

Venture capitalists and the decision to go public*

Joshua Lerner

Harvard Business School, Boston, MA 02163, USA

Received September 1992, final version received August 1993

This paper examines the timing of initial public offerings and private financings by venture capitalists. Using a sample of 350 privately held venture-backed biotechnology firms between 1978 and 1992, I show that these companies go public when equity valuations are high and employ private financings when values are lower. Seasoned venture capitalists appear to be particularly proficient at taking companies public near market peaks. The results are robust to a variety of controls and alternative explanations.

Key words: Venture capital; Initial public offerings; Financing strategy

JEL classification: G24; G32

1. Introduction

This paper examines the ability of venture capitalists to time initial public offerings (IPOs) by going public when equity values are high and using private financings when values are lower. Venture capitalists, who specialize in providing funds to privately held firms, generate the bulk of their profits from firms that go public. A Venture Economics study (1988a) finds that a \$1 investment in a firm that goes public provides an average cash return of \$1.95 beyond the initial investment with an average holding period of 4.2 years. The next best

Correspondence to: Joshua Lerner, Graduate School of Business Administration, Harvard University, Morgan Hall, Soldiers Field, Boston, MA 02163, USA.

*I thank for their suggestions Carliss Baldwin, Gary Chamberlain, Richard Caves, Joetta Forsyth, Stuart Gilson, Paul Gompers, Zvi Griliches (my dissertation chair), Michael Jensen (the editor), Steven Kaplan, Lisa Meulbroek, Jay Ritter (the referee), Richard Ruback, William Sahlman, Andrei Shleifer, Erik Sirri, Howard Stevenson, Peter Tufano, Michael Vetsuypens, and Karen Wruck. Assistance in obtaining data was provided by Jesse Reyes of Venture Economics, Mark Edwards of Recombinant Capital, and Mark Dibner of the North Carolina Biotechnology Center, and is gratefully acknowledged. Financial support was provided by the Consortium on Competitiveness and Cooperation; the Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University; and the Division of Research, Harvard Business School. All errors and omissions are my own.

alternative, an investment in an acquired firm, yields a cash return of only 40 cents over a 3.7-year mean holding period.

I use a sample of 350 privately held biotechnology firms financed by venture capitalists between January 1978 and September 1992. I examine not only the timing of their IPOs, but also their private financings. I show that venture capitalists successfully time IPOs by being more likely to take companies public when their valuations are at their absolute and short-run peaks. I also show that experienced venture capitalists appear to be more proficient in timing IPOs than their less experienced counterparts.

I focus on the biotechnology industry because the development of a bioengineered pharmaceutical or agricultural product typically takes more than a decade. Biotechnology firms remain in a research-and-development phase until well after going public. These firms mature slowly, and do not incur large up-front costs in building manufacturing facilities. Venture capitalists provide funds in stages, with each financing round accompanied by a formal review of the firm's status. Each round involves an explicit decision to go public or remain private. Therefore, venture investors in biotechnology firms have the flexibility to try to time their IPOs according to market conditions. For IPOs in other industries, the demand for capital and the changing need for oversight by active investors may be more important to the decision to go public than market conditions. Thus, my sample provides an opportunity for a more precise test of the ability to time IPOs.¹ The analysis suggests that the positive correlation between IPO volume and public equity market valuations is due not only to greater financing activity when investment opportunities are good, but also to the substitution of public for private equity.

Successful timing of the IPO market provides significant benefits to venture capitalists, even through they rarely sell shares at the time of the offering [Barry, Muscarella, Peavy, and Vetsuypens (1990)]. Taking companies public when equity values are high minimizes the dilution of the venture investors' ownership stake. Models of sequential stock sales [Allen and Faulhaber (1989), Grinblatt and Hwang (1989), Welch (1989)] suggest a second rationale for timing the IPO. The deliberate underpricing of a new issue, which may be easier to accomplish in a hot market, 'leaves a good taste' with investors. These investors are then more willing to purchase shares in follow-on offerings.

Venture capitalists have several mechanisms to insure that firms go public at times that they perceive as optimal. Venture investors usually have several board seats and powerful control rights, including the right to put their shares to the firm's management [Barry, Peavy, Muscarella, and Vetsuypens (1990),

¹Ibbotson and Jaffe (1975) and Ritter (1984) document 'hot issue' markets, while Ritter (1991) and Loughran and Ritter (1993) show that the poor long-run returns from investments in IPOs are due both to their poor performance relative to the market and their concentration around equity market peaks. The 'impresario hypothesis' of Shiller (1990) and Shiller and Pound (1989) suggests that IPOs are subject to fads, which underwriters exploit by rushing firms to the market.

Sahlman (1990)]. Probably more important is their activity as informal advisors to managers. Since 30% of the firms backed by venture capitalists over the past two decades have gone public (the remainder are liquidated or acquired in roughly equal proportions [Venture Economics (1988a)]), the venture investors have usually experienced many more IPOs than the firm's managers. Consequently, the venture capitalists may take the lead in deciding when and how a firm should go public.

The sample also enables me to isolate the impact of investor characteristics on IPO timing. The 1978–1992 period was characterized by diverse venture investors. Freed by a 1979 Department of Labor policy statement to enter into venture partnerships, pension funds invested heavily during the sample period. This led to extensive entry on the part of new venture partnerships. The pool of venture capital under management increased sixfold from 1978 to 1990 (adjusted by the Gross Domestic Product deflator). The wide range of experience among venture capitalists during the sample period makes it easier to identify the influence of venture experience.

The structure of this article is as follows: section 2 describes the construction of the data set. In section 3, I present the empirical results and check their robustness. In section 4, I examine two alternative hypotheses. Section 5 concludes the paper.

2. The sample

2.1. The financing data set

In contrast to earlier studies of IPO timing and performance, I examine both public and private financings. Information on venture capital investments is difficult to gather from public sources. Unlike mutual funds, venture capitalists need not reveal in public filings all their investments. Thus, the primary sources of public information are the companies in which they invest. For the subset of venture-backed firms that eventually go public, information is available in IPO prospectuses and S-1 registration statements. Investments in firms that do not go public are more difficult to uncover, since these investments are not usually publicized.

The relative performance of venture funds is an important issue for investors. Venture capitalists typically raise funds every few years; limited partners (wealthy individuals, endowments, and institutional investors) provide the bulk of the capital. An investment in a venture fund is almost always for at least a ten-year period, and funds may only be withdrawn under extreme circumstances. Thus, potential investors scrutinize the performance of venture capitalists' past funds. While venture partnerships present historical performance data in offering documents, the methodology of these calculations is frequently

idiosyncratic. Furthermore, because the IPO market is so variable, potential investors usually look for a measure of relative, rather than absolute, performance.

Venture Economics (1991) addresses the need for information on performance by confidentially gathering data from venture funds and institutional investors. The organization, formed in 1961 to track the venture capital industry, has compiled two databases since 1977. One reports on the performance of venture funds, the other on venture investments. I use the investment database as the source for this analysis. It includes the dates of venture financings, the investors in each round, and the amount of funds disbursed. It includes firms that did and did not go public.² In a companion paper to this [Lerner (1993)], I analyze the completeness and accuracy of the Venture Economics database. I conclude that the database is comprehensive, and accurately depicts the amount of funds disbursed. In the case of older firms with many venture investors, however, there is a tendency to include multiple entries for a single venture round.

