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Money chasing deals? The impact of fund inflows on private equity valuations☆

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Abstract

We show that inflows of capital into venture funds increase the valuation of these funds' new investments. This effect is robust to (i) controlling for firm characteristics and public market valuations, (ii) examining first differences, and (iii) using inflows into leveraged buyout funds as an instrumental variable. Interaction terms suggest that the impact of venture capital inflows on prices is greatest in states with the most venture capital activity. Changes in valuations do not appear related to the ultimate success of these firms. The findings are consistent with competition for a limited number of attractive investments being responsible for rising prices.

JEL classification: G24; G12

Keywords: Venture capital; Financing

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1. Introduction

One of the enduring questions in the finance literature is whether exogenous shifts in the demand for individual securities affect their valuations. The efficient market hypothesis implies, as Myron Scholes stated in 1972, that "the shares a firm sells are not unique works of art but rather abstract rights to an uncertain income stream for which close counterparts exist either directly or indirectly". Over the past decades, this assertion has inspired a variety of analyses. Examples include analyses of the impact on stock prices of inclusion in the Standard & Poors' 500 Index (Dhillon and Johnson, 1991; Harris and Gurel, 1986; Shleifer, 1986), the effects of eased restrictions on foreign investors on valuations in developing country stock markets (Henry, 1996; Kim and Singhal, 1996; Stulz, 1997), and the relationship between mutual fund purchases and stock market returns, both on an individual security (Wermers, 1999) and an aggregate level (Warther, 1995). While the analyses are not without their controversial aspects, several suggest that capital inflows have a real effect on valuations.

The bulk of these analyses focus on the valuation of public securities. This focus is surprising since numerous practitioner accounts suggest that the relation between asset prices and demand shifts is particularly pronounced in *private* markets. This paper examines these relations in one such environment, the U.S. private equity market. As the capital under management in this asset class has grown from $4 billion in 1978 to $200 billion in 1998, observers have claimed that increasing capital inflows have led to higher security prices, or colloquially, 'too much money chasing too few deals'.[1] This paper seeks to understand how the pricing of investments in one portion of the private equity market, venture capital, is affected by inflows to funds.[2] Further, unlike earlier studies, we are able to examine the impact of inflows in particular segments of the industry, e.g., private equity funds dedicated to specific geographic regions and investment stages, on the pricing of those particular types of transactions.

We proceed in two parts. First, we seek to document a relation between commitments to venture capital funds and the valuation of new investments. Second, we explore the cause of this relation. We examine whether this relation is driven by demand pressures or by improvements in investment prospects. For example, does more money committed to the venture industry drive up the valuation of investments or do increases in expected cash flows or a reduction in

[1] Three representative accounts over the decades are Noone and Rubel (1970), Sahlman and Stevenson (1986), and Asset Alternatives (1996).

[2] In a related analysis, Kaplan and Stein (1993) examine the evolution of buyout pricing during the 1980s, a period that saw a considerable expansion of funds established to make equity investments in buyouts. They show that the valuation of 124 buyout transactions mirrored market-wide movements in earnings–price ratios. Once these movements are controlled for, there is no significant time trend.

the riskiness of investments lead to both higher valuations and greater venture commitments?

The data set consists of over 4000 venture investments between 1987 and 1995 developed by the consulting firm VentureOne, as well as detailed information on capital inflows from two specialized information vendors. While studies of publicly traded securities can examine daily changes in prices, gaps of one to two years between refinancings of venture-backed firms are typical. A price index based purely on the changes in valuations between financings for the same company would therefore be incomplete and misleading. We consequently employ a hedonic approach, regressing the valuation of firms on their characteristics such as age, stage of development, and industry, as well as inflows into venture capital funds. The tests also control for public market valuations through industry portfolio valuations and industry book-to-market and earnings-to-price ratios.

Results show a strong positive relation between the valuation of venture capital investments and capital inflows. Other variables also have significant explanatory power, for instance, the marginal impact of a doubling in public market values is a 15–35% increase in the valuation of private equity transactions. A doubling of inflows into venture funds led to between a 7% and 21% increase in valuation levels. The results are robust to the use of a variety of specifications and control variables.

We undertake a variety of diagnostic analyses. These examine whether the relation between inflows and pricing is an artifact of our inability to fully control for firm characteristics, shifts in the value of comparable public firms, or changes in the required return on such investments. Our first approach is to add a variety of control variables that address several alternative hypotheses, e.g., price changes in comparable public firms only affect private valuations with a delay. Industry book-to-market and earnings-to-price ratios control for potential changes in market risk premia.

Second, we examine first differences. Many venture-backed firms receive multiple financing rounds, often at sharply divergent valuations. Using changes in the valuations and firm characteristics limits the impact of unobserved heterogeneity across firms. Also, two-stage regressions are used to control for the probability of refinancing. During periods of high inflows to venture funds, firms are more likely to be refinanced, but the impact of inflows on valuations remains positive.

Third, we employ an instrumental variables approach to control for any omitted variable bias that unduly inflates the significance of venture inflows. We identify a variable that should be related to shifts in commitments to the private equity industry, but otherwise largely uncorrelated with the expected success of venture capital investments: inflows into leveraged buyout funds. This approach increases the significance of the inflow measure substantially.

Fourth, we examine the impact of capital inflows in different market segments. The effect of inflows should not be uniform. Interaction terms suggest

that the impact of venture capital inflows on prices is greatest in states with the most venture capital activity. In a related analysis, we decompose inflows to venture capital funds by location or stated fund objective. The segmentation of valuations and inflows into region and investment focus effectively increases the number of independent observations. The evidence suggests that the influx of capital into funds with a particular focus has a greater impact on the valuation of investments meeting those criteria.

The final analysis examines whether increases in venture capital inflows and valuations simultaneously reflect improvements in the environment for young firms. We look at the ultimate success of venture-backed firms. Results show that success rates, whether measured through the completion of an initial public offering or an acquisition at an attractive price, did not differ significantly between investments made during the early 1990s, a period of relatively low inflows and valuations, and those of the boom years of the late 1980s. As we discussed below, the interpretation of these results is not without ambiguities. Nevertheless, the analysis may help allay concerns about simultaneous shifts in the supply of entrepreneurial opportunities. Overall, the evidence is most consistent with the demand pressure explanation.

The plan of this paper is as follows. Section 2 discusses some of the key institutional aspects of the venture capital industry. Theoretical considerations are taken up in Section 3. Section 4 describes the data set. The results are presented in the fifth section. The final section concludes the paper.

2. Background[3]

Entrepreneurs often develop ideas that require substantial capital to implement. Most entrepreneurs do not have sufficient funds to finance these projects themselves and must seek outside financing. Start-up companies that lack substantial tangible assets, expect several years of negative earnings, and have uncertain prospects are unlikely to receive bank loans or other debt financing. Venture capitalists finance these high-risk, potentially high-reward projects, purchasing equity stakes while the firms are still privately held. Venture capitalists have backed many high-technology companies, including Cisco Systems, Genentech, Intel, Microsoft, and Netscape, as well as a substantial number of service firms.

Whether the firm is in a high- or low-technology industry, venture capitalists are active investors. They monitor the progress of firms, sit on boards of directors, and mete out financing. Venture capitalists retain the right to appoint key managers and remove members of the entrepreneurial team. In addition, venture capitalists provide entrepreneurs with access to consultants, investment

[3] This section is partially based on Gompers and Lerner (1996).

bankers, and lawyers. Typically, all funds that the firm needs are not provided at once; rather the funds are disbursed in a series of financing rounds based on the attainment of milestones. Venture capitalists typically exit their successful investments by taking them public. While they rarely sell their shares at the time of the initial public offering (IPO), they frequently sell the shares or distribute them to their investors within two years of going public.

Inflows of capital to venture funds have been characterized by wide swings over the five decades since the formation of the first modern venture capital firm, American Research and Development, in 1946. Only a handful of other venture funds were established in the decade after its formation. The annual flow of money into new venture funds between 1946 and 1977 never exceeded a few hundred million dollars and was usually much less.

Funds flowing into the venture capital industry and the number of active venture organizations increased dramatically during the late 1970s and early 1980s. Important factors accounting for the increase in money flowing into the venture capital sector include the 1979 amendment to the 'prudent man' rule governing pension fund investments and the lowering of capital gains tax rates in 1978. Prior to 1979, the Employee Retirement Income Security Act limited pension funds from investing substantial amounts of money into venture capital or other high-risk asset classes. The Department of Labor's clarification of the rule explicitly allowed pension managers to invest in high-risk assets, including venture capital. In 1978, $424 million was invested in new venture capital funds, and individuals accounted for the largest share, 32%. Pension funds supplied just 15%. Eight years later, more than $4 billion was invested, and pension funds accounted for more than half of all contributions.

During this period, the limited partnership emerged as the dominant organizational form. (Most early funds had been structured as publicly traded closed-end funds.) In a venture capital limited partnership, the venture capitalists are general partners and control the fund's activities. The investors serve as limited partners. Investors monitor the fund's progress and attend annual meetings, but they cannot become involved in the fund's day-to-day management if they are to retain limited liability. Venture partnerships have pre-determined, finite life-times (usually ten years, though extensions are often allowed). Most venture organizations raise funds every two to five years. Partnerships have grown from 40% of the venture pool in 1980 to 80% in 1998.

The steady growth in commitments to the venture capital industry was reversed in the late 1980s. Returns on venture capital funds declined because of overinvestment in various industries and the entry of inexperienced venture capitalists. Between 1978 and 1988, the number of active venture organizations increased four-fold. As investors became disappointed with returns, they committed less capital to the industry; commitments (in inflation-adjusted dollars) dropped by 68% between 1987 and 1991. The recent activity in the IPO market and the exit of many inexperienced venture capitalists led to an increase in

returns. New capital commitments rose again in response, increasing by more than fourteen-fold between 1991 and 1997.

3. Theoretical considerations

This section examines two sets of predictions for the relations between inflows to venture capital funds and valuations. First, we explore the empirical implications of the view that financial markets are perfect. We then consider the alternative suggestion, that exogenous increases in inflows into venture funds affect valuations due to the segmentation of this market from other financial sectors.

Finance theory teaches that the value of a firm should equal the discounted value of its expected future cash flows. The value of a firm should increase if investors learn that its future profitability will be higher. Similarly, if they learn that the firm will be less risky than originally foreseen, i.e., its cost of capital declines, the valuation should rise. Since close substitutes exist for virtually any asset, either directly or indirectly through combinations of securities, demand curves should be flat. The movement in equity market prices, whether of publicly or privately held firms, should be driven by changes in the expected cash flows or in the firm's cost of capital.

If markets are perfect, inflows of money into venture capital funds should be unrelated to the valuations of private companies. While one might argue that an asset class such as venture capital is different from the individual securities discussed by Scholes (1972), Shleifer (1986), and Harris and Gurel (1986), the analogy to the literature on individual securities is not unreasonable. The capitalization of venture capital funds did not exceed one percent of that of public equity markets during the years under study, and was typically much smaller. Most venture-backed private firms have close substitutes among public firms. As long as the inflow of capital is exogenous, i.e., unrelated to future expected returns on venture investments, then the price of private firms should not be affected because substitutes will always exist. Neither the firm's cost of capital nor its expected cash flows should change with the inflow of capital.

If the inflow of capital to venture funds is not exogenous, however, then the empirical patterns may be more complex. In particular, more favorable expected conditions for young, high-technology companies may trigger both increases in valuations and growth in commitments to venture capital funds. In this case, prices paid for investments and venture inflows would increase simultaneously, even if there were no causal relationship between the two. We discuss below how the empirical tests control for this possibility.

