Rev Acc Stud (2006) 17:119–154
DOI 10.1007/s11142-006-6398-8

ORIGINAL ARTICLE

Venture-backed private equity valuation and financial statement information

Chris Armstrong · Antonio Davila · George Foster

Abstract The relationship between (a) private and public equity market valuations and (b) financial statement information is examined for a sample of 502 venture capital backed companies from six different industries over the 1993–2003 period. Financial statement information explains a sizable component of the levels of and changes in valuation in both the Pre-IPO and Post-IPO periods. The findings support prior research for Post-IPO companies that revenues are value enhancing and costs are value diminishing. For the Pre-IPO period, we find that cost of sales; sales, marketing, general and administrative; and research and development are value enhancing—even when revenues are included in the analysis. This is consistent with costs incurred by early-stage, venture-backed companies having a strong ''investment aspect'' as the companies build a platform/infrastructure to grow revenue and validate their business model(s). We document the growth of early stage companies for revenues and costs in both calendar time (by round of private equity financing) and event time (relative to their eventual IPO).

Keywords venture-capital · valuation · value relevence · accounting

JEL Classification M41 · G12 · G24

1. Introduction

Private equities are an important and growing part of the worldwide capital markets. This designation includes early stage investments (often venture capital backed), mezzanine/later stage investments, and leveraged buyouts. Although the role of financial statement information in valuing publicly traded equity securities has been studied extensively, there is

C. Armstrong · A. Davila · G. Foster (✉)
Graduate School of Business, Stanford University, Stanford, CA, 94305, USA
e-mail: ffoster@gsb.stanford.edu

A. Davila
IESE Business School, Barcelona, 08034, Spain

remarkably little research on the role of financial statement information in the private equity sector in the U.S. This is despite the large number of companies and the sizable amount of capital committed to private equities.[1] Lack of readily available financial statement data for privately held U.S. companies is likely the major reason for the limited research to date, and it is these companies that are the subject of the present study.

Despite the limited prior research, there is demand for a coherent valuation framework by private equity investors and stakeholders. Consider the comments from the president of the National Venture Capital Association (NVCA) before a 2004 Congressional subcommittee on the topic of accounting for employee stock options (Heesen, 2004):[2]

> *Valuation of a private, venture-backed company's stock is a process, which at best is costly, complex, and inexact. Absent new rounds of financing, venture capitalists rarely have information upon which to base changes of the set stock price because the stock is not tradable and the companies tend to be unique, with no like comparisons to benchmark. And in the end, the final number will be an inaccurate, inconsistent, and incomparable guess.*

This sentiment is echoed by many in the venture capital industry and serves to underscore the perceived difficulty in valuing privately held, venture-backed investments. In contrast to these remarks, however, the findings presented in this paper suggest a significant role for financial statement information in explaining both the level of and changes in the market value of privately held companies. Further, our results from a sample of companies across a number of industries suggest that there are common financial statement (as well as non-financial statement) variables that are consistently associated with private equity values.

Hand's (2004, 2005) research on Pre-IPO biotech startups is an important first thrust into venture-backed private equity valuation using financial statement information. Hand (2005) uses a cross-sectional levels approach to examine the association between the round-by-round pre-money valuations of venture-backed biotech startups and both financial statement and non-financial statement information. He finds that the value relevance of financial (non-financial) statement information increases (decreases) as the sample companies mature. Hand (2004) examines valuation changes (between successive rounds of private financing) for the same sample of biotech companies. He reports that ''equity returns between financing rounds are reliably negatively related to firm size and positively related to book-to-market ratios'' (p. 1).

Our research has the broader focus of venture-backed early stage companies in six diverse industries (one of which is biotech). We examine the association between financial and non-financial statement information and private equity values using both cross-sectional levels and time-series changes approaches. Our primary findings suggest a significant role for multiple balance sheet and income statement variables in valuing early stage

[1] VentureOne's Venture Capital Industry Report (2001) for 2000 indicates a growing trend in both the number of deals and amounts invested in venture capital. Specifically, from 1997 to 2000, the total number of deals in the U.S. grew from 1841 to 4107 while the amount invested grew from $11.42 billion to $68.76 billion. The period from 2001 to 2003 witnessed a decline in venture capital funding in each year with $18.9 billion invested in U.S. venture-backed companies in 2003. Venture capital investment increased during 2004 with $20.4 billion invested in 2,067 deals. (Jeffers and O'Sullivan, 2005).

[2] Privately held venture-backed companies typically make heavy use of options. The price of the security underlying the option (i.e., the share price of the venture-backed firm) is one of the parameters used to price the option within state-of-the-art option pricing models.

companies. One issue pursued in the research design is a decomposition of the aggregate income number into multiple cost line items. We examine changes in their valuation implications over time. Venture capitalists typically focus on early-stage companies that have rapid growth potential but negative cash flow. In some cases, cash outlays will precede the inflow of revenue by several years. Venture financing rounds facilitate a company building an infrastructure or platform to enable future revenues to occur. Many costs in the initial stages of a venture-backed company potentially have a strong ''capital investment'' aspect.[3] Multiple financing rounds may be necessary before revenues exceed costs and cash flow is sufficient to reduce the need for additional venture financing or the business model is sufficiently validated for financing to occur through a public offering of the company's equity. In the Pre-IPO phase of a venture-backed company, venture capitalists can exercise tight monitoring of cost outlays. Each early round of private financing typically brings with it a seat on the Board of Directors for the new lead-venture firm associated with that round. Our research probes whether the private equity venture capital market perceives cost outlays of early stage companies as ''investments.'' We also examine how the *public* equity market perceives the same income statement line items of the same companies at a later stage in their evolution.

The valuation change analysis presented in this paper is facilitated by deriving implied annual valuation changes based on the sequence of valuations at successive rounds of Pre-IPO financing. This allows us to overcome the lack of continuously available valuation information that is inherent to private equity research.[4] The association tests we report using annual changes in valuations further speak to the timeliness of financial statement information in private equity valuation. We find that changes in financial statement variables are contemporaneously associated with changes in private equity valuations. This result is consistent with prior research using publicly traded equities and suggests that the accounting system reflects much of the value creation in early stage companies on a timely basis.

The remainder of the paper proceeds as follows. In the next section we discuss the prior research on venture-backed private equity valuation. Section 3 describes the data used in this study and our sample selection procedure. The financial profile of the sample of companies is presented in Section 4. Section 5 discusses the empirical specifications used in our main analyses and also develops our various hypotheses in light of prior theoretical and empirical findings. Section 6 presents our main findings and discusses their implications in relation to prior research. Section 7 summarizes our findings, discusses directions for future research and concludes the paper.

[3] This capital investment aspect for early stage companies has also been addressed in the economics literature (Jovanovic, 2005). This author models how P/E ratios for pre-revenue stage industries (''start-up'') are much larger than P/E ratios after the industry moves to the sales stage (''maturity'').

[4] Venture-backed private companies raise financing via a negotiation between the management/board of the early stage (investee) company and one or more venture capital (investor) companies. Two key issues in this negotiation are the valuation of the investee company at the time new financing is arranged (termed pre-money valuation) and the amount of financing to be provided by the investor. The first (second, third,...) round of private funding is (are) referred to as Series A (B,C,...). The pre-money valuation plus the amount of new financing is known as the post-money valuation of the investee company. We refer to the various rounds of financing as, respectively, Series A, Series B, Series C, etc. We adopt this terminology, in part, to avoid confusion when we discuss our results in event time (e.g., −1, 0, +1) versus calendar time (e.g., Series A, B, C). In addition, this terminology is fairly standard in the entrepreneurial finance literature.

2. Research on venture-backed private equity valuation

While the growing body of research on venture-backed companies has examined a number of issues, it is only recently that specific financial statement information has been an integral part of the research design. Examples of prior research include:
(A) Growth in valuations. There is no regulatory requirement that privately held companies report information related to their round-by-round financing. However, several services (such as VentureOne and Venture Economics) have been able to collect relatively comprehensive databases, which have been used by researchers in a variety of areas. Houlihan Valuation Advisors/Venture-One (1998) use the VentureOne database to highlight the importance of rounds of financing in valuation—valuations, on average, increase over successive rounds of private equity financing. This paper (as well as Seppa and Laamanen, 2000) reports that the rate of increase in valuations declines over successive rounds while the risk of loss associated with venture capital investments is also decreasing in rounds of financing. More recently, Cochrane (2005) examines the statistical properties of the returns distribution for venture-backed companies. He finds that ''venture capital investments are much more similar to traded securities than one would otherwise suspect.'' (p. 3).
(B) Macroeconomics or Industry Based Impacts on Private Equity Valuations. Gompers and Lerner (2000) is illustrative. They report that increases in the aggregate inflow of funds into the venture-capital sector result in increases in the Pre-IPO valuations of early stage companies. In their analysis, the authors control for company-specific characteristics using information included in the VentureOne database—e.g., age of company, round of financing, and status of company (such as startup v. development v. beta v. shipping v. profitable v. restart).
(C) Impact of Financing on Growth of Venture-Back Companies. Research here has examined how various parties or events affect the growth of venture-backed companies. Hellman and Puri (2000, 2002) document ways that venture capitalists bring a broader package of professionalization benefits (over and above financing) to early stage companies. For example, associated with venture-backing is an increased likelihood of the company adopting an innovator strategy and being quicker to market. Davila, Foster, and Gupta (2003) find that new private equity financing rounds are associated with an increase in headcount. They also report that for their sample of early stage companies, increased headcount is associated with growth in Pre-IPO valuation.
(D) Equity Valuation and Financial Statement Information. Hand (2004, 2005) examines how financial statement and non-financial statement variables explain the valuation of 204 Pre-IPO and Post-IPO U.S. biotechnology companies in the 1992–2003 period. The financial statements included in the S-1 regulatory filings for an IPO were the source of Pre-IPO financial information. The company's 10-K filings were the source of the Post-IPO financial statements. Both Hand (2004, 2005) studies conclude that financial statements are value relevant in the private equity venture capital market for biotech companies. Davila and Foster (2005) also report positive Spearman correlations between changes in valuation and changes in revenues for a sample of 78 private companies (60 of which are venture-backed).

3. Sample selection and data availability

A database containing the names of 867 venture-backed companies that completed an initial public offering (IPO) in the U.S. capital markets from 1996 to 2000 was obtained from

VentureOne. This database covers a significant percentage of venture capital investments in the U.S. We then gathered S-1 filings from the SEC's EDGAR website for the sample companies. This information was available for a total of 552 of the companies. Companies in any one of the six largest groupings in the VentureOne industry segment classification were retained. The final sample of 502 companies comprised the following six industries: Software with 140 companies (28.63% of sample), Services with 127 companies (25.30% of sample),[5] Telecom and networking with 106 companies (21.12% of sample), Biotech with 59 companies (11.75% of sample), Medical Equipment with 36 companies (7.17% of sample), and Computer Hardware with 34 companies (6.77% of sample).

Since the companies in the VentureOne database all filed for an IPO of their equity, there is an obvious potential for survivorship bias in the data.[6] The sample used in this study is interesting in its own right because it constitutes a group of companies that accounted for a large fraction of value in the private equity market during the period examined in this study. The aggregate value of the companies in this sample was nearly $285 billion at the time of their eventual IPO and collectively, they raised over $68 billion in the private equity markets prior to their IPO. The aggregate public equity market value of our sample companies measured 3 months following their respective IPO was over $612 billion.[7] The IPO time-period covered by the VentureOne database is 1996 to 2000. The full period covered is from 1993 to 2003 as our analysis examines the 3 years following the IPO. (Appendix A of this paper examines the survivorship issue. It reports that key findings of our research are found for a sample of non-IPO, venture-backed companies and for companies with an IPO outside the 1996–2000 period).

Three types of data were gathered for each company in our sample. First, private equity market valuations (both pre- and post-money) were obtained at each round of venture capital funding (VentureOne) and public equity market valuations were collected from capital market information (Compustat). Second, financial statement information was gathered from the SEC filings accompanying the IPO. We include non-financial data that is expected to be common to various industries in our sample. Third, we gathered capital market related data for the time period examined in the research. Consistent with prior capital markets research, this allows us to control for the influence of market-wide price movements. Our data does not include all the variables that have been studied in the IPO literature (e.g., ownership structure changes in the IPO process, number of employees) because these variables are either not expected to be relevant to all six industries in our sample or the variables were not consistently available for a sufficient length of time prior to the sample companies' IPOs.

3.1. Equity market valuations

This study examines both the Pre- and Post-IPO periods. In the Pre-IPO period, market valuations are only available when a new round of financing is completed. The VentureOne database contains information at these various funding dates. Specifically, it includes

[5] The Services classification includes information services, consumer and business services, and healthcare services.

[6] Cochrane (2005) provides a discussion of this bias. Companies that exit via Pre-IPO acquisition are also excluded from our sample.