I confirm – and, if necessary, correct – the information in the Venture Economics database, using the following procedure:

- *Firms included in Recombinant Capital database.* Recombinant Capital (1991, 1992) is a San Francisco-based firm that specializes in collecting information on the biotechnology industry. The firm compiles data on venture financings from Securities and Exchange Commission (SEC) filings by public firms and state filings by private firms. In many states, privately held firms must provide detailed financial data to state authorities that becomes a part of the public record. The firm publishes round-by-round summaries of venture investments in biotechnology companies. I compare the Venture Economics records to those of Recombinant Capital. If they are the same, I consider the Venture Economics records as corroborated. If they conflict, and SEC filings are available, I use these filings to resolve the conflict. If the databases conflict, and SEC filings are not available, I rely on company and venture capitalist contacts. If I am unable to make any contacts, I use the Venture Economics data. I do not include as external financing rounds situations where founders contributed a small amount of funds (typically under \$20,000) in exchange for common stock, or bridge loans by venture capital providers in the six months prior to the IPO, due immediately after the offering. These entries are relatively infrequent in the Venture Economics data set.
- *Firms with SEC filings not included in Recombinant Capital database.* A firm going public discloses its investors in its prospectus (the ‘Certain Transactions’ and ‘Financial Statements’ sections) and the accompanying S-1 registration

²For firms that went public, Barry, Muscarella, Peavy, and Vetsuypens (1990) and Megginson and Weiss (1991) used information from the database published in Venture Economics’ *Venture Capital Journal*.

statement (the 'Recent Sales of Non-Registered Securities' section and exhibits). Detailed financial information is often available about private firms that have been acquired by public firms in the acquirers' proxy, 10-K, or 10-Q statements. Information on firms that file for an aborted IPO is available in the ultimately withdrawn registration statements. Using these records, I compare the Venture Economics records to the SEC filings. If they conflict, I use the SEC filings.

- *Firms without SEC filings not included in Recombinant Capital database.* I rely on company and venture capitalist contacts to confirm the Venture Economics data. I can frequently identify venture capitalists through Pratt's Guide to Venture Capital Sources [Venture Economics (1992)]. This guide is indexed by both individual and fund, so I can locate those venture capitalists associated with terminated partnerships who are still employed in the industry. I identify companies by using industry directories [Corporate (1992), Mega-Type (1992), NCBC (1990a), Ornx (1992)]. Some of the firms most difficult to obtain information about are those that failed before going public. I follow a methodology that I developed earlier [USGAO (1989)] to locate managers of failed high technology businesses. If I am unable to make any contacts, I use the Venture Economics data.

The resulting sample, summarized in table 1, consists of 750 financings by privately held firms that had already received venture capital. These include 136 IPOs and 614 private financings. The public financings raised a total of \$3.6 billion in 1992 dollars; the private financings raised \$3.1 billion. (Both figures are gross amounts, before deducting expenses associated with the equity sales.)

The firms in this sample went public after as few as one venture financing round or as many as eight. The median for the 136 IPOs in the sample is three prior venture rounds; the mean is 3.2. The mean firm went public 4.8 years after being established; the median after 4.3 years. This can be contrasted with Megginson and Weiss's sample of 320 venture-backed IPOs between 1983 and 1987, where the mean age was 8.6 years and the median 5.3 years.

2.2. *The biotechnology equity index*

To assess the ability of venture capitalists to time public and private financings, I examine the equity values around these transactions. I employ an index of publicly traded biotechnology firms. This section describes the construction of the index.

Ideally, I would use publicly traded biotechnology companies as a benchmark throughout this period. Because companies dedicated to biotechnology did not begin going public until the late 1970s, however, I must rely on 'comparable' companies in the early years. For the 1978–1982 period, I use thirteen companies identified in the 1977 business press (primarily the analyst reports

Table 1

Distribution of the sample. The table indicates by year the number and cumulative size (in millions of 1992 dollars) of public and private financings by privately held biotechnology firms which had already received venture capital. The gross amount raised is reported for both public and private financings, before any deductions for offering cost.

Year	Public financings (IPOs) by private venture-backed firms		Private financings by private venture-backed firms	
	Number of IPOs	Total \$ raised	Number of rounds	Total \$ raised
1978	0	0	4	10
1979	1	6	4	31
1980	1	59	8	93
1981	4	219	9	58
1982	4	88	18	136
1983	18	365	40	218
1984	2	35	30	129
1985	2	8	36	122
1986	17	457	52	247
1987	12	204	61	337
1988	1	23	68	334
1989	6	57	75	364
1990	4	65	87	443
1991	34	1103	86	404
1992 ^a	30	875	36	177
Total	136	3,564	614	3,103

^aThrough September 30 only.

summarized in Wall Street Transcript, but also the Wall Street Journal, Business Week, and Fortune) as well-positioned to capitalize on the then-current developments in biological science. Beginning January 1, 1983, I use thirteen 'dedicated' biotechnology firms that went public between 1979 and 1982. The pre-1983 sample has the same distribution as the dedicated biotechnology firms: seven firms specialized in human pharmaceuticals or diagnostics, three firms whose products relate to agricultural or animal science, two producers of research equipment, and one specialty chemical producer.

I invest equally in the comparable firms on January 1, 1978. At the end of each year, I rebalance the portfolio so I hold equal dollar amounts of each security. I do not rebalance the portfolio daily, because for many securities the spread between the bid and ask prices is significant relative to the share price. An index with daily rebalancing would be biased upward because of the 'bid-ask bounce' documented by Blume and Stambaugh (1983). On January 1, 1983, I liquidate the investment in the comparable portfolio, and use the proceeds to buy equal dollar amounts of the dedicated portfolio. As companies are acquired or delisted, I add the most seasoned, publicly traded dedicated biotechnology company to the index. The indices constructed using the comparable and dedicated

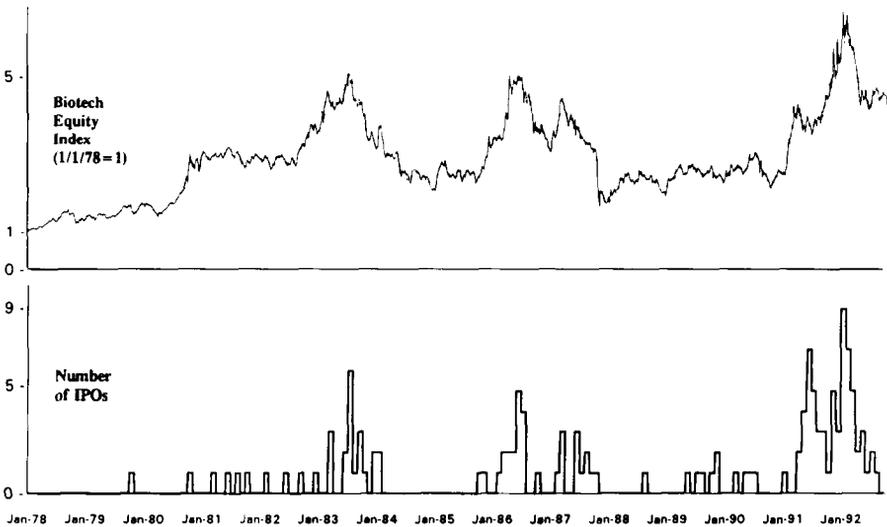


Fig. 1. The timing of initial public offerings by privately held venture-backed biotechnology companies, January 1978 through September 1992. The top graph depicts an index of biotechnology equity, computed using the value of an investment in (between 1978 and 1982) thirteen companies identified in the 1977 business press as well-positioned to capitalize on biotechnology developments and (from 1983 onwards) thirteen biotechnology companies. Acquired or delisted firms are replaced with the most seasoned, publicly traded biotechnology firm. January 1, 1978 is normalized as one. The lower plot represents the number of biotechnology IPOs in each month. The data are compiled from Venture Economics, Recombinant Capital, SEC filings, and company contacts, as well as CRSP.

portfolios are highly correlated. During 1982 and 1983 (the year before and after the switch), the correlation coefficient of the daily returns is over 0.96.

