of overvaluation. The price-to-sales ratio has traditionally been used to identify overvalued securities (see, for example, Brunnermeier and Nagel (2004), Dass, Massa and Patgiri (2008), and Greenwood and Nagel (2009)). The valuation error is defined by Rhodes-Kropf, Robinson and Viswanathan (2005). It is a more precise measure of misvaluation and is used widely in the recent literature (Campello and Graham, 2007; Elliott, Koëter-Kant, and Warr, 2008; Chi and Gupta, 2009; Hertzel and Li, 2010; Hoberg and Phillips, 2010). Specifically, for each year, we rank all stocks on the basis of *Price-to-Sales Ratio* or *Valuation Error*, and call the stocks in the top quartile the overvalued stocks. Hence, we have two measures of the dependent variable *Overvalued Stock* in our baseline regressions.[2]

To test Hypotheses 1 and 2 and investigate the difference in the likelihood of overvaluation between VC-backed and non-VC-backed firms, we adopt a test variable named as *VC-Backed*, which is a dummy variable indicating whether or not a firm has received VC funding before its IPO. To address Hypothesis 3 which predicts an association between VCs' ownership or control and the likelihood of overvaluation of VC-backed, recently public firms, we make use of four variables to proxy for VCs' ownership and control as test variables. Specifically, VCs' ownership is proxied by the variables *Ownership* and *Block Owner*. *Ownership* is defined as the percentage of shares owned by VCs, and *Block Owner* is measured as the number of VCs who hold over 5% of the equity shares. We use two variables *Chairman* and *Board Ratio* to represent VCs' control over the firm. Specifically, *Chairman* is a dummy variable indicating whether the venture capitalist is also the chairman of the board of direc-

[2] We have considered some other alternative measures of overvaluation, such as *Market-to-Book Ratio* and *Price-to-Earnings Ratio*. Also, considering the possible loss of information when continuous variables are converted into binary variables, we have tried to use the raw values of these measures. All our results are similar.

tors. *Board Ratio* indicates VCs' participation on the board of directors as measured by the ratio of the number of VC directors to the board size. We measure these four variables just after the firm's IPO. The information on ownership structure and board distribution just after IPOs is hand-collected from firms' IPO prospectuses in the section of Management and Principal Shareholders from the SEC EDGAR database. We obtain information for 671 VC-backed, recently public firms corresponding to 2,464 firm-year observations.

We control for the industry median of Tobin-Q (named as *Tobin-Q*), representing a market signal of the industry's attractiveness. The industry classification is based on the 3-digit SIC code. We use the standard definition of Tobin-Q, which is the ratio of the firm's market value to the book value of assets, where the market value is the value of the firm's common stock plus the redemption value of the preferred stock and the net value of debt.

We also include variables representing firm-level fundamental characteristics, such as the logarithm of the time since IPO (*Years since IPO*) to control for maturity, the leverage ratio (*Leverage*) to take the capital structure into account, the ratio of earnings before interest and taxes (EBIT) to sales (*EBIT*) to represent the firm's operational performance, the ratio of EBIT to sales in the past one year (*EBIT_1*) to take into account a lagged effect, the standard deviation of returns on assets (ROA) (*StdROA*) to control for performance volatility, the ratio of capital expenditures to sales (*Capital Expenditure*) and sales growth (*Growth*) to control for growth opportunities, the logarithm of total assets (*Size*) to represent firm size, and whether or not the firm is audited by a big-4 accounting auditor (*Big4*) to indicate accounting information quality.[3] All these variables follow standard definitions in the literature.

We further include year dummies to control for time-series effects and industry dummies based on the 3-digit SIC code to control for industry characteristics.

To rule out the possible influence of outliers, we winsorize the top and bottom one percentiles for each continuous variable in all our regressions.

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[3] We have also tried to control for the experience of mutual fund managers and institutional buy-side herding as suggested by Greenwood and Nagel (2009), Griffin, Harris, Shu and Topaloglu (2011), Sharma, Easterwood and Kumar (2006), and Puckett and Yan (2008). All the results are quite similar, but with about 38% reduction in our sample size.

We present the definitions, measures and sources of the dependent, independent and control variables, and some terminologies in Table 2.

[Insert Table 2 here]

3.3. Methodology

When investigating the association between VC backing and the likelihood of overvaluation, a major concern is the endogeneity problem resulting from omitted variables that may influence the likelihood of obtaining VC funding. To address this problem, we perform a two-stage procedure. In the first stage we run a probit regression to estimate the likelihood of receiving VC financing; in the second stage we use predictions from the first stage and perform a consistent probit analysis of the likelihood of overvaluation. To implement this procedure, we need instruments to act as predictive variables in the first-stage regressions. Unfortunately, the ex ante instruments are unobservable. So instead we follow the literature (Lee and Wahal, 2004; Morsfield and Tan, 2006) and use the underwriter rank (*Underwriter Rank*), logarithm of proceeds (*Proceeds*), logarithm of years since founding at the time of IPO (*Age*), sales per share in the year prior to IPO scaled by the offering price (*Sales per Share*), total assets per share in the year prior to IPO scaled by the offering price (*Assets per Share*), book value of equity per share in the year prior to IPO scaled by the offering price (*Equity per Share*) and headquarters-state dummies as exclusion instruments in the first-stage regression. The underwriter rank and proceeds are known only at the time of the IPO, which is made after receiving VC funding. We use these variables with the belief that they are likely to be correlated with the ex ante unobservable variables, such as the firm's funding requirements.

To address Hypothesis 1, the second-stage probit regression can be written as follows:[4]

$$\begin{aligned} Overvalued\ Stock_{it} = {} & \beta_0 + \beta_1 VC\text{-}Back_i + \beta_2 Tobin\text{-}Q_{ct} + \beta_3 Years\ Since\ IPO_{it} + \beta_4 Leverage_{it} \\ & + \beta_5 EBIT_{it} + \beta_6 EBIT\_1_{it} + \beta_7 StdROA_{it} + \beta_8 Capital\ Expenditure_{it} \\ & + \beta_9 Growth_{it} + \beta_{10} Size_{it} + \beta_{11} Big4_{it} + Industry\ Dummies + Year\ Dummies + \varepsilon_{it}, \end{aligned} \quad (1)$$

where *i* refers to the firm, *t* refers to the year, and *c* refers to the industry. The coefficient of interest is β_1, which captures the association between VC backing and the likelihood of overvaluation. To see how this association differs between the bubble period and other peri-

[4] All the regression results remain unchanged if we use a logit model.

ods, we separately conduct regressions in the pre-bubble, bubble and post-bubble periods. Hypothesis 1 predicts a positive and significant β_1 during the bubble period, and an insignificant β_1 during the pre- and post-bubble periods.

