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Venture capital investment cycles: The impact of public markets ☆

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Abstract

It is well documented that the venture capital industry is highly volatile and that much of this volatility is associated with shifting valuations and activity in public equity markets. This paper examines how changes in public market signals affected venture capital investing between 1975 and 1998. We find that venture capitalists with the most industry experience increase their investments the most when public market signals become more favorable. Their reaction to an increase is greater than the reaction of venture capital organizations with relatively little industry experience and those with considerable experience but in other industries. The increase in investment rates does not affect the success of these transactions adversely to a significant extent. These findings are consistent with the view that venture capitalists rationally respond to attractive investment opportunities signaled by public market shifts.

JEL classification: G24; G32

Keywords: Private equity; Initial public offering; Market cycles

1. Introduction

The high volatility of the venture capital industry is well documented. This volatility manifests itself in a number of ways: the funds flowing to venture capital firms, the investments firms make in portfolio companies, and the financial performance of portfolio companies and venture capital firms (Gompers and Lerner, 2004).

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Much of this volatility appears to be tied to valuations in public equity markets. An increase in initial public offering (IPO) valuations leads venture capital firms to raise more funds (Gompers and Lerner, 1998b; Jeng and Wells, 2000), an effect that is particularly strong among younger venture capital firms (Kaplan and Schoar, 2005). Moreover, returns of venture capital funds appear to be highly correlated with the returns on the market as a whole (Cochrane, 2005; Kaplan and Schoar, 2005; Ljungqvist and Richardson, 2003).

Many industry observers (see, for instance, Gupta, 2000) argue that the volatility of the venture capital industry is a symptom of overreaction by venture capitalists and entrepreneurs to perceived investment opportunities. These swings result in periods in which too many competing companies are funded, followed by ones in which not enough companies have access to capital. The booms of 1969–1972, 1981–1983, and 1998–2000 provide extreme illustrations of these problems. Investments during these years grew dramatically and were concentrated in a few areas. Considerable sums were devoted to supporting very similar firms: e.g., scientific instrument companies in the 1960s, personal computer hardware manufacturers in the 1980s, and Internet retailers and telecommunications concerns in the late 1990s. Meanwhile, many apparently promising areas languished unfunded during these periods as venture capitalists raced to focus on the most visible and popular investment areas.

This alleged overreaction may have its roots in the behavioral biases of venture capitalists that irrationally associate past investment successes with future investment opportunities. Or it may stem from venture capitalists who feel compelled to follow the herd out of concern for the reputation consequences of being contrarians (Scharfstein and Stein, 1990). Indeed, in 1999, even private equity firms with investment mandates to invest in leveraged buyouts felt compelled to back Internet startups.

A contrasting view is that the volatility of the venture capital industry stems not from overreaction, but from the inherent volatility of fundamentals. According to this view, fluctuation in venture capital investment activity is simply a response to changes in investment opportunities. For instance, there may be shocks to the investment opportunities of existing entrepreneurial firms or entry by new entrepreneurs, both of which increase the demand for capital.

This paper takes a step towards distinguishing between the "overreaction view" and the "fundamentals view" by examining the responses of different classes of venture investors. We start with the observation (and empirically document) that the most experienced venture capital firms generally record the best performance (Sorensen, 2004). We then examine how these investors respond to public market signals of investment opportunities. Are the most experienced investors more likely to increase their investments when the market heats ups? And, how well do they do with these investments relative to less experienced venture capitalists? If we find that the most experienced investors are more likely to increase their investment levels when the market heats up, this would suggest that shifts in fundamentals are an important component of venture capital investing. This interpretation would find further support if there is also little degradation in their performance. If we observe instead that the least experienced venture capitalists are most likely to increase their investment activity during hot markets, this would lend more credibility to the view that overreaction is a more important cause of volatility in the venture capital industry.

Our empirical results indicate that investment by the most experienced venture capital firms—notably, those with the most *industry* experience—are most responsive to public market signals of investment opportunities. We start by showing that venture capital investment activity at the industry level is very sensitive to public market signals of industry attractiveness when Tobin's Q is used; a shift from the bottom to the top quartile in Q increases the number of investments by more than 15%. There is no significant pattern, however, when we use IPO activity as our measure of public market signals.

We then show that this relationship is driven largely by venture capital firms with the most experience doing deals in the industry. Overall experience (across all industries) has no effect on investment sensitivity to industry Q and IPO activity once we control for industry experience. Moreover, although the success rate for deals associated with a hot market is lower than that for deals associated with a cold market, the difference is small. Experienced venture capital firms perform slightly better in hot markets, while less experienced venture capital firms do somewhat worse. These findings suggest that an important component of volatility in venture capital investment activity is driven by volatility of fundamentals.

Of independent interest is our finding on the importance of industry-specific rather than overall experience. This result points to the importance of industry-specific human capital and suggests that a critical part of venture capital investing is the network of industry contacts to identify good investment opportunities as well

as the know-how to manage and add value to these investments. These contacts and know-how come only from long-standing experience doing deals in an industry.

The broad question examined in this paper—the extent to which cycles in venture capital are driven by overreaction to public market signals or changes in the industry's fundamentals—is related to a substantial stream of research in financial economics. While the hypothesis remains controversial (e.g., Fama, 1998), a growing body of evidence (e.g., DeBondt and Thaler, 1985, 1990) suggests that the stock market overreacts to news, particularly at horizons greater than one year (Hong and Stein (1999) provide a theoretical framework for understanding these patterns). More recently, corporate investment has also been shown to be affected by the non-fundamental portion of stock prices (Baker, Stein, and Wurgler, 2003). By way of contrast to much of this literature, this analysis suggests that changing public market signals reflects changing fundamentals.[1]

The rest of the paper is organized as follows. Section 2, describes the construction of the data and provides basic summary statistics. Section 3 examines the impact of shifts in valuations and IPO activity on venture capital firm investment activity. In that section, we also look at how investment success depends upon both the investment cycle and the characteristics of the venture capital organizations. Section 4 concludes the paper.

2. The data

2.1. Constructing the sample

Our data on venture investments come from Thomson Venture Economics (Venture Economics). This database provides information in relation to both venture capital investors and the portfolio companies in which they invest. Our analysis focuses on investments from 1975 to 1998, dropping information prior to 1975 due to data quality concerns.[2] In keeping with industry estimates of a maturation period of three to five years for venture companies, we drop information after 1998 so that the outcome data can be meaningfully interpreted. As a result, we do not study investments made at the height of the Internet boom (1999 and 2000) or during the crash that followed.

We consider an investment to be the first time a venture capital firm invests in a particular company. This approach results in a data set with multiple observations for most portfolio companies since several venture capital firms typically invest in a company. We exclude follow-on investments by a venture capital firm in the same portfolio company since our main interest is in the relation between public market signals and new firm formation. In addition, to ensure that we are capturing genuine venture capital firms, we limit our sample to venture firms that invested in more than three portfolio companies. Firms are included in the sample only in the year after their investments exceed a total of three. Thus, we exclude from the sample all observations of organizations that never made three investments or that only invested in one year. This approach could, in principle, introduce some survivorship bias, if, for example, the worst firms are not able to make more than three investments.

By applying these selection criteria, we end up with a database of 1,084 venture capital firms that invest in a total of 13,785 companies between 1975 and 1998. This results in a sample of 32,085 observations of unique venture capital firm-portfolio company pairs.

2.2. Critical measures

Before we turn to an analysis of investment cycles, there are three data construction issues we need to address.

The first issue is how to classify venture capital industries. Our approach is to assign all investments into nine broad industry classes based on Venture Economics' classification of the industry. The original sample of investments was classified by Venture Economics into 69 separate industry segments. However, these 69

[1] At the same time, a substantial literature in accounting, sparked by Lev and Thiagarajan (1993), documents the relation between fundamentals such as earnings and stock prices. More recently, Jiambalvo, Rajgopal, and Venkatachalam (2002) show that this relation is stronger for firms with greater institutional holdings.

[2] Gompers and Lerner (2004) discuss the coverage and selection issues in Venture Economics data prior to 1975.

industries are too narrowly defined for our purposes, as they do not correspond to lines of specialization within or across venture capital firms. These 69 industries are thus combined to arrive at nine broader industries. The industries we construct from the narrower definitions are: Internet & Computers, Communications & Electronics, Business & Industrial, Consumer, Energy, Biotechnology & Healthcare, Financial Services, Business Services, and All Others. While any industry classification is somewhat arbitrary, we believe that our classification scheme groups together businesses that are similar in technology and management expertise that would make specialization in such industries meaningful. In addition, this scheme reduces the subjectivity associated with classifying firms into narrower industry groupings.

Panel A of Table 1 shows the distribution across the nine broad industries. The first column gives the number of companies in each industry. It is no surprise that Internet & Computers is the largest industry with 4,146 companies. Biotechnology & Healthcare (2,420), Communications & Electronics (2,256), and Consumer (1,882) are the next largest industries. The other industries are considerably smaller. The overall industry distribution provides some comfort that our industry classification is meaningful. While there is variation in the number of observations across industries, there are enough observations in each industry to make our analysis feasible. Throughout the analysis, we exclude the industry "All Others," since this represents an agglomeration of unrelated industries in which the responses to market signals that we look for would not be relevant.

The first panel of Table 1 also reports the number of observations for each industry in our sample; there are more observations than companies because there are multiple venture capital investors in most of the companies in our sample. On average, there are 2.3 venture capital investors in each company.

The second challenge has to do with the measurement of perceived investment opportunities. We use two measures of perceived investment opportunities in our analysis, industry Q and IPO activity. Because we do not know whether these measures overstate or understate true investment opportunities, we refer to industry Q and IPO activity simply as "public market signals."

The measurement of Q follows the standard approach in the investment literature. We calculate Q as the ratio of the market value of the firm to the firm's book value of assets, where the market value of the firm is measured as the book value of assets plus the market value of equity less the book value of equity. Since we cannot observe the Q of private firms that constitute the pool of potential venture capital investments, we use an estimate of Q for public companies as a proxy. However, in order to do so, we need to link the SIC codes of public companies to Venture Economics industries on which our data are based. Our procedure is to identify the SIC codes of all Venture Economics firms that went public. Because there are multiple SIC codes associated with each of our eight industries, we construct Q as a weighted average of the industry Q of the public companies in those SIC codes, where the weights are the relative fractions of firms that went public within the eight industries. Within the SIC code, Q is calculated by equally weighting all public companies.