Figs. 1 and 2 display the number of IPOs and private financings in each month and the biotechnology equity index. The IPOs coincide with the peaks in equity valuations, while no clear pattern appears in the private financings. In particular, the high valuations of 1983, 1986, and 1991–92 were accompanied by intense IPO activity. The level of private financing activity, however, changed little. These patterns suggest that venture capitalists are able to time the market, taking companies public at times when industry valuations are highest.

3. Empirical analysis

In this section, I examine the timing of financings by these firms. First, I look at financings in the entire sample. Then I compare more- with less-experienced venture capitalists. Finally, I check the robustness of the results through a series of diagnostic tests.

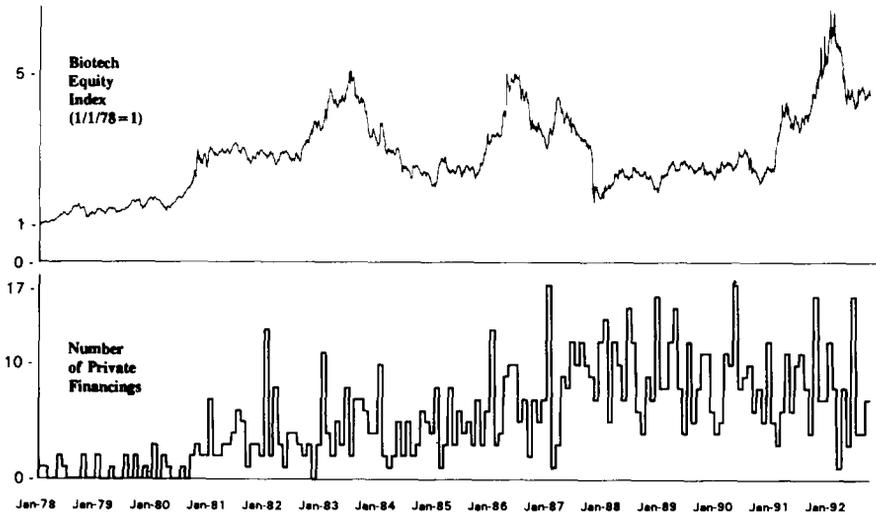


Fig. 2. The timing of private financings by privately held venture-backed biotechnology companies, January 1978 through September 1992. The top graph depicts an index of biotechnology equity, computed using the value of an investment in (between 1978 and 1982) thirteen companies identified in the 1977 business press as well-positioned to capitalize on biotechnology developments and (from 1983 onwards) thirteen biotechnology companies. Acquired or delisted firms are replaced with the most seasoned, publicly traded biotechnology firm. January 1, 1978 is normalized as one. The lower plot represents the number of biotechnology private financings in each month. The data are compiled from Venture Economics, Recombinant Capital, SEC filings, and company contacts, as well as CRSP.

3.1. The timing of financings

I first examine the timing of all external financings in the sample. Panel A of table 2 presents the main results. As figs. 1 and 2 suggest, IPOs are far more likely to occur when the equity values are high. The mean equity index at the time of IPOs is 4.05, as opposed to 3.05 at the time of private financings. (The index is normalized as one on January 1, 1978.) Using a nonparametric Wilcoxon test, panel B of table 2 shows that the difference is statistically significant at the 1% level of confidence.

I repeat this test, as well as the other shown below, adjusting the index in two ways. The increase in the equity index is partially due to inflation, and also to the need to provide a return to investors in excess of inflation. I detrend the index by the Gross Domestic Product deflator and by inflation plus a 5% annual premium. The differences in the index around IPOs and private financings remain significant. In the case of the inflation-adjusted series, the mean index at the time of the IPOs is 2.10; the mean index at the time of private financings is 1.69. (January 1, 1978, is once again normalized as one.) In the case of the inflation-adjusted series with the 5% annual premium, the mean index at

Table 2

Biotechnology equity prices around public and private financings by privately held venture-backed biotechnology companies. The sample consists of 750 IPOs and private financings between January 1978 and September 1992 by firms that had already received venture capital. The table presents the level of a biotechnology equity index^a and the mean return from biotechnology equities in the three months before and after the financing. The table also compares the means and medians of these variables.

Type of financing	Mean level of biotechnology index	Mean raw 'buy-and-hold' return from biotech equities around financing date	
		Trading days - 60 to - 1	Trading days 0 to 59
136 initial public offerings	4.05	9.9%	- 4.6%
614 private financings	3.05	4.6%	6.1%

Panel B: Tests of differences in means and medians		p-value
Test		
Wilcoxon test, median equity index on date of IPO	= median equity index on date of private financing	0.00
t-test, mean return in [- 60, - 1] window before IPO	= mean return in [- 60, - 1] window before private financing	0.00
t-test, mean return in [0, 59] window after IPO	= mean return in [0, 59] window after private financing	0.00
t-test, mean return in [- 60, - 1] window before IPO	= mean return in [0, 59] window after IPO	0.00
t-test, mean return in [- 60, - 1] window before private financing	= mean return in [0, 59] window after private financing	0.27

^aThe index and change in equity values are computed for the period 1978 to 1982 using thirteen companies identified in the 1977 business press as well-positioned to capitalize on biotechnology developments and (from 1983 onwards) thirteen biotechnology companies. Acquired or delisted firms are replaced with the most seasoned, publicly traded biotechnology firm. The index is normalized to one on January 1, 1978. For the private financings where I know only the month and year of the transaction, I use the twelfth trading day of the month.

the time of the IPOs is 1.26; the mean index at the time of private financings is 1.03. Nonparametric Wilcoxon tests reject in both cases the null hypotheses of the equality of the distributions at the 1% level of confidence. The modified indices remain significant at the 1% level of confidence when used in probit regressions akin to that reported in table 3.

An IPO is also likely to coincide with a short-term maximum in equity values. I examine the buy-and-hold returns from an equal-weighted investment in thirteen biotechnology securities in the three months before and after the financing. I use thirteen comparable securities prior to 1983, and thirteen publicly traded dedicated firms thereafter. I extend the index back into late 1977 and forward to the end of 1992 in order to be able to use observations that are near the beginning and the end of the sample period. If a firm is acquired or

delisted during the period, I roll over the investment into the most seasoned, publicly traded dedicated biotechnology firm.

Such an investment gains an average of 9.9% in the event window ($-60, -1$) before an IPO. [I choose an event window of sixty trading days so I can be consistent with Mikkelson and Partch (1988) and several other studies.] An identical investment made at the close of the IPO date has lost 4.6% of its value by day 59. Panel B indicates that the mean returns differ significantly at the 1% level of confidence.

Private financings display no such differences in the months before ($+4.6\%$) and after ($+6.1\%$) the transaction. Panel B shows that the mean returns in the three months prior to the IPOs are significantly greater than in the three months prior to the private financings. The mean returns are also significantly lower in the three months after IPOs. In some older entries in the database where the firm did not subsequently go public, I know only the month and year of the private financings. In these cases, I use the twelfth trading day of the month. The results are robust to alternative approaches, including assuming that the undated private financings took place on the first or last trading date of the month. They also are robust to using the changes in the index in the three months before and after the public and private financings, but not including the returns from the month of the financing.