[7] The top 10 in market capitalization 3 months after their IPO are Akamai Technologies ($30.305 billion), Sycamore Networks ($30.204 billion), Juniper Networks ($17.673 billion), Foundry Networks ($17.044 billion), CommerceOne ($14.731 billion), FreeMarkets ($11.993 billion), InterNAP Networks ($11.426 billion), eBay ($9.711 billion), Vignette ($9.706 billion), and Red Hat ($9.306 billion).

round-by-round information (with relatively few gaps) with the round number (e.g., Series A, Series B, etc...), the pre-money valuation, the amount raised, and the date the financing was complete.[8] In the Post-IPO period, the monthly market capitalization was computed from the Compustat Price, Dividends, and Earnings file as the number of shares outstanding (CSHOQ) times the price per share at the end of the month (PRCC).[9] Three sets of information will be used as explanatory variables:

3.2. Company financial statement information

One important feature of the regulatory environment of public equity markets in the U.S. is that a company conducting an IPO is required to file Form S-1 (formally known as the ''Registration Statement Under the Securities Act of 1933'') with the Securities and Exchange Commission. This public document includes up to 5 years of audited financial statements prepared in accordance with GAAP. One purpose of the S-1 filing is to provide investors with information about the company's financial activities prior to its IPO. The S-1 filings are made available on the SEC's EDGAR website and were obtained for the companies in our sample. A database of Pre-IPO financial information for the companies in our sample was constructed with these filings. The most systematic information available across a broad set of our sample was for years −3, −2, and −1 prior to the IPO. The database includes both balance sheet (including cash; non-cash assets; and long-term debt) and income statement (including revenues; cost of sales (COS); sales, marketing, general, and administrative (SMG&A); and research and development (R&D) expenses) items which are used in our analysis. Similar financial statement information for the sample companies in the Post-IPO period was obtained from the Compustat Annual data file.

3.3. Company non-financial statement information

Prior research has shown that non-financial statement information has a role in equity valuation in both a public equity (e.g., Amir and Lev, 1996; Barth, Clement, Foster, and Kasznik, 1998) and a private equity (e.g., Hand, 2004, 2005) context. Accordingly, we include additional non-financial variables in our analysis, many of which have been included in prior studies—e.g., indicator variables for the round of funding immediately prior to a given financial statement date, age of the company, and number of patents applications. Although prior research has found a number of industry-specific non-financial variables to be significant in explaining equity values within their respective industry, the focus in this paper is on non-financial statement information expected to be relevant in explaining private equity values across a variety of industries. This allows for an easier comparison of our results across the various industries and facilitates the generalizability of our findings to the population of venture-backed private equity companies as a whole. It,

[8] We were able to assess the severity of missing observations in the companies' funding/valuation sequence in the VentureOne database by tracking the company from its start date through its IPO and counting the number of Series in between. This analysis revealed that for our sample of companies, there were fewer than 40 missing data points (representing approximately 1.6% of the total VentureOne data points) for intermediate rounds of financing.

[9] In the Pre-IPO period, private equity market values on the date of the financial statements (i.e., December 31st for calendar year companies) are derived using the interpolation method. Following Hand (2005), as well as much of the value relevance literature (e.g., Barth, Beaver, and Landsman, 1996), we use public equity market values 3 months after the date of the financial statements (i.e., March 31st for calendar year companies).

however, likely understates the role that industry-specific, non-financial statement company variables can play in explaining Pre-IPO valuations.

3.4. Capital market information

Market- or industry public equity market indices have been found to be a significant variable in equity-market valuation research (e.g., Gompers and Lerner, 2000; Hand, 2005). We include the NASDAQ composite index in our analysis.[10]

4. Descriptive statistics and financial profile of sample firms

There is sizable variation in our sample of 502 venture-backed companies in terms of both (a) the calendar time from their start date to the date of their eventual IPO, and (b) the number of rounds of private financing leading up to their IPO. The mean (median) calendar time from the start of the company to the IPO date for our pooled sample is 5.36 (3.00) years while the mean (median) number of financing rounds prior to IPO is 4.94 (5.00). Table 1 presents summary statistics (percentage and cumulative percentage by year and round and the mean and median) for both the number of years (Panel a) and the number of rounds (Panel b) prior to IPO for the pooled sample and for each of the six industry groups. Table 1 reveals that there is substantial diversity even within an industry. Biotech companies have the largest average number of financing rounds prior to their IPO with 5.81 followed by computer hardware (5.50), medical equipment (5.39), telecommunications/network (4.90), software (4.80), and services (4.43). Biotech also has the highest percentage of companies with zero revenues in the year of their IPO with 12.1%. These facts suggest that biotech companies take longer to become financially viable from their revenue sources and, as a result, are more dependent on equity financing or cost-sharing agreements with partners for growth.

Figure 1 and Table 2 present median round-by-round statistics for valuation, financial statement, and non-financial statement variables. Two findings are especially interesting. First, the median private equity market valuation typically increases with successive rounds of financing. This result has been reported in the prior research cited in Section 2 of this paper. Second, the median net income is negative for the pooled sample and for each of the six industries for each and every round of financing in Table 2. These two findings are consistent with venture capitalists at each successive round, on average, believing that the prior costs incurred have resulted in equity value being added to the sample of companies examined.

Figure 2a presents the financial profile (.1,.3,.5,.7, and .9 deciles for revenues and expenses) for the pooled sample of companies in event time where year 0 is the year of the company's IPO. This figure illustrates the dramatic revenue and expense build-up during a relatively brief window surrounding the IPO. Figure 2b presents the comparable profile for net income. Figure 3 shows the median revenues (a), expenses (b), and net income (c) for each of the six industries in years −3 to +3 in event time during the period surrounding the IPO. Biotech companies have the lowest median revenue of the six industries with $7.921 million in the year of the IPO compared with $25.216 million for the total sample.

[10] We also included an industry specific private equity index in the Pre-IPO and Post-IPO analyses. The index was constructed from the median company value by year, by industry as reported by VentureOne. Inclusion of this variable did not significantly increase the adjusted-R^2 nor did it change the inferences drawn about the accounting variables in this study.

Table 1 Speed to IPO by (a) years since company founding, and (b) number of private equity rounds

Years/rounds	Pooled			Software			Telco/network			Services			Biotech			Medical equip.			Computer hardware		
	No.	Pctg. (%)	Cum pctg (%)	No.	Pctg. (%)	Cum pctg (%)	No.	Pctg (%)	Cum pctg (%)	No.	Pctg. (%)	Cum pctg (%)	No.	Pctg. (%)	Cum pctg (%)	No.	Pctg. (%)	Cum pctg (%)	No.	Pctg. (%)	Cum pctg (%)
Panel A: Years from company founding to IPO																					
1	8	1.6	1.6	1	.7	.7	3	2.8	2.8	4	3.1	3.1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
2	55	11.0	12.5	8	5.7	6.4	17	16.0	18.9	19	15.0	18.1	7	11.9	11.9	2	5.6	5.6	2	5.9	5.9
3	101	20.1	32.7	26	18.6	25.0	25	23.6	42.5	38	29.9	48.0	5	8.5	20.3	4	11.1	16.7	3	8.8	14.7
4	95	18.9	51.6	24	17.1	42.1	18	17.0	59.4	28	22.0	70.1	10	16.9	37.3	8	22.2	38.9	7	20.6	35.3
5	63	12.5	64.1	21	15.0	57.1	12	11.3	70.8	14	11.0	81.1	8	13.6	50.8	3	8.3	47.2	5	14.7	50.0
6	36	7.2	71.3	14	10.0	67.1	7	6.6	77.4	5	3.9	85.0	4	6.8	57.6	4	11.1	58.3	2	5.9	55.9
7	26	5.2	76.5	5	3.6	70.7	7	6.6	84.0	3	2.4	87.4	7	11.9	69.5	2	5.6	63.9	2	5.9	61.8
8	27	5.4	81.9	10	7.1	77.9	1	0.9	84.9	5	3.9	91.3	6	10.2	79.7	2	5.6	69.4	3	8.8	70.6
9	17	3.4	85.3	6	4.3	82.1	0	0.0	84.9	3	2.4	93.7	2	3.4	83.1	4	11.1	80.6	2	5.9	76.5
10	9	1.8	87.1	5	3.6	85.7	1	0.9	85.8	1	0.8	94.5	1	1.7	84.7	1	2.8	83.3	0	0.0	76.5
11	11	2.2	89.2	3	2.1	87.9	2	1.9	87.7	1	0.8	95.3	2	3.4	88.1	1	2.8	86.1	2	5.9	82.4
12	54	10.8	100.0	17	12.1	100.0	13	12.3	100.0	6	4.7	100.0	7	11.9	100.0	5	13.9	100.0	6	17.6	100.0
Total obs.	502			140			106			127			59			36			34		
Mean:			5.36			5.84			5.01			4.25			6.07			6.17			6.53
Median:			3.00			5.00			4.00			4.00			4.00			6.00			5.00
Panel B: Number of financing rounds																					
A	1	0.2	0.2	0	0.0	0.0	1	0.9	0.9	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
B	51	10.2	10.4	13	9.3	9.3	15	14.2	15.1	16	12.6	12.6	4	6.8	6.8	2	5.6	5.6	1	2.9	2.9
C	57	11.4	21.7	18	12.9	22.1	10	9.4	24.5	18	14.2	26.8	1	1.7	8.5	5	13.9	19.4	5	14.7	17.6
D	102	20.3	42.0	33	23.6	45.7	17	16.0	40.6	31	24.4	51.2	11	18.6	27.1	3	8.3	27.8	7	20.6	38.2
E	119	23.7	65.7	27	19.3	65.0	27	25.5	66.0	34	26.8	78.0	16	27.1	54.2	8	22.2	50.0	7	20.6	58.8
F	87	17.3	83.1	29	20.7	85.7	19	17.9	84.0	16	12.6	90.6	7	11.9	66.1	11	30.6	80.6	5	14.7	73.5
G	43	8.6	91.6	13	9.3	95.0	5	4.7	88.7	10	7.9	98.4	7	11.9	78.0	4	11.1	91.7	4	11.8	85.3
H	18	3.6	95.2	4	2.9	97.9	5	4.7	93.4	1	0.8	99.2	6	10.2	88.1	1	2.8	94.4	1	2.9	88.2
I	11	2.2	97.4	2	1.4	99.3	4	3.8	97.2	1	08	100.0	3	5.1	93.2	0	0.0	94.4	1	2.9	91.2
J	7	1.4	98.8	1	0.7	100.0	2	1.9	99.1	0	0.0	100.0	2	3.4	96.6	1	2.8	97.2	1	2.9	94.1
K	6	1.2	100.0	0	0.0	100.0	1	0.9	100.0	0	0.0	100.0	2	3.4	100.0	1	2.8	100.0	2	5.9	100.0
Total obs.	502			140			106			127			59			36			34		
Mean:			4.94			4.80			4.91			4.43			5.81			5.39			5.0
Median:			5.00			5.00			5.00			4.00			5.00			5.00			5.00

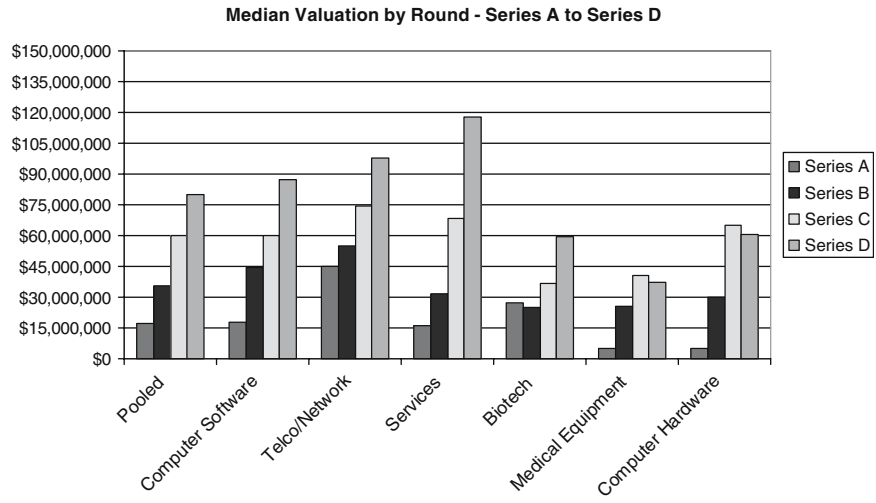

Fig. 1 Median private market (Pre-IPO) pre-money valuation by round (Series A to D) and industry

Figure 4a presents a financial profile similar to Fig. 2 (i.e., the .1,.3,.5,.7, and .9 deciles for revenues and expenses) for the Pre-IPO period by round of financing for the full sample of companies. Figure 4 uses a calendar time format as opposed to the event time format in Fig. 2. When moving from one round to the next in Fig. 4, there is attrition in the sample as companies individually exit the private equity market via an IPO. Companies that move quickly to an IPO in calendar time tend to have fewer rounds of financing and faster revenue and expense growth. To illustrate, Fig. 4b presents the round-by-round revenue and expense build-up for ''Fast-IPO'' companies (which we define as companies with, at most, Series C financing prior to their IPO). Panel c shows the round-by-round profiles for ''Slow-IPO'' companies (which we define as companies with at least Series D financing prior to their IPO). The profile for Series D through Series G in Fig. 4a and c are identical by construction since the revenue and expense data for Series D–G in the pooled sample come solely from the second sub-sample of companies. However, as you move from Series D to G, this sample represents an increasingly smaller percentage of the companies in our sample. Note that ''Fast-IPO'' companies in Fig. 4(b) have a more rapid ramp-up in revenues and expenses in their Series A to Series C rounds than do ''Slow-IPO'' companies (Panel c) in their respective Series A through Series C financing.

Figure 5 presents the median of the revenue, expense, and net income series for three groups of companies in event time according to whether the company had its IPO after Series A, B, or C, after Series D or E, or after Series F and beyond. Each of the three portfolios of companies in Fig. 5 is of roughly the same size. In Panel a, there is a nearly monotonic increase in the median net revenues of each of the three groups from 3 years prior to the IPO through the second year after the IPO. Further, the median revenue of the companies with three or fewer rounds of financing dominates that of companies with four or five rounds of financing. Panel b depicts the median expenses of the three groups of companies in event time. The three groups are much more homogeneous in their median expenses (Panel b) compared to either their median revenue (Panel a) or their median net income (Panel c).