The alternative view is motivated by the possibility that the venture capital market is segmented from other asset classes. In this case, exogenous increases in venture capital commitments may have a dramatic effect on prices. Because partnership agreements typically require that venture funds invest almost exclusively in private companies, increases in the supply of venture capital may

result in greater competition to finance companies and rising valuations. The increase in commitments to the venture industry may also have different effects on different segments of the private equity market. For example, if capital is raised by funds in a geographically concentrated area and if investment by these funds is localized, then competition should lead to greater price increases where the inflows of capital are greatest.

These industry and geographic patterns may be distinguished from positive news about an industry's prospects leading to a simultaneous increase in inflows and valuations. The favorable news reflected in the higher public market prices and inflows would likely have symmetric effects on early- and later-stage companies as well as on firms in various geographic regions. Better industry prospects would improve the expected cash flow of all firms in an industry, independent of their stage of development. It should also be acknowledged that various other factors should be related to the valuation of the private companies, whether or not inflows affect pricing. Earnings might be a useful indicator of firm value. Firm value may also be related to the company's sales, employment level, or age. Considerable uncertainty exists about private companies. Many are years away from the positive cash flows that investors value. Signals such as these can separate firms that are expected to be relatively more successful from others. We use these as control variables in the regressions that follow.

4. The data set

The core information on venture investments, including the valuation data, comes from VentureOne. VentureOne, established in 1987, collects data on firms that have obtained venture capital financing. Firms that have received early-stage financing exclusively from individual investors, federally chartered Small Business Investment Companies, and corporate development groups are not included in the database.

The companies are initially identified from a wide variety of sources, including trade publications, company Web pages, and telephone contacts with venture investors. VentureOne then collects information about the businesses through interviews with venture capitalists and entrepreneurs. The data collected include the amount and valuation of the venture financings, and the industry, strategy, employment, and revenues of the firm. Data on the firms are updated and validated through monthly contacts with investors and firms.[4] VentureOne then

[4] The valuations associated with the financing of private firms are typically not revealed in public documents, and investors and entrepreneurs may consider this to be sensitive information. VentureOne seeks to overcome this reluctance by emphasizing that its database also helps firms obtain financing. In particular, firms can alert investors whether they intend to seek further private financing or intend to go public in upcoming months.

markets the database to venture funds and corporate business development groups.

VentureOne officials suggest that two forms of selection bias may affect the completeness of their valuation data. First, in its initial years, neither the firm's data collection methodology nor its reputation in the industry was as established as today. Thus, it was less likely to obtain valuation data. Second, they are sometimes able to collect information about earlier financing rounds at the time a firm seeks refinancing. Consequently, the most recent data – which includes many firms that have not subsequently sought refinancing – may not be as complete as earlier years' data.

These claims are borne out through an examination of Table 1. Of the 7375 venture rounds identified by the firm between 1987 and 1995,[5] the valuations of the firm at the time of the financing can be calculated in 4069 cases (55%).[6] Forty-five percent of observations have valuation data in the first three years of the sample, compared to 61% in the 1990–1994 period. Consistent with the above discussion, the completeness of observations for 1995 is again lower, 49%.

A comparison of the rounds with and without valuation data provides insight on the impact of the missing data. Table 2 summarizes these patterns. First, VentureOne has had the least success in obtaining financing data about start-up transactions. This is not surprising. In these cases the number of investors is typically very small, and concerns about secrecy are the greatest. VentureOne has also been less successful in obtaining valuation data about firms in the amalgam referred to as 'other industries' than in the high-technology industries traditionally funded by venture capitalists.[7] VentureOne officials attribute this pattern to the firm's greater visibility among entrepreneurs and investors in high-technology industries. Similarly, reflecting the firm's California base, it has been more successful in obtaining information about firms based in the western

[5] The VentureOne database also includes a variety of other transactions including initial and follow-on public offerings by venture-backed firms, investments in leveraged buyouts and publicly traded firms by venture funds, and so forth. In tabulating venture capital rounds, we eliminate these transactions and only include equity investments by professional venture organizations in privately held firms.

[6] Throughout this paper, we use what is known in the venture industry as the "pre-money" valuation, equal to the product of the price paid per share in the financing round and the shares outstanding prior to the financing round. As discussed at length in Lerner (1994a), the pre-money valuation is more appropriate for hedonic pricing analyses. The pre-money valuation is independent of the amount invested in the firm during the current financing round. As Gompers (1995) discusses, the amount invested may vary with many considerations, including the fundraising environment. In calculating the valuation, VentureOne converts all preferred shares into common stock at the cconversion ratios specified in the agreements. Warrants and options outstanding are included in the total, as long as their exercise price is below the price per share being paid in the financing round.

[7] The definitions of the investment stage, industry, and regional groupings used in this paper are given in the appendix.

Table 1
Number of observations, by year

The table shows the number of professional venture financings of privately held firms in the VentureOne database, as well as the number and percentage with valuation data. Of the rounds with valuation data, the table also displays the number and percentage for which we obtained sales and employment data for the beginning of the year of the financing.

Year	Number of financing rounds	Rounds with valuation data	Percentage with valuation data (%)	Of rounds with valuation data			
				Rounds with sales data	Percentage with sales data (%)	Rounds with employment data	Percentage with employment data (%)
1987	693	255	36.8	166	65.1	191	74.9
1988	634	314	49.5	207	65.9	221	70.4
1989	751	369	49.1	262	71.0	276	74.8
1990	797	420	52.7	269	64.0	275	65.5
1991	785	440	56.1	283	64.3	297	67.5
1992	941	626	66.5	334	53.4	332	53.0
1993	952	647	68.0	364	56.3	358	55.3
1994	955	570	59.7	349	61.2	428	75.1
1995	867	428	49.4	268	62.6	315	73.6
All years	7375	4069	55.2	2502	61.5	2693	66.2

Table 2
Comparisons of financing rounds with and without valuation data

The sample consists of 7375 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database. The table summarizes the characteristics of the 4069 financing rounds in the sample for which VentureOne was able to determine the valuation of the financing round, and the 3306 where VentureOne was not able to do so. The table also presents the *p*-values from *t*- and χ^2-tests of the null hypothesis that these two populations are identical. Industry public equity indexes are normalized to 1.00 on January 1, 1987. The value-weighted (VW) and equally weighted (EW) industry public equity indexes are measured at the beginning of the month of financing and the VW and EW book-to-market (B/M) and earnings-to-price (E/P) ratios are measured at the beginning of the quarter of financing.

	Rounds with valuation data	Rounds without valuation data	*p*-Value from test of equality
Stage of firm at time of round:			
Start-up stage	9%	18%	0.000
Development stage	31%	28%	0.001
Beta stage	5%	2%	0.000
Shipping stage	43%	44%	0.734
Profitable stage	8%	8%	0.184
Restart stage	2%	1%	0.008
Industry of firm:			
Data processing industry	9%	8%	0.256
Computer software industry	17%	17%	0.450
Communications industry	16%	13%	0.001
Consumer electronics industry	1%	1%	0.133
Industrial equipment industry	4%	4%	0.780
Medical industry	31%	27%	0.000
Instrumentation industry	2%	2%	0.562
Components industry	3%	3%	0.651
Semiconductor industry	4%	3%	0.008
Other industry	13%	22%	0.000
Location of firm:			
Eastern states	24%	28%	0.000
Western states	57%	50%	0.000
Elsewhere	19%	22%	0.000
Time and other characteristics:			
Date of financing	January 1992	June 1991	0.000
VW industry public equity index	2.31	2.19	0.000
EW industry public equity index	2.53	2.26	0.000
VW industry B/M ratio	0.37	0.39	0.000
EW industry B/M ratio	0.80	0.70	0.155
VW industry E/P ratio	0.03	0.03	0.924
EW industry E/P ratio	− 0.15	− 0.15	0.847
Age of firm (years)	4.0	4.1	0.262
Venture capital inflow in prior four quarters (millions of 1995 dollars)	3165	3429	0.000

United States. Finally, the observations with valuation data are disproportionately in the years 1990 through 1994 and this period is characterized by higher average public equity values and weaker inflows to venture capital funds.

We do not believe these omissions of valuation data introduce systematic biases in the analyses. To address this concern, in unreported analyses we repeat the regressions reported in Table 6 through 8 using a Heckman sample selection approach. We first estimate the probability that VentureOne has been able to obtain information about the valuation in the financing round, and then seek to explain the determinants of the valuation. This correction has little impact on the magnitude or the significance of the independent variables in the analyses of the determinants of valuations.[8]

Table 3 provides an overview of the patterns of valuations in the sample. Not surprisingly, more mature firms receive higher valuations, with the exception of the dramatically depressed valuations for firms undergoing restarts (financial and product market restructurings). Semiconductor, data processing, and communications companies have on average the highest valuations, while industrial equipment and instrumentation companies have the lowest. Firms based in the western United States, particularly in California, appear to be priced at a premium.

We supplemented the VentureOne data in several ways. First, some firms in the VentureOne sample were missing either an assignment to one of the 103 VentureOne industry classes or information on the firm's start date. We examined a variety of reference sources to determine this information, including Corporate Technology Information Service's *Corporate Technology Directory* (1996), Dun's Marketing Services' *Million Dollar Directory* (1996), Gale Research's *Ward's Business Directory of U.S. Private and Public Companies* (1996), National Register Publishing Company's *Directory of Leading Private Companies* (1996), and a considerable number of state and industry business directories in the collections of Harvard Business School's Baker Library and the Boston Public Library. We also employed several electronic databases: the Company Intelligence and Database America compilations available through LEXIS's COMPANY/USPRIV library and the American Business Disk CD-ROM directory.

Second, until recently VentureOne has not archived employment and sales data on firms. Instead, they merely updated the database entries. We consequently

[8] These tabulations of completeness beg the question as to whether VentureOne captures the total number of venture rounds, or whether the denominator substantially understates the total number of financings. In recent years, the total number of financing rounds identified by VentureOne has been within 10% of the total identified by Venture Economics (which compiles this information using the annual reports of venture capital funds). Before 1990, however, the Venture Economics tabulations indicate a substantially larger number of rounds than VentureOne does. This may partially reflect the incompleteness of the early VentureOne data, but it also reflects the tendency of the older Venture Economics entries to record a single venture as multiple financings (discussed in Lerner, 1995).

Table 3
Pre-money valuations of financing rounds, by firm characteristic

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round, expressed in millions of 1995 dollars. The table presents the mean and standard error of the pre-money valuation for each category, as well as the number of observations in each category.

	Pre-money valuation		
	Mean	Standard Error	No. of Obs
Stage of firm at time of round:			
Start-up stage	2.7	0.1	366
Development stage	14.3	0.6	1231
Beta stage	21.1	1.6	217
Shipping stage	20.1	0.6	1706
Profitable stage	33.4	2.0	332
Restart stage	3.9	0.5	73
Industry of firm:			
Data processing industry	20.0	1.3	376
Computer software industry	14.4	0.8	706
Communications industry	19.0	1.0	636
Consumer electronics industry	16.2	2.4	44
Industrial equipment industry	12.9	1.2	164
Medical industry	17.8	0.7	1260
Instrumentation industry	13.9	1.5	63
Components industry	15.5	1.7	112
Semiconductor industry	31.5	2.8	169
Other industry	15.9	1.2	528
Location of firm:			
Eastern states	16.0	0.7	983
Western states	19.1	0.5	2321
Elsewhere	15.1	0.8	765

use the reference sources cited above to determine firms' sales and employment at the end of the calendar year prior to each financing with valuation data. When either sales or employment were not available from these sources, we contacted the firms for this information. (The VentureOne database provides the contact information for these firms.) Each firm received a faxed letter. Non-respondents were contacted at least twice by telephone. The final two columns of Table 1 summarize our success rate. In all, we identified historical sales data for 61% of the observations with valuation data in the VentureOne database and employment data for 66%.