Our second, less standard measure is the level of venture capital-backed IPO activity in an industry. We use this measure for both theoretical and practical reasons. The theoretical rationale is based on the observation that IPOs are by far the most important (and profitable) means for venture capitalists to exit an investment (Gompers and Lerner, 2004). Thus, an increase in the number of IPOs in a particular sector may make investing in that sector more attractive. In addition, an increase in IPO activity may also attract more potential entrepreneurs into a sector, thereby increasing the pool of potential investments and the likelihood that a venture capitalist will find an attractive one. The practical rationale for using IPO activity is that our Q measure may not accurately reflect the shifts in public investors' appetite for venture capital-backed firms both because it uses data on mature public companies and because it relies on an inexact match between SIC codes and Venture Economics codes. Given the strong link between IPO activity and market valuations (Pagano, Panetta, and Zingales, 1998; Ritter and Welch, 2002), the IPO measure may actually be a better proxy for the public market's perception of the types of investments in our sample.

Figs. 1 and 2 depict the relation between industry venture capital investment activity and the two measures of public market signals for four of the industries in the sample. In Internet and Computers, the correlation between Q and investment activity in Fig. 1 appears to be very high throughout the period. This high correlation can also be seen in IPO activity in Fig. 2. In other industries, the relation is less pronounced. For instance, in both Biotechnology & Healthcare and Energy, the number of investments climbed until 1998, while the number of IPOs peaked in 1996.

Table 1
Sample characteristics

Panel A: Sample by industry

Industry	Companies	Obs.
Internet and Computers	4,146	11,148
Biotech and Healthcare	2,420	6,779
Communications and Electronics	2,256	6,412
Consumer	1,882	3,149
Business/Industrial	1,081	1,651
Energy	462	806
Financial Services	509	745
Business Services	413	577
All others	616	818
Total	13,785	32,085

Panel B: Sample characteristics

	0.25	0.50	0.75	Mean	s.d.	*N*
Industry–Firm–Year Level						
Overall Experience	7	15	35	29.91	40.15	81,603
Industry Experience	0	1	3	3.56	8.25	81,603
Specialization	0.00	0.04	0.18	0.11	0.16	81,603
Adjusted Overall Experience	0.27	0.55	1.26	1.00	1.22	81,603
Adjusted Industry Experience	0.00	0.29	1.31	1.00	1.82	81,563
Adjusted Non-Industry Experience	0.27	0.55	1.27	1.00	1.23	81,603
Log Adj. Experience (*EXPERIENCE*)	−1.24	−0.57	0.23	−0.47	0.94	81,603
Log Adj. Industry Experience *(INDEXP)*	−0.88	−0.46	0.17	−0.38	0.85	81,603
Log Adj. Non Industry Experience *(NONINDEXP)*	−1.22	−0.56	0.23	−0.48	0.96	81,603
Industry–Firm–Year Level Conditional on One Investment in Industry-Year						
Overall Experience	10	25	58	45.05	55.44	14,816
Industry Experience	1	4	12	9.67	14.74	14,816
Specialization	0.07	0.19	0.32	0.23	0.20	14,816
Adjusted Overall Experience	0.45	0.96	1.97	1.52	1.64	14,816
Adjusted Industry Experience	0.39	1.12	2.57	1.94	2.48	14,812
Adjusted Non-Industry Experience	0.41	0.92	1.95	1.48	1.65	14,816
Log Adj. Experience (EXPERIENCE)	−0.7720	−0.0218	0.6893	−0.0295	0.9713	14,816
Log Adj. Industry Experience (INDEXP)	−0.5664	0.0965	0.7659	0.0863	0.9508	14,816
Log Adj. Non Industry Experience (NONINDEXP)	−0.8707	−0.0793	0.6542	−0.1249	1.0613	14,816
Deal-Level						
Overall Experience	13	33	75	58.33	68.77	31,267
Industry Experience	3	9	22	17.25	22.71	31,267
Specialization	0.14	0.26	0.40	0.29	0.21	31,267
Adjusted Overall Experience	0.53	1.28	2.72	1.98	2.09	31,267
Adjusted Industry Experience	0.78	1.91	3.95	2.89	3.11	31,262
Adjusted Non-Industry Experience	0.39	1.07	2.44	1.76	2.02	31,267
Log Adj. Experience (EXPERIENCE)	−0.60	0.23	0.97	0.18	1.02	31,267
Log Adj. Industry Experience (INDEXP)	−0.20	0.53	1.20	0.48	0.97	31,267
Log Adj. Non Industry Experience (NONINDEXP)	−0.77	0.12	0.89	0.02	1.16	30,294

Panel C: Sample characteristics by year

1980						
Overall Experience	6	9	16	11.74	8.05	1,167
Adjusted Overall Experience	0.51	0.77	1.36	1.00	0.69	1,167
Industry Experience	0	1	2	1.19	1.90	1,167
Adjusted Industry Experience	0.00	0.39	1.38	1.00	1.61	1,167
Specialization	0.00%	1.61%	14.29%	8.84%	13.61%	1,167

Table 1 *(continued)*

1985						
Overall Experience	7	12	30	23.11	26.32	3,639
Adjusted Overall Experience	0.30	0.52	1.30	1.00	1.14	3,639
Industry Experience	0	1	3	2.73	5.86	3,639
Adjusted Industry Experience	0.00	0.33	1.30	1.00	1.92	3,639
Specialization	0.00%	3.66%	17.65%	11.35%	16.43%	3,639
1990						
Overall Experience	8	18	40	31.88	38.73	4,876
Adjusted Overall Experience	0.25	0.56	1.25	1.00	1.21	4,876
Industry Experience	0	1	4	3.80	8.04	4,876
Adjusted Industry Experience	0.00	0.31	1.44	1.00	1.73	4,876
Specialization	0.00%	4.76%	18.31%	11.69%	16.35%	4,876
1995						
Overall Experience	9	19	49	37.29	48.59	5,000
Adjusted Overall Experience	0.24	0.50	1.30	0.99	1.29	5,000
Industry Experience	0	1	4	4.49	9.91	5,000
Adjusted Industry Experience	0.00	0.26	1.28	1.00	1.81	5,000
Specialization	0.00%	4.35%	18.52%	11.77%	16.98%	5,000

Panel A shows the distribution of the sample by industry. There are 13,785 unique companies and 32,085 unique venture capital (VC) firm-company pairs. This is the only panel in the paper where investments in the "All Others" category are used.
Panels B and C summarize characteristics of venture capital firms in the sample. The unit of observation is VC firm f in industry g in year t. VC firms are included in the years after they reach a total of three prior investments and excluded in the years after their final investment in the sample is made. The table then presents the same statistics, further restricted to those industries and years where the VC firms actually made a new investment. It also shows these characteristics in four selected years. Statistics include investments from 1975 to 1998, inclusive, and exclude the industry category "All Others." *Overall Experience* is the number of investments made by VC firm f prior to year t. *Adjusted Overall Experience* is the ratio of the number of investments made by VC firm f prior to year t and the average of the number of investments made by all VC firms prior to year t. *Adjusted Log Overall Experience (EXPERIENCE)*, which we use in our regression analyses, is the difference between the log of one plus the number of investments made by VC firm f prior to year t and the log of one plus the average of the number of investments made by all firms prior to year t. *Industry Experience* is the number of investments made by VC firm f in industry g prior to year t. *Non-Industry Experience* is the number of investments made by VC firm f in industries other than g $(\sim g)$ prior to year t. Adjusted industry and non-industry experience measures are computed following the template of the adjustments of Overall Experience. *Adjusted Log Industry Experience* (*INDEXP*) and *Adjusted Log Non-Industry Experience (NONINDEXP)* are computed following the analogous procedure to the construction of *Adjusted Log Overall Experience*. *Specialization* is the number of investments made by VC firm f in industry g divided by the number of investments made by the VC firm in total prior to year t.

The final challenge is to measure the characteristics of the venture capital groups in the sample. The second panel of Table 1 presents data on the three characteristics of venture capital firms that we use throughout the paper. The first characteristic, "Overall Experience," is the total number of investments made by a venture capital firm prior to the time of the investment in question. The second characteristic, "Industry Experience," is constructed similarly, but includes only investments in the same industry as the investment in question. The third characteristic, "Specialization," is the fraction of all previous investments that the venture capital organization made in a particular industry, that is, the ratio of industry to overall experience. Throughout the paper, we use all prior investments by the venture capital firm to compute these measures, regardless of whether the investment is made by the current or a previous fund.[3]

2.3. Summary statistics

Panel B of Table 1 summarizes the data on the overall experience, industry experience, and specialization measures. In the first part of Panel B, we use as observations the annual activity of each active venture capital firm in each industry where they could have potentially invested. Thus, each observation in the analysis is at the venture capital firm-industry-year level, with a firm active from 1995 to 1998 contributing 32 observations (4 years x 8 industries). Many of these observations include industries in which the venture capital firm did not

[3]Venture organizations typically raise new funds every three to five years.