Table 2 Private market (Pre-IPO) medians for select variables at rounds of private equity financing: total sample and by industry[a]

	Series A	Series B	Series C	Series D	Series E	Series F+
Pooled Sample (*nobs.*)	101	165	214	210	144	133
Private equity market valuation	17,500,000	35,500,000	60,000,000	80,020,000	136,880,000	207,800,000
Total assets	388,570	2,950,600	6,375,200	8,822,500	12,354,000	18,920,000
Book value of equity	0	415,430	2,373,400	4,030,600	6,015,500	8,554,000
Revenue	3,116,500	2,781,000	1,815,800	2,610,700	4,847,700	8,155,000
COS	1,493,700	1,280,000	688,830	1,523,900	2,356,800	3,806,000
SMG&A	1,439,000	1,792,400	2,771,500	3,799,000	5,217,000	6,110,000
R&D	454,000	1,055,000	1,962,000	2,846,800	3,708,600	6,154,000
Net income	−575,180	−1,488,000	−3,917,500	−6,023,900	−8,475,500	−10,291,000
Number of patents granted	1	1	0	0	1	1
Days since prior round of financing	N/A	380	348	306	282	283
Software (*nobs.*)	26	47	74	65	39	34
Private equity market valuation	17,530,000	44,700,000	60,100,000	87,000,000	146,100,000	196,070,000
Total assets	0	2,674,900	5,298,500	9,421,400	12,499,000	17,562,000
Book value of equity	0	0	1,304,800	2,977,000	5,465,800	3,600,500
Revenue	3,926,600	4,462,000	3,288,500	3,924,200	7,599,000	11,409,000
COS	1,703,000	1,167,000	1,099,100	1,644,000	2,663,000	5,263,000
SMG&A	2,716,500	2,823,000	4,679,000	6,521,000	8,150,000	12,912,000
R&D	1,430,100	1,482,400	2,003,500	3,425,000	3,845,200	5,621,500
Net income	−1,013,900	−1,180,000	−3,611,000	−6,059,000	−8,134,000	−11,450,000
Number of patents granted	0	0	0	0	1	1
Telco/Network (*nobs.*)	19	28	32	32	27	23
Private equity market valuation	45,150,000	55,070,000	74,363,000	97,850,000	360,730,000	203,000,000
Total assets	3,226,800	8,301,500	8,033,000	11,254,000	41,695,000	23,990,000
Book value of equity	0	2,758,200	5,411,900	5,103,000	17,120,000	11,405,000
Revenue	8,231,000	4,144,000	1,303,000	2,401,900	7,230,000	9,858,000
COS	5,699,300	2,821,100	1,362,000	3,208,500	7,357,000	7,019,000
SMG&A	2,072,000	1,513,500	2,436,700	4,132,500	5,469,000	7,414,000
R&D	291,000	1,096,500	1,608,200	3,483,000	4,183,000	7,121,000
Net income	−27,047	-1,174,200	−5,507,700	−7,837,600	−15,300,000	−13,418,000
Number of patents granted	1	1	0	0	1	1
Services (*nobs.*)	38	45	44	45	24	16
Private equity market valuation	16,050,000	31,800,000	68,550,000	118,000,000	162,990,000	304,570,000
Total assets	625,600	2,108,000	5,980,900	14,884,000	10,555,000	24,452,000
Book value of equity	0	657,080	2,872,600	7,409,700	4,468,400	16,853,000
Revenue	1,304,200	2,189,400	1,410,800	2,646,500	8,418,500	10,214,000
COS	593,430	1,229,000	1,633,000	2,360,000	4,516,500	5,633,500
SMG&A	638,500	1,680,000	3,060,300	3,585,000	7,465,000	10,059,000
R&D	259,800	394,270	1,049,600	1,232,000	1,415,000	1,774,200
Net income	−1,018,500	−2,813,900	−4,164,400	−6,339,000	−9,798,500	−12,341,000
Number of patents granted	1	1	1	1	1	1
Biotech (*nobs.*)	5	14	23	25	22	25
Private equity market valuation	27,500,000	25,070,000	36,810,000	59,200,000	89,655,000	218,610,000
Total assets	0	6,958,800	6,774,000	8,664,000	8,085,700	20,574,000
Book value of equity	0	3,615,500	716,680	4,352,400	2,414,600	10,562,000

Table 2 Continued

	Series A	Series B	Series C	Series D	Series E	Series F+
Revenue	6,200,000	2,142,400	317,630	982,760	542,390	2,935,600
COS	0	721,080	0	0	0	0
SMG&A	2,603,000	1,320,900	1,995,800	1,814,000	2,560,500	3,952,000
R&D	2,659,000	2,994,800	5,321,000	7,589,000	9,129,700	11,933,000
Net income	−1,727,400	−2,274,500	−4,587,800	−8,737,600	−7,787,000	−8,934,100
Number of patents granted	0	0	0	0	1	7
Medical Equipment (*nobs*.)	5	8	10	13	14	16
Private equity market valuation	4,960,000	25,400,000	40,765,000	37,200,000	64,090,000	133,680,000
Total assets	0	4,006,400	6,697,800	3,019,500	3,618,300	16,399,000
Book value of equity	0	1,893,700	5,258,300	0	2,080,100	7,446,800
Revenue	1,040,700	922,640	165,180	132,000	356,530	8,863,000
COS	1,493,700	767,320	337,920	0	0	4,475,800
SMG&A	390,840	906,750	1,224,000	1,032,000	772,560	2,498,200
R&D	1,554,500	1,271,400	1,893,000	3,712,000	3,112,400	4,320,000
Net income	−2,090,700	−2,582,200	−3,108,100	−5,310,600	−5,787,800	−7,634,200
Number of patents granted	1	1	1	0	0	3
Computer Hardware (nobs.)	2	6	13	15	9	15
Private equity market valuation	5,165,000	29,750,000	65,000,000	60,300,000	165,200,000	205,000,000
Total assets	597,500	0	7,676,000	4,185,000	12,343,000	16,814,000
Book value of equity	−210,000	0	3,347,000	1,037,000	7,759,800	6,579,000
Revenue	4,137,000	384,400	1,774,000	3,680,300	7,803,000	15,362,000
COS	2,739,000	268,200	1,031,000	2,312,500	3,787,000	6,033,000
SMG&A	748,000	135,880	1,042,800	0	0	0
R&D	612,000	1,139,000	2,318,200	3,176,000	4,524,000	6,294,000
Net income	25,500	−1,105,500	−1,944,000	−4,036,000	−5,978,800	−9,090,000
Number of patents granted	1	0	0	0	2	4

[a]Private equity market valuation is the pre-money valuation for a given series of financing. Financial statement information is from the S-1 financial statement date that is closest (in calendar time) to the series of financing

5. Research design and empirical predictions

First we analyze the level of private and public equity value as a function of company financial statement, company non-financial statement, and a capital market variable. We then proceed to analyze changes (both undeflated and deflated) in equity value as a function of changes in a subset of those variables. We present findings for both and relate them to each other as well as to prior findings for publicly traded equities.

5.1. Levels analysis

Valuation information for private equity is not available on an approximately continuous basis as it is for publicly traded equities. Private equity valuations are typically performed only when rounds of financing are completed. Table 2 reports for the pooled sample the median number of days between successive financing rounds—from Series A to B it is 380 days, from Series B to C it is 348 days, and from Series C to D it is 306 days. We use

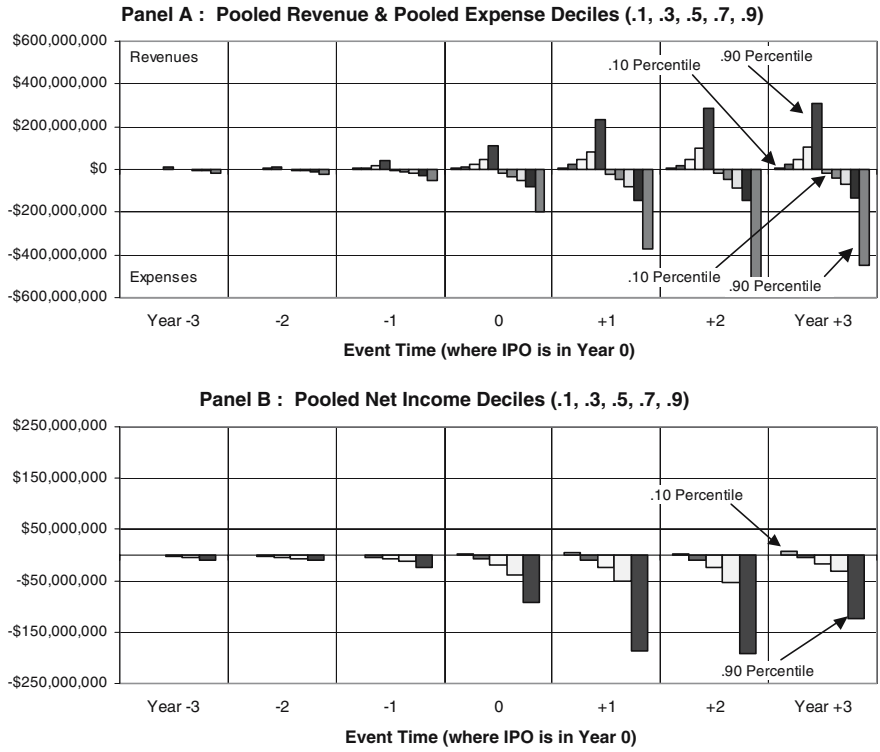

Fig. 2 Financial profile evolution of early-stage companies for pooled sample: private market (Pre-IPO) and public market (Post-IPO) event time. (**a**) Pooled revenue & pooled expense deciles (.1, .3, .5, .7, .9) and (**b**) Pooled net income deciles (.1, .3, .5, .7, .9)

two approaches for pairing these intermittent equity valuations with the annual financial statement information from the S-1 filing. The first (referred to as the ''matching approach'') follows the methodology developed in Hand (2005). Each set of annual financial statement information is paired with pre-money valuation of the next round of financing that occurs subsequent to the date of the financial statements. Any additional rounds of funding that occur after this round of funding, but before the next set of financial statements, are discarded from the analysis. This approach has the virtue of simplicity. One drawback is that the financial statement information could be relatively stale if a long time has elapsed between the financial statements and the next round of funding.[11] A second drawback is the discarding of observations when multiple financing rounds occur in a single fiscal year.

The second methodology we adopt (referred to as the ''interpolation approach'') is to use each company's unique sequence of funding dates and valuation amounts to compute the implied valuation at intermediate dates in between rounds of funding—namely the

[11] This is expected to be the case more so if more than 6 months have elapsed between the date of the financial statements and first round of funding after that date. In this case, the round of financing would be closer (in calendar time) to the next set of financial statements, but would nevertheless be paired with the earlier set of financial statements.

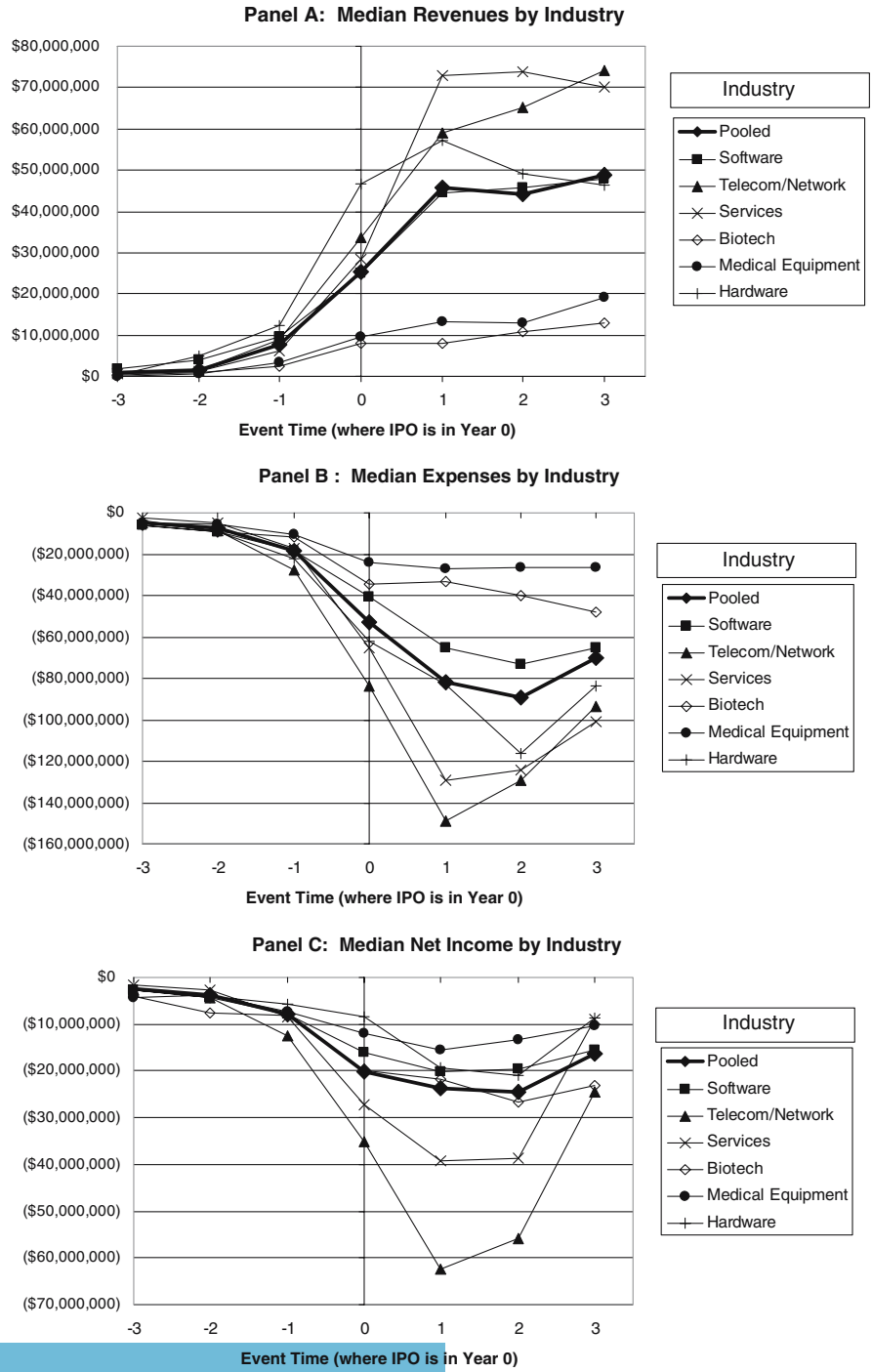

Fig. 3 Financial profile evolution of early-stage companies by industry: private market (Pre-IPO) and public market (Post-IPO) event time. (**a**) Median revenues by industry. (**b**) Median expenses by industry. (**c**) Median net income by industry