To test Hypothesis 2, we employ the same two-stage probit model on the recently and seasoned public subsamples. Hypothesis 2 predicts that the positive and significant coefficient β_1 in the second-stage regression is driven by the recently public subsample instead of the seasoned public subsample.

To address Hypothesis 3, we apply a probit analysis by regressing *Overvalued Stock* on VCs' ownership or control, as proxied by *Ownership*, *Block Owner*, *Chairman* and *Board Ratio*, and other control factors. The regression model is:

$$\begin{aligned} Overvalued\ Stock_{it} = {} & \gamma_0 + \gamma_1 VC\ Factor_{it} + \gamma_2 Tobin\text{-}Q_{ct} + \gamma_3 Years\ Since\ IPO_{it} + \gamma_4 Leverage_{it} \\ & + \gamma_5 EBIT_{it} + \gamma_6 EBIT\_1_{it} + \gamma_7 StdROA_{it} + \gamma_8 Capital\ Expenditure_{it} \\ & + \gamma_9 Growth_{it} + \gamma_{10} Size_{it} + \gamma_{11} Big4_{it} + Industry\ Dummies + Year\ Dummies + \zeta_{it}. \end{aligned} \quad (2)$$

The variable "*VC Factor*" indicates either *Ownership*, *Block Owner*, *Chairman* or *Board Ratio*. We predict a positive and significant γ_1 during the bubble period, and an insignificant γ_1 during the pre- and post-bubble periods.

3.4. Summary statistics, univariate analysis and correlation matrix

Table 3 presents summary statistics for all the variables. The numbers of observations, means, medians and standard deviations are presented. As shown, the means and medians of the control and test variables are similar and the standard deviations are all within an acceptable range, suggesting that the distributions of these variables are not severely skewed.

[Insert Table 3 here]

Overvalued Stock is a dummy variable indicating whether or not the firm's stock belongs to the top quartile of *Price-to-Sales Ratio* or *Valuation Error*. Both definitions of *Overvalued Stock* have the same mean of 0.25. Around 45.1% of the firms in the whole sample are backed up by VC. In the VC-backed, recently public subsample, VCs on average own 28.2% of the shares (with a median of 25.8%), 2.55 VCs (with a median of 2) are block owners owning more than 5% of the shares, 13.5% of the board chairmen are VCs, and VCs on average hold 31.0% of the available board seats (with a median of 28.6%) just after IPOs. These statistics are highly consistent with existing studies (Barry, Muscarella, Peavy, and

Vetsuypens, 1990; Sahlman, 1990; Baker and Gompers, 2003; Kaplan and Stromberg, 2003).

We also report the results of the univariate analysis in Table 3, which involve *t*-tests for the equality of means and Wilcoxon tests for the equality of medians between the overvalued and non-overvalued subsamples,[5] where the overvalued and non-overvalued subsamples consist respectively of overvalued and non-overvalued stocks in our sample. As shown, those firms backed up by VCs are more likely to be overvalued at the 1% significance level. Positive associations are found between overvaluation and the variables *Ownership*, *Block Owner*, *Chairman* and *Board Ratio*. As suggested by the univariate tests, there are strong relationships between all the control variables and the likelihood of overvaluation, suggesting a need to control for these factors.

As indicated by unreported correlation coefficients, the likelihood of overvaluation is positively correlated with the test variables *VC-Backed*, *Ownership*, *Block Owner*, *Chairman* and *Board Ratio*. The likelihood of overvaluation is also positively correlated with the control variables *Tobin-Q, StdROA, Capital Expenditure, Growth, Size* and *Big4*, and is negatively correlated with the control variables *Years since IPO*, *Leverage, EBIT* and *EBIT_1*, suggesting the need to control for these variables. Moreover, except between *EBIT* and *EBIT_1*, there is no serious correlation between any two control variables or between the test and control variables, suggesting that our regression model does not suffer from severe multicollinearity.

4. Empirical analysis

In this section, we provide empirical evidence supporting Hypotheses 1-3. We run regressions separately over the three time periods: the pre-bubble period (1994–1997), the bubble period (1998–2000) and the post-bubble period (2001–2004). The industry dummies, defined by the 3-digit SIC code, and year dummies are included in all the regressions to

[5] In Tables 3, we only report the univariate tests in which *Price-to-Sales Ratio* is used to define overvalued stocks. But the results are quite similar if we define overvalued stocks using *Valuation Error*.

control for industry and year fixed effects. All the *z-statistic*s are adjusted for heteroskedasticity (White, 1980) and firm-level clustering (Petersen, 2009).

4.1. Association between VC backing and overvaluation

Panels A and B of Table 4 respectively present our baseline regression results without and with the consideration of endogeneity using the two-stage probit model. In panel A, we conduct probit regressions of *Overvalued Stock* on the variable *VC-Backed* and other control variables directly. The dependent variable *Overvalued Stock* is defined respectively based on *Price-to-Sales Ratio* and *Valuation Error* in models 1–3 and models 4–6. As indicated in models 1–3, the coefficients on *VC-Backed* are positive in all three periods, but they are significant only in the bubble period. Similarly, models 4–6 predict a larger and more significant association between *VC-Backed* and *Overvalued Stock* in the bubble period than in the pre- and post-bubble periods.

[Insert Table 4 here]

However, as explained in section 3.3, there may be an endogeneity problem because of omitted variables in determining the likelihood of obtaining VC funding. Panel B presents the results from the two-stage probit model after taking endogeneity into account, which makes our analysis more convincing. Models 1–3 report the first-stage probit results from regressing *VC-Backed* on instrumental variables *Underwriter Rank*, *Proceeds*, *Age*, *Sales per Share*, *Assets per Share*, *Equity per Share*, headquarters-state dummies and other control variables. Models 4–9 report the second-stage probit results from regressing *Overvalued Stock* on *VC-Backed* obtained from the first-stage probit analysis and other control variables. The dependent variable *Overvalued Stock* in models 4–6 and 7–9 is defined respectively based on *Price-to-Sales Ratio* and *Valuation Error*.