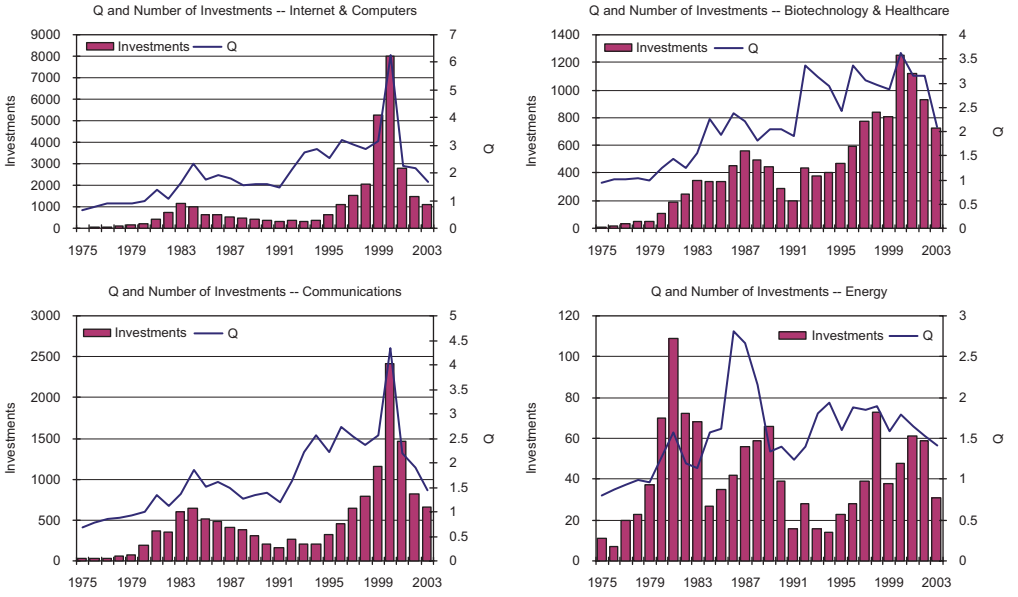

Fig. 1. Q and number of investments for selected industries. The graphs show years on the x-axis, the number of venture investments in the industry as bars calibrated on the right y-axis, and Q as a line calibrated on the left y-axis.

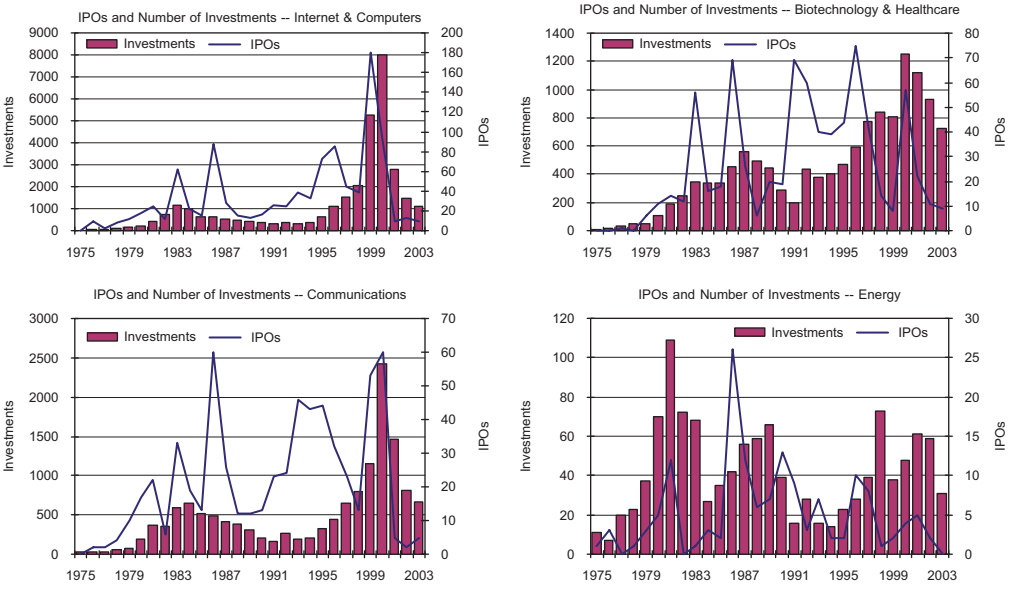

Fig. 2. IPOs and number of investments for selected industries. The graphs show years on the x-axis, the number of venture investments in the industry as bars calibrated on the right y-axis, and the number of IPOs as a line calibrated on the left y-axis.

invest. We analyze both the decision not to invest in an industry as well as a subsample that only includes firms that were investors in an industry in a given year. We analyze this subsample in part because some venture capital firms may not have the expertise or investment charter to invest in an industry regardless of how attractive the opportunity may seem. We would expect these firms to be less responsive to signals of investment opportunities in those industries. Data on this subsample are presented in the second part of Panel

B. Finally, in the last part of Panel B we summarize the data at the deal level, that is, at the level of the investment made by the venture capital firm.

In the first part of Table 1, Panel B—analyzed at the venture capital firm-industry-year level—the average venture capital firm invested in 29.9 prior companies, 3.56 of which were in the industry of the observation. As noted, many of the observations are in industries in which the venture capital firm has chosen not make any investments. Thus, it is not surprising that the average level of industry experience is quite low. The corresponding average level of specialization is also quite low for the same reason. When we condition on venture capital firms that make an investment in the industry, as we do in the second part of Panel B, we see that average Overall Experience and average Industry Experience increase to 45.1 and 9.7, respectively. The numbers are even higher in the last part of Panel B where we look at averages at the deal level. The average venture capital investment is undertaken by a venture capital firm that has conducted 58.3 prior deals, 17.3 of which are in the same industry as the investment.

One feature of these experience measures is that they will grow mechanically over time. Because the venture industry in 1998 is much more mature than it was in 1975, firms should have a lot more experience in the latter part of the sample. Thus, we construct and present a measure of experience that controls for the general increase in experience over time. A venture capital firm's Adjusted Experience in year t normalizes Overall Experience by the average Overall Experience of active venture capital firms in year t. Specifically, Adjusted Experience is measured as the number of investments that the venture firm made prior to year t divided by the average number of investments that active venture firms made prior to year t. (Overall Experience is averaged across all firms active in a year, with one observation per firm-year entering the calculation.) Likewise, we compute Adjusted Industry Experience and Adjusted Non-Industry Experience by normalizing by their respective annual averages. Once we make these adjustments, there is no time trend in the adjusted experience levels. There are fewer observations in the rows that include industry measures because the sample begins with data from 1974. For several industries, there were no investments in 1974, and thus the average industry experience for those industries is zero. Since we are dividing by the annual average to calculate industry experience, the adjusted industry measure is missing for those observations. One can see, however, from the last part of Panel B that the average venture capital investment is undertaken by a firm that has close to twice the average level of overall experience of active venture capital firms and nearly three times the average level of industry experience. This indicates that more experienced venture capital firms are also making more investments.

Table 1, Panel C presents the experience and specialization variables for four years of the sample; namely, 1980, 1985, 1990, and 1995, at the venture capital firm–industry–year level. As would be expected, overall and industry experience increase over time. Specialization increases from 1980 to 1985, but is at the same level in 1990 and 1995 as it was in 1985.

Table 2 breaks out venture capital firm characteristics by quartile (Panel A) and examines the relation among them (Panel B). The unit of observation is one for each venture capital (VC) firm f in industry g in year t. Overall experience quartiles are calculated for each year, and industry experience and specialization quartiles are calculated separately for each industry and year so that industries with fewer investments are not disproportionately sampled in lower quartiles and the highest experience quartiles do not disproportionately reflect later investments. As with the remainder of the paper, the first quartile represents the least experienced or specialized firms, while the fourth quartile represents the most experience or specialized firms. Panel A of Table 2 shows that, not surprisingly, venture capital firms in the higher quartiles of industry experience have made more investments overall than firms in lower quartiles of industry experience and those with the most overall experience have the most industry experience. The venture capital firms with most overall experience are also the least specialized (26% vs. 34%), while those with the most industry experience are the most specialized (35% vs. 14%).

In Panel B of Table 2, we present correlations among the main variables in our study. We find that there is a high correlation between industry experience and overall experience, regardless of whether we use the unadjusted or adjusted experience measures. Specialization, on the other hand, is not highly correlated with the experience measures; in fact, it is negatively correlated with overall experience (adjusted or not). This pattern probably arises because specialization limits the pool of investments from which a venture capital firm can choose and because firms with fewer prior deals are, by construction, less likely to have invested in a wide variety of industries.

Table 2
Venture capital firm characteristics

Panel A: Investor characteristics by quartile

		Experience		Industry Experience		Specialization		Success
	N	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean
Experience Quartile (Within Year)								
1	6,424	7.98	3.56	3.29	3.17	34.08%	0.2836	53.2%
2	6,920	21.02	10.17	7.53	6.45	31.04%	10.1677	53.8%
3	7,368	42.97	20.15	13.44	10.75	28.21%	6.4528	54.6%
4	10,555	124.17	81.82	34.79	30.27	26.11%	0.2314	57.7%
Industry Experience Quartile (Within Industry Year)								
1	6,242	14.87	16.73	1.52	1.46	14.36%	0.1690	49.9%
2	5,909	24.58	24.01	5.46	2.97	30.36%	0.2267	52.8%
3	7,514	42.60	35.31	11.55	6.53	32.87%	0.2169	54.0%
4	11,602	109.10	84.61	35.42	28.32	34.58%	0.1863	57.0%
Specialization Quartile (Within Industry Year)								
1	5,862	43.05	56.29	5.05	8.69	8.51%	0.0800	49.9%
2	7,201	75.98	78.50	17.21	20.83	20.67%	0.0973	56.1%
3	8,887	76.09	79.56	24.13	29.38	28.71%	0.1244	56.7%
4	9,317	37.38	44.15	18.41	19.62	49.73%	0.2271	53.3%
All Deals	31,267	58.33	68.77	17.25	22.71	29.33%	0.2131	55.2%

Panel B: Correlations

($N = 30{,}294$)	Experience	Industry Experience	Specialization	EXPERIENCE	INDEXP	NONINDEXP
Experience	1.00					
Industry Experience	0.81	1.00				
Specialization	−0.05	0.32	1.00			
EXPERIENCE	0.81	0.65	−0.09	1.00		
INDEXP	0.68	0.71	0.30	0.82	1.00	
NONINDEXP	0.76	0.52	−0.36	0.94	0.63	1.00

The unit of observation is VC firm *f*'s initial investment in portfolio company *c*. Panel A presents data on quartiles of *Overall Experience*, *Industry Experience*, and *Specialization*. Quartiles are constructed at the beginning of each calendar year based on the values at the end of the previous year for each active VC firm. *Industry Experience* and *Specialization* quartiles are calculated separately for each industry, so that industries with fewer investments are not disproportionately sampled in lower quartiles. The first quartile includes the least experienced or specialized VC firms, while the fourth quartile includes the most experienced or specialized VC firms. *Success* is a binary variable that equals one if the portfolio company was acquired, merged, in registration for an IPO, or went public by the end of 2003, and equals zero otherwise. Panel B presents data on the correlations between *Overall Experience*, *Industry Experience*, and *Specialization.* All correlations are significant at the 5% level.