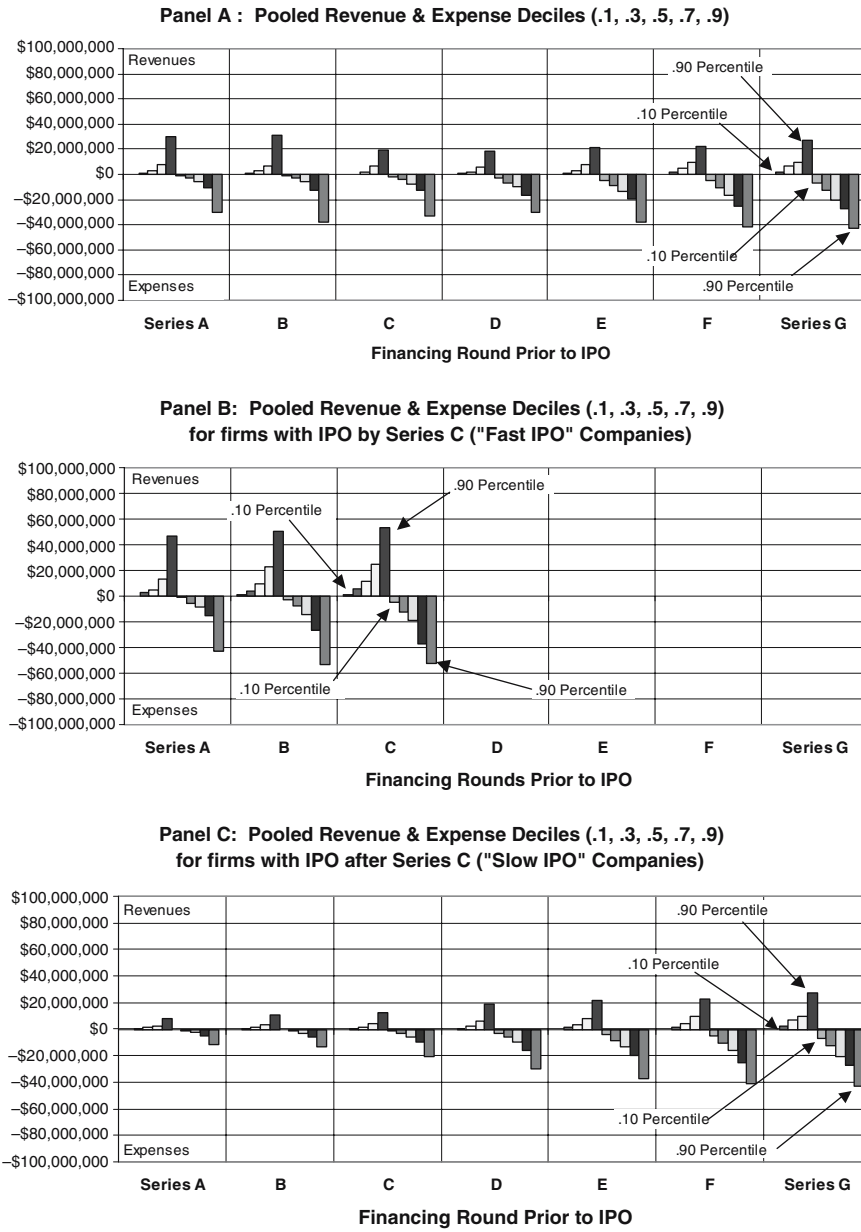

Fig. 4 Financial profile evolution of early-stage companies: by private market (Pre-IPO) financing round (calendar time). (**a**) Pooled revenue & expense deciles (.1, .3, .5, .7, .9). (**b**) Pooled revenue & expense deciles (.1, .3, .5, .7, .9) for firms with IPO by Series C (''Fast IPO'' Companies). (**c**) Pooled revenue & expense deciles (.1, .3, .5, .7, .9) for firms with IPO after Series C (''Slow IPO'' Companies)

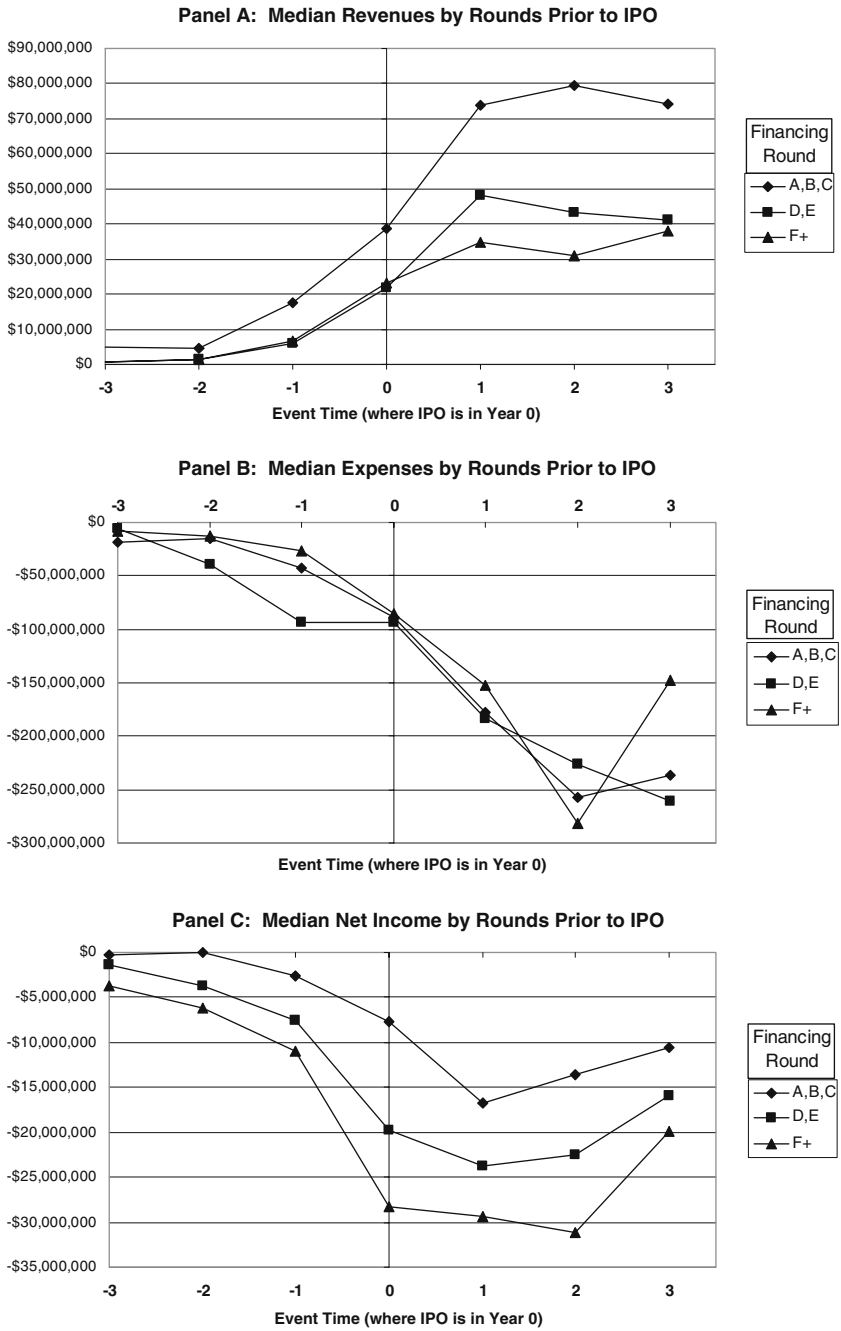

Fig. 5 Financial profile evolution of early stage companies: ''Fast IPO'' companies (A,B,C) v. ''Slow IPO'' companies (D,E,F) private market (Pre-IPO) and public market (Post-IPO) event time. (**a**) Median revenues by rounds prior to IPO. (**b**) Median expenses by rounds prior to IPO. (**c**) Median net income by rounds prior to IPO

financial statement dates.[12] To highlight the difference between the two approaches, consider a hypothetical venture-backed company modeled after a company in our sample. Figure 6 depicts the pre- and post-money valuations at the company's Series A to Series D funding dates (and the IPO date) by the solid points. The linearly interpolated value at any time between funding dates can be obtained from the solid lines connecting the points. For example, the interpolated company value on December 31, 1997 is approximately $25,130,000, which, under the interpolation approach, is the amount paired with the December 31, 1997 financial statements. In contrast, under the matching approach, the pre-money valuation of $36,815,000 at the July 25, 1998 funding (Series D) would be paired with the company's December 31, 1997 financial statements. The difference between these two approaches for this particular set of financial statements is roughly $11.5 million, which is more than 45% greater than the company's interpolated value. The interpolated private equity values are crucial in allowing us to synchronize the dependent and independent variables in our annual valuation changes analysis.[13]

The first specification examined is a regression of the level of private equity value on the level of various financial and non-financial statement variables and a capital market index. The full model is given by the following equation:[14]

$$\begin{aligned}\text{MV-PRIV}_{i,t} = {} & \alpha + \beta_1 \text{CASH}_{i,t} + \beta_2 \text{NCA}_{i,t} + \beta_3 \text{LTD}_{i,t} + \beta_4 \text{REV}_{i,t} + \beta_5 \text{COS}_{i,t} \\ & + \beta_6 \text{SMGA}_{i,t} + \beta_7 \text{RD}_{i,t} + \phi_1 \text{AGE}_{i,t} + \sum_{j=2-6} \phi_j \text{SERIES}_{i,t} \\ & + \phi_7 \text{DILUTE}_{i,t} + \phi_8 \text{PAT}_{i,t} + \theta_1 \text{NASDAQ}_t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where the dependent variable, MV-PRIV$_{i,t}$, is either the interpolated private equity market value of company i on date t (using the interpolation approach) or the private equity market value of company i at first funding date after time t (using the matching approach). The independent variables are defined as follows (with the company and time subscripts suppressed):

Company financial statement variables:

CASH = cash balance of company i at time t
NCA = non-cash assets of company i at time t
LTD = long-term debt of company i at time t
REV = revenue of company i for the year ended at time t
COS = cost of sales expense of company i for the year ended at time t

[12] Inferences are unaffected by using the interpolated equity value 3 months after the financial statement date. Use of equity value at a date after the financial statement date is standard in research that examines publicly traded equities in order to ensure that market participants have access to the company financial statements. This is expected to be less of an issue with venture-backed securities where equity investors typically have real-time access to the investee's financial results.

[13] One drawback of the interpolation method relative to the matching method is that it requires funding information both prior to and following the financial statement date. If, for example, financial statements are produced prior to a company's first round of venture capital funding, then that set of financial statements is not useable under the interpolation method.

[14] This model is similar to the main specification in Hand (2005). The model includes total assets of the company—decoupled into cash and non-cash assets—and long-term liabilities. These three categories collectively account for most of the balance sheet value in our sample companies. In addition, the three income statement cost variables—COS expense; SMG&A expense; and R&D expense—are the three largest cost items for our companies.

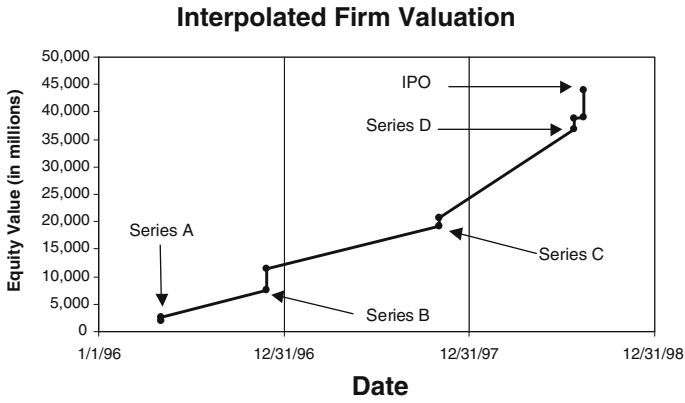

Fig. 6 Interpolation method for deriving implied Pre-IPO equity valuations at selected calendar times

SMGA = sales, marketing, general and administrative expense of company *i* for the year ended at time *t*
RD = research and development expense of company *i* for the year ended at time *t*

Company non-financial statement variables:

AGE = the age (in years) of company *i* at time *t*
SERIES = the series (B, C, ..., G+) of funding of company *i* at the first funding after time *t*[15]
DILUTE = the equity dilution that occurred for company *i* at the first funding after time *t*[16]
PAT = the number of patent applications filed by company *i* as of time *t*

Capital market variable:

NASDAQ = level of the NASDAQ composite index at time *t*

The different coefficients, β, ϕ, and θ are used to distinguish between financial statement, non-financial statement, and capital market information, respectively. This distinction is important for subsequent analysis where we compare the relative importance of each information set in explaining equity values at various points relative to the IPO.