Third, we develop several measures of public market valuations at the beginning of the month or the quarter of each financing. Rather than employing an overall market index, we construct industry indexes. We first associate each of the 103 VentureOne industry classes with a three-digit Standard Industrial Classification (SIC) code. This is based on an examination of all firms in each VentureOne class that had gone public. The Securities Data Company's Corporate New Issues database provides the primary three-digit SIC code assigned to these firms at the time they went public. In most cases, the overwhelming majority of firms in each VentureOne class are assigned to a single three-digit SIC code. When no SIC code represents a majority, we also examine the distribution of the three-digit SIC codes of the active privately held firms listed in the *Corporate Technology Directory*. In cases that remain ambiguous, we consult with VentureOne officials regarding their classification criteria. In some cases, multiple VentureOne classifications were assigned to the same three-digit SIC code. For example, numerous classifications were matched to SIC code 737, 'Computer and Data Processing Services'.

For each of the 35 three-digit SIC codes, we identify all active companies that have a primary classification to that SIC code in Compustat. For each of these firms, we extract their monthly returns, shares outstanding, and market price at the beginning of each month from the Center for Research in Security Prices database. From Compustat, we identify the net income during and shareholders' equity at the beginning of each quarter.

These variables are used to create two sets of valuation measures. First, we construct monthly equal- and value-weighted industry stock price indexes for each VentureOne code. These industry stock price indexes should be a measure of industry investment opportunity. Including them in the regression controls for the portion of the increase in venture capital prices that is attributable to better investment opportunities. All firms in each three-digit industry with a return in that month are included and portfolios are rebalanced monthly. A concern is that these public market indexes might not perfectly measure future investment opportunities in an industry. In particular, an industry stock price index could be higher in 1995 than in 1988 because of (i) increases in price levels in the economy as a whole, (ii) upward revisions by investors of the expected future cash flows for that particular industry, or (iii) a decrease in the systematic riskiness of the industry leading to declines in the industry cost of capital. Increases in expected future cash flows and decreases in systematic industry risk would both lead to higher industry prices (and private valuations) and increases in investment inflows without the inflows driving up the prices. We also controlled for price levels using the Gross Domestic Product (GDP) deflator to alleviate the concern that industry stock prices might just measure increases in nominal prices.

Second, we measure valuation levels using two market multiples. Price-earnings and market-to-book ratios are frequently used by practitioners as an

approximate measure of equity market values. These ratios may be better measures of future investment opportunities in an industry than the industry indexes are. For each of the public firms assigned to the 35 industries, we compute (i) the ratio of net income in the four previous quarters to the equity market value at the beginning of the quarter of the financing and (ii) the ratio of shareholders' equity to the market value of the equity at the beginning of the quarter. If multiple classes of common and preferred stock were outstanding, the combined value of all classes is used. In many industries, numerous small firms with significant negative earnings introduce a substantial skewness to the distribution of these ratios. Consequently, both the simple averages of these ratios and the averages weighted by equity market capitalization at the beginning of the quarter are used.

Finally, we tabulate the inflow of capital to funds devoted to investments in venture capital and leveraged buyout transactions. Data are obtained from the records of the consulting firm Asset Alternatives (the publisher of the newsletter *Private Equity Analyst*). Many institutions defer making commitments of capital until the last quarter, meaning that financings display a strong seasonal pattern. Consequently, the total inflation-adjusted amount of funds raised in the previous four quarters is tabulated.[9]

5. Empirical analyses

Before examining the determinants of the valuations of venture investments econometrically, we present the basic patterns. Table 4 makes clear that the highest inflation-adjusted valuations between 1987 and 1995 occurred in 1987, 1994, and 1995. These were also the years with the greatest inflows to private equity funds in constant dollars. The table also presents the value-weighted average book-to-market ratios and inflation-adjusted equity indexes for 35 industries whose construction is described above. Here, the correlation with the pricing of venture investments is less clear; the greatest public market valuations were confined to the final years of the sample.

[9] The tabulation of venture capital raised by year (displayed in Table 4) differs from those presented in Gompers and Lerner (1996). The latter tabulation was based on the records of Venture Economics whose methodology differs from that of Asset Alternatives in two ways. First, many funds raise capital through multiple closings. In a closing, an investor or group of investors signs a contract that binds them to supply a set amount of capital to a private equity fund, and often provides a fraction of that capital immediately. The Venture Economics database treats the total amount ultimately raised by the fund as having been raised on the date of the first closing; the Asset Alternatives database treats each closing as a separate event. Second, some private equity funds make investments into both venture capital and buyout transactions. While there does not appear to be a systemic pattern, Venture Economics and Asset Alternatives differ in how they classify some of the hybrid funds.

Table 4
Pre-money valuations of financing rounds, by year

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round, expressed in millions of 1995 dollars. The table presents the mean and standard error of the pre-money valuation for each year, the inflow into the venture capital industry in that year (in millions of 1995 dollars), the mean level of the 35 value-weighted industry stock indexes used to control for the public market valuations of firms in the sample (January 1, 1987 is normalized as 1.00 for each index, with an adjustment for inflation), and the mean level of the book-to-market ratio for the 35 industries (each industry ratio measure is the market value-weighted average of each active firm).

Year	Pre-money valuation		Inflow into venture industry	Average of value-weighted indexes	Average of book-to-market ratio
	Mean	Standard error			
1987	19.0	1.6	$4,969	1.18	0.50
1988	16.5	1.2	3,995	1.09	0.54
1989	16.6	1.1	4,082	1.33	0.54
1990	18.0	1.2	2,221	1.25	0.49
1991	15.8	1.0	1,542	1.51	0.58
1992	15.8	1.0	2,108	1.80	0.49
1993	16.4	0.8	3,065	2.06	0.43
1994	20.1	1.1	4,825	2.16	0.38
1995	20.9	1.4	4,517	2.47	0.41

Two figures graphically depict the pricing patterns. Fig. 1 presents the average of the public market indexes and the private equity valuations on a quarter-by-quarter basis, as well as the annual inflow into venture funds. For the sake of clarity, both the market indexes and the inflows are presented on a scale that is normalized to 1.00 in 1987. Fig. 2 presents the valuation of early- and later-stage investments on a biannual basis. The more dramatic rise of pricing levels for later-stage investments in both the first and last years of the sample is apparent.

A natural question is the extent to which the changes in valuations over time are driven by the changing mixture of firms being financed. The higher valuations in 1987, 1994, and 1995 may reflect different firms being funded during periods of rapid growth in commitments to venture funds. Venture capital organizations do not proportionately add partners as they increase capital under management. (For a discussion and evidence, see Gompers and Lerner, 1996.) Meanwhile, the number of investments that each partner can oversee is typically quite limited. Each investment requires extensive due diligence, attendance at monthly board meetings, and frequent informal interactions.

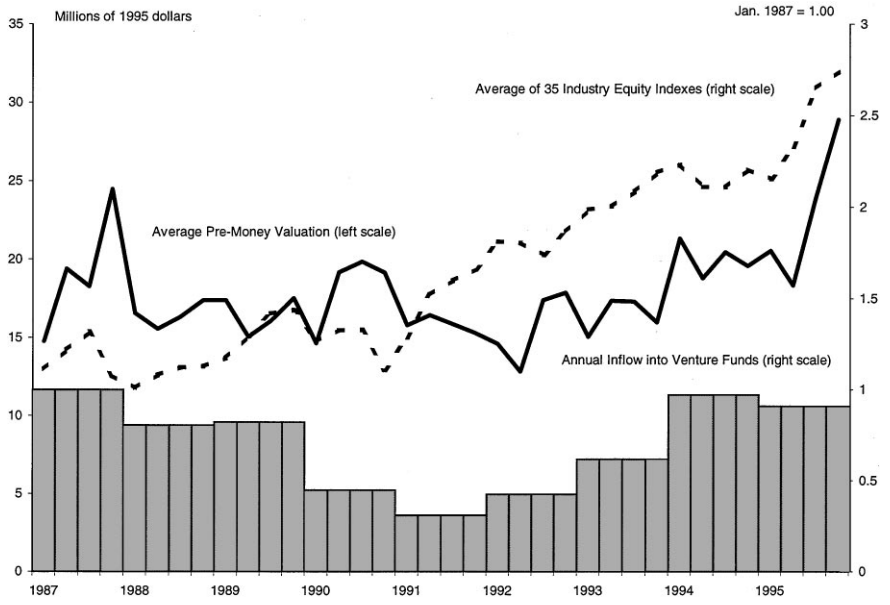

Fig. 1. Pre-money valuations of financing rounds, average public market equity values, and inflows into the venture capital industry. The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round, expressed in millions of 1995 dollars. The figure presents the mean pre-money valuation for each quarter, the unweighted average of the 35 value-weighted industry stock indexes used to control for the public market valuations (with January 1, 1987 normalized as 1.00 for each index and with an adjustment for inflation), and the total annual inflow to the venture capital industry (with 1987 normalized as 1.00).

Consequently, venture funds that are rapidly growing tend to increase the average amount that they invest in each firm and shift from early- to later-stage investments, which can typically absorb more capital. This suggests the desirability of examining the share of firms being funded each year that are of the types that command high valuations. Examples include firms with higher sales, those which are already profitable, and those in the semiconductor industry. Regression analyses also control for these characteristics.

Table 5 presents some univariate evidence on these issues:

- The relation between sales and employment on the one hand and venture capital inflows on the other is economically and statistically insignificant. For example, the correlation coefficient between inflows and sales is only 0.006.

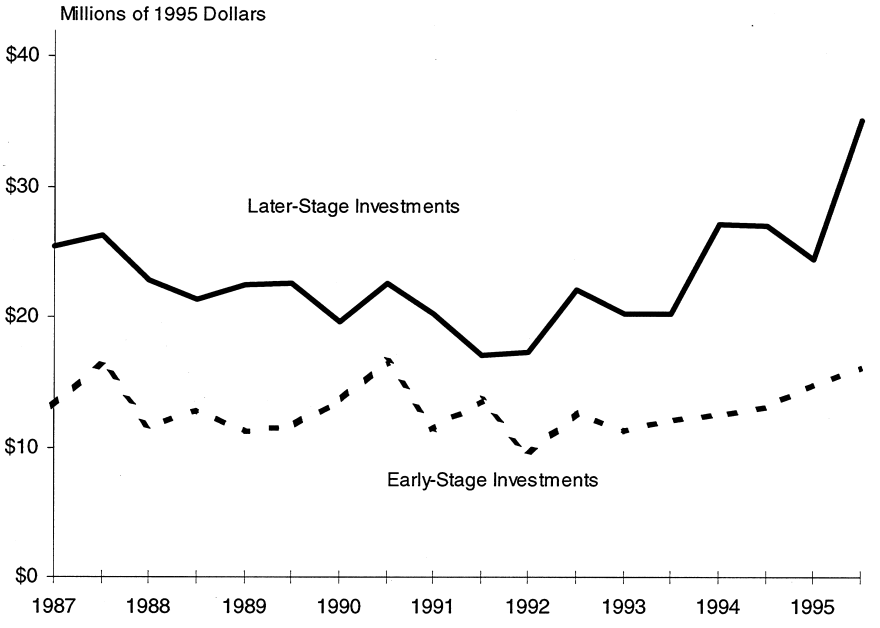

Fig. 2. Pre-money valuations of later- and early-stage financing rounds. The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round, expressed in millions of 1995 dollars. The figure presents the mean pre-money valuation for firms in the shipping or profitable stages (later-stage investments), as well as those in all other stages (early-stage investments), in each half-year period.