Table 3 presents a summary of how venture capital activity varies with public market signals of investment opportunities. In the first part of the table we divide the 24 years into four quartiles based on Q in the previous year. (Hence, observations of "Internet & Computers" activity in six years will be assigned to each of the four quartiles.[4]) The total number of investments is greater in higher quartiles of Q as are the number of active venture capital firms. The average number of investments made by active venture capital firms (conditional on at least one investment) also tends to increase with Q quartiles, as does Adjusted Overall Experience and Adjusted Industry Experience.

[4]The numbers of investments and venture capital groups are not the same in each quartile, because the number of venture groups changes over time: the years with many IPOs and high Q are concentrated at the end of the sample, when many more venture groups were active.

Table 3
Summary statistics by Q and IPO quartile

	Quartiles of Industry Q				
	1	2	3	4	All
Total Investments by VC Firms	1,313	7,477	10,349	12,128	31,267
Number of Active VC Firms	80	419	528	673	1,084
Average Number of Investments by VC Firms per Industry per Year	0.34	0.37	0.41	0.37	0.38
Average Number of Investments by VC Firms per Industry per Year, Conditional on one Industry Investment	1.57	1.95	2.05	2.37	2.11
Average Adj. Experience in Year of VC Firms Investing in Year	1.176	1.857	1.974	2.146	1.979
Average Adj. Industry Experience in Year of VC Firms Investing in Year	2.687	2.842	2.805	3.025	2.894
Average Adj. Specialization of VC Firms Investing in Year, Conditional on one Industry Investment	0.214	0.258	0.287	0.329	0.293
	Quartiles of Detrended Industry IPO Activity				
	1	2	3	4	All
Total Investments by VC Firms	5,733	10,481	7,489	7,564	31,267
Number of Active VC Firms	424	427	425	424	1,084
Average Number of Investments by VC Firms per Industry per Year	0.28	0.51	0.37	0.37	0.38
Average Number of Investments by VC Firms per Industry per Year, Conditional on one Industry Investment	1.83	2.11	2.21	2.29	2.11
Average Adj. Experience in Year of VC Firms Investing in Year	2.00	2.05	1.92	1.92	1.98
Average Adj. Industry Experience in Year of VC Firms Investing in Year	2.92	2.86	2.89	2.92	2.89
Average Adj. Specialization of VC Firms Investing in Year, Conditional on one Industry Investment	0.27	0.31	0.31	0.28	0.29

The first part of the table presents data on quartiles of Industry Q. Quartiles are constructed for each industry, with the lowest quartile being the six years with the lowest values of Q for that industry. The second part of the table presents data on quartiles of Detrended Industry IPO Activity. Detrended Industry IPO Activity is the residual of a regression of the logarithm of one plus the number of IPOs in an industry on a time trend. The first quartile represents the lowest level of Detrended Industry IPO Activity.

The second part of the table constructs public market signal quartiles by detrending industry IPO activity. We detrend because IPOs increase over time with the general increase in the scale of the stock market. As this part of the table shows, there is no clear linear relation between the total number of investments and quartiles of detrended IPO activity, although the number of investments is lowest in the lowest quartile of detrended IPO activity. A similar pattern obtains in the average number of investments by venture capital firms across detrended IPO quartiles, and in the experience and specialization measures.

3. Analysis

3.1. The determinants of investments

We now focus on understanding the relation between public market signals and the investment decisions of venture capitalists. In Section 3.2, we turn to understanding the determinants of investment success.

Table 4
Impact of public market signals

Dependent variable	(1) Industry Investments	(2) Industry Investments	(3) Industry Investments	(4) Industry Investments
Model	Panel regression	Corrected for AR (1)	OLS	OLS
Lagged Q	0.3303		0.1717	
	[*2.81*]***		[*2.11*]**	
Lagged IPOs		0.0417		0.0377
		[*0.93*]		[*0.98*]
Lagged Industry Investments			0.6416	0.6516
			[*12.40*]***	[*12.14*]***
Industry Fixed Effects	No	No	Yes	Yes
Year Fixed Effects	No	No	Yes	Yes
Adj. *R*-squared			96.47%	96.39%
N	192	192	184	184

The sample consists of yearly observations with one observation per industry per year for 1975–1998, inclusive. The dependent variable is the log of the number of investments made by all VC firms in industry g in year t. *Lagged IPOs* is the log of the number of initial public offerings (IPOs) of venture-backed companies in industry g in year $t-1$. *Lagged Q* is the lagged average ratio of the market value of the firm to the book value of assets for companies in the same industry. More details on the construction of this variable are provided in the text. *Industry Investments* is the dependent variable. Controls in some regressions include industry and year fixed effects. Specifications 1 and 2 fit a general linear model specifying an AR (1) correlation structure for the industry panels.
***, **, * Indicate statistical significance at the 1%, 5%, and 10% level, respectively.

To validate the use of Q and IPO activity as measures of perceived investment opportunities, Table 4 presents a regression-based analysis of the relation between public market signals and investment at the industry level. The dependent variable is the logarithm of the total number of investments made in an industry in a year plus one. The first column shows the results where lagged Q is the regressor. We include industry and year fixed effects in this regression.

In the first and second columns, we fit a general linear model specifying an AR(1) within-group correlation structure for the panels, where the panels are industries. The coefficient estimate implies that an increase in Q from the bottom to the top quartile increases the number of investments by almost 30%. Although the coefficient for IPOs is positive as well, it is not statistically significant. In the final two columns, we add an industry-specific AR(1) term to the specifications. This approach is also motivated by the concern that both the dependent and independent variables may be serially correlated. Both coefficients continue to take on the expected positive sign. The coefficient for lagged IPOs is again no longer statistically significant. Lagged Q, however, is statistically significant, with a coefficient estimate implying that an increase in Q from the bottom to the top quartile increases the number of investments by more than 15%.

Table 5 presents our findings on the relation between venture capital firm characteristics, public market signals, and investment behavior. The analysis is conducted at the venture capital firm–industry–year level. Thus, for each active venture capital firm there are eight observations per year corresponding to the eight industries. The dependent variable is the log of one plus the number of investments made by venture capital firm f in industry g in year t.

The public market signal (PM signal) is either *Lagged Q,* the average Q in industry g in year $t-1$, or *Lagged IPOs,* the log of the number of initial public offerings (IPOs) of venture-backed companies in industry g in year $t-1$. The basic results are the same using both measures. Our measure of experience is the log of one plus experience minus the log of one plus average experience in the year of the investment. Like the adjusted experience variables summarized in Table 1, this measure adjusts for the positive time trend in experience. It also transforms the experience measure into logs because an additional deal for the least experienced firms is likely to be a more meaningful increase in experience than an additional deal for the most experienced firms. (Of course, we add one to the experience measure to avoid taking logs of zero). We refer to this variable as *EXPERIENCE,* where the upper case letters indicate that we are using the adjusted log measure. Likewise, we use an adjusted log measure for industry experience and non-industry experience, referred to, respectively, as

Table 5
Investment patterns (no interactions)

Dependent variable	(1) Firm Industry Investment	(2) Firm Industry Investment	(3) Firm Industry Investment	(4) Firm Industry Investment	(5) Firm Industry Investment	(6) Firm Industry Investment	(7) Firm Industry Investment	(8) Firm Industry Investment
PM Measure	*Q*	*Q*	*Q*	*Q*	*Q*	*Q*	IPOs	IPOs
PM Measure	0.0430	0.0430	0.0483	0.0485	0.0430	0.0430	0.0230	0.0200
	[*8.94*]***	[*8.70*]***	[*9.50*]***	[*8.99*]***	[*8.94*]***	[*8.69*]***	[*11.00*]***	[*9.84*]***
EXPERIENCE		0.0520				0.0523		0.0524
		[*16.04*]***				[*16.19*]***		[*16.20*]***
INDEXP			0.0727	0.0852			0.0727	
			[*19.80*]***	[*23.72*]***			[*19.85*]***	
NONINDEXP			0.0133	−0.0200			0.0133	
			[*4.74*]***	[*8.40*]***			[*4.73*]***	
SPECIALIZATION					−0.0003	0.0019		0.0019
					[*0.31*]	[*2.06*]**		[*2.12*]**
Lagged Firm Industry Invest.	0.5236	0.4897	0.4427	0.3936	0.5239	0.4877	0.4418	0.4869
	[*42.80*]***	[*47.03*]***	[*43.51*]***	[*40.17*]***	[*41.51*]***	[*45.86*]***	[*43.35*]***	[*45.74*]***
Lagged Firm Non Industry Invest.				0.0752				
				[*28.13*]***				
Fixed Effects:	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year
Adj. *R*-squared	37.03%	38.19%	38.91%	40.33%	37.03%	38.20%	38.90%	38.18%
N	81,509	81,509	81,509	81,509	81,509	81,509	81,509	81,509

The unit of observation is VC firm *f* in industry *g* in year *t*. The dependent variable is the log of one plus the number of investments made by VC firm *f* in industry *g* in year *t*. The public market measure (PM Measure) is either *Lagged Q* or *Lagged IPOs. Lagged Q* is the lagged average ratio of the market value of the firm to the book value of assets for companies in the same industry. More details on the construction of this variable are described in the text. *Lagged IPOs* is the log of one plus the number of initial public offerings (IPOs) of venture-backed companies in industry *g* in year *t*−1, *EXPERIENCE* is the difference between the log of one plus the number of investments made by VC firm *f* prior to year *t* and the log of one plus the average of the number of investments made by all firms prior to year *t*. *INDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* in industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms in industry *g* prior to year *t*. *NONINDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* outside industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms outside industry *g* prior to year *t*. *SPECIALIZATION* is the number of investments made by VC firm *f* in industry *g* divided by the number of investments made by VC firm *f* in total prior to year *t* divided by the average of the same figure for all VC firms in year *t*. *Lagged Firm Industry Invest.* is an AR(1) term, which is the firm's experience in that industry in the previous year. Similarly, *Lagged Firm Industry Non Industry Invest.* is the firm's experience in all other industries in the previous year. Regressions include industry and year fixed effects. *T*-statistics in italics below coefficient estimates are based on robust errors allowing for data clustering by VC firm.
***, **, * Indicate statistical significance at the 1%, 5%, and 10% level, respectively.