The model given by Equation (1) can be motivated within the Ohlson (1995) framework. First, the balance sheet variables—cash; non-cash assets; and long-term debt—can be viewed as a disaggregation of book value of equity. Second, the income statement items—revenue; COS, marketing, general, and administrative, and R&D—can be similarly

[15] Using the interpolated methodology, SERIES is the most recent series of funding of company *i preceding* time *t*.

[16] Using the interpolated methodology, DILUTE is the equity dilution that occurred at the most recent series of funding of company *i* preceding time *t*. It should also be noted that our measure of equity dilution is a proxy variable since we measure equity dilution as the amount of funding over the pre-money valuation at a given round of funding. This measure does not consider any additional stock options that are issued at the time of the funding, which is typical in venture-backed companies. This information is not available for our sample firms so we instead rely on our proxy.

viewed as a disaggregation of net income.[17,18] The Ohlson (1995) model constrains these amounts (i.e., the components of equity and the components of net income) to have the same coefficients (and, therefore, the same valuation implications). Since most of the firm-years in our sample are unprofitable (i.e., negative net income) and some have negative book value of equity, we do not expect the variables to have the same valuation implications. That is, instead of focusing on aggregate net income, we expect investors to instead look to its various components when valuing a company's equity. In addition, the non-financial variables in Equation (1) can be viewed as ''other information,'' each with its own valuation implications.

Equation (1) is adapted for the sample of Post-IPO company-year observations since some of the independent variables are no longer applicable.[19] The Post-IPO model is described by the following equation:

$$\begin{aligned}\text{MV-PUB}_{i,t} = {} & \alpha + \beta_1 \text{CASH}_{i,t} + \beta_2 \text{NCA}_{i,t} + \beta_3 \text{LTD}_{i,t} + \beta_4 \text{REV}_{i,t} + \beta_5 \text{COS}_{i,t} \\ & + \beta_6 \text{SMGA}_{i,t} + \beta_7 \text{RD}_{i,t} + \phi_1 \text{AGE}_{i,t} + \sum_{j=2-3} \phi_j \text{YEAR} + \text{j}_{i,t} \\ & + \phi_4 \text{PAT}_{i,t} + \theta_1 \text{NASDAQ}_t + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where $\text{MV-PUB}_{i,t}$ is the market value (i.e., market capitalization) of publicly traded company i 3 months after time t, Year + j for j = 2, 3 are indicator variables for 2 and 3 years following the IPO, respectively, and the remaining variables are as described for Equation (1) above.

We present the results for Equations (1) and (2) using a rank regression. We adopt a rank regression approach for estimation because it has been shown to perform well when the dependent variable is a non-linear, monotonic function of the independent variables. This is likely to be the case for the early-stage companies that comprise our sample. Indeed, Sahlman (1993) documents three option components of venture capital investment—the option to abandon investment, the option to revalue a project, and the option to increase capital commitment—which are likely to introduce non-linearities in the valuation of private equity securities. Further, in contrast to robust regression techniques such as winsorizing extreme observations, rank regression gives equal weight to extreme observations (Iman and Conover, 1979). Thus, extreme observations of either the dependent or independent variables are not treated as ''outliers'' but instead as valid data points that are accorded equal weight in the analysis. The distribution of most of the financial statement variables is highly (positively) skewed which could be the result of differences in company size, age, stage in its lifecycle, as well as idiosyncrasies related to the company's products and operations. Figure 2 provided a visual depiction of the distribution (.1, .3, .5, .7, and .9

[17] To the extent there are other liabilities, or other expenses not included in Equation (1), then the disaggregation of equity and net income, respectively, is incomplete. These omitted items, however, are relatively small in magnitude compared to the items included in Equation (1) for our sample.

[18] Disaggregating net income into its accrual and cash flow components is becoming increasingly popular in the accounting literature. For example, Barth, Beaver, Hand, and Landsman (2004) disaggregate total accruals into various accrual accounts for the purpose of predicting equity values within an Ohlson (1995) framework.

[19] The SERIES and DILUTE variables in Equation (1) do not appear in the Post-IPO model.

deciles) of revenues and expenses for our sample companies in event time. The other financial statement variables tend to follow a similar pattern.[20]

5.2. Empirical predictions

Regarding the balance sheet variables in our specifications, we first decouple total assets into cash and non-cash assets.[21] Cash is the single most important balance sheet asset for early-stage, venture-backed companies so it is included as a separate variable in our analysis. Across the six industries in our sample, there are no other sizable asset accounts in the very early years, so the remaining accounts are grouped together as non-cash assets. In addition, we include long-term debt because it is the largest liability across our sample. We expect both the private and public equity market valuations to be increasing in cash and non-cash assets, and decreasing in long-term debt. The book value of cash and cash equivalents are very close to their market values, so we predict these amounts to be positively associated with market value of equity.[22] Similarly, non-cash assets, although generally carried at historical cost on the balance sheet, are also predicted to be positively associated with equity market value. Finally, long-term debt represents creditor claims against a company's assets and future cash flows. It is therefore predicted to be negatively associated with equity value.

For the income statement variables, we first predict that revenues will be positively associated with both private and public equity market values. The three main cost categories for the companies in our sample are COS; SMG&A; and R&D. Collectively, these three expenses account for over 87% of the total expenses of our sample companies in the Pre-IPO period and nearly 75% of all expenses in the 3 years following the IPO.[23] The hypothesis that cost outlays in early-stage companies are ''investments'' predicts private equity market valuations to be increasing in the magnitude of these costs. If the IPO date is one operational indicator of maturity, then in the Post-IPO period the prediction is that public equity market valuations are decreasing in the magnitude of these costs.[24] Collectively, this would predict these three expense items to be positively associated with private equity values in the Pre-IPO period and negatively associated with public equity values in the Post-IPO period. We depart from these predictions in the case of R&D expense in the Post-IPO period. There is a debate in the literature over the long-term equity valuation implications of R&D. Lev and Sougiannis (1996) find that public equity values

[20] An alternative approach to dealing with non-linearities is to transform some or all of the dependent and independent variables. Hand (2005) adopts a log-linear specification in which the variables are replaced with their natural logarithm.

[21] The category ''cash'' also includes cash equivalents.

[22] In addition, in the private equity market, there could be signaling implications of cash balances in that a higher cash balance (generated either through operations or financing) would signal to potential venture investors that the companies investment opportunities are attractive enough to have secured capital from other investors.

[23] Relative to revenues, cost of goods sold, SG&A, and R&D are roughly 63, 48, and 33% of total revenues for the pooled sample of companies in the Pre-IPO period. In the 3 years following the IPO, these three expense categories are 66, 64, and 19% of total revenues, respectively.

[24] See, for example, Penman and Yehuda (2004) in which net income is disaggregated into revenues and cost of goods sold. In a ''levels'' regression of price on revenue and cost of goods sold, a positive and negative coefficient (both significant), respectively, obtain. This results also holds for a ''changes'' regression of return on change in revenue and change in cost of goods sold. In addition, Ohlson and Penman (1992) regress returns on the various components of earnings. They find that ''the signs are...correct; income items have positive (estimated) coefficients, whereas expense items have negative coefficients.''

are positively associated with R&D expenditures, which suggests that the market does not treat these amounts as expenses in the year incurred. Accordingly, for the Post-IPO period, the long-term value aspect of R&D predicts public equity market valuations to be increasing with the magnitude of such costs.

Regarding the company non-financial statement variables, we expect the coefficients on the series indicator variables to be positive.[25] That is, holding the other variables in Equation (1) constant, we expect private equity market valuations to be increasing in the series of funding. This prediction is consistent with prior research (such as Houlihan Valuation Advisors/Venture-One, 1998), which finds that valuations increase over successive rounds of funding.[26] Next, we predict private equity market value to be increasing in the number of patent applications filed. Although patents aren't necessarily equally relevant across all six industries, we do expect to find a positive association between the number of patent applications and company value for the pooled sample because this signals the validation of a company's investments. Next, we expect private equity market value to be decreasing in the equity dilution at a given round of funding. Much of the value of early-stage start-up companies is tied to their investment opportunity set. The more attractive the company's investment opportunities, *ceteris paribus*, the less of an equity stake the current owners will be required to relinquish for a given amount of funding. Finally, lacking either a compelling theory or prior empirical guidance regarding how company value should be related to company age, we make no prediction for the sign of the coefficient on that variable in either the private equity or public markets.

Regarding the capital market variable, we expect the level of the NASDAQ composite index to be positively associated with both private and public equity values. This capital market index captures general expectations as to the growth of the underlying economy. There is a large body of research that stock price movements are influenced by expectations about general economic trends as well as by company-specific variables—see King (1966) for an early study.

5.3. Changes analysis

We also examine changes in implied private equity market valuation as a function of the change in both the financial and non-financial variables. The changes specification serves as a robustness check for the results of our levels analysis.[27] In addition, it allows us to better relate our private equity findings to the extensive research on changes in the valuation of publicly traded companies. One benefit of a changes, as opposed to a levels, specification is that it removes the effects of any correlated omitted variables that are constant across periods. However, as noted by Landsman and Magliolo (1988), the efficacy

[25] Note that Equation (1) has indicator variables for Series B to Series G+. Thus, the coefficients on these variables are interpreted as the contribution of a particular funding series incremental to Series A financing. That is, Series A is reflected in the intercept of the regression equation.

[26] The sample companies all successfully completed an IPO, which potentially induces a survivorship bias in our data. This bias would predict that private equity market valuations are increasing in the rounds of funding. However, in the Appendix A we show (using an expanded database) that private equity market valuations are also increasing in the round of funding for companies that do not (or have not yet) completed an IPO.

[27] An untabulated correlation matrix reveals that the variables in their first-difference form are much less correlated than in their levels form. This holds for both Pearson product-moment correlation as well as Spearman rank-order correlation. The latter is more appropriate in this analysis, since descriptive statistics suggest that the variables are far from normally distributed.

of this approach depends on the extent to which the omitted variable(s) are constant across periods. If the value of the omitted variable changes between periods, then the effect of the variable will not be removed when the variables are differenced, and the induced bias may be greater than with the levels specification. The specification of our changes model is given as follows:

$$\begin{aligned}\Delta\text{MV-PRIV}_{i,t} = {} & \gamma_0 + \gamma_1\Delta\text{CASH}_{i,t} + \gamma_2\Delta\text{NCA}_{i,t} + \gamma_3\Delta\text{LTD} + \gamma_4\Delta\text{REV} + \gamma_5\Delta\text{COS} \\ & + \gamma_6\Delta\text{SMGA} + \gamma_7\Delta\text{RD}_{i,t} + \gamma_8\Delta\text{NASDAQ}_t + \gamma_9\Delta\text{PAT}_{i,t} + \delta_{i,t} \qquad (3)\end{aligned}$$

where the variables are as defined above in their first difference form. In addition, certain variables that lack meaning in this form (e.g., company age) are omitted from this specification.[28] The dependent variable in Equation (3) is the annual change in implied private equity market value (computed using the interpolation procedure described in the previous section). We present results for two versions of the changes model—an undeflated and a deflated version of Equation (3).[29] The deflated version scales the dependent variable and the independent variables (except the change in the NASDAQ, which is scaled by its own beginning value to yield a variable that captures the market return) by the beginning implied company valuation.[30] The deflated version is analogous to a returns specification and provides another link to prior empirical capital markets research.[31] The deflated specification also provides a robustness check for heteroskedasticity in the data in addition to ensuring that our results are not driven by differences in scale for our sample firms.

Similar to the changes model for the Pre-IPO period, the changes model in the Post-IPO period is given by the following equation.

$$\begin{aligned}\Delta\text{MV-PUB}_{i,t} = {} & \gamma_0 + \gamma_1\Delta\text{CASH}_{i,t} + \gamma_2\Delta\text{NCA}_{i,t} + \gamma_3\Delta\text{LTD}_{i,t} + \gamma_4\Delta\text{REV}_{i,t} + \gamma_5\Delta\text{COS}_{i,t} \\ & + \gamma_6\Delta\text{SMGA}_{i,t} + \gamma_7\Delta\text{RD}_{i,t} + \gamma_8\Delta\text{NASDAQ}_t + \gamma_9\Delta\text{PAT}_{i,t} + \delta_{i,t} \qquad (4)\end{aligned}$$

The variables in Equation (4) are the first-differenced counterparts of the variables from Equation (2). The empirical predictions for both the Pre- and Post-IPO period are identical with our expectations for the levels specifications. That is, changes in the variables that are predicted to be positively associated with the level of (both private and public) equity are also expected to be positively associated with changes in (both private and public) equity values.

[28] The series indicators and the equity dilution independent variables are also are omitted because these variables take their value at a given round of financing. Unlike financial statement and certain non-financial statement variables (such as the number of patents), these variables lack meaning in annual differences.

[29] Similar to the levels specifications, the changes specifications are also estimated using a rank regression approach. For the changes specifications, the change in the variables is first computed (either scaled or unscaled) and the change is then ranked. This is different than using the change in the rank from year to year. Rank regression requires that the variable lie in the interval $[1,n]$ where n is the number of observations. This will not always be the case with the latter approach (i.e., the change in the rank), but will be the case with the former approach (i.e., the rank of the change). For further details, see Iman and Conover (1979).

[30] Christie (1987) argues that beginning of period equity valuation is the proper deflator with respect to equity valuation. This result is expected to be applicable in a private equity setting.

[31] Aboody, Barth, and Kasznik (2004) is a good example of a research design that features both a levels and a changes specification in a value relevance context. Consistent with Christie (1987), the independent variables in their returns regression are deflated by beginning of period market capitalization.