- Start-ups, which command the lowest valuations on average, actually comprise a greater percentage of the sample during periods with high inflows into venture capital funds. Also, the probability that firms in the sample are shipping products or are profitable varies negatively with inflows. This is exactly the opposite pattern than we would have expected were the valuation pattern a consequence of the mixture of transactions.
- For medical-related and data processing firms, the probability of being funded is significantly negatively correlated with venture capital inflows. During years with the greatest venture capital inflows, there are more transactions with firm in the data processing industry and less with firms in the medical industry.

Thus, the pattern of valuations over time does not appear to be determined by the changing mix of transactions. We must look elsewhere for an explanation of the time-series variation.

Table 5
Characteristics of the sample firms receiving venture financing, by year

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The table summarizes the mean characteristics of the firms financed in each year included in the sample, as well as the correlation coefficient between these measures and the inflow into venture capital funds in the four quarters prior to the financing (in millions of 1995 dollars), and the *p*-value of the test of the null hypothesis that the correlation coefficient equals zero. Sales (in millions of 1995 dollars) and employment are at the beginning of the year of the financing.

Year	Firm sales	Firm employment	Firm is in start-up stage	Firm is in shipping stage	Firm is in profitable stage	Firm is in data processing industry	Firm is in communications industry	Firm is in medical industry	Firm is in semiconductor industry
1987	10.9	90.0	13%	35%	4%	20%	13%	20%	5%
1988	9.6	79.3	17	37	6	21	14	21	7
1989	9.4	79.5	11	38	8	14	15	24	5
1990	7.2	66.1	6	47	5	12	16	26	6
1991	8.1	59.6	6	47	7	11	15	32	4
1992	7.8	67.0	7	45	8	6	14	36	3
1993	7.5	78.7	9	42	13	4	16	36	3
1994	5.7	57.8	8	42	9	5	17	34	3
1995	7.7	77.7	8	38	7	4	18	35	3
Corr. coeff.	0.006	0.016	0.055	− 0.059	− 0.065	0.044	0.002	− 0.056	0.022
p-Value	0.763	0.398	0.000	0.000	0.000	0.000	0.847	0.000	0.064

5.1. Basic econometric analysis

As the above findings suggest, the econometric analysis of the valuation of venture capital investments poses estimation challenges somewhat different from traditional studies of the pricing of publicly traded assets. Most pricing studies examine changes in the prices of an essentially constant basket of securities (except, of course, for new offerings and delistings). This environment is quite different. The average time between refinancings in our sample, and hence price observations, is 16.4 months.

One approach would be to examine only the changes in prices for firms that have a previous observed valuation. This is reminiscent to the 'matched model' approach employed in pricing analyses. As Berndt and Griliches (1993) argue, this method can lead to misleading estimates. In particular, if the process through which new firms are valued is different from that in the refinancing of existing firms, this analysis may give a biased impression. For instance, in the pharmaceutical industry political pressures have often limited companies' abilities to raise the price of existing pharmaceutical products, but such pressures have had much less impact on the initial pricing of new drugs. Furthermore, this approach eliminates those companies that only receive one financing. These firms, which are typically the concerns that are liquidated or merged, may differ systematically from other firms.

Consequently, we examine the pricing pattern using a hedonic regression approach. This method, first developed by Frederick Waugh to examine the pricing of vegetables in Boston's Fanueil Hall in 1927, includes all price observations in a regression analysis. The analysis includes firms receiving their first or follow-on financings. The price is the dependent variable, and the characteristics of the firm and the environment are the independent variables. The regression approach enables us to incorporate even those firms that received just one financing round.

An important assumption of hedonic pricing models is that the researcher can either measure the factors that are important for determining the price of the firm or good or identify reasonable proxies for these measures. If the qualities that determine the price are not quantifiable or measurable, then the hedonic regression model will have little explanatory power. Alternatively, the omitted variables may introduce biases that lead to mistaken interpretations of the results.

Tables 6 and 7 present the basic analysis.[10] We employ an ordinary least squares (OLS) specification and a 'log–log' framework, meaning that the

[10] The regressions in these and all other tables (with the exception of the Heckman sample selection regressions reported in the third and fourth columns of Table 10) employ *t*-statistics computed with heteroskedastistic-consistent standard errors (White, 1980). Because in many cases there are several observations of the same firm (due to multiple financing rounds), the observations may not be independent. We address this issue in the final two paragraphs of this section.

Table 6
Ordinary least squares regression analyses of pre-money valuations of financing rounds

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round. The logarithm of the pre-money valuation, expressed in millions of current dollars, is used as the dependent variable. The independent variables include dummy variables controlling for the firm's status, industry, and location, and the logarithms of the firm's age (in years), sales (in millions of 1995 dollars) and employment at the beginning of the year of the financing, of two indexes for the public market valuations of publicly traded firms in the same industry as the firm at the beginning of the month of the financing (with January 1, 1987 normalized as 1.00 for each index), and of the inflow into venture capital funds in the four quarters prior to the financing (in millions of 1995 dollars). Absolute heteroskedastistic-consistent *t*-statistics are in brackets.

Independent variables	No firm size measure		Using firm sales		Using firm employment	
Stage of firm:						
Start-up stage	− 0.85 [6.67]	− 0.87 [6.77]	− 0.89 [5.35]	− 0.90 [5.42]	− 0.76 [5.35]	− 0.77 [5.45]
Development stage	− 0.14 [1.11]	− 0.16 [1.26]	− 0.08 [0.52]	− 0.11 [0.65]	− 0.02 [0.16]	− 0.05 [0.37]
Beta stage	0.13 [0.96]	0.10 [0.75]	0.22 [1.26]	0.18 [1.02]	0.25 [1.62]	0.18 [1.20]
Shipping stage	0.16 [1.37]	0.15 [1.23]	0.18 [1.16]	0.15 [0.95]	0.19 [1.47]	0.14 [1.12]
Profitable stage	0.52 [3.98]	0.50 [3.83]	0.46 [2.80]	0.41 [2.49]	0.45 [3.17]	0.38 [2.70]
Restart stage	− 1.22 [8.66]	− 1.25 [8.82]	− 1.30 [7.71]	− 1.35 [7.98]	− 1.28 [8.49]	− 1.35 [8.98]
Industry of firm:						
Data processing industry	0.32 [3.64]	0.27 [2.99]	0.27 [2.37]	0.17 [1.48]	0.35 [3.35]	0.24 [2.36]
Computer software industry	− 0.04 [0.51]	− 0.02 [0.26]	− 0.09 [1.04]	− 0.07 [0.80]	− 0.04 [0.56]	− 0.02 [0.19]
Communications industry	0.34 [4.76]	0.29 [3.98]	0.28 [3.14]	0.19 [2.05]	0.34 [4.13]	0.23 [2.83]
Consumer electronics industry	0.25 [1.47]	0.25 [1.48]	0.27 [1.48]	0.26 [1.46]	0.23 [1.56]	0.22 [1.58]
Industrial equipment industry	− 0.21 [2.01]	− 0.24 [2.29]	− 0.23 [1.72]	− 0.28 [2.13]	− 0.18 [1.49]	− 0.23 [1.91]
Medical industry	0.39 [5.86]	0.37 [5.38]	0.43 [4.89]	0.37 [4.04]	0.46 [5.91]	0.38 [4.69]
Instrumentation industry	0.01 [0.13]	− 0.02 [0.13]	0.04 [0.32]	− 0.01 [0.08]	0.09 [0.76]	0.04 [0.29]
Components industry	− 0.04 [0.38]	− 0.05 [0.49]	− 0.06 [0.49]	− 0.08 [0.66]	− 0.07 [0.54]	− 0.08 [0.66]
Semiconductor industry	0.60 [5.55]	0.60 [5.48]	0.45 [3.74]	0.44 [3.58]	0.49 [4.56]	0.49 [4.46]

Location and other characteristics:						
Eastern states	0.10 [1.92]	0.09 [1.78]	0.17 [2.62]	0.15 [2.42]	0.16 [2.77]	0.15 [2.54]
Western states	0.30 [6.48]	0.29 [6.39]	0.33 [5.72]	0.33 [5.61]	0.32 [5.97]	0.32 [5.90]
Log of firm age (in years)	0.43 [13.90]	0.43 [13.90]	0.30 [7.11]	0.30 [7.04]	0.19 [4.55]	0.18 [4.27]
Log of firm sales			0.19 [7.44]	0.20 [7.68]		
Log of firm employment					0.27 [13.73]	0.30 [14.31]
Log of value-weighted industry index	0.16 [4.21]		0.27 [5.20]		0.31 [6.42]	
Log of equal-weighted industry index		0.15 [4.17]		0.26 [5.61]		0.35 [7.93]
Log of inflow of venture capital	0.18 [4.94]	0.19 [5.20]	0.14 [3.10]	0.16 [3.46]	0.07 [1.67]	0.09 [2.03]
Constant	− 0.19 [0.58]	− 0.24 [0.73]	− 0.06 [0.14]	− 0.16 [0.37]	− 0.11 [0.27]	− 0.26 [0.65]
R^2	0.32	0.32	0.34	0.34	0.38	0.38
F-statistic	98.94	98.38	69.47	70.80	76.33	76.39
p-value	0.000	0.000	0.000	0.000	0.000	0.000
Number of observations	3896	3896	2433	2433	2622	2622

Table 7
Ordinary least squares regression analyses of pre-money valuations of financing rounds, with alternative measure of public market valuations

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round. The logarithm of the pre-money valuation, expressed in millions of current dollars, is used as the dependent variable. The independent variables include dummy variables controlling for the firm's status, industry, and location, and the logarithms of the value-weighted and equally-weighted average ratios of book-to-market equity value and earnings-to-market equity value of publicly traded firms in the same industry as the firm, of the Gross Domestic Product deflator at the beginning of the quarter of the financing, of the firm's age (in years) at the beginning of the year of the financing, of the firm's sales (in millions of 1995 dollars) and employment at the beginning of the year of the financing, and of the inflow into venture capital funds in the four quarters prior to the financing (in millions of 1995 dollars). Absolute heteroskedastistic-consistent t-statistics are in brackets.