INDEXP and *NONINDEXP*. Each specification includes *Lagged Firm Industry Investments,* an AR(1) term that is the number of investments made by venture capital firm *f* in industry *g* in year *t*−1. This term adjusts for autocorrelation, and is also interesting in its own right as it is the firm's most recent industry experience. Finally, the specialization variable we use in the regressions is adjusted for industry and year effects. Thus, our adjusted specialization variable subtracts the average level of specialization in an industry and year. We call this adjusted specialization variable *SPECIALIZATION*. These variables are summarized in Panel B of Table 1.

In all specifications, we include both industry and year fixed effects. The *t*-statistics are given in italics below the coefficient estimates and are based on robust errors allowing for data clustering by venture capital organization.

The first column of Table 5 repeats the industry-level regression in Table 4, with the unit of observation being VC firm *f* in industry *g* in year *t*. Not surprisingly, the regression indicates that venture capital firms tend

to increase their investments in years and industries in which lagged *Q* is high. The coefficient of 0.043, which is statistically significant, implies that an increase in IPO activity from the 25th percentile to the 75th percentile boosts the venture capital firm's investment activity in the industry by 3.8%. As the second column of Table 5 indicates, there is also a strong positive relation between *EXPERIENCE* and investment activity. The coefficient estimate indicates that at the 75th percentile of *EXPERIENCE* venture capital firms invest 16% more than at the 25th percentile of *EXPERIENCE*. The third column breaks out *EXPERIENCE* into *INDEXP* (our adjusted log industry experience variable) and *NONINDEXP* (our adjusted non-industry log experience variable). The regression indicates that what drives the relation with *EXPERIENCE* is actually the component that is related to *INDEXP*. Prior investment activity outside the industry has a much weaker relation with within-industry investment activity. The average venture capital firm in the highest quartile of industry experience (that is, at the 75th percentile) invests 7.6% more in the industry than a firm in the lowest quartile (at the 25th percentile) of industry experience.[5] This difference is understated since it excludes the impact of the pervious year's industry experience (the AR(1) term), which has a coefficient of 0.44.

Column 4 adds *Lagged Firm Non-Industry Investments*, which is the number of investments made by venture capital firm *f* in industries other than *g* in year $t-1$. Since the firm's most recent investing experience is highly relevant to investments, this measure parallels the AR(1) term but includes only the previous year's number of investments in other industries. Industry experience continues to be positively related to industry investment activity and non-industry experience has a statistically significant negative relation with industry investment. Comparing the coefficients on the previous year's investments, the effect of industry experience is almost five times that of non-industry experience.

Columns 5 and 6 of Table 5 add industry specialization to the regressions. In column 5, there is no relation between future investment in an industry and specialization. Once we control for experience (recall that specialized firms tend to be less experienced), however, we observe a significant (if modest) pattern: the results in column 6 indicate that an organization in the top industry specialization quartile makes 0.25% more investments in the industry than one in the bottom quartile. Finally, the last two columns of Table 5 replicate the results in columns 3 and 6 using IPO activity rather than *Q* as the measure of the public market. The basic patterns continue to hold in these regressions, and the magnitude of the effects is similar.

The next two tables present our main results on how venture capital firms with different characteristics respond to changes in public market signals of investment opportunities. In Table 6, we add to the specifications in Table 5 variables that interact our public market signals with our measures of venture capital firm characteristics. Throughout our discussion of the results, when we refer to periods with high *Q* we are referring to those at the top quartile (75th percentile) of lagged Q; low *Q* refers to those periods at the bottom quartile (25th percentile). Likewise, high values of EXPERIENCE, INDEXP, and SPECIALIZATION refer to venture capital firms at the top quartile, while those with low values of these variables refer to those VC firms at the bottom quartile.

The first column of Table 6 indicates that the coefficient on the interaction term EXPERIENCE * *Q* is positive and statistically significant, meaning that the industry investment activity of more experienced venture capital firms is more sensitive to *Q* than it is for less experienced venture capital firms. At the mean of the other variables, experienced venture capital organizations (again, where experience is defined as a firm at the 75th percentile in adjusted log experience) invest 5.5% more when *Q* activity is high (at the 75th percentile) than when it is low (at the 25th percentile). By contrast, relatively inexperienced venture capital firms (those at the 25th percentile of in adjusted log overall experience) invest only slightly more (1.5% more) when *Q* is high

[5]One might have thought that experience in another industry would also have been an important explanation for two reasons. First, the most experienced venture capital firms tend to have the greatest access to financial capital. They may already have raised large funds or they may have established reputations and networks that enable them to raise additional capital easily. Second, firms with the most overall experience may have access to a large pool of human capital that they can redeploy across sectors. That is, one might think of venture capital firms as having an internal labor market to complement an internal capital market. However, our finding that industry experience is the key driver of investment activity suggests that it is not easy to redeploy venture capitalists across sectors. This would be the case if human capital that specializes in a given industry, say biotechnology, was unable or unwilling to shift focus to a different industry, say, the Internet. This prediction is in line with the view that diversified firms have a difficult time redeploying capital into sectors with more investment opportunities: see Scharfstein and Stein (1990), Scharfstein (1998), and Rajan, Servaes, and Zingales (2000). Fulghieri and Sevilir (2004) model some of these issues in a venture capital context.

Table 6
Investment patterns (includes interactions of IPOs)

Dependent variable	(1) Firm Industry Investment	(2) Firm Industry Investment	(3) Firm Industry Investment	(4) Firm Industry Investmen	(5) Firm Industry Investment	(6) Firm Industry Investment	(7) Firm Industry Investment	(8) Firm Industry Investment	(9) Firm Industry Investment
PM Measure	*Q*	*Q*	*Q*	*Q*	*Q*	*Q*	*Q*	IPOs	IPOs
PM Measure	0.0611 [*10.05*]***	0.0709 [*10.85*]***	0.0531 [*9.18*]***	0.0672 [*10.04*]***	0.0715 [*10.39*]***	0.0297 [*5.89*]***	0.0466 [*7.48*]***	0.0346 [*12.58*]***	0.0274 [*9.74*]***
EXPERIENCE	−0.0115 [*1.58*]						−0.0119 [*1.62*]		−0.0250 [*5.35*]***
INDEXP		−0.0012 [*0.15*]		−0.0252 [*2.95*]***	−0.0120 [*1.45*]			−0.0405 [*5.86*]***	
NONINDEXP			0.0109 [*1.52*]	0.0396 [*5.42*]***	−0.0090 [*1.22*]			0.0157 [*3.60*]***	
SPECIALIZATION						−0.0218 [*6.17*]***	−0.0220 [*6.30*]***		−0.0124 [*6.11*]***
EXPERIENCE * PM Measure	0.0340 [*7.62*]***						0.0345 [*7.71*]***		0.0308 [*12.30*]***
INDEXP * PM Measure		0.0416 [*9.57*]***		0.0495 [*11.63*]***	0.0490 [*11.50*]***			0.0385 [*15.09*]***	
NONINDEXP * PM Measure			0.0165 [*3.65*]***	−0.0139 [*3.26*]***	−0.0060 [*1.40*]			−0.0004 [*0.18*]	
SPECIALIZATION * PM Measure						0.0133 [*6.32*]***	0.0148*** [*7.10*]		0.0081*** [*7.50*]
Lagged Firm Industry Investments	0.4871 [*48.12*]***	0.4403 [*44.10*]***	0.5035 [*47.75*]***	0.4429 [*43.75*]***	0.3934 [*40.75*]***	0.5222 [*41.17*]***	0.4828 [*46.71*]***	0.4352 [*43.64*]***	0.4683 [*46.49*]***
Lagged Firm Non Nonindustry Invest.					0.0762 [*28.21*]***				
Controls:	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year	Industry Year
Adj. *R*-squared	38.37%	39.11%	37.91%	39.20%	40.65%	37.10%	38.47%	39.37%	38.75%
N	81,509	81,509	81,509	81,509	81,509	81,509	81,509	81,509	81,509

The unit of observation is VC firm *f* in industry *g* in year *t*. The dependent variable is the log of one plus the number of investments made by VC firm *f* in industry *g* in year *t*. The public market measure (PM Measure) is either *Lagged Q* or *Lagged IPOs*. *Lagged Q* is the lagged average ratio of the market value of the firm to the book value of assets for companies in the same industry. More details on the construction of this variable are described in the text. *Lagged IPOs* is the log of one plus the number of initial public offerings (IPOs) of venture-backed companies in industry *g* in year *t*−1. *EXPERIENCE* is the difference between the log of one plus the number of investments made by VC firm *f* prior to year *t* and the log of one plus the average of the number of investments made by all firms prior to year *t*. *INDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* in industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms in industry g prior to year *t*. *NONINDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* outside industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms outside industry *g* prior to year *t*. *SPECIALIZATION* is the number of investments made by VC firm *f* in industry *g* divided by the number of investments made by VC firm *f* in total prior to year *t* divided by the average of the same figure for all VC firms in year *t*. *Lagged Firm Industry Invest.* is an AR(1) term, which is the firm's experience in that industry in the previous year. Similarly, *Lagged Firm Industry Non Industry Invest.* is the firm's experience in all other industries in the previous year. Regressions include industry and year fixed effects. *T*-statistics in italics below coefficient estimates are based on robust errors allowing for data clustering by VC firm.