6. Primary results

6.1. Levels analysis

Table 3 presents the findings for the pooled sample in both the Pre- and Post-IPO periods under the matching and the interpolation approaches. Full results are presented using:

A. Four income statement variables—revenues, COS, SMG&A, and R&D.
B. Three income statement variables—revenues, SMG&A, and R&D.

We also present (in Table 5) summary results with single income statement variables (first revenues, then total costs) and with two income statement variables (revenues and total costs together). The highest positive collinearity among the income statement variables is between revenues and COS. In the Pre-IPO period, for the levels variables, the Spearman correlation is .83 (Pearson correlation is .97), while in the Post-IPO period, the Spearman correlation is .77 (Pearson correlation is .92).

We will focus mostly on the four income statement variable model—Model 1(A)—for the Pre-IPO levels regressions in Table 3a. The two balance sheet asset variables (cash and non-cash assets) have the predicted positive coefficients and are statistically significant.[32] Long-term debt has the predicted negative coefficient with the matching method, but a positive coefficient with interpolation method—both are statistically insignificant. The four income statement variables each have the predicted positive coefficient, and all but COS with the matching method is statistically significant. When the COS variable is omitted in the three income statement variable model—Model 1(B)—the *t*-statistic on revenue increases as one would expect with the deletion of a collinear independent variable; from 4.05 in 1(A) to 6.98 in 1(B) with the matching method and from 3.25 in 1(A) to 6.50 in 1(B) with the interpolation method.[33] When COS rather than revenue is included in a three income statement variable model, the *t*-statistics (untabulated) for the estimated coefficients on COS are 5.84 (matching method) and 5.98 (interpolation method). These results are consistent with the prediction that private equity investors view cost outlays of early stage companies as ''investments.''

The company non-financial variables for successive financing round valuations are all positive as predicted and statistically significant. This finding is similar to that in the Houlihan Valuation Advisors/Venture-One (1998) study of private market valuations for venture-backed companies in a broad cross-section of industries.[34]

The coefficient on equity dilution is negative and highly significant in Table 3a as predicted. This is consistent with Hand (2005) and indicates that company equity value is decreasing in equity dilution at successive rounds of financing. The coefficient on the number of patent applications is also positive and significant with the interpolation method

[32] Significance refers to statistical significance at the 5% level or less using a one-sided test for signed predictions and a two-sided test in other cases. Since the distribution of the parameters is unknown, all results were replicated using (and are robust to) bootstrapped standard errors.

[33] We extended Model 1(A) in Table 3 for the interpolation method to include an extra variable that interacts COS (COS) and Firm Age. This estimated coefficient on this interaction variable was −.50 (t=−3.68), which is consistent with the positive correlation between equity value and COS declining as a firm gets older. All other inferences were unaffected by the inclusion of this interaction variable.

[34] We re-estimated Equation (1) for our subsample of biotech firms in the Pre-IPO period. The results (untabulated) indicate that the estimated coefficients on successive financing rounds, although generally positive, are all insignificant. This result is further evidence that biotech companies may systematically differ from other companies in our sample.

Table 3 Private market (Pre-IPO) and public market (Post-IPO) association between equity valuations (levels) and financial/non-financial variables[a,b,c,d]

	Matching method				Interpolation method			
	Model 1(A)		Model 1(B)		Model 1(A)		Model 1(B)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Panel A: Rank regressions in levels—Pre-IPO period								
Intercept	−0.64	−3.41	−0.63	−3.37	−0.75	−3.81	−0.72	−3.66
Financial statement info.								
Cash	0.22	7.57	0.22	7.57	0.19	6.28	0.19	6.29
Non-cash assets	0.18	4.69	0.19	4.98	0.14	3.44	0.15	3.80
Long-term debt	−0.04	−1.40	−0.04	−1.49	0.01	0.17	0.00	0.06
Revenue	0.15	4.05	0.19	6.98	0.13	3.25	0.19	6.50
COS exp.	0.05	1.53		0.08	2.08			
SMG&A exp.	0.06	2.52	0.06	2.61	0.07	2.65	0.07	2.79
R&D exp.	0.08	3.27	0.07	2.96	0.19	7.27	0.17	6.96
Non-financial statement info.								
Firm age (in years)	−0.09	−3.89	−0.09	−3.85	−0.09	−3.70	−0.09	−3.69
Series B	0.09	2.21	0.09	2.22	0.11	2.10	0.11	2.03
Series C	0.13	3.01	0.13	3.01	0.13	2.54	0.12	2.45
Series D	0.20	4.59	0.21	4.72	0.22	4.57	0.22	4.66
Series E	0.29	6.07	0.29	6.14	0.31	5.88	0.31	5.91
Series F +	0.31	6.04	0.31	6.05	0.29	5.34	0.29	5.31
New equity dilution	−0.24	−12.13	−0.24	−12.14	−0.30	−10.16	−0.30	−10.12
Number of patent applications	0.02	0.98	0.02	0.83	0.05	2.25	0.05	2.04
Capital market info.								
NASDAQ Index	0.24	10.21	0.24	10.22	0.23	8.85	0.23	8.81
Total adjusted R^2	69.83%		69.79%		63.60%		63.60%	
Financial stmt. adjusted R^2	58.25%		58.17%		53.94%		53.80%	
Non-financial stmt. adjusted R^2	37.42%		37.42%		28.74%		28.74%	
Market adjusted R^2	33.22%		33.22%		26.10%		26.10%	
F-test	2039		2037		1506		1499	
Number of observations	898		898		879		879	

Table 3 Continued

	Matching method			
	Model 2(A)		Model 2(B)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Panel B: Rank regressions in levels—Post-IPO period				
Intercept	0.56	7.98	0.54	7.64
Financial statement info.				
Cash	0.41	17.31	0.39	16.52
Non-cash assets	0.18	5.15	0.12	3.56
Long-term debt	0.01	0.40	−0.01	−0.41
Revenue	0.31	8.31	0.20	6.49
COS exp.	−0.17	−5.17		6.49
SMG&A exp.	−0.10	−3.30	−0.03	−1.03
R&D exp.	0.10	4.47	0.10	4.19
Non-financial statement info.				
Firm age (in years)	−0.07	−3.50	−0.05	−2.70
IPO +2	−0.27	−10.23	−0.28	−10.47
Year IPO +3	−0.30	−9.30	−0.31	−9.68
Number of patent applications	0.09	4.21	0.09	4.04
Capital market info.				
NASDAQ Index	0.24	11.28	0.25	11.23
Total adjusted R^2	61.82%		61.02%	
Financial stmt. adjusted R^2	46.26%		44.64%	
Non-financial stmt. adjusted R^2	17.14%		17.14%	
Market adjusted R^2	20.90%		20.90%	
F-test	1973		1908	
Number of observations	1231		1231	

[a]Total adjusted R^2 is for regression with company financial statement independent variables, company non-financial statement independent variables, and a capital market independent variable (coefficients reported above)

[b]Financial adjusted R^2 is for regression with only the set of company financial statement independent variables

[c]Non-financial adjusted R^2 is for regression with only the set of company non-financial statement independent variables

[d]Market adjusted R^2 is for regression with only the capital market independent variable

(but insignificant with the matching method). This too is consistent with our predictions as well as prior empirical findings (Lerner, 1994).[35] Finally, although no prediction was made regarding the sign of the coefficient on company age, Table 3 reveals that it is negative and significant across all specifications. Thus, holding the other variables in the regression constant, private equity market value is decreasing in the number of years since a company's inception.[36]

Moving to the capital market variable, we find that the coefficient on the level of the NASDAQ composite index is positive and highly significant. This is in agreement with prior research (Gompers and Lerner, 2000). Periods in which public equity valuations on NASDAQ are higher (lower) are also periods in which private equity valuations are higher (lower).

The Post-IPO period results are in Table 3b. The almost continuous availability of stock price data in public capital markets enables us to avoid making the assumptions underlying either the matching method or the interpolation method in Panel a. Panel b, which presents the results of estimating Equation (2), reveals that the Post-IPO results are similar to the Pre-IPO results for the three balance sheet variables. The four income statement variable model has the predicted positive coefficient for revenue and for R&D expense. In both the Pre-IPO and Post-IPO periods, R&D is treated as having ''investment'' attributes. The two other expense categories—COS and SMG&A—have significant negative coefficients. This is consistent with the capital market viewing these two cost series as more of an operational outlay than an investment outlay.

Table 3c has two event time-based indicator variables in the company non-financial statement variables—Year IPO +2 and Year IPO +3. Both are negative and highly significant. One interpretation of this result is that it is a manifestation of the ''IPO puzzle'' documented by Loughran and Ritter (1995), whereby companies tend to underperform the market during the 3-year period following their IPO.[37]

6.2. Changes

The Pre-IPO results of the changes rank regression are presented in Table 4a. The first four columns of Panel a pertain to the undeflated rank regression. The last four columns relate to the changes regression run in a deflated format. The most important balance sheet variable to be significant is cash—changes in cash are positively correlated with annual changes in Pre-IPO equity valuation. Changes in all four income statement variables are also positively correlated with annual changes in Pre-IPO equity valuation. As observed with the levels specification, the statistical significance of the change in revenue variable

[35] The specifications were also tested using the number of patents granted instead of the number of patent applications. These two numbers are highly correlated—Pearson product-moment correlation of .90 and Spearman rank order correlation of .77. Inferences are unaffected by the inclusion of patents granted instead of patent applications.

[36] One potential explanation for this result is the importance of ''time-to-exit'' for venture capitalists. This metric captures the time elapsed between investment in the start-up and when the investor recoups his investment through either the sale of the company or a public offering of the company's shares. Holding the other variables in the equation fixed, the more time elapsed since the company's inception, the longer the time-to-exit for the venture capitalists (and the lower their internal rate of return on their investments).

[37] We re-estimated Model 2A in Table 3 to exclude observations after December 31, 2000 to probe whether the negative coefficients on the IPO+2 and IPO+3 indicator variables are due to clustering of observations when there was a sustained decline in technology stock prices. For the reduced sample of 767 observations (vis-à-vis 1231 in Table 3), the coefficients were −.026 (t = −8.22) for IPO + 2 and −.25 (t = −5.15) for IPO + 3. This result is consistent with the ''IPO puzzle'' reported by Loughran and Ritter (1995).

Table 4 Private market (Pre-IPO) and public market (Post-IPO) association between annual changes in equity valuation (differences) and annual changes in financial/non-financial variables[a, b, c, d]

	Undeflated—Model 3				Deflated—Model 3			
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Panel A: Rank regressions in annual changes—Pre-IPO								
Intercept	−0.17	−2.00	−0.16	−1.93	−0.04	−0.42	−0.01	−0.08
Financial statement info.								
DeltaCash	0.26	6.84	0.26	6.87	0.33	8.31	0.33	8.29
Delta non-cash assets	0.02	0.47	0.03	0.57	−0.01	−0.12	0.01	0.22
Delta long-term debt	−0.01	−0.21	−0.01	−0.19	0.07	−1.80	−0.07	−1.69
Delta revenue	0.25	4.55	0.27	6.55	0.12	2.19	0.20	4.57
Delta COS exp.	0.03	0.59			0.11	2.10		
Delta SMG&A exp.	0.18	4.36	0.18	4.40	0.29	6.57	0.29	6.66
Delta R&D exp.	0.10	2.55	0.10	2.50	0.11	2.75	0.10	2.53
>Non-financial statement info.								
Delta patent application	0.01	0.23	0.01	0.19	−0.02	−0.44	−0.02	−0.55
>Capital market info.								
Delta NASDAQ Index	0.32	8.62	0.32	8.66	0.17	4.55	0.17	4.47
Total adjusted R^2	38.88%		38.97%		40.48%		40.05%	
Financial stmt. adjusted R^2	28.32%		28.18%		34.79%		34.18%	
Non-financial stmt. adjusted R^2	−0.16%		−0.16%		0.63%		0.63%	
Market adjusted R^2	14.09%		14.09%		0.88%		0.88%	
F-test	295		297		316		311	
Number of observations	474		474		474		474	
	Undeflated—Model 4				Deflated—Model 4			
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Panel B: Rank regressions in annual changes—Post-IPO								
Intercept	0.36	5.76	0.33	5.35	−0.01	−0.09	−0.02	−0.30
Financial statement data								
Delta cash	0.24	8.14	0.25	8.31	0.14	4.59	0.14	4.52
Delta non-cash assets	0.13	3.39	0.11	2.97	0.15	4.23	0.13	3.77
Delta long-term debt	0.05	1.68	0.05	1.51	0.05	1.80	0.05	1.67

Table 4 Continued

	Undeflated—Model 3				Deflated—Model 3			
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Delta revenue	0.19	3.91	0.09	2.27	0.28	6.98	0.22	6.39
Delta COS exp.	−0.15	−3.59			−0.11	−2.84		
Delta SMG&A exp.	−0.25	−5.96	−0.25	−5.85	−0.16	−4.19	−0.15	−3.90
Delta R&D exp.	−0.08	−2.30	−0.10	−2.80	−0.01	0.22	−0.01	−0.26
Non-financial statement info.								
Delta patent application	0.00	−0.07	0.00	−0.16	0.10	3.05	0.09	2.85
Capital Market Info.								
Delta NASDAQ Index	0.53	18.33	0.53	18.31	0.55	18.90	0.55	18.79
Total adjusted R^2	42.70%		42.41%		40.97%		40.42%	
Financial stmt. adjusted R^2	17.28%		16.12%		10.66%		10.37%	
Non-financial stmt. adjusted R^2	0.13%		0.13%		1.77%		1.77%	
Market adjusted R^2	31.76%		31.76%		29.84%		29.84%	
F-test	565		545		526		515	
Number of observations	768		768		768		768	

[a]Total adjusted R^2 is for regression with company financial statement independent variables, company non-financial statement independent variables, and a capital market independent variable (coefficients reported above)

[b]Financial adjusted R^2 is for regression with only the set of company financial statement independent variables

[c]Non-financial adjusted R^2 is for regression with only the set of company non-financial statement independent variables

[d]Market adjusted R^2 is for regression with only the capital market independent variable

increases when the collinear variable—change in COS—is omitted from the regression; from t=4.55 to 6.55 with the undeflated version and from t=2.19 to 4.57 with the deflated version.[38] When the change in COS variable is included and the change in revenue variable excluded, the coefficient on change in COS is positive and significant (t=4.64 for undeflated and t=4.53 for deflated). These results in the annual changes specification reinforce our prior finding that in the Pre-IPO period, private equity investors view the COS, SMG&A and R&D series as having investment characteristics.