Independent variables	Using book to market		Using earnings to value	
	Value-weighted	Equally weighted	Value-weighted	Equally weighted
Stage of firm:				
Start-up stage	− 0.97 [5.76]	− 0.98 [5.78]	− 0.87 [6.05]	− 0.87 [6.07]
Development stage	− 0.18 [1.07]	− 0.18 [1.08]	− 0.15 [1.11]	− 0.16 [1.13]
Beta stage	0.09 [0.51]	0.10 [0.56]	0.06 [0.37]	0.06 [0.37]
Shipping stage	0.07 [0.42]	0.07 [0.47]	0.14 [0.27]	0.04 [0.27]
Profitable stage	0.33 [1.91]	0.33 [1.95]	0.27 [1.81]	0.27 [1.82]
Restart stage	− 1.43 [8.19]	− 1.41 [8.05]	− 1.45 [9.26]	− 1.45 [9.26]
Industry of firm:				
Data processing industry	0.23 [1.93]	0.28 [2.29]	0.31 [3.01]	0.31 [3.00]
Computer software industry	0.01 [0.08]	− 0.03 [0.30]	0.08 [1.05]	0.08 [1.06]
Communications industry	0.24 [2.68]	0.30 [3.00]	0.30 [3.66]	0.30 [3.68]
Consumer electronics industry	0.32 [1.79]	0.38 [2.07]	0.29 [2.05]	0.29 [2.05]
Industrial equipment industry	− 0.21 [1.57]	− 0.15 [1.04]	− 0.14 [1.18]	− 0.14 [1.18]
Medical industry	0.48 [5.50]	0.46 [5.27]	0.52 [6.70]	0.52 [6.65]
Instrumentation industry	0.07 [0.54]	0.11 [0.75]	0.13 [1.09]	0.13 [1.08]
Components industry	− 0.03 [0.25]	0.01 [0.08]	− 0.02 [0.18]	− 0.03 [0.22]
Semiconductor industry	0.46 [3.77]	0.49 [3.95]	0.51 [4.64]	0.50 [4.57]

Location and other characteristics:				
Eastern states	0.16 [2.55]	0.16 [2.46]	0.16 [2.66]	0.16 [2.70]
Western states	0.33 [5.69]	0.33 [5.68]	0.32 [5.95]	0.32 [6.00]
Log of firm age (in years)	0.28 [6.63]	0.28 [6.59]	0.16 [3.80]	0.16 [3.84]
Log of firm sales	0.21 [7.78]	1.84 [7.85]		
Log of firm employment			0.30 [14.02]	0.30 [14.00]
Log of gross domestic product deflator	1.96 [5.92]	1.84 [5.44]	2.48 [8.05]	2.53 [8.05]
Log of equal-weighted industry book-to-market ratio	− 0.004[1.27]			
Log of value-weighted industry book-to-market ratio		− 0.36 [1.80]		
Log of equal-weighted industry earnings-to-market value ratio			0.01 [0.43]	
Log of value-weighted industry earnings-to-market value ratio				0.54 [0.82]
Log of inflow of venture capital	0.20 [4.31]	0.19 [4.06]	0.14 [3.07]	0.13 [2.92]
Constant	− 9.62 [5.74]	− 8.84 [5.11]	− 12.18 [7.92]	− 12.40 [7.93]
R^2	0.34	0.34	0.38	0.38
F-statistic	68.69	68.75	74.62	75.15
p-value	0.000	0.000	0.000	0.000
Number of observations	2433	2433	2622	2622

logarithm of the valuation is regressed on the dummy variables and the logarithms of the continuous, non-negative variables. The log–log specification makes sense because many of the factors should be multiplicative. For instance, an increase in public market values should lead to a greater dollar increase in the valuation of an already substantial firm than that of a smaller one. As opposed to Table 4, we employ the nominal value of the valuation, correcting for inflation by including the GDP deflator as an additional independent variable.

We use a variety of independent variables. First, dummy variables capture the firm's industry, stage of development, and location. Second, we control for public market valuations of firms in the same industry. Table 6 includes the value of corresponding equal- and value-weighted industry indexes at the end of the month prior to the financing. Table 7 shows the regressions using the value of the two market multiples at the end of the quarter prior to the financing. Third, we employ venture capital inflows (in constant dollars) in the four quarters prior to the investment. Finally, regressions include the firm's age, employment, and sales. Because employment and sales data are missing in some cases, and the two measures are highly correlated, we present regressions that do not use either variable and then ones that use each in turn.

Significantly higher valuations are associated with profitable firms. There is a monotonic relation between stage of development and valuation. Start-ups and firms undergoing restructurings have lower valuations. These firms have considerably more uncertainty about whether they will ultimately be successful. Older and larger firms are associated with higher valuations than less developed firms. Greater age and size are also likely to be proxies for superior future prospects.

The regressions also suggest that firms in the eastern and western United States are associated with higher valuations, as are those in the computer hardware, communications, medical, and semiconductor industries. The geographic patterns are consistent with firms situated in high-technology complexes enjoying a variety of benefits, which are reflected in higher valuations. As Krugman (1991) discusses, benefits include the presence of specialized intermediaries such as patent lawyers, an ample supply of the highly skilled employees that they require, and technological spillovers.[11] We have no prior reason to believe any industry patterns should emerge, but they may reflect the greater expected future cash flows for firms in these industries.

Public market valuations have an uneven impact. Industry indexes are consistently significant. A 10% increase in public market values is associated with

[11] Inferences are robust to employing dummy variables for the states with the greatest venture capital investment, for example, California and Massachusetts, or using the pool of venture funds based in each state at the beginning of 1987. It is also possible that the East and West Coast dummies proxy for intense competition for attractive investments. We discuss this alternative later.

a marginal increase in private equity valuations of between 1.5% and 3.5%. The coefficient on the average industry book-to-market ratio is, as expected, negative. An industry whose average book-to-market ratio is high has lower private equity valuations in the subsequent quarter. An industry with a high book-to-market ratio is commonly interpreted as having low future growth prospects. However, this variable is only marginally significant. The earnings-to-price ratio of firms in the same industry at the end of the previous quarter is consistently insignificant, and its sign is opposite of what would be expected. Using the median industry earnings-price ratio, which may be less influenced by outliers, the coefficient takes on the expected negative sign but remains statistically insignificant. The results are also robust to using the inflation-adjusted valuation as the dependent variable and the inflation-adjusted industry stock index as an independent variable.

Finally, inflows to venture capital funds are significantly related to the valuations of these funds' investments in private firms. A 10% increase in venture inflows is associated with a marginal increase in valuations of between 0.7% and 2.1%. This result is consistent with the suggestion that demand pressures affect prices. The magnitude and significance of the coefficient on venture capital inflows coefficient falls when employment is used as a control variable, but to a much less extent when sales is employed. This is puzzling given the low correlation between inflows and the employment of firms financed. It appears to reflect the fact that the firms in which the employment is known are not entirely representative of the sample as a whole. Furthermore, this may partially reflect the smaller sample size. Were we to have full data on employment of these firms, the coefficient would be likely to be more significant. However, many of the regressions below continue to use both sales and employment as control variables as a check of the robustness of the relation between inflows and valuations.

One concern with these analyses is the potential impact of autocorrelation across the different financings of the same firm. While regressions control for heteroskedasticity, the estimates may still be biased if the residuals are correlated. We address this concern repeating the estimation of several of the regressions reported in Table 6 employing generalized least squares (GLS). McCallagh and Nelder (1989) show that this approach simultaneously controls for first-order autocorrelation across the subsequent financings of the same firm and heteroskedasticity across the observations of the different firms. Unfortunately, the estimation can only employ observations in which firms have had two or more financings with valuation data. As a result, we compare the standard errors in these regressions to those in heteroskedasticity-corrected regressions only using cases for which there is more than one observation of each firm.

We compare the Table 6 regressions, which use White's heteroskedasticity adjustment, to the GLS regressions. The comparison is restricted to the

regression observations in which the firm had two or more financings with valuation data. The comparison shows that the correction for first-order autocorrelation has little impact on the results. While the standard errors are generally (but not universally) higher, the effects are modest. Consider the leftmost regression in Table 6. The standard errors for the location dummy variables are 1.6% higher on average in the GLS regressions, and those of the sector dummies are 0.1% higher. The standard error on the venture inflow measure is actually very slightly lower once the GLS correction is made. The results of the other regressions in Table 6 are similar. In each case, the average standard error increases by less than 10% when the GLS specification is substituted for the heteroskedasticity-adjusted OLS regressions, holding the sample in each case constant.

5.2. *Using control variables to assess robustness*

While results show a relation between venture inflows and prices, specification errors may cause a spurious correlation. This section seeks to assess the robustness of results. None of these adjustments appear to alter the basic patterns seen above. Venture inflows continue to have a large, positive effect on valuations.

One possibility is that additional factors not captured in the basic specification affect the value of the venture-backed firms. The firms used to construct the public market benchmarks, while matched by industry, differ systematically from the firms backed by venture capitalists in at least two ways. They are on average considerably larger, and they have already successfully accessed the public capital markets. Fama and French (1992) have shown that the stock market returns of small firms differ significantly from those of other concerns.

We address this concern by adding additional control variables to the basic specification. The first of these, as shown in the top panel of Table 8, is an index of the performance of small-capitalization stocks. We employ Ibbotson and Associates' monthly index of the total return on the two smallest deciles of firms traded on the New York and American Stock Exchanges. While this small-capitalization stock index has considerable explanatory power, the influx of funds into venture capital funds remains highly significant.

A variety of additional factors are added in unreported regressions. For instance, small private firms might be more sensitive to business cycles. To address this suggestion, we add indexes measuring the level of the GDP deflator, the real GDP, and the changes in these measures in the past three and six months. We also explore the impact of credit market conditions. Some firms may consider bank loans to be an alternative to venture financing. In situations where bank loans are more expensive or less available, entrepreneurs may be willing to settle for lower equity valuations, i.e., pay a higher cost of equity capital. The difference in the average yields of bonds rated by Moody's as Aaa

and those rated Baa proxies for the premium that firms with weaker balance sheets must pay to borrow money. The number of small business failures and incorporations as tabulated by the U.S. Small Business Administration's Office of Advocacy captures changing conditions and expectations for small businesses as a whole. In each case, the impact of venture capital inflows on prices changes little in magnitude or significance.

A second possibility is that the pricing of investments by private equity firms reflects equity valuation levels in the public market, but only with a substantial lag. Negotiations between venture investors and entrepreneurs can be protracted, for example, if the venture investor needs to find a syndication partner before finalizing the transaction. Consequently, the price of the investment might be tentatively agreed upon well before the date of the closing.

To address this possibility, we include the lagged industry price index as an additional independent variable. Alternative regressions employ the index value six, twelve, and eighteen months prior to the financing. Panel B of Table 8 reports the results of the regression employing the index value twelve months prior to the financing. These controls have little impact on the coefficient or the significance of the variable measuring the inflow of funds into the venture industry.

A third possibility is that prices may be affected by differences between first and later round investors. In particular, Lerner (1994b) shows that established venture groups tend to syndicate second and later venture rounds with less established investors. These later rounds are associated with a substantial premium, which partially reflects the fact that these later-round investors are rarely asked to join the board or provide other value-added services.

To examine the possibility that these changing syndication patterns affect valuations, we control for the round of venture investment.[12] In the regression reported in Panel C of Table 8, we add a dummy variable indicating whether the transaction was a second or later venture round. While the dummy is strongly positive, suggesting that first-round investors are being compensated for their services by buying equity at lower prices, the measure of venture inflows remains positive and significant at least at the ten percent confidence level. Similar results appear when we employ additional independent variables to more finely indicate the round of venture investment.

[12] The reader may be confused about the addition of this control variable since we have already controlled for the firm's stage of development. While most firms receive their initial venture capital financing while still in the start-up or development stages, a significant minority receive their first venture financing after a number of years of operations. For instance, Gompers (1995) reports that the average consumer products company was nearly six years old at the time of its first venture financing. These older firms are likely to be shipping product or even to be profitable at the time of their initial financing round.