I have one concern with the tests of the equality of means: their assumption of independence. The bunching of the IPOs and private financings implies that many of the sixty-trading-day windows over which returns are calculated overlap. To address concerns about whether the bunching of returns may lead to an overstating of significance levels, I undertake analyses that repeat the t -tests in table 2 in a regression framework. I regress the return on a constant and a dummy variable to indicate if the observation is from one of the two classes being compared: e.g., if this is an observation of the returns in the sixty trading days prior to a private financing. Instead of assuming independence, however, I use a Generalized Least Squares (GLS) approach akin to that used by Hansen and Hodrick (1980) and Meulbroek (1992). These authors employ in their analyses monthly observations of forward and futures prices several months ahead. Through the use of GLS estimation, they correct their standard errors for the degree of overlap in the observations. Though the overlap here arises from the clustering of observations rather than the sampling procedure, I use a similar approach to examine the robustness of the results. I create a variance-covariance matrix Ω , and compute standard errors from the matrix $(X'\Omega^{-1}X)^{-1}$. I constrain the off-diagonal elements of the variance-covariance matrix Ω to be zero if the sixty-trading-day windows over which the equity index is calculated do not overlap, and to be proportional to the extent of the overlap otherwise. In this way, nearby observations are assigned less weight in the analysis. Returns in the sixty trading days before and after IPOs remain significantly different at the 1% level of confidence. Returns in the sixty trading

Table 3

Estimated probit regressions of the decision of privately held venture-backed biotechnology firms to employ public or private financing. The sample consists of 750 IPOs and private financings between January 1978 and September 1992 by firms that had already received venture capital. The dependent variable is 1 for firms that went public and 0 for firms that employed private financings. Independent variables include three alternative measures of market timing: the level of a biotechnology equity index^a at the time of the financing, and the changes in equity prices in the three months before and after the financing (absolute *t*-statistics in brackets).

	Dependent variable: did firm go public?			
	Regressions use alternative measures of market timing			
Level of biotechnology index	0.50	[9.33]		
Raw return from biotech equities in [- 60, - 1] window			0.74	[2.80]
Raw return from biotech equities in [0, 59] widow				- 0.65 [3.64]
Constant	- 2.65	[13.16]	- 0.96	[16.78] - 0.90 [16.71]
Log-likelihood	- 307.55		- 351.14	- 348.23
χ^2 -statistic	95.00		7.83	13.66
<i>p</i> -value	0.00		0.00	0.00
Number of observations	750		750	750

^aThe index and change in equity values are computed for the period 1978 to 1982 using thirteen companies identified in the 1977 business press as well-positioned to capitalize on biotechnology developments and (from 1983 onwards) thirteen biotechnology companies. Acquired or delisted firms are replaced with the most seasoned, publicly traded biotechnology firm. The index is normalized to one on January 1, 1978. For the private financings where I know only the month and year of the transaction, I use the twelfth trading day of the month.

days prior to public and private financings do not differ at conventional confidence levels. Returns in the sixty trading days after public and private financings differ at the 5% level of confidence. In another analysis, I detrend the sixty-trading-day returns for inflation and inflation plus a 5% annual premium. I find these corrections make little difference.

I examine these patterns using the probit regression shown in table 3. I employ as observations each financing by a privately held firm that has already received venture capital. The dependent variable is a dummy indicating whether the firm received public or private financing (where 1 denotes an IPO and 0 a private financing):

$$IPO_{it} = \alpha_0 + \alpha_{1j}TIMING_{ijt} + \varepsilon_{it}. \quad (1)$$

The three measures of timing are the value of the biotechnology index at the time of the financing, the raw returns from an investment in biotechnology securities in the three months before the financing, and the raw returns in the three months after the financing.

Each of the variables is significant in explaining the decision to go public. As the coefficient of 0.50 suggests, a higher level of the equity index increases the probability of a public financing. I assess the magnitude of this coefficient by examining the effect of a 10% increase in the level of the equity index on the predicted probability that a public financing is employed. At the mean of all independent variables, the regression coefficients imply that the probability of an IPO is 15%. A 10% increase in the level of the equity index (i.e., from the mean of 3.23 to 3.56) boosts the probability of an IPO to 19%, or an increase of 27%. Increases in biotechnology equity values in the three months prior to the financing boost the chance of an IPO (the coefficient of 0.74), as do decreases in the three months after an IPO (-0.65).

3.2. The impact of venture capitalist experience

I next examine whether seasoned and inexperienced venture capitalists differ in their proficiency in taking firms public at market peaks. To examine this, I repeat the analyses in tables 2 and 3. I divide up the firms into those financed by more or less seasoned venture capitalists.

I use as a proxy for venture capitalist experience the age of the oldest venture capital partnership having financed the firm. My approach differs slightly from Barry, Muscarella, Peavy, and Vetsuypens (1990). Those authors used the venture capitalist with the largest equity stake in the firm at the time of the IPO to characterize the venture investors. Since I do not always know the relative valuation of each round, however, I cannot always determine the largest shareholder. In section 3.3 below, I consider the use of alternative measures of venture capital experience. In point of fact, these measures show little difference. Venture capitalists tend to syndicate investments either to their peers or to their less experienced counterparts. They are not likely to invest in deals begun by their less seasoned counterparts [Lerner (1994)]. The lead venture capitalist is usually the oldest one.

To establish that this is an economically meaningful partition of firms, I divide the 136 IPOs in the sample by the age of the oldest venture capital organization investing in the firm. I characterize venture capital organizations by using several reference volumes [Clay (1987), National Register (1992), Venture Economics (1988b, 1992)]. If the name of the venture capital fund recorded in the Venture Economics database does not match an entry in these directories of venture organizations, then to establish a match I use an unpublished database from Venture Economics which lists venture capital funds and organizations. I collect data about the IPOs from prospectuses, S-1 registration statements, and the SDC corporate new issues database (1992).

IPOs divided in this manner differ in several respects. Table 4 shows that the reputation of the underwriter differs significantly at the 1% level of confidence. I use the Carter–Manaster (1990) rankings of underwriter prestige. In this

Table 4

Characteristics of IPOs by venture-backed biotechnology firms, divided by the age of the oldest venture investor in the firm. The sample consists of 136 IPOs between January 1978 and September 1992. The table compares the underwriter ranking,^a the presence of a 'Big Six' accounting firm as the firm's auditor, and the most frequently represented underwriters, law firms, and accounting firms. The remaining columns describe these offerings: the share of equity retained by employees and management after the IPO,^b the mean inflation-adjusted offering size,^c the percentage of offerings in which units rather than common stock were sold, and the percentage change from the offering price to the first-day close.^d The table also compares the means of these variables for firms whose oldest venture capitalist is above and below the median age.

Characteristics	Firms divided by age of oldest venture capital provider		<i>p</i> -value, <i>t</i> -test of difference of means
	Above median	Below or equal to median	
<i>Underwriter characteristics</i>			
Carter–Manaster ranking	6.6	4.8	0.00
Most frequent firm (number)	Hambrecht and Quist (6)	D.H. Blair (14)	
<i>Auditor characteristics</i>			
% of firms in 'Big Six'	98.5%	96.1%	0.56
Most frequent firm (number)	Ernst and Young (26) ^c	Ernst and Young (21) ^c	
<i>Issuer's law firm characteristics</i>			
Most frequent firm (number)	Cooley, Godward, Castro, Huddleston, and Tatum (11)	Bachner, Tally, Polevoy, and Misher (5)	
<i>Offering characteristics</i>			
% of equity retained by employees and management	7.2%	11.8%	0.00
Funds raised (millions of 1992 dollars)	29.7	22.6	0.08
% of IPOs which are unit offerings	4.4%	25.0%	0.00
Initial return	10.3%	15.4%	0.31

^aCarter and Manaster's (1990) ranking of lead underwriter prestige is employed, with 9 representing the most prestigious underwriters and 0 the least. If the book underwriter is not included in the Carter–Manaster ratings, I use the ranking of the co-managing underwriter. If there is no co-managing underwriter, or it is also not ranked, I assign these underwriters a rank of 0.