The first-stage regression in models 1–3 has a high pseudo-R^2 of over 0.22, suggesting that the model fits the data well. Sargan's (1958) and Basmann's (1960) tests reject the null hypothesis that the equation is underidentified (i.e., the exclusion instruments are not valid at the 0.1% significance level). Cragg and Donald's (1993) test also strongly rejects the null hypothesis that the exclusion instruments are weak instruments (with an F-statistic greater than 50 and a p-value less than 0.01%). Also, the coefficients are quite similar across the three time periods, suggesting that the equation is well identified. Our results indicate that

the instrumental variables *Underwriter Rank*, *Age* and *Sales per Share* are strongly related to the likelihood of receiving VC funding. The unreported coefficients for the headquarters-state dummies indicate that VC financing is highly biased towards the states of California and Massachusetts. These findings are consistent with the literature (Barry, Muscarella, Peavy, and Vetsuypens, 1990; Sahlman, 1990; Kaplan and Stromberg, 2003; Lee and Wahal, 2004; Nahata, 2008).

The second-stage regression results in models 4–9 suggest that a VC-backed firm is more likely to be overvalued during the bubble period, after controlling for endogeneity and other control factors. Specifically, the likelihood of overvaluation is 6.66 percentage points higher for a VC-backed firm than for a non-VC-backed firm in the bubble period (with a *z-statistic* of 2.65) if a bubble stock is defined based on *Price-to-Sales Ratio*; it is 5.65 percentage points higher (with a *z-statistic* of 2.78) if a bubble stock is defined based on *Valuation Error*. By contrast, *VC-Backed* is not significantly associated with *Overvalued Stock* in the pre- and post-bubble periods. These findings support Hypothesis 1.

The signs of the estimated coefficients of the control variables are generally consistent with our expectations. For example, in models 4–6 when *Overvalued Stock* is defined by *Price-to-Sales Ratio*, *Tobin-Q* is positively related to the likelihood of overvaluation, suggesting that a firm in a fast-growing industry is more likely to be overvalued. The coefficients of *Years since IPO* are in general negative, indicating that a newly public firm is more likely to be overvalued, probably due to high expectations and large asymmetric information between outsiders and insiders. The coefficients of *Leverage* are negative suggesting that a firm with more debt is less likely to be overvalued probably due to limitation from debt covenants. *EBIT* is negatively related to *Overvalued Stock*, indicating that operational performance helps to reduce the likelihood of overvaluation. Also, the coefficients of *StdROA*, *Capital Expenditure, Growth* and *Size* are positive, suggesting that the more volatile the ROA, the better the growth opportunities, and that the higher the growth rate, the larger the firm size, and so the more likely the firm will be overvalued. Further, the coefficients of *Big4* and *EBIT_1* are overall insignificant. Models 7–9 give findings that are generally consistent with those in models 4–6.

4.2. Analysis on the recently public firms and seasoned public firms subsamples

Next, we turn to Hypothesis 2, that is, whether the association between VC backing and the likelihood of overvaluation differs between recently and seasoned public firms. We decompose our sample into two subsamples based on *Years since IPO*, with one containing recently public firms and the other containing seasoned public firms. The dividing point for each year is the median of the numbers of years since IPOs, with the mean being 5.09 years old and a range of 4 to 8 years across the sample. Specifically, for each year, those firms with *Years since IPO* less than or equal to the median go into the recently public subsample, while those firms with *Years since IPO* greater than the median go into the seasoned public subsample. With this division, the recently public subsample consists of 7,752 firm-year observations (3,856 VC-backed and 3,896 non-VC-backed), and the seasoned public subsample consists of 6,612 firm-year observations (2,616 VC-backed and 3,996 non-VC-backed). We apply the two-stage probit model to both subsamples. There is no need to include the variable *Years since IPO* since the sample partition is based on the variable. To save space, we only report the second-stage probit results from regressing *Overvalued Stock* on the estimated *VC-Backed* derived from the first-stage regression and other control variables in Table 5. Panels A and B present the results with the dependent variable *Overvalued Stock* being defined by *Price-to-Sales Ratio* and *Valuation Error*, respectively.

[Insert Table 5 here]

Panel A shows that, for recently public firms, the coefficients of *VC-Backed* are significantly positive in both the bubble and post-bubble periods when *Overvalued Stock* is defined by *Price-to-Sales Ratio*, and the coefficient of *VC-Backed* in the bubble period is much larger and more significant than that in the post-bubble period. Panel B indicates that, for recently public firms, the coefficients of *VC-Backed* are only significantly positive in the bubble period when *Overvalued Stock* is defined by *Valuation Error*. For seasoned public firms, both Panels A and B show that the coefficients of *VC-Backed* are insignificant in all three periods with either definition of *Overvalued Stock*, that is, the likelihood of overvaluation is statistically the same between VC-backed and non-VC-backed firms, after controlling for endogeneity and other factors. In general, the difference in the likelihood of overvaluation between VC-backed and non-VC-backed firms is mainly found in the recently public subsample and

in the bubble period. In the bubble period, the likelihood of overvaluation for a VC-backed firm that is recently public is 14.32 percentage points higher than that for a non-VC-backed firm that is also recently public (with a *z-statistic* of 3.92) if *Overvalued Stock* is defined by *Price-to-Sales Ratio*; it is 11.63 percentage points higher (with a *z-statistic* of 4.06) if *Overvalued Stock* is defined by *Valuation Error*. These findings are highly consistent with Hypothesis 2.

4.3. Analysis on VCs' ownership and control

In Table 6, we provide evidence on the association between VCs' ownership or control and the likelihood of overvaluation using the subsample of VC-backed, recently public firms. Panels A-B and C-D present the results with the dependent variable *Overvalued Stock* defined by *Price-to-Sales Ratio* and *Valuation Error*, respectively. To save space, the coefficients of control variables are not reported.