Table 8
Ordinary least squares regression analyses of pre-money valuations of financing rounds, with controls for additional hypotheses

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round. The logarithm of the pre-money valuation, expressed in millions of current dollars, is used as the dependent variable. The independent variables in all regressions include dummy variables controlling for the firm's status, industry, and location, and the logarithms of two indexes for the public market valuations of publicly traded firms in the same industry as the firm at the beginning of the month of the financing (with January 1, 1987 normalized as 1.00 for each index), of the firm's age (in years) at the beginning of the year of the financing, and of the inflow into venture capital funds in the four quarters prior to the financing (in millions of 1995 dollars). In Panel B, the logarithm of the firm's sales (in millions of 1995 dollars) at the beginning of the year of the financing is an additional independent variable. In Panel C, the logarithm of the firm's employment at the beginning of the year of the financing is included. Also, Panels A, B, and C respectively add as independent variables the logarithm of a small capitalization stock index, the logarithm of the relevant price index twelve months prior to the investment, and a dummy variable denoting second and later rounds of venture capital investment. Only selected coefficients are presented. Absolute heteroskedastistic-consistent *t*-statistics are in brackets.

Panel A: Adding a small capitalization stock index		
Log of value-weighted industry index	0.06 [1.20]	
Log of equal-weighted industry index		0.02 [0.39]
Log of small capitalization stock index	0.24 [2.77]	0.27 [2.42]
Log of inflow of venture capital	0.14 [3.80]	0.14 [3.33]
Panel B: Adding a lagged price index		
Log of value-weighted industry index	0.07 [0.80]	
Log of equal-weighted industry index		0.11 [1.36]
Log of value-weighted industry index from 12 months previously	0.23 [2.20]	
Log of equal-weighted industry index from 12 months previously		0.17 [2.00]
Log of inflow of venture capital	0.14 [3.02]	0.13 [2.48]
Panel C: Adding a dummy variable for later venture rounds		
Log of value-weighted industry index	0.27 [5.64]	
Log of equal-weighted industry index		0.30 [7.02]
Second or later venture round?	0.47 [11.91]	0.46 [11.53]
Log of inflow of venture capital	0.07 [1.74]	0.09 [2.05]

5.3. First difference analysis

One persistent concern is that the analyses above cannot capture many of the firm-specific determinants of pricing. One way to address this concern is to undertake a first difference analysis. By examining the changes in valuation across venture rounds, we are able to minimize the distortionary effects of unobservable firm characteristics. While this analysis is not without its

limitations, the first-difference analysis can provide another check on the validity of the results.[13]

The first two columns of Table 9 present the results of several OLS analyses. The observations include all venture rounds in which the valuation is known in the current and subsequent financing rounds. The dependent variable is the difference between the logarithm of the valuation in the subsequent and current rounds. To maximize the sample size, the table presents the results from regressions that do not use employment or sales data. The other results are similar.

The greatest write-ups are associated with firms with the lowest valuations in the current rounds, i.e., those in the start-up, development, or restart phase. These are also the firms that are in greatest risk of not receiving another financing round. Many of the firms that disappear from the VentureOne database have either been terminated or else joined the ranks of the "living dead", ongoing firms whose future growth prospects are so modest that they are not attractive candidates for an IPO or an acquisition. Thus, it is not surprising that the low-valued firms which receive a subsequent financing are associated with the greatest mark-ups. The very fact that they have been refinanced implies that they have made substantial progress. Neither is it surprising that firms encountering difficulty between the current and subsequent financing and undertaking a restart round experience a dramatic drop in valuations. The change in price reflects new information that becomes available on these firms. Few clear patterns emerge by industry or location.

With respect to changes in the external environment, quite stark results emerge. Changes in public market valuations, whether measured using equal- or value-weighted indexes or (in unreported regressions) using the market multiples, have little impact on pricing. However, changes in venture inflows have a significant impact. The valuation of a firm financed in two consecutive years will increase by an additional 8% if the venture capital inflow doubles in that period. The first differences results provide additional evidence that venture inflows could be driving up prices through greater investment competition.

The third and fourth columns of Table 9 present Heckman sample selection analyses. Using each financing round as an observation, we estimate a two-equation system. The first equation measures the probability that there will be a subsequent financing round. If there is a subsequent round, the second equation measures the change in the valuation, again expressed as the difference between the logarithm of the valuation in the subsequent and current rounds. In the unreported first-stage probit analysis, several patterns emerge. The probability of refinancing is higher during periods of large venture

[13] Problems with 'matched model' estimations are discussed in the second paragraph of Section 5.1.

Table 9
Ordinary least squares (OLS) and Heckman sample selection regression analyses of changes in pre-money valuations between financing rounds

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round. The difference between the logarithm of the pre-money valuation in the subsequent and current venture rounds, expressed in millions of current dollars, is used as the dependent variable. The independent variables include dummy variables controlling for the firm's status, industry, and location at the time of the current round, dummies that indicate a change in status between the current and subsequent round, the logarithm of the time between the two financing rounds (expressed in years), and the differences in the logarithms of the two indexes of the valuations of publicly traded firms in the same industry as the firm (with January 1, 1987 normalized as 1.00 for each index) and of the inflows into venture capital funds in the four quarters prior to the financing (in millions of 1995 dollars). The third and fourth columns present the coefficients from the second equation in a two-equation system. (The initial equation controls for the probability that the current round is followed by another venture financing. The χ^2-statistic and the number of observations refer to the entire two-equation system.) Absolute heteroskedastistic-consistent t-statistics are in brackets in the first two columns and absolute *t*-statistics in the third and fourth columns.

Independent variables	OLS estimates		Heckman equation estimates	
Stage of firm in prior round:				
Start-up stage	0.84 [7.29]	0.84 [7.27]	0.81 [6.53]	0.80 [6.48]
Development stage	0.58 [5.12]	0.57 [5.08]	0.55 [4.74]	0.54 [4.67]
Beta stage	0.40 [2.98]	0.40 [2.96]	0.38 [3.00]	0.38 [2.97]
Shipping stage	0.32 [2.85]	0.31 [2.81]	0.30 [2.80]	0.29 [2.74]
Profitable stage	0.29 [2.42]	0.29 [2.38]	0.30 [2.37]	0.29 [2.33]
Restart stage	0.80 [4.11]	0.79 [4.10]	0.79 [5.05]	0.78 [5.00]
Industry of firm:				
Data processing industry	− 0.05 [0.75]	− 0.06 [0.78]	− 0.05 [0.83]	− 0.06 [0.88]
Computer software industry	− 0.01 [0.19]	− 0.01 [0.21]	− 0.01 [0.22]	− 0.01 [0.23]
Communications industry	0.07 [1.15]	0.06 [1.09]	0.07 [1.24]	0.07 [1.17]
Consumer electronics industry	− 0.03 [0.29]	− 0.03 [0.32]	− 0.03 [0.24]	− 0.04 [0.26]
Industrial equipment industry	− 0.20 [2.28]	− 0.20 [2.29]	− 0.20 [2.37]	− 0.20 [2.38]
Medical industry	0.01 [0.22]	0.01 [0.17]	0.01 [0.24]	0.01 [0.19]
Instrumentation industry	− 0.02 [0.19]	− 0.02 [0.20]	− 0.02 [0.19]	− 0.03 [0.22]
Components industry	− 0.06 [0.68]	− 0.06 [0.70]	− 0.06 [0.58]	− 0.06 [0.60]
Semiconductor industry	0.06 [0.68]	0.06 [0.66]	0.06 [0.70]	0.05 [0.68]

Location of firm:				
Eastern states	− 0.01 [0.24]	− 0.01 [0.24]	− 0.02 [0.33]	− 0.02 [0.33]
Western states	0.001 [0.02]	0.002 [0.04]	− 0.01 [0.13]	− 0.01 [0.13]
Events between prior and current round:				
Firm began active product marketing	0.01 [0.26]	0.01 [0.25]	0.01 [0.26]	0.01 [0.24]
Firm underwent restart	− 1.72 [12.69]	− 1.72 [12.71]	− 1.72 [16.99]	− 1.72 [17.00]
Log of time between rounds	0.01 [0.27]	0.0003 [0.01]	0.001 [0.06]	− 0.01 [0.21]
Change in log of value-weighted index	0.02 [0.27]		0.03 [0.44]	
Change in log of equal-weighted index		0.05 [0.75]		0.05 [1.01]
Change in log of venture capital inflow	0.08 [2.03]	0.08 [2.15]	0.08 [2.50]	0.09 [2.66]
Constant	0.13 [1.06]	0.13 [1.05]	0.19 [1.30]	0.20 [1.34]
R^2	0.23	0.23		
F-statistic	19.56	19.76		
χ^2-statistic			961.17	961.27
p-value	0.000	0.000	0.000	0.000
Number of observations	1941	1941	4064	4064

capital inflows.[14] This is broadly consistent with the impact of inflows on valuations. Those firms that are either already profitable (who typically go public thereafter) or undergoing a 'restart' (many of which are abandoned) are less likely to obtain subsequent venture financing. The probability of another venture financing falls when we examine firms financed at the end of the sample period, which reflects the fact that we do not observe financings subsequent to the end of 1995. Results from the second-stage regressions, reported in the third and fourth columns of Table 9, are similar to the OLS analysis. The coefficients on the variables explaining the change in valuations in the first two regressions, including the influx into venture capital, remain statistically significant in this analysis.

5.4. Decomposition of price movements

This section examines whether influxes of capital affect certain types of firms particularly strongly. We undertake two types of analyses. First, we examine whether the pricing of particular investments is especially sensitive to the influx of venture capital or to public market values. We then examine whether the influxes into venture capital funds based in different locations and with particular investment foci have differential effects on the valuation of these types of transactions.

If the increase in valuations associated with periods of high venture inflows is caused by competition for investments between venture funds, then it is likely that the increase will not be uniform. First, while regions like Silicon Valley and Route 128 are characterized by a concentration of entrepreneurial ventures, the representation of venture capitalists is even more disproportionate. For instance, several hundred venture organizations have offices on Sand Hill Road near the Stanford University campus. Lerner (1995) notes that many venture capitalists invest locally, implying that the regions with the most venture funds are likely to experience the greatest competition for transactions. Second, as discussed above, the typical venture organization has seen an increase in capital managed per partner as fund size grew. Because of the pressure to deploy capital in larger transactions, we might expect that high venture inflows should disproportionately inflate the valuation of later-stage investments. Finally, because venture funds often invest locally and have at least somewhat well-defined mandates, the growth of venture funds of a particular type should have a disproportionate effect on valuations of that particular class of investment.

The first panel of Table 10 presents two representative regressions using interaction terms. Each uses the base specification, i.e., without employment or

[14] In a similar vein, Gompers (1995) shows that a one standard deviation increase in venture capital commitments leads to a two-month reduction in the time between venture financings.

Table 10
Ordinary least squares regression analyses of pre-money valuations of financing rounds, dividing the sample by firm characteristics

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round. The logarithm of the pre-money valuation, expressed in millions of current dollars, is used as the dependent variable. In all regressions, the independent variables include dummy variables controlling for the firm's status, industry, and location, and the logarithms of two indexes for the public market valuations of publicly traded firms in the same industry as the firm at the beginning of the month of the financing (with January 1, 1987 normalized as 1.00 for each index), of the firm's age (in years) at the beginning of the year of the financing, and of the inflow into venture capital funds in the four quarters prior to the financing (in millions of 1995 dollars). In Panel B, the logarithm of the firm's sales (in millions of 1995 dollars) at the beginning of the year of the financing is an additional independent variable. In Panel C, the logarithm of the firm's employment at the beginning of the year of the financing is used. In Panel A, interactions between the market valuation, venture inflow, and firm characteristic variables are also used as independent variables (with a total of 3896 observations used in the regressions). Later-stage firms are defined as those in shipping or profitable stages at the time of the investment. In Panels B and C, the regression is restricted to firms in the eastern United States (a total of 641 observations) and in the later stages of investment (a total of 1579 observations), respectively. The relative impact of fundraising by venture funds located or specializing in that particular sector and other funds is compared. Absolute heteroskedastistic-consistent *t*-statistics are in brackets.