^bThis measure includes all shareholdings by full-time managers and employees, but not venture capitalists or other financiers working as consultants at the firm.

^cThis is the gross amount paid by the public, before allowance for direct and indirect underwriting fees. The Gross Domestic Product deflator is used.

^dThe closing price, when not available, is calculated as the mean of the bid and ask.

^eIncludes predecessor entities Ernst and Whinney and Arthur Young.

scheme, 9 denotes the most prestigious underwriters and 0 the least prestigious. They determine these rankings through the positioning of companies in 'tombstones', the advertisements that underwriters use to publicize offerings. If the book underwriter is not included in the Carter–Manaster ratings, I use the ranking of the co-managing underwriter. For twelve cases, there is no

co-managing underwriter, or else it is not ranked. (These are all small regional investment banks with limited underwriting experience [National (1992)].) I assign these underwriters a rank of 0. While Hambrecht and Quist is the most frequent underwriter for firms backed by experienced venture capitalists, D.H. Blair dominates the less experienced group.

I also examine other intermediaries involved in the offering. A partition frequently used to divide accounting firms in underpricing studies is the 'Big Six' (previously the 'Big Eight'), the largest U.S. accounting firms as measured by revenue [Balvers, McDonald, and Miller (1988), Beatty (1989)]. While the firms backed by more experienced venture capitalists are more likely to have a 'Big Six' accounting firm, the difference is not significant. I also report the most frequently used accountants and law firms.

The offerings also differ in magnitude. The equity stake retained by managers and employees after the offering is significantly larger for firms backed by the less experienced venture capitalists. In addition, the dollars raised in the IPOs by firms with seasoned venture investors is larger (though only at the 10% level of confidence). Both results are consistent with Leland and Pyle (1977), who argue that lower-quality managers must retain larger equity stakes and raise less money to obtain any external financing.

Firms backed by seasoned venture capitalists are significantly less likely to employ a unit offering. These bundled offerings include at least one share of stock and one warrant. Schultz (1993) shows that unit offerings are usually employed by small firms with uncertain prospects. He suggests that by providing only some of the funding up front, unit offerings limit the danger of managers squandering invested capital. The remaining funds are provided only if the warrants are exercised. Because the warrants are typically 'out-of-the-money' at the time of the IPO (i.e., they can be exercised at a price higher than the per-share price of the IPO), the exercise of the warrants is usually conditional on the stock price rising. The first-day returns from the IPOs are lower for the firms backed by experienced venture capitalists, consistent with Barry, Peavy, Muscarella, and Vetsuypens (1990), but the difference is not significant.

After separating firms by whose oldest venture investor is above or below the median age, I repeat the analysis in table 2. Panel A of table 5 examines the choice between private and public equity. Both classes of firms appear to time IPOs. The effectiveness of this timing, however, appears greater for the more experienced venture capitalists, as the tests in panel B confirm. The average firm backed by experienced venture capitalists went public when the index was at 4.31; for the firms below the median, the level was 3.80. Similarly, the index run-up in the three months before the IPO and the run-down in the three months after are both larger.

Table 6 repeats the probit regression estimation of the decision to go public. I separate firms by venture capitalists above or below the median age. Again, I examine the probability of the firm going public, using the three measures of

Table 3

Biotechnology equity prices around public and private financings for privately held venture-backed biotechnology companies, divided by the age of the oldest venture investor in the firm. The sample consists of 750 IPOs and private financings between January 1978 and September 1992 by firms that had already received venture capital. The table presents the level of a biotechnology equity index,^a and the changes in equity prices in the three months before and after the financing. The table also compares the means and medians of these variables for firms whose oldest venture capitalist is above and below the median age.

<i>Panel A: Biotechnology equity prices</i>	
Type of financing	Mean raw 'buy-and-hold' returns from biotech equities around financing date
	Trading days - 60 to - 1
	Trading days 0 to 59
136 initial public offerings	
Firms whose oldest venture investor is above the median age	12.5%
Firms whose oldest venture investor is below the median age	7.4%
	- 6.8%
	- 2.4%
614 private financings	
Firms whose oldest venture investor is above the median age	3.08
Firms whose oldest venture investor is below the median age	3.03
	5.1%
	4.0%
	6.6%
	5.1%

Panel B: Tests of differences in means and medians

<i>Tests using firms whose oldest venture investor is above the median age</i>		p-value
Wilcoxon test, median equity index on date of IPO = median equity index on date of private financing		0.00
t-test, mean return in [-60, -1] window prior to IPO = mean return in [-60, -1] window prior to private financing		0.00
t-test, mean return in [0,59] window after IPO = mean return in [0,59] window after private financing		0.00
<i>Tests using firms whose oldest venture investor is below the median age</i>		
Wilcoxon test, median equity index on date of IPO = median equity index on date of private financing		0.00
t-test, mean return in [-60, -1] window prior to IPO = mean return in [-60, -1] window prior to private financing		0.20
t-test, mean return in [0,59] window after IPO = mean return in [0,59] window after private financing		0.01
<i>Tests comparing firms whose oldest venture investor is above and below the median age</i>		
Wilcoxon test, median equity index on date of IPO is same for both sets of firms		0.00
t-test, mean return in [-60, -1] window prior to IPO is same for both sets of firms		0.03
t-test, mean return in [0, 59] window after IPO is same for both sets of firms		0.07

^aThe index and change in equity values are computed for the period 1978 to 1982 using thirteen companies identified in the 1977 business press as well-positioned to capitalize on biotechnology developments and (from 1983 onwards) thirteen biotechnology companies. Acquired or delisted firms are replaced with the most seasoned publicly traded biotechnology firm. The index is normalized to one on January 1, 1978. For the private financings where I know only the month and year of the transaction, I use the twelfth trading day of the month.

Table 6

Estimated probit regressions of the decision of privately held venture-backed biotechnology firms to employ public or private financing, with observations are divided by the age of the oldest venture investor in the firm. The sample consists of 750 financing rounds between January 1978 and September 1992 by firms that had already received venture capital. The dependent variable is 1 for firms that went public and 0 for firms that employed private financings. Independent variables include three alternative measures of market timing: the level of a biotechnology equity index* at the time of the financing, and the changes in equity prices in the three months before and after the financing (absolute *t*-statistics in brackets). The table also compares the regression coefficients for firms whose oldest venture capitalist is above and below the median age.