***, **, * Indicate statistical significance at the 1%, 5%, and 10% level, respectively.

than when it is low. The results also indicate that *EXPERIENCE* increases the level of investment, not just the sensitivity of investment to *Q*.

In columns 2–4, we repeat the analysis, but decompose EXPERIENCE into its industry and non-industry components. The results in column 2 indicate that more industry-experienced venture capital firms invest 6.2% more when *Q* is high than when it is low. By contrast, less industry-experienced venture capital firms invest 2.7% more. When both experience measures are included, the investment of more industry-experienced firms continues to be more sensitive to *Q* than is the investment of less industry-experienced firms. Experience outside the industry appears to reduce the sensitivity to industry *Q* as implied by the negative coefficient of the interaction term *NONINDEXP* * *Q*.

The fifth column again adds a term with the previous year's non-industry experience to the specification. The cumulative impact of industry and non-industry experience is muted by the fact that much of the relevant experience is captured by the previous year's experience. When *Q* is high, industry-experienced venture capital firms with relatively low experience out of the industry invest 2.0% more than when it is low, while venture capital firms with high experience out of the industry, but low experience *within* the industry, invest only 0.8% more when *Q* is high. Again, these differences are much greater including the impact of the previous year's industry and non-industry experience.

The sixth and seventh columns of Table 6 look at the effect of industry specialization on investment behavior. Consistent with our findings about industry experience, we find that more specialized venture capital firms tend to increase their industry investments by more than less specialized firms when *Q* increases. The effect, however, is small in column 6, implying an increase in investment by 3.8% for specialized firms and 2.4% for less specialized firms. When overall experience and specialization are used in column 7, both interactions terms continue to be economically and statistically significant.

Finally, the last two columns in Table 6 report the results using IPO activity as an alternative public market measure. Those columns replicate the basic findings in columns 4 and 7 of the table. The magnitude of the effects is similar to those estimated using *Q*.

A natural question to ask is why less experienced venture capitalists do not scale up their investment in a sector as much as more industry-experienced venture capitalists when investment opportunities appear to be more attractive. We believe that this pattern reflects a crowding out effect: the less experienced venture capitalists may wish to invest in the sector as well, but cannot get a "seat at the table" in the transactions being completed. While ultimately the supply of transactions in a given sector may adjust to accommodate demand, in the short run there may be intense competition for transactions.[6]

In Table 7, we check whether our results are driven by venture capital firms that choose not to invest in a given industry. Thus, we eliminate from the regressions all observations in which the venture capital firm made no investments in the industry in a year. All of the findings in Table 6 continue to hold, although the magnitude of the effects is in some cases smaller. Thus, in part this phenomenon is driven by less experienced firms "opting out" of markets with substantial investment opportunities, but even those inexperienced venture capital firms that are still active reduce their level of activity.

Collectively, these results suggest that industry-specific experience (human capital) is an important channel through which venture capital firms respond to shifts in public market signals. Contrary to popular wisdom, it does not appear that booms and busts are driven by the investment behavior of young, inexperienced venture capital firms. In fact, these results suggest that the cyclicality seen in the venture capital industry is driven mostly by the more successful venture firms, that is, those with the most experience. The next section, Section 3.2, attempts to address the question of whether the sensitivity of more experienced firms to public market signals is a rational reaction to fundamentals or an overreaction by examining these firms' history of success on their investments.

3.2. The determinants of investment success

In this section we explore whether the greater responsiveness of more experienced venture capital firms to public market signals is efficient or whether it is an overreaction to these signals. If these experienced firms

[6]This hypothesis is consistent with evidence in the venture industry of the phenomenon of "money chasing deals," that is, inflows of capital into venture funds driving valuations upwards (Gompers and Lerner, 2000).

Table 7
Investment patterns for organizations that made investments in that industry in that year

Dependent variable	(1) Firm Industry Investment (>0)	(2) Firm Industry Investment (>0)	(3) Firm Industry Investment (>0)	(4) Firm Industry Investment (>0)	(5) Firm Industry Investment (>0)	(6) Firm Industry Investment (>0)	(7) Firm Industry Investment (>0)	(8) Firm Industry Investment (>0)	(9) Firm Industry Investment (>0)
PM Measure	*Q*	*Q*	*Q*	*Q*	*Q*	*Q*	*Q*	IPOs	IPOs
PM Measure	0.1432	0.1473	0.1415	0.1410	0.1505	0.1134	0.1130	0.0662	0.0542
	[*10.94*]***	[*11.57*]***	[*10.75*]***	[*10.97*]***	[*11.57*]***	[*8.63*]***	[*8.50*]***	[*9.95*]	[*7.82*]***
EXPERIENCE	0.0151						0.0121		0.0095
	[*0.92*]						[*0.73*]		[*0.65*]
INDEXP		−0.0018		−0.0396	−0.0210			−0.0287	
		[*0.10*]		[*2.35*]**	[*1.26*]			[*1.78*]	
NONINDEXP			0.0360	0.0604	0.0062			0.0438	
			[*2.51*]**	[*4.24*]***	[*0.46*]			[*3.36*]	
SPECIALIZATION						−0.0224	−0.0309		−0.0096
						[*3.71*]***	[*5.36*]***		[*2.72*]***
EXPERIENCE *	0.0248						0.0301		0.0204
PM Measure	[*3.13*]***						[*3.68*]***		[*4.16*]***
INDEXP *		0.0409		0.0547	0.0554			0.0318	
PM Measure		[*4.92*]***		[*6.70*]***	[*6.86*]***			[*6.15*]	
NONINDEXP *			0.0054	−0.0229	−0.0168			−0.0100	
PM Measure			[*0.79*]	[*3.48*]***	[*2.60*]***			[*2.37*]	
SPECIALIZATION *						0.0155	0.0274		0.0107
PM Measure						[*3.75*]***	[*6.95*]***		[*6.23*]***
Lagged Firm Ind.	0.2727	0.2403	0.2907	0.2435	0.2068	0.3041	0.2557	0.2430	0.2536
Invest	[*26.82*]***	[*23.21*]***	[*27.28*]***	[*22.56*]***	[*21.59*]***	[*22.30*]***	[*23.44*]***	[*22.49*]	[*23.37*]***
Lagged Firm					0.0753				
Nonindustry Invest.					[*10.24*]***				
Fixed Effects:	Industry	Industry	Industry	Industry	Industry	Industry	Industry	Industry	Industry
	Year	Year	Year	Year	Year	Year	Year	Year	Year
Adj. *R*-squared	33.28%	33.82%	32.56%	33.96%	35.04%	31.47%	33.73%	33.61%	33.46%
N	14,795	14,795	14,795	14,795	14,795	14,795	14,795	14,795	14,795

The unit of observation is VC firm *f* in industry *g* in year *t conditional on the VC firm making at least one investment in the industry.* The dependent variable is the log of one plus the number of investments made by VC firm *f* in industry *g* in year *t*. The public market measure (PM Measure) is either *Lagged Q* or *Lagged IPOs. Lagged Q* is the lagged average ratio of the market value of the firm to the book value of assets for companies in the same industry. More details on the construction of this variable are described in the text. *Lagged IPOs* is the log of one plus the number of initial public offerings (IPOs) of venture-backed companies in industry *g* in year *t*−1. *EXPERIENCE* is the difference between the log of one plus the number of investments made by VC firm *f* prior to year *t* and the log of one plus the average of the number of investments made by all firms prior to year *t. INDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* in industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms in industry *g* prior to year *t. NONINDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* outside industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms outside industry *g* prior to year *t. SPECIALIZATION* is the number of investments made by VC firm *f* in industry *g* divided by the number of investments made by VC firm *f* in total prior to year *t* divided by the average of the same figure for all VC firms in year *t. Lagged Firm Industry Invest.* is an AR(1) term, which is the firm's experience in that industry in the previous year. Similarly, *Lagged Firm Industry Non Industry Invest.* is the firm's experience in all other industries in the previous year. Regressions include industry and year fixed effects. *T*-statistics in italics below coefficient estimates are based on robust errors allowing for data clustering by VC firm.***, **, * Indicate statistical significance at the 1%, 5%, and 10% level, respectively.

ramp up the number of investments they make in response to public market signals, but suffer a significant degradation of performance on these investments, their response may, in fact, be an overreaction. In addition to the practitioner accounts alluded to above, there are at least two reasons to believe this might be the case. First, Baker, Stein, and Wurgler (2003) show that industrial firms whose investment is most sensitive to Q have the lowest subsequent stock returns following periods of heavy investment. A similar effect might be observed among experienced venture capital firms whose investment is most sensitive to Q and IPO activity. Second, at the same time that venture capital firms are buying equity in portfolio companies, these companies are, of course, issuing equity. We know from numerous studies, including Loughran and Ritter (1995), that when firms (albeit public firms) issue equity, their subsequent stock returns are abnormally low.

To assess this question, we examine the performance of the companies in which the venture capital firms invest. Ideally, one would have data on the actual returns on the venture capital firm's investment. Unfortunately, the best we can do is to determine whether the investment resulted in what would appear to be a profitable exit for the venture capital firm. This is most likely the case if the company went public, registered for an IPO (as of the date we collected the data from Venture Economics), or was acquired or merged. Venture Economics does not collect valuation information for all of the companies that were merged or acquired and it is possible that these outcomes are not as lucrative as those where the company exited with a public offering. However, we characterize these as successes because they are likely to have generated higher returns than investments in which there has not been an exit or the firm has been shut down. (We also repeat the analysis below eliminating acquisitions in order to avoid these ambiguities.)

The final column of Table 2 provides some initial indications of the patterns of success by venture capital firm characteristics. The tabulations suggest that investments made by venture capital firms with more overall—and especially more industry-specific—experience are more successful. The patterns with specialization are not monotonic, with the most and least specialized venture capital firms appearing to be the poorest performers. However, one must be cautious in interpreting these univariate relations given the lack of controls for industry, time period, and (in the specialization analysis) experience.