Panel A: Adding interaction terms to the base regression		
Log of value-weighted industry index	0.19 [2.97]	
Log of equal-weighted industry index		0.21 [3.22]
Log of inflow of venture capital	0.11 [2.29]	0.13 [2.71]
Log of industry index∗Firm is in later stages?	0.02 [0.36]	− 0.04 [0.68]
Log of venture inflow∗Firm is in later stages?	0.09 [1.27]	0.07 [0.95]
Log of industry index∗Firm is in California or Massachusetts?	− 0.06 [0.87]	− 0.06 [0.93]
Log of venture inflow∗Firm is in California or Massachusetts?	0.02 [2.48]	0.02 [2.54]
Panel B: Exclusively examining firms based in the eastern United States		
Log of value-weighted industry index	0.16 [1.52]	
Log of equal-weighted industry index		0.19 [1.91]
Log of inflow of venture funds based in eastern United States	0.38 [3.09]	0.41 [3.28]
Log of inflow of venture funds based elsewhere in United States	− 0.12 [0.98]	− 0.13 [1.07]
p-Value, test of equality of two venture inflow variables	0.030	0.020
Panel C: Exclusively examining later-stage firms		
Log of value-weighted industry index	0.19 [3.05]	
Log of equal-weighted industry index		0.20 [3.53]
Log of inflow of venture funds focusing on later-stage investments	0.11 [2.67]	0.10 [2.05]
Log of inflow of venture funds focusing on other investment stages	0.08 [3.16]	0.09 [2.60]
p-Value, test of equality of two venture inflow variables	0.661	0.872

sales, and measuring public market values with the equity indexes. The results using the sales, employment, and market multiple variables are similar. The reported regressions interact venture capital inflows and the public market indexes with a dummy variable indicating whether the firm is located in the two states with the largest venture pools, California or Massachusetts, or the financing is a later-stage transaction, a firm in the shipping or profitable stages at the time of the investment. The regressions employ an OLS specification and the equal- and value-weighted industry indexes. Rather than presenting the coefficients of all the variables, we present selected results.

Neither firm characteristic is significant when interacted with public market values. Shifts in public market values appear to affect all transactions equally, regardless of stage or region. This supports the suggestion that the industry public market indexes measure the expected future profitability of the industry and hence affect the prospects of all firms. It is not the case that later-stage companies' 'closeness' to the public markets causes greater sensitivity to public market price movements because of financing substitutability. However, consistent with the discussion above, venture capital inflows appear to increase the valuations of California and Massachusetts firms more than other firms. The coefficient on the interaction between the venture capital inflow and the pool of venture capital based in the state is also significant. This finding is robust to measuring the pool in absolute or per capita terms. In each case, we use the venture pool at the beginning of 1987 to avoid simultaneity problems. The coefficient on the interaction between inflows and later-stage investments has the predicted positive sign, but is statistically insignificant.

Panels B and C of Table 10 present two representative analyses of how influxes of funds located in particular regions and focusing on certain stages affect the valuations of firms in those segments. The regressions examine the pricing of two particular classes of venture transactions: firms based in the eastern United States and later-stage investments. We compare how valuations change with the influx of funds based in that region or specializing in that class of investment, as well as with influxes to other types of funds.[15] By segmenting flows and valuations, we increase the number of independent observations that we can observe. In the former case, the coefficient is significantly greater on influxes into funds based in this particular region. Similar results hold in several unreported analyses employing other geographic partitions. A similar pattern emerges from the analysis of later-stage investments, but the difference is smaller in magnitude and statistically insignificant. This may partially reflect the imprecision with which funds report their investment targets. Many venture organizations, which originally specialized in early-stage investments, continue to report

[15] These classifications are from annual compilations of venture capital fundraising by Asset Alternatives and (in earlier years) Venture Economics.

such a focus long after they have raised substantial funds and shifted to later-stage transactions. It is possible that these firms are reluctant to alert their limited partners, who might reasonably worry that the funds' returns will suffer during this transition. This analysis provides at least some corroboration of the suggestion that the influx of funds influences the pricing of venture investments.

5.5. Addressing omitted variable bias

In settings where an important control variable is missing from a regression, Judge et al. (1985) show that omitted variable bias may lead to the coefficients of correlated independent variables being inflated. This effect may be happening here. In particular, we may have omitted an important explanatory variable that would control for the changes in the quality of investments presented to venture capitalists. This omission may cause us to falsely impute significance to the measure of venture capital inflows. To address this problem, we employ an instrumental variable. The instrumental variable should be correlated with the inflows to the venture capital industry, but otherwise unrelated to the venture capitalist's opportunity set.

The reason for worrying about this problem is as follows. The changes in opportunities facing venture capitalists are difficult to observe. Venture investors fund only a minute fraction of businesses begun each year, so it is unlikely that the count of business starts can control for shifts in high-quality technological opportunities. Public market indexes may inaccurately measure the shifts in value of private equity financed firms since the types of firms in each public index may be somewhat different from the corresponding firms attracting venture financing. For instance, in certain years there were many private venture-backed Internet service providers and biotechnology firms, but few publicly traded ones. If the shifts in the number of opportunities are being measured inaccurately and inflows to the venture industry are correlated with these changes, our estimations may be misleading. In particular, inflows to the venture industry may be falsely identified as having a significant effect on pricing levels.

To address this problem, we employ the influx of capital to funds specializing in leveraged buyout (LBO) investments. This is an attractive instrument for two reasons. First, it is clear that inflows to venture and buyout funds are correlated. Using annual data between 1980 and 1995, the correlation coefficient is 0.66 (with a p-value of 0.006). Like commitments to venture funds, influxes to buyout funds soared during the 1980s, dropped sharply in the early 1990s, and then recovered dramatically in the middle of the decade. These parallels reflect the manner in which institutional investors allocate their portfolios. Typically, a single group that specializes in 'alternative investments' manages investments in venture and buyout funds. When the institution's investment policy committee increases the allocation to alternatives, the inflows to venture and buyout funds are both likely to increase.

Meanwhile, there has been relatively little correlation in recent years between the success of venture and buyout investments. Most successful investments by both venture and buyout investors are exited through IPOs. But in recent years, IPOs of firms backed by venture and buyout firms have not been strongly associated. In fact, between 1991 and 1995[16] the correlation between the number and dollar volume of venture- and buyout-backed IPOs has actually been *negative* (-0.24 and -0.19 respectively), though neither coefficient is significant at conventional confidence levels. Thus, LBO inflows do not appear to be correlated with the success of venture investments. These two considerations suggest that this is an appropriate instrument for venture capital inflows.

Table 11 repeats the OLS analyses from Table 6, now estimated using the inflow into LBO funds as an instrumental variable. In each, the impact of venture inflows is equal or larger in magnitude and statistically more significant. The results are similar when the other reported OLS regressions are re-estimated. The instrumental variable estimations underscore the suggestions that capital inflows may be associated with greater competition for investments.

5.6. Demand pressure or better prospects

The analyses above have implicitly treated inflows to venture funds as exogenous. It has been used as an independent variable in the above regressions. This assumption may be questioned. In particular, inflows to venture funds may be a response to information that suggests that entrepreneurial firms are likely to do well in the future. This same information could lead venture capitalists to assign higher valuations to firms in which they invest. We could be implying a causal impact to fund inflows on the pricing of venture investments when both are actually correlated with the future prospects of these firms. We address this concern by examining the success rates of venture-backed firms over time.

Before addressing this issue empirically, our concerns can be at least partially assuaged by an examination of the determinants of inflows into venture funds. Gompers and Lerner (1998) examines the forces that affect fundraising by independent venture capital organizations between 1972 and 1995. That paper studies both overall fundraising patterns and fundraising by individual venture organizations. These analyses underscore the importance of public policy changes on the overall fundraising patterns. The Department of Labor's clarification of the 'prudent man' rule, which allowed pension funds to invest in venture capital, had a positive effect on commitments to the industry, as did decreases in the capital gains tax rate. While short-run performance, for example, recent

[16] Venture-backed IPOs are compiled by both VentureOne and Venture Economics; but only Venture Economics tracks buyout offerings. They did not begin doing so on a systematic basis until the early 1990s.

IPOs, influenced fundraising by individual organizations, shifts in public equity offering activity appeared to have little impact on overall fundraising activity. The importance of exogenous policy shifts in determining the inflow to venture funds at least partially addresses our concerns about using inflows as an independent variable.

Another way to address these concerns is to examine the ultimate success of the firms funded by venture capitalists. If inflows to venture funds and high valuations are rational responses to information about the changing prospects of young firms, investments during these 'hot' periods should be more successful. If venture capitalists just simply made fewer investments during 'cold' periods, this pattern would not occur. But in general, as a comparison of Tables 1 and 4 make clear, there is much greater variation in the inflows of capital to venture funds than in the number of firms receiving venture investments.

This analysis faces two challenges. Ideally, we would compare the rate of return, adjusted to reflect the risks associated with the varying maturity of these firms, from the investments in various time periods. Unfortunately, many of the firms remain privately held, or else were acquired for an undisclosed price. Thus, we employ two proxies. The first of these is the percentage of firms that have been taken public or filed to go public with the SEC. Successful IPOs are highly correlated with attractive returns. Venture capitalists generate the bulk of their profits from firms that go public. A Venture Economics study (1988) finds that a \$1 investment in a firm that goes public provides an average cash return of \$1.95 in excess of the initial investment, with an average holding period of 4.2 years. The next best alternative, an investment in an acquired firm, yields a cash return of only 40 cents over a 3.7 year mean holding period. The second measure that we employ is the percentage of investments that either resulted in an IPO or were acquired for at least twice the valuation of that round. While VentureOne is not able to obtain the valuation for all acquired firms, it is able to do so for many of the larger and hence more visible transactions.[17]

A second concern is that many of these firms remained privately held at the time we assessed their status, March 1996. Some of these will ultimately be successful. As a result, we only examine the outcome of venture investments between 1987 and 1991. This may lead to a bias: the later years (e.g., 1990 to 1991) should have a lower share of companies reaching successful exits simply because they have had less time to mature to the point of being taken public or sold.

Table 12 presents the results of this analysis. We compare the success of investments in the years with high influxes to venture funds with those in other

[17] We also explore the robustness of the results to the use of other definitions of successful acquisitions, such as those five or ten times the valuation at the time of the venture financing. These alternative definitions have little impact on the results.

Table 11
Instrumental variable regression analyses of pre-money valuations of financing rounds

The sample consists of 4069 professional venture financings of privately held firms between January 1987 and December 1995 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The pre-money valuation is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round. The logarithm of the pre-money valuation, expressed in millions of current dollars, is used as the dependent variable. The independent variables include dummy variables controlling for the firm's status, industry, and location, and the logarithms of the firm's age (in years), sales (in millions of 1995 dollars) and employment at the beginning of the year of the financing, of two indexes for the public market valuations of publicly traded firms in the same industry as the firm at the beginning of the month of the financing (with January 1, 1987 normalized as 1.00 for each index), and of the inflow into venture capital funds in the four quarters prior to the financing (in millions of 1995 dollars). The inflow into leveraged buyout funds in the four quarters prior to the financing (in millions of 1995 dollars) is used as an instrument for the inflow into venture funds. Absolute heteroskedastistic-consistent t-statistics are in brackets.