Panel A: Estimated probit regressions using firms whose oldest venture investor is above the median age

	Dependent variable: did firm go public?		
	Regressions use alternative measures of market timing		
Level of a biotechnology index	0.65	[7.75]	
Raw return from biotech equities in [-60, -1] window		0.93	[2.53]
Raw return from biotech equities in [0, 59] window			-1.44 [3.94]
Constant	-2.79 [10.10]	-0.87 [10.89]	-1.04 [12.90]
Log-likelihood	-160.40	-191.14	-187.52
χ^2 -statistic	67.95	6.48	9.11
<i>p</i> -value	0.00	0.01	0.00
Number of observations	375	375	375

Panel B: Estimated probit regressions using firms whose oldest venture investor is below the median age

	Dependent variable: did firm go public?		
	Regressions use alternative measures of market timing		
Level of biotechnology index	0.31	[4.92]	
Raw return from biotech equities in [-60, -1] window		0.48	[1.23]
Raw return from biotech equities in [0, 59] window			-0.54 [2.32]
Constant	-2.39 [8.09]	-1.07 [12.84]	0.78 [10.65]
Log-likelihood	-145.46	-157.32	-155.58
χ^2 -statistic	25.33	1.52	5.60
<i>p</i> -value	0.00	0.29	0.02
Number of observations	375	375	375

Panel C: χ^2 -tests of differences in regression coefficients

Tests comparing firms whose oldest venture investor is above and below the median age	<i>p</i> -value
Coefficient of 'level of biotechnology index' variable is identical in both regressions	0.01
Coefficient of 'raw return from biotech equities in [-60, -1] window' variable is identical in both regressions	0.21
Coefficient of 'raw return from biotech equities in [0, 59] window' variable is identical in both regressions	0.03

*The index and change in equity values are computed for the period 1978 to 1982 using thirteen companies identified in the 1977 business press as well-positioned to capitalize on biotechnology developments and (from 1983 onwards) thirteen biotechnology companies. Acquired or delisted firms are replaced with the most seasoned, publicly traded biotechnology firm. The index is normalized to one on January 1, 1978. For the private financings where I know only the month and year of the transaction, I use the twelfth trading day of the month.

market timing as independent variables. In each of the three pairs of regressions, the timing variable is greater in magnitude and significance in the seasoned venture capital regression.

In panel C, I examine whether the regression coefficients differ significantly. First I estimate a pooled regression, allowing firms above and below the median to have distinct coefficients for the timing variable and constant. I then constrain the coefficient of the timing variable to be the same in both regressions. The table presents the p -values from χ^2 -tests of this constraint. In two of the three cases, I reject the null hypothesis of no difference at the 5% level of confidence. These findings suggest that firms backed by established venture capitalists are more successful at timing their IPOs.

3.3. Robustness to alternative measures and control variables

I undertake several analyses to assess the robustness of the results to alternative measures of venture experience and the presence of control variables. They have little effect on the qualitative and quantitative results.

First, I examine whether the results are an artifact of the criteria that I used to divide the venture capitalists. As an alternative, I use size to divide venture capitalists into experienced and inexperienced investors. In this way, I count as seasoned investors experienced venture capitalists who raise new (but large) partnerships. I compute the ratio of funds under management by the partnership to the total pool of venture capital under management in the year of the investment. I use the annual values reported in Pratt's Guide [Venture Economics (1992)]. When this information is incomplete, I use the unpublished Venture Economics database. The results using this partition are consistent with the ones reported earlier.³

I use a related set of regressions to divide firms by relative, rather than absolute, age and size. The mean age and size of the venture partnerships that financed biotechnology firms dipped in the mid-1980s, reflecting the extensive entry into venture capital. I examine the age of the oldest venture capitalist providing funds to each biotechnology firm in each year. I then divide the firms by whether their oldest investor was older or younger than the oldest investor in the median firm in that year. (The procedure for size is similar.) There appears to be little difference between these results and those in tables 5 and 6. These tests are not independent: relatively older venture partnerships are often the older ones on an absolute scale as well. The analysis shows, however, that these results are not an artifact of a particular approach to dividing firms.

I also recast my independent variables, using the change in the market index over two- and four-month windows. Using the longer window tends to slightly strengthen the results; the shorter window tends to weaken them. While there

³I do not report the results in the tables, but would be glad to send them to any interested reader.

are only a small number of cases in the sample where venture capitalists exited viable firms through mergers or sales, nevertheless I examine the impact of including these cases. I recast the dependent variable to measure IPOs and acquisitions of firms at prices higher than that of the last venture round. This change has little impact.

Finally, I control for the quality of the firms going public. More experienced venture capitalists are likely to fund higher-quality firms, which may bias the results. I use three sets of control variables for firm quality:

- (1) *The age of the firm.* I use, in order of preference, the incorporation date reported in SEC filings, the self-reported founding date in industry directories [Corporate (1992), Mega-Type (1992), NCBC (1990a), Ornx (1992)], a questionnaire response [NCBC (1990b)], or the date reported by Venture Economics.
- (2) *A private placement from a corporation with a related line of business.* Strategic investments are frequently used in high-technology industries, particularly biotechnology, to cement long-run agreements [Pisano (1989)]. I define corporations with related lines of business as those with any of the following Standard Industrial Code identifiers in the Million Dollar Directory [Dun's (1992)] in the year of the transaction: SIC 283, Drugs; SIC 287, Agricultural Chemicals; and SIC 384, Medical Instruments and Supplies.
- (3) *The firm's intellectual property position.* Intellectual property protection was a critical focus of biotechnology firms in the 1980s. [See Kenney (1986) and USOTA (1989) for an overview.] Product market competition was embryonic, and the alternative methods of protecting intellectual property ineffective. The disposition of a single patent could shift the valuation of a biotechnology firm by as much as 50%. I identify the patents associated with these 350 firms using U.S. Patent Office databases [USPTO/OPDLP (1989, 1990)]. I identify not only patents assigned to these firms, but also those assigned to their wholly owned subsidiaries and their research-and-development limited partnerships. I count awards to joint ventures and spin-offs to the extent that the firm had an interest in the venture. I construct two alternative variables. The first indicates the number of the patents awarded at the time of the financing round. The second indicates the number of successful patent applications awarded and in progress at the time. Because patent applications are held confidential by USPTO until the time of award, I use only observations made prior to 1990 in the second analysis.

I find in unreported regressions that, while the age and patents variables have significant explanatory power, the timing variables remain significantly larger in the regressions employing the firms backed by seasoned venture capitalists.

Table 7

Time from the filing of the original S-1 statement to the effective date of initial public offering, divided by the age of the oldest venture provider. The sample consists of 136 IPOs by venture-backed biotechnology firms between January 1978 and September 1992. The table also compares the mean and median time for firms whose oldest venture capitalist was above and below the median age.

<i>Panel A: Months from S-1 filing to IPO effective date</i>		
	Mean	Median
Firms whose oldest venture investor is above the median age	2.0	1.6
Firms whose oldest venture investor is below the median age	1.9	1.7
<i>Panel B: Tests of differences in means and medians</i>		
<i>Tests comparing firms whose oldest venture investor is above and below the median age</i>		<i>p-value</i>
<i>t</i> -test, mean months from S-1 filing to IPO effective date is same for both sets of firms		0.52
Wilcoxon test, median months from S-1 filing to IPO effective date is same for both sets of firms		0.54

4. Alternative explanations

4.1. Speed of IPO execution

One alternative explanation for established venture capitalists' apparent superiority in timing IPOs is better execution. The failure of less experienced venture capitalists to take their firms public at market peaks may reflect their limited skill in planning and executing an offering, not their inability to perceive when the market is hot. In particular, SEC reviews of proposed IPOs can be protracted. Similarly, organizing a selling syndicate and assuring demand for the offering may be time-consuming.

I test this claim by examining the time from the receipt of the original S-1 statement by the SEC to the effective date of the IPO. I identify the filing date from SDC's corporate new issues database (1992). When it is not available from this source, I use the date of the 'Received' stamp on the original S-1 filing.

Table 7 summarizes the results. The mean time from filing to offering does not differ significantly for the firms financed by seasoned or inexperienced venture capitalists (2.0 months for more experienced, 1.9 months for the less experienced). Nor do the medians differ appreciably. The results provide no support for the claim that the superior timing of the IPO market by seasoned firms is due to better execution.