In the Post-IPO period, the coefficients on change in revenue are positive and significant and the coefficients on change in COS and change in SMG&A are negative and significant. This finding for the changes specification mirrors that found with the levels specification. In the Post-IPO public market for the companies examined, the COS and SMG&A cost series are perceived to have operating rather than investment characteristics. The coefficient on change in R&D in the changes specification is not consistent across the undeflated and deflated versions of Model 4. When the change in all four income statement variables are included in the regression, change in R&D is negative and significant in the undeflated model, but positive and insignificant in the deflated model. When the change in COS variable is excluded, the coefficient on the change in R&D is negative (significantly so for the undeflated version with t=−2.80 and insignificantly so for the deflated version with t=−.26). This inconsistent result for changes in R&D in the Post-IPO period between the levels (Table 3) and changes (Table 4) specifications means a lower reliability of inferences we draw for how the R&D series is viewed by the public equity markets for recent-IPO companies.

Changes in annual equity valuation are positively correlated with changes in the NASDAQ composite index both in the Pre- and the Post-IPO periods. The statistical significance of the change in NASDAQ variable in Table 4 ranges from a low of 4.55 to a high of 18.90. This finding is consistent with much capital market research showing that individual stock prices positively covary with changes in aggregate market indices (such as the NASDAQ).

Overall, the results from the various changes specifications tend to corroborate the results of our levels analysis. Specifically, the changes models suggest that our results are robust to correlated omitted variables as well as to differences in scale among the companies in our sample. The results from the changes analysis also speak to the timeliness of accounting information. That is, changes in key accounting variables are found to be contemporaneously correlated with annual changes in private equity values. This result is consistent with findings in the literature related to publicly traded equities.

6.3. Overview of levels and changes

Table 5 provides a summary of the t-statistics for the various combinations of income statement variables in the regressions reported in Tables 3 and 4. All other independent variables listed in Tables 3 and 4 are included in the Table 5 regressions. Scenarios 1–4 change the number and composition of the income statement variables included in these regressions. Table 5 highlights several features of our results. The positive collinearity between (a) the revenue variable and (b) the total costs variable makes it difficult to interpret their coefficients when only one of revenues or total costs is included in the valuation analysis in Scenarios 1 or 2. Note the consistency of the sign of the t-statistics in Scenarios 1 and 2 in Table 5 despite Scenario 1 using revenues and Scenario 2 using total costs. This point has been documented in the context of publicly traded equities by Penman

[38] The Spearman correlation between change in revenue and change in COS is .70 for our Pre-IPO sample and .76 for the Post-IPO period.

Table 5 Summary of *t*-statistics from various models that include different combinations of income statement variables

	Pre-IPO				Post-IPO		
	Levels		Differences		Levels	Differences	
	Matching	Interpolated	Undeflated	Deflated		Undeflated	Deflated
Scenario 1							
Revenue	7.22	6.20	7.30	5.10	6.70	−2.18	5.11
Scenario 2							
Total cost	11.37	14.11	9.40	10.28	1.77	−7.69	−1.73
Scenario 3							
Revenue	2.84	0.51	3.58	2.30	6.80	3.43	6.80
Total cost	9.03	12.40	6.71	8.81	−2.09	−8.16	−4.76
Scenario 4							
Revenue	4.05	3.25	4.55	2.19	8.31	3.91	6.98
COS	1.53	2.08	0.59	2.10	−5.17	−3.59	−2.84
SMG&A	2.52	2.65	4.36	6.57	−3.30	−5.96	−4.19
R&D	3.27	7.27	2.55	2.75	4.47	−2.30	0.22

and Yehuda (2004). In Scenario 3 when revenues and total costs are both included as the two income statement independent variables, the coefficient on revenues in both the Pre-IPO and Post-IPO periods is positive. However, the coefficient on the total cost independent variable is positive in the Pre-IPO period and negative in the Post-IPO period. This paper is the first to highlight the change in the sign of the coefficient of the total cost variable between public and private equity markets. Finally, when we move to the set of four income statement independent variables (Scenario 4), all three cost categories have a positive coefficient in the Pre-IPO period. In the Post-IPO period, two of the three cost variables have the negative coefficient found for the total cost variable in the valuation analysis that considered only two income statement variables (i.e., revenues and total costs).

6.4. Relative importance of financial statement information

The importance of financial statement information in private equity valuation has been questioned. The introduction to this paper cited the claim by the NVCA president (Heesen, 2004) that ''venture capitalists rarely have information upon which to base changes of the set stock price because the stock is not tradable and the companies tend to be unique, with no like comparisons to benchmark.'' An alternative viewpoint is that venture capitalists have rich access to financial statement information for their private investee companies. Monthly board meeting packages for directors typically include detailed financial statement information (revenues, often at a customer by customer level; costs, often at a detailed line by line item level of both budgeted and actual amounts). New venture investors at each round have broad access to past and current financial budgets. New potential investors have sizable leverage in requesting whatever level of detailed financial information they deem fit to make a decision on the pricing of a new private funding round. Moreover, venture capitalists have rich experience (often based on many past investments) as to what financials and non-financials are required to justify a certain pre-money valuation. This viewpoint would imply that financial statement information plays a relatively important role in venture-backed private equity investment.

Insights into the relative importance of financial statement information can be gained by comparing the adjusted R^2 with all independent variables included vis-à-vis subsets of the independent variables in the Table 3 and 4 analysis. The three subsets examined are:

A. Company financial statement variables (i.e., three balance sheet and four income statement variables);
B. Company non-financial statement variables; and
C. Capital market variables (i.e., NASDAQ composite index).

Figure 7a presents the adjusted R^2 for the full set of independent variables and for each of the above three subsets of variables for the levels specification (i.e., Equations (1) and (3)). Separate regressions are run each event year, where −3, −2, and −1 refer to the 3 years prior to the IPO (year 0) and +1, +2, and +3 refer to the first 3 years following the IPO. Similarly, Panel c presents the adjusted R^2's for the changes specification (i.e., Equations (2) and (4)). Panels b and d express the R^2's for each ''subset'' regression as a

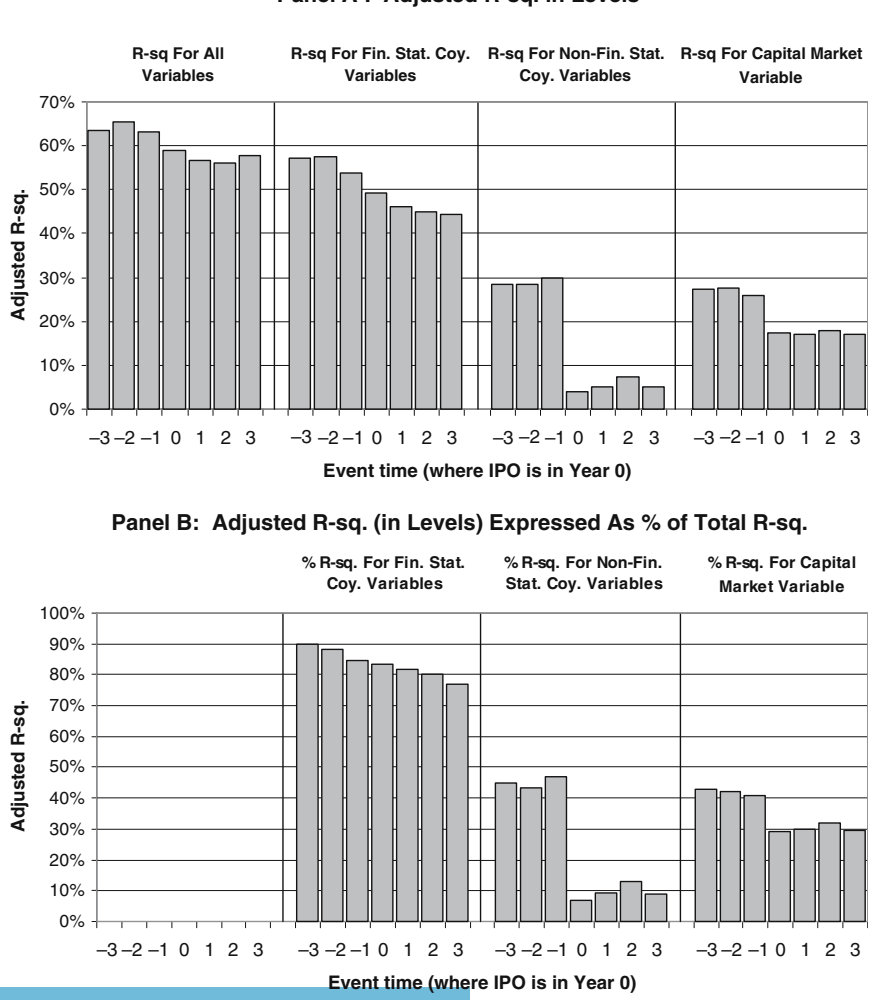

Fig. 7 Relative percentage of adjusted R^2 attributable to (A) all variables, (B) company financial statement variables, (C) company non-financial statementvariables, and (D) capital market variables. (**a**) Adjusted R^2 in levels. (**b**) Adjusted R^2 (in levels) expressed as % of total R^2. (**c**) Adjusted R^2 in undeflated changes. (**d**) Adjusted R^2. (in changes) expressed as % of total R^2

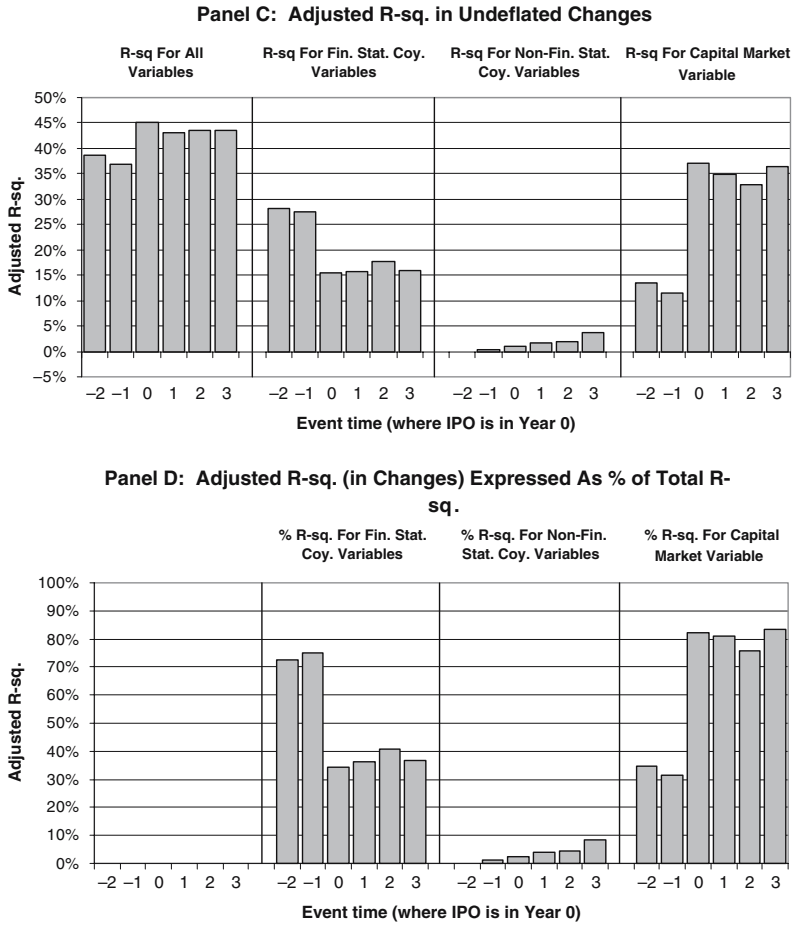

Fig. 7 Continued

percentage of the ''full model'' regression. Note that the comparisons in Fig. 7 do not attempt to indicate the unique contribution of the A, B, or C information subsets. There can be common elements in the information underlying each of the three subsets examined.

Some caveats are appropriate when interpreting the results in Fig. 7. Due to the diverse nature of the six industries in our sample, our non-financial statement variables include only some generic variables that probably understate the relative importance of this general category of variables. Moreover, a subset of the significant variables (rounds of private financing) relate only to the Pre-IPO period for the levels format.

The block of company financial statement variables is the single largest block for both the Pre-IPO and Post-IPO period using valuation levels and the Pre-IPO period using valuation changes. It is only in the Post-IPO period for valuation changes that the adjusted R^2 for the financial statement block is below that of the capital market variable. The size of the R^2's in Panels a and c highlight the absolute importance of the financial statement variables in both the Pre-IPO and Post-IPO periods. Panels b and d highlight their relative importance. All panels in Fig. 7 support the conclusion that financial statements are an important information set when explaining the pricing of venture-backed private equities.