Independent variables	No firm size measure		Using firm sales		Using firm employment	
Stage of firm:						
Start-up stage	− 0.85 [6.61]	− 0.86 [6.72]	− 0.88 [5.29]	− 0.89 [5.37]	− 0.76 [5.28]	− 0.77 [5.40]
Development stage	− 0.13 [1.04]	− 0.15 [1.19]	− 0.07 [0.46]	− 0.10 [0.60]	− 0.01 [0.08]	− 0.04 [0.32]
Beta stage	0.14 [1.01]	0.11 [0.79]	0.23 [1.30]	0.19 [1.05]	0.25 [1.66]	0.19 [1.23]
Shipping stage	0.17 [1.45]	0.16 [1.30]	0.19 [1.24]	0.16 [1.02]	0.20 [1.56]	0.15 [1.19]
Profitable stage	0.53 [4.05]	0.51 [3.89]	0.47 [2.88]	0.42 [2.56]	0.47 [3.28]	0.40 [2.78]
Restart stage	− 1.21 [8.57]	− 1.24 [8.74]	− 1.28 [7.63]	− 1.33 [7.92]	− 1.26 [8.40]	− 1.33 [8.91]
Industry of firm:						
Data processing industry	0.32 [3.63]	0.26 [2.97]	0.27 [2.36]	0.17 [1.46]	0.35 [3.32]	0.24 [2.34]
Computer software industry	− 0.04 [0.53]	− 0.02 [0.27]	− 0.09 [1.06]	− 0.07 [0.81]	− 0.05 [0.58]	− 0.02 [0.20]
Communications industry	0.34 [4.75]	0.29 [3.96]	0.28 [3.13]	0.19 [2.04]	0.34 [4.11]	0.23 [2.81]
Consumer electronics industry	0.25 [1.46]	0.25 [1.47]	0.27 [1.48]	0.26 [1.46]	0.23 [1.56]	0.22 [1.58]
Industrial equipment industry	− 0.21 [2.04]	− 0.24 [2.33]	− 0.23 [1.76]	− 0.29 [2.17]	− 0.19 [1.54]	− 0.24 [1.95]
Medical industry	0.39 [5.86]	0.37 [5.37]	0.43 [4.89]	0.37 [4.03]	0.46 [5.91]	0.38 [4.68]
Instrumentation industry	0.01 [0.13]	− 0.02 [0.14]	0.04 [0.30]	− 0.01 [0.10]	0.09 [0.73]	0.03 [0.27]
Components industry	− 0.04 [0.40]	− 0.06 [0.51]	− 0.06 [0.52]	− 0.09 [0.69]	− 0.07 [0.57]	− 0.09 [0.68]
Semiconductor industry	0.60 [5.54]	0.60 [5.47]	0.45 [3.73]	0.44 [3.57]	0.49 [4.55]	0.49 [4.46]

Location and other characteristics:						
Eastern states	0.10 [1.90]	0.09 [1.77]	0.17 [2.62]	0.15 [2.42]	0.16 [2.76]	0.15 [2.54]
Western states	0.30 [6.47]	0.29 [6.38]	0.33 [5.72]	0.33 [5.61]	0.32 [5.95]	0.31 [5.89]
Log of firm age (in years)	0.43 [13.91]	0.43 [13.90]	0.30 [7.17]	0.30 [7.10]	0.20 [4.64]	0.18 [4.35]
Log of firm sales			0.18 [7.39]	0.20 [7.65]		
Log of firm employment					0.27 [13.60]	0.29 [14.23]
Log of value-weighted industry index	0.16 [4.29]		0.27 [5.24]		0.31 [6.42]	
Log of equal-weighted industry index		0.15 [4.28]		0.27 [5.69]		0.35 [7.96]
Log of inflow of venture capital	0.21 [5.60]	0.22 [5.85]	0.19 [3.87]	0.20 [4.17]	0.12 [2.67]	0.13 [2.81]
Constant	− 0.47 [1.38]	− 0.53 [1.53]	− 0.42 [0.95]	− 0.50 [1.12]	− 0.52 [1.25]	− 0.60 [1.44]
R^2	0.32	0.32	0.34	0.34	0.37	0.38
F-statistic	98.94	98.36	69.24	70.65	76.26	76.39
p-Value	0.000	0.000	0.000	0.000	0.000	0.000
Number of observations	3896	3896	2433	2433	2622	2622

Table 12
Analyses of the success of venture backed firms.

The sample consists of 1798 professional venture financings of privately held firms between January 1987 and December 1991 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The first panel examines the percentage of the financings that were taken public (or had filed to go public) as of March 1996. The panel presents two divisions of observations: one comparing investments made in 1987 and 1988 with those made between 1989 and 1991, the other comparing those from 1987 through 1989 to those made in 1990 and 1991. The table also presents the average annual fund inflow in these periods (in millions of 1995 dollars), and the p-value from a χ^2-test of the equality of the probability of a successful outcome. The second panel examines the percent of investments that were taken public, had filed to go public, or had been acquired at more than twice the valuation of the original venture round.

Year of investment	Average fund inflow in period	Investments with successful outcomes
Panel A: Successful outcome is an initial public offering (or IPO Filing)		
1987–1988	4482	33.6%
1989–1991	2615	30.1%
p-value, χ^2-test of equality of success probabilities		0.141
1987–1989	4348	32.5%
1990–1991	1881	29.7%
p-value, χ^2-test of equality of success probabilities		0.209
Panel B: Successful outcome is an IPO (or IPO Filing) or acquisition at 2 or more times original valuation		
1987–1988	4482	35.5%
1989–1991	2615	31.7%
p-value, t-test of equality of success probabilities		0.106
1987–1989	4348	34.5%
1990–1991	1881	31.1%
p-value, t-test of equality of success probabilities		0.115

years. The observations include the 1798 professional venture financings of privately held firms between January 1987 and December 1991 in the VentureOne database for which VentureOne was able to determine the valuation of the financing round. The first panel compares whether the firm had gone public or had filed to go public as of March 1996. The second panel measures if the firm had gone public, filed to go public, or been acquired at more than twice the valuation of the original venture round as of March 1996. Each panel divides the observations in two ways. We compare financings in 1987 and 1988 to those between 1989 and 1991, and those made between 1987 and 1989 to those from 1990 and 1991.

In each case, the probability of a successful exit is slightly higher in the earlier period with high inflows to venture funds. However, none of these differences are statistically significant at conventional confidence levels. Because many of the

firms funded in the later years were still quite immature in March 1996, over time the difference between the success rate of the two classes of investments should narrow. While as discussed above, the interpretation of these patterns is not unambiguous, they help allay fears that shifts in venture inflows and valuations were driven by changes in future prospects.

6. Conclusions

This paper revisits the question of whether flows of capital into an asset class affect the valuation of those assets and whether those changes in valuation reflect shifts in the demand for those securities or changes in future prospects. Unlike virtually every previous analysis, which focus on public markets, this study examines the U.S. private equity market, where practitioner accounts suggest these effects are particularly strong.

We address two primary questions in this paper. First, the analysis shows that inflows to venture capital funds have had a substantial impact on the pricing of private equity investments. This effect is robust to the addition of a variety of variables to control for alternative hypotheses, an analysis of first differences, and the use of instrumental variables. Consistent with predictions, the impact of venture capital inflows on prices is greatest in states with the most venture capital activity and segments with the greatest growth in venture inflows. The increase in the probability of refinancing in the Heckman sample selection regressions during periods of high inflows is also broadly consistent with the valuation patterns.

Second, the relation between increased fundraising and prices does not appear to be due to greater perceived investment prospects. The regulatory- and tax-driven nature of venture fundraising and the insignificant difference in success rates of investments in 'hot' and 'cold' fundraising periods suggest that demand pressure drives prices up during high inflow periods.

These findings have a variety of implications. First, the results suggest that examinations of the impact of fund inflows on valuations in other investment classes in which fund inflows fluctuate widely due to regulatory and tax factors would be fruitful. Real estate and developing country capital markets are two particular areas that may enhance our understanding of this phenomenon.

Second, the results raise a series of public policy questions. Several economists, such as Stiglitz (1993), have expressed concerns about the destabilizing influence of shifts in foreign capital inflows ("hot money") on developing countries' equity markets. It may be that some of the same detrimental effects are at work here. The U.S. venture capital market is also characterized by highly variable capital inflows, which affect not only the volume of investments but also the valuations of these transactions. Numerous industry observers have expressed concern about the impact of these shifts on the pace and direction of

technological innovation. During periods with high inflows, venture capitalists' standards for funding firms are alleged to be lowered, only to be raised dramatically when inflows decline.[18] A careful examination of the effects of financing patterns on the rate and pattern of innovation is a fertile area for future research.

Appendix A. Definition of firm categorizations

A.1. Definition of investment stages

Start-Up: Company with a skeletal business plan, product, or service development in preliminary stages.
Development: Product or service development is underway, but the company is not generating revenues from sales.
Beta: For companies specializing in information technology, the beta phase is when the product is being tested by a limited number of customers but not available for broad sales. For life sciences companies, beta is synonymous with a drug in human clinical trials or a device being tested.
Shipping: The product or service is being sold to customers and the company is deriving revenues from those sales, but expenses still exceed revenues.
Profitable: The company is selling products or services and the sales revenue yields a positive net income.
Restart: A recapitalization at a reduced valuation, accompanied by a substantial shift in the product or marketing focus.

A.2. Definition of industry groups

Data Processing: Firms whose primary lines-of-business include personal computing, minicomputers or workstations, mainframe computers, CAD/CAM/CAE systems, data storage, computer peripherals, memory systems, office automation, source data collection, multimedia devices, and computer networking devices.
Computer Software: Firms whose primary lines-of-business include compilers, assemblers, and systems, application, CAD/CAM/CAE/CASE, recreational and home, artificial intelligence, educational, and multimedia software.
Communications: Firms whose primary lines-of-business include modems, computer networking, fiber optics, microwave and satellite communications,

[18] For a discussion of the detrimental impacts of these cycles on both private and social welfare, see National Advisory Committee on Semiconductors (1989).

telephone equipment, pocket paging, cellular phones, radar and defense systems, television equipment, teleconferencing, and television and radio broadcasting.
Consumer Electronics: Firms whose primary lines-of-business include audio and video consumer equipment, automotive electronics, and consumer electronic games.
Industrial Equipment: Firms whose primary lines-of-business include energy management and process control systems, robotics, lasers, and inspection, integrated circuit production, and oil-and-gas drilling equipment.
Medical: Firms whose primary lines-of-business include biotechnology, pharmaceuticals, diagnostic imaging, patient monitoring, medical devices, medical lab instruments, hospital equipment, medical supplies, retail medicine, hospital management, medical data processing, and medical lab services.
Instrumentation: Firms whose primary line-of-business include analog, digital and analytical instruments, as well as analytical and test equipment.
Components: Firms whose primary lines-of-business include connectors, displays, power supplies, microwave components, switches and relays, transducers and sensors, semiconductor packaging, and circuit boards.
Semiconductor: Firms whose primary lines-of-business include discrete semiconductors, semiconductor memories, microprocessors, optoelectronics, and application specific, linear/analog, digital logic and gallium arsenide integrated circuits.
Other: Firms whose primary lines-of-business include retailing, construction, information services, financial services and institutions, data management services, publications, education, transportation, services, energy, agriculture, textiles, remediation and recycling, and environmental equipment.

A.3. Definition of regions

Eastern States: Firms whose headquarters are located in Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia.
Western States: Firms whose headquarters are located in Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, and Wyoming.

Source: Compiled from VentureOne (1996).

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