4.2. Willingness to withdraw offerings

A second explanation relates to withdrawn offerings. The legal procedure in canceling a proposed IPO is straightforward. Firms may use a letter to SEC to

withdraw proposed security offerings before their effective date. Often firms do not withdraw failed IPOs. When a registration statement has been on file at the SEC for nine months, the SEC writes a letter to the firm, and then declares the offering abandoned (17 CFR § 230.479).

While the formalities associated with an IPO withdrawal are few, the repercussions may be severe. A firm that withdraws its IPO may later find it difficult to access the public marketplace. Even if the stated reason for the withdrawal is poor market conditions, the firm may be lumped with other businesses whose offerings did not sell because of questionable accounting practices or gross mispricing. These reputational considerations may be less severe for a firm associated with a major venture capitalist. A greater willingness to withdraw IPOs in the face of deteriorating market conditions may explain the apparent superiority of experienced venture capitalists in timing offerings.

To examine these claims, I identify withdrawn or abandoned IPO filings by these firms. I identify these offerings using the SDC corporate new issues database. [SDC employs a data collection procedure similar to the Investment Dealers' Digest listings used by Mikkelson and Partch (1988) to identify withdrawn seasoned security offerings.] Because the coverage of abandoned IPOs is less than comprehensive, I supplement these records with the 'No Go IPOs' section of Going Public [Howard (1992)] and a database of failed IPOs compiled by a federal agency. (The official responsible for the creation of this database has requested anonymity.) I identify fourteen withdrawn or abandoned IPOs by these firms in this period.

In table 8, I examine the probability that an IPO filing is completed successfully. I use as observations all filings of S-1 registration statements by privately held firms in the Venture Economics sample. (These include the 136 successful IPOs and the fourteen withdrawn offerings.) I estimate in a probit regression:

$$COMPLETE_{it} = \beta_0 + \beta_1 MAXAGE_{it} + \varepsilon_{it}. \quad (2)$$

The dependent variable is a dummy, which takes on the value of 1 if the offering was successfully completed. The independent variable measures the age (in years) of the oldest venture capitalist to have financed the firm. I find no evidence that older venture capitalists are more willing to withdraw IPOs: the coefficient, 0.01, is of the opposite sign and insignificant.

The right-hand column reports the results when I rerun the regression, controlling for the quality of the firm. Superior-quality offerings may be less likely to be withdrawn, no matter who the venture investor. I use the same independent variables discussed in section 3.3: the age of the firm, the presence of a private placement from a related corporation, and the number of patent awards at the time of the financing. I can find no evidence that firms backed by seasoned venture capitalists are more likely to withdraw offerings, even after controlling for quality.

Table 8

Estimated probit regressions of the successful completion of an IPO by privately held venture-backed biotechnology firms who filed S-1 registration statements. The sample consists of 150 filings between January 1978 and September 1992. The dependent variable is 1.0 for firms that went public and 0.0 for firms that withdrew or abandoned their offerings. Independent variables include the age of the oldest venture investor, the age of the firm at the time of the filing, the number of patents awarded to the firm at the time of the filing,^a and a dummy variable indicating whether the firm had previously received a private placement from a corporation with a related line of business at the time of the filing^b (absolute *t*-statistics in brackets).

	Dependent variable: did firm go public?	
Age of oldest venture investor (in years)	0.01 [0.46]	0.01 [0.76]
Age of firm at time of filing (in years)		- 0.08 [1.48]
Patents awarded at time of filing		0.10 [1.04]
Did firm receive private placement from related corporation?		- 0.32 [1.08]
Constant	1.22 [4.63]	1.58 [4.44]
Log-likelihood	- 46.62	- 44.67
χ^2 -statistic	0.21	3.71
<i>p</i> -value	0.64	0.44
Number of observations	150	150

^aAll patents assigned to firms, their wholly owned subsidiaries, and their research and development limited partnerships are included. Awards to joint ventures and spin-offs are counted to the extent that a firm had an interest in the venture.

^bCorporations with related lines of business are defined as those with any of the following Standard Industrial Code identifiers in the Million Dollar Directory [Dun's (1992)] in the year of the transaction: SIC 283, Drugs; SIC 287, Agricultural Chemicals; and SIC 384, Medical Instruments and Supplies.

I also examine equity valuations after the filing of S-1 statements. Mikkelson and Partch (1988) examine stock prices after the announcement of seasoned security issues. In the weeks after the announcement of an ultimately withdrawn seasoned issue, both the market returns and the issuer's net-of-market returns are negative. No such pattern appears after the filing of successful offerings. I examine the returns from an equally-weighted investment in thirteen biotechnology securities between the close of the S-1 filing date and the close of the twentieth trading day thereafter. (I use the same procedure as above.) The index rises by 2% after the filing of successful offerings, and declines by 9% after the filing of ultimately withdrawn offerings. The difference is significant at the 1% level of confidence, as are those computed using other windows.

5. Conclusions

In this paper, I explore the choice between private and public equity. Using a sample of 350 privately held venture-backed firms, I examine both the private and public financings. I show that venture capitalists take firms public at market

peaks, relying on private financings when valuations are lower. Seasoned venture capitalists appear more proficient at timing IPOs. The results are robust to the use of alternative criteria to separate firms and controls for firms' quality. The results are not caused by differences in the speed of executing the IPOs, or in the willingness to withdraw the proposed IPOs.

Two limitations deserve further discussion. The first reflects the design of this study, which examined a setting particularly conducive to the empirical identification of market timing. In other industries, the need for oversight, or lumpy demands for capital, as the firm matures may affect the going-public decision more dramatically. In other periods, the heterogeneity between new and seasoned venture capitalists may not be as pronounced. Practitioner accounts, however, underscore the importance of IPO timing across industries and time. As an example, I cite an investment manager's discussion [McNamee (1991)] of market conditions around peak periods for computer and electronics IPOs:

The whole problem can be summed up in the phrase 'IPO window'. The IPO window occurs when sellers try to bail out and buyers try to get rich without doing any work. . . . It is when the AEA (American Electronics Association) puts up a billboard on Highway 101 near Great America that says, 'The buy side has lost its mind, let's bag them quick, before they catch on.' Sometime late in the IPO window, we get to watch venture capitalists behave like Keystone Kops.

Nor are such narratives confined to the 1980s and 1990s. For instance, Jeffery (1961) describes similar patterns in the market for new securities of high-technology firms in the 1950s. In the business press, Stern and Pouschine (1992) discuss the timing of 'reverse LBOs' (IPOs of firms that have previously undergone leveraged buy-outs) by LBO funds. Venture capitalists may also time the market when they sell or distribute shares in firms which have gone public. In an ongoing project on the contractual arrangements between venture partnerships and their limited partners, Paul Gompers and I are examining this issue.

A second concern relates to the results' interpretation. The seasoned venture capitalists' more effective timing of IPOs may reflect their superior proficiency. They may be better at recognizing when valuations are at a peak. There remain, however, several alternative interpretations. Less experienced venture capitalists may also wish to take firms public at market peaks, but may be unable to command the attention of investment bankers. This assertion may be plausible if underwriting services are rationed in key periods. Alternatively, Gompers' (1993) 'grandstanding' model suggests that inexperienced venture capitalists may not wait until the market is optimal to take firms public, because they need to signal *their* quality to potential investors in follow-on funds. The mechanisms through which managers and venture capitalists decide to go public and obtain access to investment bankers deserve further study.

A second opportunity for further research relates to the implications of the timing of the going-public decision. IPOs have been shown to coincide with declines in operating performance [Jain and Kini (1992)] and broad shifts in the incentives offered managers [Beatty and Zajak (1992)]. Do early initial public offerings affect the subsequent performance of the firm? To what extent are these factors related to the maturity of the firm and the market conditions at the time of the IPO? The interactions between these financing choices and operational performance deserve further scrutiny.