[Insert Table 6 here]

We find a significantly positive relationship between *Overvalued Stock* and VCs' ownership or control as proxied by *Ownership*, *Block Owner*, *Chairman* and *Board Ratio* in the bubble period. This relationship generally disappears in the pre- and post-bubble periods. On the marginal effects, for a VC-backed, recently public firm, a one standard deviation increase in *Ownership* (about 17.46 percentage points) at the mean level increases the likelihood of overvaluation by 4.90 percentage points (with a *z-statistic* of 2.03) when *Overvalued Stock* is defined by *Price-to-Sales Ratio*, and by 5.40 percentage points (with a *z-statistic* of 2.08) when *Overvalued Stock* is defined by *Valuation Error* in the bubble period. A one standard deviation increase in *Block Owner* (about 1.69) at the mean level increases the likelihood of overvaluation by 4.22 percentage points (with a *z-statistic* of 1.69) when *Overvalued Stock* is defined by *Price-to-Sales Ratio*, and by 6.71 percentage points (with a *z-statistic* of 2.85) when *Overvalued Stock* is defined by *Valuation Error* in the bubble period. If the board chairman position is held by a venture capitalist and the firm has recently gone public, the likelihood of overvaluation for the firm is increased by 13.63 percentage points (with a *z-statistic* of 2.12) when *Overvalued Stock* is defined by *Price-to-Sales Ratio*, and by 10.66 percentage points (with a *z-statistic* of 3.76) when *Overvalued Stock* is defined by *Valuation Error* in the bubble period. A one standard deviation increase in *Board Ratio* (about 18.99

percentage points) at the mean level increases the likelihood of overvaluation for a VC-backed, recently public firm by 3.50 percentage points (with a *z-statistic* of 2.38) when *Overvalued Stock* is defined by *Price-to-Sales Ratio*, and by 4.06 percentage points (with a *z-statistic* of 1.75) when *Overvalued Stock* is defined by *Valuation Error* in the bubble period. These findings support the prediction that VCs with high ownership and control over the firms they back exhibit more prominent opportunistic behavior in bubble periods than in other periods.

Our empirical analysis yields interesting findings. VC-backed firms are more likely to be overvalued during a bubble period, but only if the firms have recently gone public. Further, those firms over which VCs have higher ownership and control are more likely to be overvalued during a bubble period. All these findings are consistent with our Hypotheses 1–3, suggesting VC opportunism during boom periods.

5. Conclusion

This paper focuses on the association between VC backing and overvaluation in and around the high-tech bubble period of 1998-2000. We make use of 14,364 firm-year observations of firms listed on NASDAQ, including firms with or without VC support. We consider three periods: the pre-bubble period of 1994–1997, the bubble period of 1998–2000, and the post-bubble period of 2001–2004. After controlling for endogeneity and other market- and firm-level characteristics, the main findings are as follows. First, a VC-backed firm is significantly more likely to become an overvalued stock in the bubble period than a non-VC-backed firm. Second, this association between VC backing and overvaluation is limited to recently public firms (measured in terms of how much time had elapsed since the firm's IPO). Third, VCs' ownership and control over the recently public firms they backed have a positive relationship with the likelihood of overvaluation in the bubble period.

Our findings enrich the understanding of VC opportunism during boom periods and provide more evidence on the behavior of financial institutions over the business cycle. We pose two questions for future research. Can strategic interactions between VCs and entre-

preneurs affect overvaluation? And have VCs learned from this bubble experience and changed certain behaviors since?

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Tables

Table 1

Sample distribution

This table presents sample distributions by year. The sample consists of 14,364 firm-year observations from COMPUSTAT, SDC global new issues, Jay Ritter's website and SDC VentureXpert for the period 1994–2004. Percentages and numbers of observations are reported for the whole sample, the VC-backed subsample and the non-VC-backed subsample. The sample period is divided into three sub-periods: the pre-bubble period of 1994–1997, the bubble period of 1998–2000, and the post-bubble period of 2001–2004.

Year		Whole		VC-backed		Non-VC-backed	
		Obs.	%	Obs.	%	Obs.	%
Pre-bubble period	1994	984	6.850	433	6.690	551	6.982
	1995	1,060	7.380	456	7.046	604	7.653
	1996	1,196	8.326	522	8.066	674	8.540
	1997	1,463	10.185	640	9.889	823	10.428
Subtotal		4,703	32.742	2,051	31.690	2,652	33.604
Bubble period	1998	1,458	10.150	634	9.796	824	10.441
	1999	1,348	9.385	577	8.915	771	9.769
	2000	1,519	10.575	703	10.862	816	10.340
Subtotal		4,325	30.110	1,914	29.574	2,411	30.550
Post-bubble period	2001	1,452	10.109	684	10.569	768	9.731
	2002	1,426	9.928	671	10.368	755	9.567
	2003	1,369	9.531	643	9.935	726	9.199
	2004	1,089	7.581	509	7.865	580	7.349
Subtotal		5,336	37.148	2,507	38.736	2,829	35.846
Total		14,364	100	6,472	100	7,892	100

Table 2

Variable definition

This table gives the definitions, measures and data sources of all the variables.

Variable	Definition and measure	Data source
Dependent variable:		
Overvalued Stock	A dummy variable indicating whether or not a firm's stock value belongs to the top quartile of *Price-to-Sales Ratio* or *Valuation Error* in a year.	COMPUSTAT
Independent variable:		
VC-Backed	A dummy variable that equals 1 if a firm is financed by VCs before its IPO.	SDC VentureXpert
Ownership	The ratio of VCs' stock ownership as a group just after the IPO.	SEC EDGER
Block Owner	The number of VCs who are block stock owners after the IPO, as measured by the number of VCs who hold over 5% of stocks just after the IPO.	SEC EDGER
Chairman	Whether the venture capitalist is also the chairman of the board of directors just after the IPO.	SEC EDGER
Board Ratio	The ratio of VCs' participation on the board of directors, as measured by the ratio of the number of VC seats to board size just after the IPO.	SEC EDGER
Control variables:		
Tobin-Q	Industry median of Tobin-Q (COMPUSTAT: (PRCC_F*CSHO+PSTKRV+DLTT+DLC)/AT) based on the 3-digit SIC code.	COMPUSTAT
Years since IPO	The logarithm of the number of years since the IPO.	SDC global new issues; Jay Ritter's website
Leverage	The ratio of short-term and long-term debt to total assets (COMPUSTAT: (DLTT+DLC)/AT).	COMPUSTAT
EBIT	The ratio of EBIT to sales (COMPUSTAT: EBIT/SALE).	COMPUSTAT
EBIT_1	The ratio of EBIT to sales (COMPUSTAT: EBIT/SALE) in the previous year.	COMPUSTAT
StdROA	The historical standard deviation of ROA (COMPUSTAT: IB/AT) in the past five years. For those firms with less than five years' worth of ROA information in COMPUSTATA, we use the available historical ROA in the past five years to calculate the standard deviation.	COMPUSTAT
Capital Expenditure	The ratio of capital expenditure to sales (COMPUSTAT: CAPX/SALE).	COMPUSTAT
Growth	The sales (COMPUSTAT: SALE) growth in the previous year.	COMPUSTAT
Size	Firm size (COMPUSTAT: ln(1+AT)).	COMPUSTAT
Big4	A dummy variable, which is equal to 1 if the firm is audited by one of the big four auditors and 0 otherwise.	COMPUSTAT
Variables used in the first-stage regression		
Underwriter Rank	The rank of the book underwriter in the IPO, as defined by the Carter-Manaster ranking	SDC global new issues;