7. Conclusion

This study is the first to systematically examine the role of financial statement information in a broad cross-section of industries in the venture-backed, private equity market. Using an implied equity valuation methodology, we conduct an association study in both levels and first-differences. We find that the results from a levels specification are largely robust to the first-differences specification. Overall, our results highlight that financial statement information can be used to explain Pre-IPO differences across companies in their private equity valuations and changes in these valuations over time. Revenues are value-enhancing in both the Pre-IPO and Post-IPO periods. In the Pre-IPO period, each of the major cost items (COS; SMG&A and R&D) is viewed by the private equity market as having an ''investment'' aspect. This is consistent with those early stage companies that access venture capital using the funds raised to invest in an infrastructure/platform to enable revenue generation and to validate their business model(s). Following the IPO, the public capital market adopts the already documented perspective that revenues are value-enhancing and major cost categories such as COS and SMG&A have a more operational (value-diminishing) role. Our results for R&D costs in the Post-IPO period are not consistent across regression specifications (levels v. changes; undeflated v. deflated changes, etc.).

This study has examined equity values on either side of an important point in the business lifecycle—the IPO. Future research might employ the methodologies developed in this paper to examine a number of unresolved issues surrounding initial public offerings such as the ''IPO puzzle.''[39] Use of accounting (and other non-financial statement) data prior to the IPO can speak to a company's underlying value. Such an analysis in the years leading up to an IPO could provide insight into possible sources of the documented underperformance of equity securities in the immediate Post-IPO years.

Other avenues for future research include more industry specific studies of private equity values aimed at developing alternative valuation models and for studies of other types of private equity. This study had the goal of examining financial and non-financial variables that are relevant to a broad array of venture-backed industries. The results suggest more industry-specific non-financial statement variables could better explain private equity values within certain industries. Such research would be of interest to industry participants such as venture capitalists for determining the fair value of shares at funding dates (i.e., pre-money values) or employees and management for determining share value for use in option pricing models. Another potential extension of this study would be to examine valuations across different types of private equity. Our research examines venture-capital backed companies. A fertile area for future research would appear to be valuation for mezzanine/later stage investments and private leverage buyouts. The dollar amounts at stake here are much larger than in most venture-backed companies. Moreover, there is typically less expectation of negative operating cash flows giving rise to the more frequent use debt financing than is the case with the venture-backed companies examined in this study.

[39] The IPO Puzzle refers to the underperformance of companies following an IPO of their equity. Loughran and Ritter (1995) document that for their sample of 4753 companies with an IPO during 1970–1990, the average return to investors was only 5% per year in the 5-year period following their IPO. Teoh, Wong, and Rao (1998) document evidence that IPO firms tend to have high earnings and abnormal accruals in the year of their IPO, which suggests that earnings management is one possible explanation for the subsequent underperformance of IPO shares.

Acknowledgements We wish to thank John Gabbert from VentureOne for providing key data that made this project possible and the Center for Entrepreneurial Studies (CES), Graduate School of Business, Stanford University for their financial support. The support of Irv Grousbeck, Chuck Holloway, Garth Saloner, and Linda Wells at CES is appreciated. The research assistance of Jakub Wilsz, Nicole Ang, Nicole Bastian, Qintao Fan, Barbara Lubben, and Richard Price in constructing the database used in this research was invaluable. The comments of John Hand on an earlier draft and participants at seminars at Stanford University, Australian Graduate School of Management, and The University of Sydney were of much assistance in our research. We also appreciate the comments of an anonymous referee and Charles Lee (the editor).

Appendix A

Research inferences and time-period/survivorship issues

Our research examines 502 venture-backed companies that completed an IPO in the U.S. capital markets in the 1996–2000 period. There are two key restrictions as regards generalizing from our results to the broader universe of all venture-backed companies in the U.S.:

(a) The sample restriction to only venture-backed companies that completed an IPO, and
(b) The 5 year time-period restriction to 1996–2000.

This Appendix A examines a broader VentureOne database that covers over 13,000 venture-backed companies over the 1988 to early 2005 period.

Table A.1 reports the median pre-money valuation and median amount raised for rounds A to E for the expanded database according to (1) the time period of the last observation in the database and (2) whether the company completed an IPO. If the company completed an IPO,

Table A.1 Median pre-money values and median amounts Raised for larger VentureOne Database

	1996–2000			Non-1996–2000			Full sample		
	Median pre-money valuation	Median amount raised	Nobs.	Median pre-money valuation	Median amount raised	Nobs.	Median pre-money valuation	Median amount raised	Nobs.
IPO									
Round A	5.7	3.4	754	7.2	4.9	284	5.9	3.5	1038
Round B	18.7	6.6	780	26.8	10.0	362	21.1	7.0	1142
Round C	37.0	9.9	715	39.1	14.0	337	38.0	10.1	1052
Round D	75.4	13.7	608	45.2	14.3	315	61.4	14.0	923
Round E	117.0	22.5	461	51.9	16.5	248	86.8	20.1	709
Non-IPO									
Round A	5.9	3.0	3515	5.8	3.1	6651	5.8	3.0	10166
Round B	13.5	4.7	2344	13.5	6.0	5433	13.5	5.4	7777
Round C	23.9	5.0	1350	22.0	7.0	3737	22.5	6.2	5087
Round D	28.0	5.0	753	28.0	6.1	2327	28.0	6.0	3080
Round E	36.0	4.4	382	32.9	7.0	1272	33.8	6.0	1654
Total									
Round A	5.8	3.0	4269	5.9	3.2	6935	5.9	3.0	11204
Round B	14.8	5.0	3124	14.5	6.0	5795	14.7	5.7	8919
Round C	29.7	6.5	2065	24.4	7.0	4074	26.2	7.0	6139
Round D	52.2	7.8	1361	32.4	7.0	2642	40.1	7.2	4003
Round E	84.3	11.2	843	38.5	7.5	1520	53.7	9.0	2363

then the year of the last observation will correspond to the year of the IPO. If, however, the company did not complete an IPO, then the year of the last observation represents one of the following: the year that the company was acquired, the year of the round prior to the company going out of business (e.g., filing for bankruptcy), the year of the round prior to VentureOne being unable to contact the company, or (if the company is still in business) the year of the most recent round of funding. This classification for non-IPO companies makes the results of the different sub-periods more comparable to those for companies that complete an IPO. The numbers of companies in each of the sub-groups are:

	1996–2000	Non-1996–2000
IPO	916	723
Non-IPO	4,169	7,951

Table A.1 reveals that pre-money valuations increase monotonically for both IPO and non-IPO companies during both the 1996–2000 and the non-1996–2000 subperiods. This result holds when the data are grouped according to time period and IPO-status as well. This finding provides support for our research prediction that valuations are increasing in the rounds of funding. It also illustrates that companies—both those that complete an IPO and those that do not—tend to experience increases in valuations between subsequent rounds. Companies that do not make an IPO exit from the database in a given time period

Table A.2 Correlation between valuation and revenue for larger VentureOne Database[a]

	1996–2000		Non-1996–2000		Full sample	
	Spearman	Pearson	Spearman	Pearson	Spearman	Pearson
IPO						
Matching-pre	0.4176	0.21096	0.3412	0.29001	0.35904	0.26781
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
	2107		2072		4179	
Matching-post	0.43213	0.23007	0.3737	0.30068	0.35845	0.28016
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
	2107		2072		4179	
Interpolated valuation	0.4434	0.24579	0.40871	0.5191	0.43034	0.4593
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
	1730		840		2570	
Change in valuation	0.41722	0.6189	0.37764	0.51749	0.39976	0.24063
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
	1032		515		1547	
Non-IPO						
Matching-pre	0.32209	0.25328	0.37549	0.20296	0.36237	0.21048
	<.0001	0.0004	<.0001	<.0001	<.0001	<.0001
	189		438		627	
Matching-post	0.30103	0.23767	0.37368	0.19555	0.38679	0.20238
	<.0001	.0001	<.0001	<.0001	<.0001	<.0001
	189		438		627	
Interpolated valuation	0.26802	0.29159	0.2756	0.3564	0.27791	0.34132
	0.0024	0.0009	<.0001	<.0001	<.0001	<.0001
	126		374		500	
Change in valuation	0.30993	0.16722	0.26511	0.2456	0.29983	0.59208
	0.0548	0.3089	0.0014	0.0033	<.0001	<.0001
	39		142		181	

[a] Each block reports the correlation, the significance level, and the number of observations (same for both the Spearman and Pearson correlations)

may have alternate exits in that same time period (via a trade sale, a merger, or a company windup/dissolution) or may remain as a private venture-backed company in the database.

Table A.2 reports correlations (both Spearman rank-order and Pearson product-moment) between the level of valuation and revenue and the change in valuation and the change in revenue. To parallel our main analysis, we report the correlation using the pre- and post-money values from the matching method (i.e., the valuation of the next round subsequent to the date of the financial statements to which the revenue relates), the interpolated company value, and the annual change in revenue. We report the level of significance and the number of observations below the correlations. The results reveal that there is a positive and statistically significant correlation between the level of private equity value and the level of revenue (using all three measures) for both companies that complete an IPO and those that do not (or have not yet). This holds across both the 1996–2000 subperiod and the non-1996–2000 subperiod. The results in Tables A.1 and A.2 show that our finding a positive association between private equity values and revenues is not unique to companies that complete an IPO during the 1996–2000 period. Instead, this result appears to be robust across (a) companies that exit the venture-backed private equity market via an IPO and those not exiting via an IPO, and (b) companies with an IPO in 1996–2000 vs. an IPO in other years.

References

Aboody, D., Barth, M., & Kasznik, R. (2004). SFAS No. 123 Stock based compensation expense and equity market values. *The Accounting Review*, *79*, 251–275

Amir, E., & Lev, B. (1996). Value-relevance of nonfinancial information: The wireless communications industry. *Journal of Accounting and Economics*, *22*, 3–30

Barth, M., Beaver, W., Hand, J., & Landsman, W. (2004). Accruals, accounting-based valuation models, and the prediction of equity values. Working Paper, Stanford University.

Barth, M., Beaver, W., & Landsman, W. (1996). Value-relevance of banks' fair value disclosures under SFAS No. 107. *The Accounting Review*, *71*, 513–537

Barth, M., Clement, M., Foster, G., & Kasznik, R. (1998). Brand values and capital market valuation. *Review of Accounting Studies, 3*, 41–68

Cochrane, J. (2005). Risk and return of venture capital. *Journal of Financial Economics, 75*, 3–52

Christie, A. (1987). On cross-sectional analysis in accounting research. *Journal of Accounting and Economics, 9*, 231–258

Davila, A., & Foster, G. (2005). Management accounting systems adoption decisions: Evidence and performance implications from startup companies. *The Accounting Review*, 1034–1068.

Davila, A., Foster, G., & Gupta, M. (2003). Venture capital financing and the growth of startup companies. *Journal of Business Venturing, 18*, 689–708

Gompers, P., & Lerner, J. (2000). Money chasing deals?: The impact of fund inflows on the valuation of private equity investments. *Journal of Financial Economics, 55*, 281–325

Hand, J. (2004). Determinants of the round-to-round returns to Pre-IPO venture investments in U.S. Biotechnology Companies. Working Paper, University of North Carolina.

Hand, J. (2005). The value relevance of financial statements in the venture capital market. *The Accounting Review, 80*, 613–648

Heesen, M. (2004). Independence of the Financial Accounting Standards Board. Congressional Testimony Federal Document Clearing House, Congressional Information Service, Inc. April 20, 2004.

Hellman, T, & Puri, M. (2000). The interaction between product market and financing strategy: The role of venture capital. *Review of Financial Studies, 13*, 959–984

Hellman, T., & Puri, M. (2002). Venture capital and the professionalization of startup companies: Empirical evidence. *Journal of Finance, 57*, 169–197

Houlihan Valuation Advisors/Venture-One. (1998). The pricing of successful venture-backed high-tech and life-sciences companies. *Journal of Business Venturing, 13*, 333–351

Iman, R., & Conover, W. (1979). The use of the rank transform in regression. *Technometrics, 21*, 499–509

Jeffers, M., & O'Sullivan, C. (2005). U.S. Venture-Capital Investment Increases to $20.4 billion in 2004 in first year-over-year increase since 2000. Press release VentureOne and Ernst & Young LLP, July 21, 2005

Jovanovic, B. (2004). The pre-producers. Working Paper, New York University

King, B. (1996). Market and industry factors in stock price behavior. *Journal of Business, 39*, 139–190

Landsman, W., & Magliolo, J. (1988). Cross-sectional capital market research and model specification. *The Accounting Review, 63*, 586–604

Lerner, J. (1994). The importance of patent scope: An empirical analysis. *RAND Journal of Economics, 25*, 319–333

Lev, B., & Sougiannis, T. (1996). The capitalization, amortization, and value-relevance of R&D. *Journal of Accounting and Economics, 21*, 107–138

Loughran, T., & Ritter, J. (1995) the new issue puzzle. *Journal of Finance, 50*, 23–51

Ohlson, J. (1995) Earnings, book values, and dividends in equity valuation. *Contemporary Accounting Research*, *11*, 661–687

Ohlson, J., & Penman, S. (1992). Disaggregated accounting data as explanatory variables for returns. *Journal of Accounting, Auditing, and Finance*, *7*, 553–573

Penman, S., & Yehuda, N. (2004). The pricing of earnings and cash flows and an affirmation of accrual accounting. Working Paper, Columbia University.

Sahlman, W. (1993). *Aspects of financial contracting in venture capital. The new corporate finance: Where theory meets practice* (pp. 229–242). McGraw Hill, New York

Seppa, T., & Laamanen, T. (2000). Valuation of venture capital investments: empirical evidence. Working paper version 2000-06-28.

Teoh, S., Wong, T., & Rao, G. (1998). Are accruals during initial public offerings opportunistic? *Review of Accounting Studies, 3*, 175–208

VentureOne. (2001). *Venture capital source book*. San Francisco, CA: Venture Corp.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, *48*, 817–838