Tables 8 and 9 examine the determinants of success in a regression framework. The dependent variable is a dummy variable, which equals one if the company was successful before the end of 2003. In addition to the industry and year controls used earlier, we also control for the stage of the company and the financing round at the time of the investment, since more mature firms are closer to an exit. As in our previous regressions, we exclude observations after 1998 in order for the outcomes of the investments to be meaningful. Here we are doing the analysis at the deal level. Because there are multiple observations for each portfolio company in the sample (due to the fact that multiple venture capital firms invest in the company), we calculate robust standard errors by clustering at the company level. In the discussion below, we define the high and low levels of EXPERIENCE, INDEXP, NONINDEXP, and SPECIALIZATION as the quartiles based on values that are on the 25th and 75th percentiles, where the unit of observation is VC firm f's initial investment in portfolio company c.

The first column of Table 8 suggests there is no statistically significant relation between success and Q in the sample as a whole. The second column of Table 8 indicates that more experienced venture capital firms are more likely to make successful investments. However, the third and fourth columns show that the effect of experience is limited to venture capital firms with industry experience. Investments made by venture capitalists with the top-quartile industry experience are 3% more likely to succeed than those made by the venture capitalists at the 25th percentile. Given a baseline success rate of 55%, this amounts to a fairly significant increase in the probability of success. In the regressions with industry specialization in columns 5 and 6, experience remains a critical determinant of success. Columns 7 and 8 replicate the results using IPO activity as our measure of the public market signal and report results of similar statistical significance and economic magnitude. Column 9 shows that the results are similar when denoting only IPOs as successful outcomes.

Table 8 makes clear that venture capital firms with industry experience do not perform worse, on average, as a result of being more sensitive to shifts in public market activities. Table 9 digs deeper by investigating whether experienced venture capital firms perform worse on the investments they make when industry Q and IPO activity are high. The results indicate that just the opposite is true. Overall, venture capital firms do somewhat worse on the investments they make when Q and IPO activity are high, although the estimated effect is statistically insignificant. However, the more experienced venture capitalists exhibit less degradation in

Table 8
Success

Dependent variable	(1) Success	(2) Success	(3) Success	(4) Success	(5) Success	(6) Success	(7) Success	(8) Success	(9) IPO
PM Measure	*Q*	*Q*	*Q*	*Q*	*Q*	*Q*	IPOs	IPOs	*Q*
PM Measure	−0.0249	−0.0251	−0.0246	−0.0266	−0.0248	−0.0248	−0.0179	−0.0164	−0.0270
	[*1.18*]	[*1.19*]	[*1.16*]	[*1.25*]	[*1.17*]	[*1.17*]	[*1.39*]	[*1.28*]	[*1.08*]
EXPERIENCE		0.0192				0.0197		0.0197	
		[*6.84*]***				[*6.88*]***		[*6.88*]***	
INDEXP			0.0238	0.0211			0.0213		0.0189
			[*7.64*]***	[*4.98*]***			[*5.04*]***		[*4.00*]
NONINDEXP				0.0038			0.0036		0.0006
				[*1.12*]			[*1.07*]		[*0.15*]
SPECIALIZATION					−0.0005	0.0018		0.0019	
					[*0.25*]	[*0.91*]		[*0.98*]	
Fixed Effects:	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year
Adj. *R*-squared	8.74%	8.90%	8.96%	9.03%	9.00%	8.90%	9.03%	8.90%	10.16%
N	31,267	31,267	31,267	30,294	31,262	31,262	30,294	31,262	20,256

The unit of observation is VC firm *f*'s initial investment in portfolio company *c*. The dependent variable is *Success,* which equals one if the portfolio company was acquired, merged, in registration for an IPO, or went public by the end of 2003, and equals zero otherwise. Controls include industry, investment stage, round number, and year fixed effects. *T*-statistics in italics below coefficient estimates are based on robust standard errors allowing for data clustering by venture capital organization. The public market measure (PM Measure) is either *Lagged Q* or *Lagged IPOs. Lagged Q* is the lagged average ratio of the market value of the firm to the book value of assets for companies in the same industry. More details on the construction of this variable are described in the text. *Lagged IPOs* is the log of one plus the number of initial public offerings (IPOs) of venture-backed companies in industry *g* in year *t*−1. *EXPERIENCE* is the difference between the log of one plus the number of investments made by VC firm *f* prior to year *t* and the log of one plus the average of the number of investments made by all firms prior to year *t*. *INDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* in industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms in industry *g* prior to year *t*. *NONINDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* outside industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms outside industry *g* prior to year *t*. *SPECIALIZATION* is the number of investments made by VC firm *f* in industry *g* divided by the number of investments made by VC firm *f* in total prior to year *t* divided by the average of the same figure for all VC firms in year *t*.
***, **, * Indicate statistical significance at the 1%, 5%, and 10% level, respectively.

their performance than do the less experienced venture capitalists. For instance, in column 3, for an industry experienced venture capital firm (again defined as one at the 75th percentile of venture capital firms making investments) at the median of non-industry experience, as we move from a market where *Q* is low to one where it is high the probability of success decreases by only a small amount (2%). For a venture capital firm with relatively little industry experience, the decline is much higher at 11%. Similarly, columns 4 and 5 show that more specialized firms experience less of a deterioration in performance in high *Q* markets. The patterns continue to hold when we use IPO activity as our measure of the public market signal (columns 7 and 8) and when denoting only IPOs as successful outcomes (column 9). (Acquisitions in some cases can generate very attractive returns to venture investors; while in other cases they yield only pennies for each dollar of invested capital.) Based on the results in Tables 8 and 9, it would be hard to argue that the greater responsiveness of experienced venture capital firms to IPO activity and *Q* comes at the expense of performance.

3.3. Robustness analyses

This section summarizes further analyses undertaken to determine whether our basic findings are robust. We first discuss two tables with additional regressions, and then turn to a variety of unreported regressions.

Table 9
Success (includes interactions)

Dependent variable	(1) Success	(2) Success	(3) Success	(4) Success	(5) Success	(6) Success	(7) Success	(8) IPO
PM Measure	*Q*	*Q*	*Q*	*Q*	*Q*	IPOs	IPOs	*Q*
PM Measure	−0.0238	−0.0256	−0.0331	−0.0347	−0.0374	−0.0250	−0.0261	−0.0362
	[*1.12*]	[*1.20*]	[*1.54*]	[*1.62*]	[*1.74*]	[*1.90*]*	[*1.98*]**	[*1.44*]
EXPERIENCE	0.0339				0.0297		0.0257	
	[*3.62*]***				[*3.13*]***		[*2.22*]**	
INDEXP		0.0197	−0.0030			−0.0276		−0.0160
		[*1.93*]*	[*0.22*]			[*1.76*]*		[*1.06*]
NONINDEXP			0.0318			0.0411		0.0389
			[*2.88*]***			[*3.17*]***		[*3.03*]***
SPECIALIZATION				−0.0130	−0.0151		−0.0105	
				[*2.49*]**	[*2.82*]***		[*2.91*]***	
EXPERIENCE * PM Measure	−0.0067				−0.0039		−0.0014	
	[*1.63*]				[*0.94*]		[*0.42*]	
INDEXP * PM Measure		0.0019	0.0118			0.0156		0.0169
		[*0.43*]	[*1.94*]*			[*3.28*]***		[*2.49*]**
NONINDEXP * PM Measure			−0.0132			−0.0120		−0.0179
			[*2.73*]***			[*3.10*]***		[*3.18*]***
SPECIALIZATION * PM Measure				0.0075	0.0102		0.0057	
				[*2.55*]**	[*3.32*]***		[*3.88*]***	
Controls:	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year	Industry Stage Round Year
Adj. *R*-squared	8.90%	8.96%	9.06%	8.76%	8.94%	9.08%	8.95%	10.22%
N	31,267	31,267	30,294	31,262	31,262	30,294	31,262	20,256

The unit of observation is VC firm *f*'s initial investment in portfolio company *c*. The dependent variable is *Success,* which equals one if the portfolio company was acquired, merged, in registration for an IPO, or went public by the end of 2003, and equals zero otherwise. Controls include industry, investment stage, round number, and year fixed effects. *T*-statistics in italics below coefficient estimates are based on robust standard errors allowing for data clustering by venture capital organization. The public market measure (PM Measure) is either *Lagged Q* or *Lagged IPOs. Lagged Q* is the lagged average ratio of the market value of the firm to the book value of assets for companies in the same industry. More details on the construction of this variable are described in the text. *Lagged IPOs* is the log of one plus the number of initial public offerings (IPOs) of venture-backed companies in industry *g* in year *t*−1. *EXPERIENCE* is the difference between the log of one plus the number of investments made by VC firm *f* prior to year *t* and the log of one plus the average of the number of investments made by all firms prior to year *t*. *INDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* in industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms in industry *g* prior to year *t*. *NONINDEXP* is the difference between the log of one plus the number of investments made by VC firm *f* outside industry *g* prior to year *t* and the log of one plus the average of the number of investments made by all firms outside industry *g* prior to year *t*. *SPECIALIZATION* is the number of investments made by VC firm *f* in industry *g* divided by the number of investments made by VC firm *f* in total prior to year *t* divided by the average of the same figure for all VC firms in year *t*.
***, **, * Indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Using quartiles rather than continuous variables. Table 10 repeats the three analyses, now measuring experience using quartiles rather than as a continuous variable. Each specification includes an AR(1) term. In each case, we replicate an analysis reported earlier using industry and non-industry experience: column 4 in Tables 6 and 7 and column 3 in Table 9. We find that the same basic patterns hold. In particular, more experienced investors are more likely to invest when *Q* is high (Table 10, Column 1). A similar pattern holds when we look at the subsample of investors. Similarly, there is no clear pattern between success and investment rates, except for greater success for investments by the most experienced venture organizations in the markets with the greatest investment opportunities.