		Jay Ritter's website
Proceeds	The natural logarithm of IPO proceeds.	SDC global new issues
Age	The firm's age at its IPO, as measured by the logarithm of the number of years since its founding.	SDC global new issues; Jay Ritter's website
Sales per Share	The sales per share (COMPUSTAT: SALE/CSHO) in the year prior to the IPO scaled by the offering price.	COMPUSTAT
Assets per Share	The total assets per share (COMPUSTAT: AT/CSHO) in the year prior to the IPO scaled by offering price.	COMPUSTAT
Equity per Share	The book value of equity per share (COMPUSTAT: CEQ/CSHO) in the year prior to the IPO scaled by the offering price.	COMPUSTAT
Misc.		
Price-to-Sales Ratio	The ratio of price to sales (COMPUSTAT: PRCC_F*CSHO/SALE).	COMPUSTAT
Valuation Error	The residual of the model of Rhodes-Kropf, Robinson and Viswanathan (2005). Their model regresses market value on financial leverage (COMPUSTAT: 1-CEQ/AT), book value of assets (COMPUSTAT: AT) and net income (COMPUSTAT: NI) for the twelve Fama-French sectors of the economy. *Valuation Error* equals *Firm-Specific Valuation Error* plus *Industry-Specific Valuation Error*.	COMPUSTAT
Firm-Specific Valuation Error	The difference between market valuation and the valuation implied by contemporaneous industry-level valuation multiples, as measured by the $m_{it} - v(\theta_{it}; \alpha_{jt})$ component in Rhodes-Kropf, Robinson and Viswanathan's (2005) model.	COMPUSTAT
Industry-Specific Valuation Error	The difference between the valuation implied by contemporaneous industry-level valuation multiples and the valuation implied by long-run industry-level valuation multiples, as measured by the $v(\theta_{it}; \alpha_{jt}) - v(\theta_{it}; \alpha_j)$ component in Rhodes-Kropf, Robinson and Viswanathan's (2005) model.	COMPUSTAT
Recently Public Sample	The subsample covers observations with *Years since IPO* less than the median in a year.	COMPUSTAT
Seasoned Public Sample	The subsample covers observations with *Years since IPO* greater than the median in a year.	COMPUSTAT
Market-to-Book Ratio	The ratio of market value to the book value of assets (COMPUSTAT: (PRCC_F*CSHO+AT-CEQ -TXDB)/AT).	COMPUSTAT
Price-to-Earnings Ratio	The ratio of price to earnings per share (COMPUSTAT: PRCC_F/EPSPX).	COMPUSTAT
Mutual	Net percentage change in shares held by experienced mutual fund managers, as measured by the percentage change in shares held by older mutual fund managers minus the percentage change in shares held by younger mutual fund managers.	CDA Spectrum
Buy Herding	Buy-side institutional herding, as defined by Lakonishok, Shleifer and Vishny (1992).	CDA Spectrum

Table 3
Summary statistics and univariate analysis

This table presents summary statistics of the dependent, independent and control variables, as well as other variables used in estimating VC backing (the first-stage regression), in measuring overvaluation and in robustness tests. The definitions and data sources for these variables are given in Table 2. The means, medians and standard deviations are presented. *Overvalued Stock* is defined by *Price-to-Sales Ratio* and *Valuation Error* in rows (1) and (2), respectively. The results of *t*-tests for the equality of the means and Wilcoxon tests for the equality of the medians between overvalued and non-overvalued samples are also reported, where the overvalued stocks are defined by *Price-to-Sales Ratio*.

Variable	Obs.	Mean	Median	Std. Dev.	Overvalued		Non-overvalued	
					Mean	Median	Mean	Median
Overvalued Stock	14,364	0.250	0	0.433				
Overvalued Stock	14,364	0.250	0	0.433				
VC-Backed	14,364	0.451	0	0.498	0.598***	1***	0.401	0
Ownership	2,464	0.282	0.258	0.180	0.291**	0.283**	0.277	0.249
Block Owner	2,464	2.551	2	1.700	2.834***	2.500***	2.393	2
Chairman	2,464	0.135	0	0.341	0.198***	0***	0.100	0
Board Ratio	2,464	0.310	0.286	0.187	0.318**	0.333**	0.305	0.286
Tobin-Q	14,364	1.669	1.514	0.737	2.140***	2.009***	1.511	1.389
Years since IPO	14,364	1.771	1.792	0.754	1.629***	1.609***	1.818	1.946
Leverage	14,364	0.152	0.061	0.195	0.097***	0.011***	0.170	0.096
EBIT	14,364	-0.527	0.042	2.426	-1.847***	-0.027***	-0.086	0.045
EBIT_1	14,364	-0.643	0.043	2.914	-2.098***	-0.075***	-0.157	0.048
StdROA	14,364	0.164	0.075	0.261	0.234***	0.120***	0.141	0.065
Capital Expenditure	14,364	0.119	0.045	0.272	0.246***	0.085***	0.077	0.037
Growth	14,364	0.344	0.156	0.843	0.649***	0.323***	0.243	0.122
Size	14,364	4.715	4.635	1.311	4.889***	4.770***	4.657	4.600
Big4	14,364	0.779	1	0.415	0.840***	1***	0.759	1
Underwriter Rank	14,364	6.769	8.001	2.471	7.246***	8.001***	6.609	8.000
Proceeds	14,364	3.123	3.219	0.900	3.253***	3.353***	3.080	3.176
Age	14,364	2.206	2.197	0.874	1.958***	1.946***	2.289	2.303
Sales per Share	14,364	0.812	0.491	1.005	0.302***	0.148***	0.983	0.643
Assets per Share	14,364	7.655	2.269	16.572	1.792***	0.619***	9.611	3.125
Equity per Share	14,364	0.393	0.363	0.224	0.331***	0.292***	0.414	0.394
Price-to-Sales Ratio	14,364	7.552	1.650	22.291	25.929***	10.482***	1.419	1.034
Valuation Error	14,364	0.014	-0.061	0.637	0.579***	0.567***	-0.174	-0.207