References

- Allen, Franklin and Gerald Faulhaber, 1989, Signaling by underpricing in the IPO market, *Journal of Financial Economics* 23, 303–323.
- Balvers, Ronald J., Bill McDonald, and Robert E. Miller, 1988, Underpricing of new issues and the choice of auditor as a signal of investment banker reputation, *Accounting Review* 63, 605–622.
- Barry, Christopher B., Chris J. Muscarella, John W. Peavy III, and Michael R. Vetsuypens, 1990, The role of venture capital in the creation of public companies: Evidence from the going public process, *Journal of Financial Economics* 27, 447–471.
- Beatty, Randolph A., 1989, Auditor reputation and the pricing of initial public offerings, *The Accounting Review* 64, 693–709.
- Beatty, Randolph A. and Edward Zajak, 1992, Firm risk and alternative mechanisms for internal corporate control: Evidence from initial public offerings, Unpublished working paper (Southern Methodist University, Dallas, TX and Northwestern University, Evanston, IL).
- Blume, Marshall E. and Robert F. Stambaugh, 1983, Biases in computed returns: An application to the size effect, *Journal of Financial Economics* 12, 387–404.
- BRS Information Technologies, 1986, PATDATA, Mimeo.
- Carter, Richard and Steven Manaster, 1990, Initial public offerings and underwriter reputation, *Journal of Finance* 45, 1045–1067.
- Clay, Lucius, 1987 and earlier years, *The venture capital report guide to venture capital in the U.K.* 3rd ed. (Venture Capital, Bristol).
- Corporate Technology Information Services, 1992 and earlier years, *Corporate technology directory* (CorpTech, Woburn, MA).
- Dun's Marketing Services, 1992 and earlier years, *Million dollar directory* (Dun and Bradstreet, Parsippany, NJ).
- Gompers, Paul A., 1993, Grandstanding in the venture capital industry, Unpublished working paper (University of Chicago, Chicago, IL).
- Grinblatt, Mark and Chuan Y. Hwang, 1989, Signaling and the pricing of new issues, *Journal of Finance* 44, 383–420.
- Hansen, Lars P. and Robert J. Hodrick, 1980, Forward exchange rates as optimal predictors of future spot rates: An econometric analysis, *Journal of Political Economy* 88, 829–853.
- Howard and Company, 1992 and earlier years, *Going public: The IPO reporter* (Howard and Co., Philadelphia, PA).
- Ibbotson, Roger G. and J.F. Jaffe, 1975, 'Hot' issue markets, *Journal of Finance* 30, 1027–1042.
- Jain, Bharat A. and Omesh Kini, 1992, Information asymmetry, agency costs and the operating performance of IPOs, Unpublished working paper (Pennsylvania State University, University Park, PA).
- Jeffery, Grant, 1961, *Science and technology stocks: A guide for investors* (Meridian, New York, NY).
- Leland, Hayne E. and David H. Pyle, 1977, Informational asymmetries, financial structure and financial intermediation, *Journal of Finance* 33, 371–387.
- Lerner, Joshua, 1993, *Venture capitalists and the oversight of private firms*, Unpublished working paper (Harvard University, Cambridge, MA).
- Lerner, Joshua, 1994, *The syndication of venture capital investments*, *Financial Management*, forthcoming.

- Loughran, Tim and Jay R. Ritter, 1993, The timing and subsequent performance of IPOs: The U.S. and international evidence, Unpublished working paper (University of Illinois, Urbana-Champaign, IL).
- McNamee, Roger, 1991, How to fix the IPO market, *Upside* 3, Jan., 24–27.
- Mega-Type Publishing, 1991, Genetic engineering and biotechnology-related firms – Worldwide directory (Mega-Type, Princeton Junction, NJ).
- Meggison, William C. and Kathleen A. Weiss, 1991, Venture capital certification in initial public offerings, *Journal of Finance* 46, 879–893.
- Meulbroek, Lisa, 1992, Comparison of forward and futures prices of an interest rate-sensitive financial asset, *Journal of Finance* 47, 381–396.
- Mikkelson, Wayne H. and M. Megan Partch, 1988, Withdrawn security offerings, *Journal of Financial and Quantitative Analysis* 23, 119–133.
- National Register Publishing Company, 1992 and earlier years, Corporate finance sourcebook, (National Register Publishing Co., Wilmette, IL).
- North Carolina Biotechnology Center, Biotechnology Information Division (NCBC), 1990a, North Carolina Biotechnology Center documentation for companies database (NCBC, Research Triangle Park, NC).
- North Carolina Biotechnology Center, Biotechnology Information Division (NCBC), 1990b, Survey of U.S. biotechnology firms, Unpublished report (NCBC, Research Triangle Park, NC).
- Ornx Press, 1991 and earlier editions, BioScan: The worldwide biotech industry reporting service (Ornx Press, Phoenix, AZ).
- Pisano, Gary P., 1989, Using equity participation to support exchange: Evidence from the biotechnology industry, *Journal of Law, Economics and Organization* 5, 109–126.
- Recombinant Capital, 1991, Valuation histories for private biotechnology companies (Recombinant Capital, San Francisco, CA).
- Recombinant Capital, 1992, Valuation histories for public and acquired biotechnology companies (Recombinant Capital, San Francisco, CA).
- Ritter, Jay R., 1984, The ‘hot issue’ market of 1980, *Journal of Business* 57, 215–240.
- Ritter, Jay R., 1991, The long-run performance of initial public offerings, *Journal of Finance* 46, 3–27.
- Sahlman, William A., 1990, The structure and governance of venture capital organizations, *Journal of Financial Economics* 27, 473–521.
- Schultz, Paul, 1993, Unit initial public offerings: A form of staged financing, *Journal of Financial Economics* 34, 199–129.
- Securities Data Company (SDC), 1992, Corporate new issues database: A tutorial (SDC, Newark, NY).
- Shiller, Robert J., 1990, Speculative prices and popular models, *Journal of Economic Perspectives* 4, 55–65.
- Shiller, Robert J. and John Pound, 1989, Survey evidence of diffusions of interest and information among investors, *Journal of Economic Behavior and Organization* 12, 47–66.
- Stern, Richard L. and Tatiana Pouschine, 1992, Junk equity, *Forbes* 149, March 2, 40–42.
- Teitelman, Robert, 1990, Gene dreams: Wall Street, academia and the rise of biotechnology (Basic Books, New York, NY).
- U.S. Department of Commerce, Patent and Trademark Office, Office of Patent Depository Library Programs (USPTO/OPDLP), 1989, ASSIST disk notes, Mimeo. (USPTO/OPDLP, Washington, DC).
- U.S. Department of Commerce, Patent and Trademark Office, Office of Patent Depository Library Programs (USPTO/OPDLP), 1990, CASSIS/BIB user’s guide (USPTO/OPDLP, Washington, DC).
- U.S. General Accounting Office (USGAO), 1989, Assessment of small business innovation research programs (USGAO, Washington, DC).
- Venture Economics, 1988a, Exiting venture capital investments (Venture Economics, Needham, MA).
- Venture Economics, 1988b and earlier years, Guide to European venture capital sources (Venture Economics, London).
- Venture Economics, 1991, Untitled documentation of databases, Mimeo. (Venture Economics, New York, NY).
- Venture Economics, 1992 and earlier years, Pratt’s guide to venture capital sources (Venture Economics, New York, NY).
- Welch, Ivo, 1989, Seasoned offerings, imitation costs, and the underpricing of initial public offerings, *Journal of Finance* 44, 421–449.