Restricting the sample size. Table 11 looks at whether the results are robust when the sample is limited. In particular, in the above analyses, we use as observations each active venture capital firm and industry. In some

Table 10
Results in quartiles

Dependent variable	Table 6 Firm industry investments	Table 7 Firm industry investments (Investors)	Table 9 Success
PM Measure	*Q*	*Q*	*Q*
PM Measure	0.0134	0.1137	−0.0174
	[*2.57*]**	[*7.74*]***	[*0.74*]
Industry Experience Quartile Dummy:			
2	−0.0667	−0.0450	−0.0018
	[*5.38*]***	[*1.99*]**	[*0.07*]
3	−0.0725	−0.0814	−0.0442
	[*3.89*]***	[*3.07*]***	[*1.59*]
4	−0.1163	−0.1178	−0.0310
	[*3.62*]***	[*2.80*]***	[*1.00*]
Interaction of Industry Experience Quartile Dummy and PM Measure:			
2	0.0491	0.0299	0.0104
	[*6.96*]***	[*2.49*]**	[*0.78*]
3	0.0725	0.0709	0.0358
	[*6.77*]***	[*4.87*]***	[*2.66*]***
4	0.1691	0.1499	0.0383
	[*9.48*]***	[*6.51*]***	[*2.57*]**
Nonindustry Experience Quartile Dummy:			
2	0.0632	0.0523	0.0723
	[*5.42*]***	[*2.20*]**	[*2.76*]***
3	0.1058	0.1225	0.0953
	[*5.90*]***	[*4.52*]***	[*3.68*]***
4	0.0012	0.1130	0.1054
	[*0.05*]	[*3.06*]***	[*3.67*]***
Interaction of Non Industry Experience Quartile Dummy and PM Measure:			
2	−0.0217	−0.0271	−0.0403
	[*3.49*]***	[*2.12*]**	[*3.28*]***
3	−0.0336	−0.0620	−0.0546
	[*3.55*]***	[*4.07*]***	[*4.43*]***
4	0.0250	−0.0386	−0.0438
	[*1.70*]*	[*1.84*]*	[*3.24*]***
Controls:	Industry Year AR(1)	Industry Year AR(1)	Industry Year Stage Round
Adj. *R*-squared	39.28%	34.19%	9.07%
N	81,509	14,795	31,267

See the earlier tables for the definitions of the sample used in the regressions.
***, **, * Indicate statistical significance at the 1%, 5%, and 10% level, respectively.

cases, a venture capital firm may be very unlikely to invest in an industry because it has no capabilities to assess such transactions. We therefore eliminate as observations any cases in which the venture capital firm had not invested in an industry prior to the year of the observation (reported in column 1), or alternatively, the venture capital firm never invested in the industry during the entire sample period (reported in column 2). We estimate regressions equivalent to those in column 4 in Table 6, but only report the interaction terms. The results are quite similar and the magnitudes of the coefficients are slightly larger.

Addressing the possibility of capital constraints. One of our main measures of investment opportunities is industry IPO activity. This variable, however, might also be related to the availability of capital. Typically, venture capitalists will distribute shares to their investors between one and two years following an IPO (Gompers and Lerner, 1998a). If the investors seek to maintain a constant allocation to venture capital, they

Table 11
Robustness checks

Sample	(1) Ever invested in past	(2) Ever invested in sample	(3) Above median fund size	(4) Above median success rate	(5) Full sample
Dependent variable	Firm industry Investments	Firm industry Investments	Firm industry Investments	Firm industry Investments	Firm Industry Investments
PM Measure	*Q*	*Q*	*Q*	*Q*	IPO Pop
N	49,549	57,540	40,721	41,010	73,667
INDEXP * PM	0.0940	0.0617	0.0600	0.0560	0.1183
Measure	[*14.20*]***	[*11.37*]***	[*9.60*]***	[*9.52*]***	[*8.12*]***
NONINDEXP *	−0.0354	−0.0215	−0.0255	−0.0200	−0.0026
PM Measure	[*6.61*]***	[*4.43*]***	[*4.14*]***	[*3.65*]***	[*0.29*]

The regressions here are similar to those reported in regression (4) of Table 6. See the labeling of that table for the definition of the sample and variables. The sample is varied here to include the following: (Regression 1) only venture capital firms that have ever invested in the industry in the past, (Regression 2) VCs that have ever made an investment in that industry in the sample (past or future), (Regression 3) only VCs with above-median fund size, and (Regression 4) only VCs with above-median success rates. Regression 5 is based on the full sample, but uses as the measure of public market performance the average first-day returns of all venture-backed IPOs in that sector in the previous year. Only some of the regression coefficients are reported in this table. All regressions included AR(1) terms as controls. *T*-statistics in italics below coefficient estimates are based on robust standard errors allowing for data clustering by VC firm.
***, **, * Indicate statistical significance at the 1%, 5%, and 10% level, respectively.

may rapidly reinvest those funds. This pattern may imply that in periods following many venture capital-backed IPOs, venture capitalists would have considerably more funds to invest. Thus, a relation between lagged IPOs and investments may exist even if lagged IPOs do not capture investment opportunities.[7]

To address this capital availability story, we first examine the subset of venture funds whose capital under management is above the median in the year of the observation. Kaplan and Schoar (2005) show that there is a concave relationship between investment success and future fundraising: more successful venture capital firms appear to limit the amount of capital they raise, even though they could raise many times the amount. Thus, in these firms availability of capital is unlikely to be a problem. We also examine those funds with an above-median success rate. Successful venture firms find it easier to raise capital (Gompers and Lerner, 1998b; Kaplan and Schoar, 2005). Again, these firms—even if they have relatively limited capital under management—have the potential to raise large sums and should not be constrained. In columns 3 and 4 of Table 11, we repeat the analysis in Table 6, limiting the sample to these two subsets of funds where capital constraints are unlikely to be an issue. We find that results continue to hold as before.

Alternative proxies for public market signals. Our analysis above uses *Q* and the IPO activity of venture capital-backed firms as proxies for public market signals. Here we expand our IPO activity measure to include all IPOs, not just those that were venture capital-backed. The two measures are highly correlated (0.81) since both measures include venture capital-backed IPOs. Not surprisingly, the results are not appreciably altered. We also considered several other market-based measures, including the earnings-to-price ratio, market-to-book ratio, and historical industry returns. When we use all of these measures in unreported regressions, we obtain results similar to those presented above.

Column 5 of Table 11 presents the results using one such alternative measure, the success of IPOs in the prior year in that industry. When IPOs are being well received, it may be an indication of investor perception of opportunity in that sector. (See Hanley (1993) for a discussion of why underwriters do not fully adjust the offering price for an issue that encounters unexpectedly strong demand.) To measure the price change, we compute the average of the percentage change between the offer price and the share price in the first trading day (IPO "pop") for all venture-backed IPOs in that sector in the past year from information in Security Data

[7]Even if this story holds, it should be noted that it is by no means clear that the limited partners will invest in the same venture capital organizations. Nor is it certain that the venture funds will reinvest in the same sectors as where they recently took firms public.

Company's Corporate New Issues database and the Center for Research in Security Prices pricing data.[8] The results show that the interaction terms are positive, and the coefficient on industry experience is larger than that on non-industry experience. However, the results are less robust, becoming insignificant when we use 30-day returns as our measure of IPO market performance. The IPO pop is perhaps less likely to serve as a signal of fundamental opportunities in a sector, since it may be measuring something fundamentally different, such as market sentiment or underwriter market power.

One observation per company. Since the data set includes multiple observations on the same portfolio companies, each outcome reflects not only a given venture capital firm's characteristics, but also those of the other venture capitalists invested in the company. As an additional robustness check to the relations among experience, industry experience, specialization, and success, we use a sample with one observation for each portfolio company and the average levels of each variable for the venture capitalists investing in the company. In these specifications, both industry and non-industry experience are positively associated with success, as is specialization, although the coefficient on specialization is not significantly different from zero. In the absence of more information about the specific roles that each venture capital organization plays in the selection and development of the company, it is difficult to draw any conclusions from the interactions of the different venture capitalists invested in the company. This remains a rich topic for future research.

4. Conclusions

The venture capital industry is a highly volatile one, as dramatic fluctuations in fundraising and investment activity over the past few years demonstrate. These fluctuations seem to be related to changes in public market valuations and activity. Practitioner accounts and the academic literature suggest that it would be valuable to understand the impact of this volatility on the success of venture capital investments in particular; do public market shifts lead venture capitalists to make poor investment choices or do they provide valuable information to investors? We address this question by examining the determinants and success of investments by the venture industry as a whole, as well as by subclasses of firms with different levels of experience and specialization.

We analyze over 30,000 venture capital investment decisions over the past two decades. We find that the greatest response to shifts in the public markets is not by new or inexperienced venture capital firms, but rather by specialized organizations with considerable industry experience. These experienced venture capital firms increase their investments during market booms with no real degradation in their performance. Our results suggest that shifts in public markets provide information, whether directly to the venture investors or else to individuals who then seek venture financing. However, not all venture capital firms are able to take advantage of this information: the critical factor appears to be human capital. As noted in the introduction, the fundamental pattern seen here—that the changing public market signals seems to reflect shifting fundamentals—runs counter to much of the recent work in financial economics on investor overreaction.

The greater investment sensitivity is associated with industry, but not non-industry, investment experience. Whether that effect is from greater knowledge of the industry or better networks that allow for recruitment of senior management, customers, and strategic partners needs further exploration.

A variety of open issues remain for future research. First, as we acknowledge above, the precise mechanisms behind the relative performance of more industry experienced and specialized organizations remain unclear. For instance, is it possible to disentangle the relative importance of superior investment selection and ability to add value from the ability to persuade entrepreneurs to accept ones' capital? (While Kaplan and Stromberg (2004) present an intriguing initial look at the venture capital decision-making process, many open questions remain. Sorensen (2004) represents another important step in untangling these issues.) Second, because we seek to examine investment outcomes, our analysis only extends through 1998; we do not analyze the events of 1999 and 2000. While the venture capital market has seen many cycles in the past, the magnitude of the boom and bust during this period was second to none. Understanding whether the patterns delineated above

[8]Based on discussions with practitioners, we expect that it is absolute rather than relative performance that matters the most in evaluating the success of IPOs. We run similar analyses adjusting the returns for market performance, measuring the market both with NASDAQ and the S&P 500, and obtain similar results.

continued to hold during that most dramatic of cycles is an important question for future researchers to examine.

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