The significance levels at the 1%, 5% and 10% are identified by ***, ** and *, respectively.

Table 4
Analysis with and without controlling for endogeneity

Panel A reports regression results without controlling for the endogeneity of VC backing. Panel B reports regression results using a two-stage regression model to control for endogeneity, where the first-stage regression is a probit regression that estimates the likelihood of receiving VC backing before the IPO with *VC-Backed* as the dependent variable, and the second-stage regression is also a probit regression that estimates the likelihood of overvaluation using *VC-Backed* estimated from the first stage as the explanatory variable. The instrumental variables used in the first-stage regression are *Underwriter Rank*, *Proceeds*, *Age*, *Sales per Share*, *Assets per Share*, *Equity per Share* and the headquarters state dummies. The dependent variable in Panel A and in the second stage of Panel B is *Overvalued Stock,* which is defined by *Price-to-Sales Ratio* or *Valuation Error*. The control variables are *Tobin-Q, Years since IPO*, *Leverage, EBIT, EBIT_1, StdROA, Capital Expenditure, Growth, Size* and *Big4*. The definitions and data sources for these variables are given in Table 2. The industry fixed effects as defined by the 3-digit SIC code and the year fixed effects are included, but their coefficients are not reported. The *z-statistic*s based on the standard error adjusted for heteroskedasticity (White 1980) and clustering at the firm level (Petersen 2009) are printed in parentheses.

Panel A. Probit analysis without controlling for endogeneity

Variable	*Price-to-sales ratio*			*Valuation error*		
	1	2	3	4	5	6
	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble
VC-Backed	0.129	0.170**	0.007	0.156***	0.162***	0.070
	(1.61)	(2.46)	(0.09)	(2.62)	(2.64)	(1.15)
Tobin-Q	0.354***	0.326***	0.493***	0.488***	0.438***	0.518***
	(2.69)	(6.78)	(4.97)	(3.71)	(8.91)	(5.83)
Years since IPO	-0.084	-0.165***	-0.026	-0.113***	-0.129***	0.030
	(-1.59)	(-3.44)	(-0.47)	(-2.73)	(-3.30)	(0.66)
Leverage	-2.262***	-1.555***	-1.590***	-0.947***	-0.739***	-0.390**
	(-8.80)	(-6.49)	(-7.50)	(-4.95)	(-4.02)	(-2.39)
EBIT	-0.151***	-0.159***	-0.207***	-0.063***	-0.020	-0.030*
	(-3.05)	(-5.10)	(-4.83)	(-3.11)	(-1.17)	(-1.88)
EBIT_1	0.068***	0.023	0.029	0.089***	0.010	0.057***
	(3.17)	(1.38)	(1.30)	(6.09)	(0.81)	(3.52)
StdROA	0.406**	0.290**	0.239**	0.294**	0.308***	0.374***
	(2.25)	(2.07)	(2.29)	(2.16)	(2.61)	(4.57)
Capital Expenditure	1.023***	0.362**	1.087***	0.057	-0.183	0.007
	(5.51)	(2.23)	(3.73)	(0.46)	(-1.44)	(0.06)
Growth	0.322***	0.137***	0.247***	0.361***	0.119***	0.365***
	(6.00)	(4.00)	(4.21)	(7.87)	(3.99)	(7.60)
Size	0.276***	0.327***	0.244***	0.103***	0.172***	0.078***
	(6.88)	(9.86)	(8.24)	(3.32)	(6.43)	(3.31)
Big4	0.058	0.084	0.109	-0.007	0.035	0.213***
	(0.62)	(1.04)	(1.11)	(-0.10)	(0.54)	(2.84)
Constant	-2.493***	-2.675***	-1.956***	-1.420***	-0.436***	-1.903***
	(-4.21)	(-6.78)	(-6.51)	(-5.06)	(-2.75)	(-7.27)
Industry and Year	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	3,849	3,596	4,528	4,131	3,617	4,864
Pseudo-R^2	0.265	0.274	0.284	0.142	0.131	0.107

The significance levels at 1%, 5% and 10% are identified by ***, ** and *, respectively.

Panel B. Analysis after controlling for endogeneity using a two-stage probit model

Variable	First-stage			Second-stage					
	VC-Backed			*Price-to-Sales Ratio*			*Valuation Error*		
	1	2	3	4	5	6	7	8	9
	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble
Underwriter Rank	0.123***	0.151***	0.152***						
	(5.17)	(6.27)	(5.68)						
Proceeds	-0.058	-0.035	-0.069						
	(-0.63)	(-0.42)	(-0.77)						
Age	-0.118**	-0.145***	-0.144**						
	(-2.20)	(-2.85)	(-2.55)						
Sales per Share	-0.129	-0.170**	-0.191**						
	(-1.56)	(-2.08)	(-2.17)						
Assets per Share	0.008*	0.003	0.005						
	(1.78)	(0.82)	(1.27)						
Equity per Share	-0.222	-0.164	-0.143						
	(-0.94)	(-0.82)	(-0.65)						
VC-Backed				0.021	0.214***	0.134	0.048	0.184***	0.097
				(0.23)	(2.65)	(1.51)	(0.64)	(2.78)	(1.38)
Tobin-Q	-0.040	-0.037**	0.054*	0.354***	0.334***	0.492***	0.489***	0.442***	0.518***
	(-0.60)	(-2.12)	(1.83)	(2.71)	(6.90)	(4.95)	(3.74)	(8.97)	(5.84)
Years since IPO	-0.080	-0.143**	-0.160***	-0.088*	-0.152***	-0.002	-0.117***	-0.118***	0.039
	(-1.20)	(-2.26)	(-2.95)	(-1.66)	(-3.16)	(-0.04)	(-2.80)	(-3.01)	(0.85)
Leverage	-0.585**	-0.286	0.030	-2.291***	-1.530***	-1.573***	-0.971***	-0.721***	-0.383**
	(-2.47)	(-1.37)	(0.14)	(-8.77)	(-6.34)	(-7.40)	(-5.05)	(-3.91)	(-2.35)
EBIT	-0.009	0.001	0.021	-0.153***	-0.159***	-0.207***	-0.063***	-0.020	-0.030*
	(-0.47)	(0.08)	(1.39)	(-3.01)	(-5.01)	(-4.86)	(-3.08)	(-1.19)	(-1.88)
EBIT_1	0.016	-0.005	-0.019	0.069***	0.023	0.031	0.089***	0.010	0.057***
	(1.18)	(-0.37)	(-1.62)	(3.16)	(1.40)	(1.39)	(6.07)	(0.79)	(3.52)
StdROA	0.179	-0.028	-0.108	0.421**	0.281**	0.233**	0.298**	0.296**	0.373***
	(1.07)	(-0.20)	(-0.88)	(2.33)	(2.03)	(2.24)	(2.18)	(2.51)	(4.55)
Capital Expenditure	0.020	-0.002	0.048	1.015***	0.373**	1.078***	0.056	-0.183	0.005
	(0.14)	(-0.02)	(0.34)	(5.45)	(2.28)	(3.75)	(0.45)	(-1.42)	(0.04)
Growth	0.053	0.010	-0.059*	0.322***	0.139***	0.252***	0.360***	0.120***	0.366***
	(1.28)	(0.29)	(-1.69)	(5.97)	(4.06)	(4.31)	(7.84)	(4.00)	(7.62)
Size	0.116**	0.102**	0.075**	0.284***	0.315***	0.234***	0.109***	0.161***	0.074***

	(2.24)	(2.55)	(2.00)	(6.80)	(9.24)	(7.79)	(3.37)	(5.75)	(3.10)
Big4	0.203**	0.219***	0.302***	0.068	0.063	0.079	0.002	0.017	0.199***
	(2.19)	(2.61)	(3.53)	(0.72)	(0.77)	(0.79)	(0.02)	(0.26)	(2.58)
Constant	-0.032	-5.849***	-6.416***	-2.420***	-1.579***	-2.116***	-1.330***	-2.538***	-1.917***
	(-0.02)	(-5.27)	(-6.02)	(-4.08)	(-3.59)	(-6.67)	(-4.77)	(-2.77)	(-7.34)
Headquarters-State	Yes	Yes	Yes						
Industry and year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering				Yes	Yes	Yes	Yes	Yes	Yes
Obs.	4,102	3,851	4,676	3,579	3,419	4,151	3,816	3,449	4,508
Pseudo-R^2	0.231	0.221	0.220	0.365	0.335	0.341	0.134	0.129	0.102

Table 5
Analysis on the recently public and seasoned public subsamples

This table presents the second-stage probit regression results on the recently public and seasoned public subsamples. The dependent variable *Overvalued Stock* is defined by *Price-to-Sales Ratio* and *Valuation Error* in Panels A and B, respectively. The test variable is *VC-Backed* estimated from the first-stage probit regression with *Underwriter Rank*, *Proceeds*, *Age*, *Sales per Share*, *Assets per Share*, *Equity per Share* and the headquarters state dummies as instrumental variables. The control variables include *Tobin-Q, Leverage, EBIT, EBIT_1, StdROA, Capital Expenditure, Growth, Size* and *Big4*. The definitions and data sources for the variables are given in Table 2. The industry fixed effects defined by the 3-digit SIC code and the year fixed effects are included in all the regressions, but their coefficients are not reported. The *z-statistic*s based on the standard error adjusted for heteroskedasticity (White 1980) and clustering at the firm level (Petersen 2009) are printed in parentheses.

Panel A. The second-stage probit analysis on the recently public and seasoned public subsamples with the dependent variable *Overvalued Stock* defined by *Price-to-Sales Ratio*

Variable	*Recently Public*			*Seasoned Public*		
	1	2	3	4	5	6
	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble
VC-Backed	0.032	0.410***	0.206*	-0.042	0.078	0.037
	(0.29)	(3.92)	(1.70)	(-0.27)	(0.57)	(0.27)
Tobin-Q	0.348**	0.336***	0.458***	0.520*	0.261***	0.486***
	(2.05)	(5.41)	(3.19)	(1.91)	(2.75)	(2.94)
Leverage	-2.518***	-1.554***	-1.761***	-2.135***	-1.738***	-1.677***
	(-7.81)	(-5.03)	(-6.29)	(-4.87)	(-4.51)	(-4.90)
EBIT	-0.149***	-0.110***	-0.145***	-0.199	-0.345***	-0.666***
	(-2.69)	(-3.77)	(-4.46)	(-1.54)	(-4.19)	(-4.27)
EBIT_1	0.066***	0.024	0.020	0.071	0.078**	0.143**
	(2.93)	(1.40)	(1.00)	(1.35)	(2.25)	(2.20)
StdROA	0.508***	0.169	0.215*	0.152	0.812*	0.113
	(2.68)	(1.19)	(1.83)	(0.28)	(1.86)	(0.46)
Capital Expenditure	0.912***	0.390**	0.652***	1.904***	0.514	2.821***
	(5.24)	(2.22)	(2.59)	(2.93)	(1.16)	(4.08)
Growth	0.332***	0.146***	0.176***	0.320***	0.337***	0.557***
	(5.45)	(4.07)	(2.91)	(2.90)	(3.83)	(3.59)
Size	0.301***	0.311***	0.226***	0.305***	0.376***	0.295***
	(5.93)	(6.63)	(5.15)	(4.69)	(7.97)	(6.47)
Big4	0.072	0.077	-0.029	0.067	0.017	0.048
	(0.64)	(0.73)	(-0.23)	(0.43)	(0.12)	(0.29)
Constant	-1.636	-3.018***	-2.756***	-2.939***	-2.480***	-2.772***
	(-1.40)	(-6.50)	(-8.52)	(-3.99)	(-2.67)	(-4.83)
Industry and Year	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,968	1,816	2,198	1,343	1,336	1,659
Pseudo-R^2	0.380	0.321	0.294	0.332	0.345	0.426

The significance levels at 1%, 5% and 10% are identified by ***, ** and *, respectively.

Panel B. The second-stage probit analysis on the recently public and seasoned public subsamples with the dependent variable *Overvalued Stock* defined by *Valuation Error*

Variable	*Recently Public*			*Seasoned Public*		
	1	2	3	4	5	6
	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble
VC-Backed	0.101	0.346***	0.027	0.010	0.039	0.151
	(1.06)	(4.06)	(0.28)	(0.08)	(0.36)	(1.56)
Tobin-Q	0.534***	0.509***	0.511***	0.418*	0.255***	0.517***
	(3.08)	(8.01)	(3.92)	(1.68)	(2.80)	(3.93)
Leverage	-1.470***	-0.962***	-0.455**	-0.604**	-0.536**	-0.337
	(-5.35)	(-3.83)	(-2.02)	(-2.13)	(-1.96)	(-1.37)
EBIT	-0.053**	0.009	-0.012	-0.080*	-0.068**	-0.052*
	(-2.14)	(0.42)	(-0.67)	(-1.92)	(-2.23)	(-1.94)
EBIT_1	0.084***	0.008	0.057***	0.083***	0.028	0.045*
	(4.62)	(0.52)	(2.78)	(2.69)	(1.17)	(1.89)
StdROA	0.256*	0.201	0.193**	0.684**	0.840***	0.913***
	(1.70)	(1.54)	(2.00)	(1.97)	(2.84)	(4.76)
Capital Expenditure	0.077	-0.083	0.078	0.114	-0.286	-0.147
	(0.55)	(-0.53)	(0.61)	(0.42)	(-1.14)	(-0.68)
Growth	0.328***	0.123***	0.328***	0.462***	0.214***	0.431***
	(6.52)	(3.77)	(5.65)	(4.17)	(3.00)	(4.91)
Size	0.108***	0.162***	0.059*	0.136***	0.193***	0.119***
	(2.60)	(4.11)	(1.72)	(2.81)	(4.71)	(3.34)
Big4	-0.002	-0.092	0.075	0.022	0.178	0.247**
	(-0.03)	(-1.08)	(0.69)	(0.18)	(1.60)	(2.10)
Constant	-1.278	-1.969**	-1.113***	-1.705***	-0.465**	-1.072***
	(-1.19)	(-2.03)	(-4.21)	(-4.19)	(-2.45)	(-5.64)
Industry and Year	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	2,105	1,902	2,372	1,492	1,391	1,973
Pseudo-R^2	0.133	0.115	0.0818	0.144	0.134	0.138

Table 6
Analysis on VCs' ownership and control

This table reports the results of regressing *Overvalued Stock* on VCs' Ownership and control. The sample consists of VC-backed firms that have recently gone public. The dependent variable is *Overvalued Stock*, which is defined by *Price-to-Sales Ratio* (Panels A and C) or *Valuation Error* (Panels B and D). The test variables are *Ownership*, *Block Owner*, *Chairman* or *Board Ratio*. The control variables are *Tobin-Q, Years since IPO, Leverage, EBIT, EBIT_1, StdROA, Capital Expenditure, Growth, Size,* and *Big4*. The definitions and data sources for the variables are given in Table 2. The industry fixed effects defined by the 3-digit SIC code and the year fixed effects are included in all the regressions. The coefficients of control variables, industry dummies and year dummies are not reported. The *z-statistic*s based on the standard error adjusted for heteroskedasticity (White 1980) and clustering at the firm level (Petersen 2009) are printed in parentheses.

Panel A. Probit analysis on VC's ownership with the dependent variable *Overvalued Stock* defined by *Price-to-Sales Ratio*

Variable	1	2	3	4	5	6
	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble
Ownership	-1.642	0.951**	0.241			
	(-0.98)	(2.03)	(0.77)			
Block Owner				-0.080	0.065*	0.020
				(-0.92)	(1.69)	(0.60)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry and Year	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	134	712	1,455	128	797	1,372
Pseudo-R^2	0.381	0.212	0.175	0.272	0.234	0.241

Panel B. Probit analysis on VC's ownership with the dependent variable *Overvalued Stock* defined by *Valuation Error*

Variable	1	2	3	4	5	6
	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble
Ownership	1.460	0.870**	-0.256			
	(1.21)	(2.08)	(-0.90)			
Block Owner				0.206	0.104***	-0.007
				(1.59)	(2.85)	(-0.26)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry and year	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	139	714	1,549	137	715	1,576
Pseudo-R^2	0.385	0.292	0.234	0.381	0.265	0.238

Panel C. Probit analysis on VC's control with the dependent variable *Overvalued Stock* defined by *Price-to-Sales Ratio*

Variable	1	2	3	4	5	6
	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble
Chairman	0.188	0.344**	0.159			
	(0.52)	(2.12)	(1.26)			
Board Ratio				1.080	0.464**	0.135
				(1.17)	(2.38)	(0.46)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry and Year	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	130	689	1,348	126	669	1,377
Pseudo-R^2	0.265	0.211	0.272	0.275	0.233	0.240

Panel D. Probit analysis on VC's control with the dependent variable *Overvalued Stock* defined by *Valuation Error*

Variable	1	2	3	4	5	6
	Pre-bubble	Bubble	Post-bubble	Pre-bubble	Bubble	Post-bubble
Chairman	0.512	0.269***	0.142**			
	(1.19)	(3.76)	(2.05)			
Board Ratio				-0.174	0.561*	-0.210
				(-0.18)	(1.75)	(-0.81)

Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry and year	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	135	714	1,407	129	713	1,581
Pseudo-R^2	0.177	0.156	0.160	0.338	0.258	0.239

The significance levels at 1%, 5% and 10% are identified by ***, ** and *, respectively.