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Market valuations of start-up ventures around the technology bubble

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Abstract
This study explores whether, and how, the relevance of financial information for valuation of start-up ventures changed during the period of a technology bubble and the fluctuations that occurred in the capital market after the bubble burst. We find that since the bubble burst, there has been a learning curve and a period of market adjustment. Specifically, during the time of the bubble the market did not rely on accounting information with respect to the valuation of start-ups. After the bubble burst the market became overly conservative, relying predominantly on accepted accounting fundamentals – book value of equity and earnings. In later years, as the process stabilized, the market gradually moved away from these measures and began relying on growth in sales, which may serve as an indication of technological feasibility and the venture's market potential. The study also explores the effect of market cycles on investor reliance on multiples. We find that, despite over/underpricing effects when using the benchmark multiples of comparable firms in valuating start-ups, these remain the accepted tool, probably due to the absence of alternative valuation methods.

Keywords
multiples, technology bubble, value relevance, venture capital

Introduction

One of the questions with which both researchers and practitioners (analysts, accountants, etc.) grapple is the extent to which it is possible to rely on standard accounting measures for valuation of young technology companies, particularly during times of extreme fluctuations on the capital market. The technology bubble on NASDAQ led to an unprecedented rise in stock prices of high-technology firms. In particular, pricing of young 'start-up' ventures that went Initial Public Offering (IPO) during what has been referred to by practitioners and researchers as the 'New Economy' period (see, e.g. Core et al., 2003) reached astronomical levels during the bubble.[1] The

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bursting of the bubble raised the question of the relevance of financial statements in reflecting the economic reality of a company's basic business (Olstein, 2006; Penman, 2003).

This study explores whether, and how, the relevance of financial variables for explaining equity prices of start-up ventures changed from the time of the technology bubble (henceforth, the 'bubble') through the five years after the bubble burst. While there is an extensive body of research on the value relevance of financial statement information in general, and for high-technology industries in particular, no study thus far has investigated if, or how, this relevance is affected by a stock market bubble and the fluctuations that occur in the capital market after the bubble bursts. Our focus on start-up firms is motivated by the fact that, in contrast to mature high-tech firms, value-relevance studies dealing with the start-up subsector are relatively scarce. Start-up firms that went IPO are a relatively new phenomenon in comparison to high-technology firms in general, and hence make an interesting case to study, in particular, with regards to changes in the role that accounting variables play as proxies for expectations about these firms' future prospects. Start-up firms are characterized by a high intensity of intangible assets that are difficult to evaluate according to "Generally Accepted Accounting Principles". Moreover, these firms are often in the early phases of their lifecycle, show little if any revenue, and hence, generally report negative earnings.

Employing both levels and changes analyses, we examine changes in the relation between traditional financial variables and equity values and returns, as well as changes in the power of the former to explain the latter.[2] The investigated period is unique in that in a span of only five years, the capital market underwent unusual vicissitudes – the bubble in 1999 leading up to March 2000, the bursting of the bubble in 2000, the downturn in the capital market that followed the bursting of the bubble through 2002 and then the rebound that occurred in 2003 and continued in 2004. We expect that these dramatic events had a significant effect on investor reliance on traditional proxies for expectations about future cash flows. Specifically, we hypothesize that the use the market makes of accounting variables in valuations of start-up ventures is a dynamic process which changes over time and that the market experiences a learning curve in terms of the type of variables preferred.

Concomitantly, we examine whether such a dynamic process pertains to market-based measures such as multiples. Specifically, we investigate whether investor reliance on price-multiples benchmark valuation methods, in which a firm is evaluated based on price multiples of comparable firms, has changed (decreased) since the bubble burst. To capture changes in the role of accounting variables and multiples, we apply by-year (rather than aggregated) univariate and multivariate analyses.

The study utilizes a unique sample of 40 Israeli start-up companies that went IPO on NASDAQ between 1993 and 1999 (total of 240 firm-year observations for our sample period of 1999–2004). Investigating the case of Israeli start-up ventures in this context is interesting, as Israel has been defined as 'the world's most vital place for entrepreneurship' (Haour, 2005). Notably, Israel is ranked among the leading countries in terms of companies that go IPO on NASDAQ (Avnimelech and Schwartz, 2009; Avnimelech and Teubal, 2006; Dashti et al., 2008). Previous studies have found that the emergence of the venture investment industry in Israel is considered to be the most successful instance of diffusion of the Silicon Valley model of venture capital outside of North America (Avnimelech, 2008; Avnimelech and Teubal, 2004a,b; Bresnahan et al., 2001; Carmell and de Fontaenet, 2004). Hence, Israeli start-ups are born global with a clear orientation to go IPO, particularly on NASDAQ. This is a consistent phenomenon during the investigated period – before and after the bubble. We point out that our sample is based upon all Israeli start-ups that went IPO during the sample period. This consistent pattern enables the prevention of selection bias, which

might be relevant for other countries where the decision to go IPO on NASDAQ could influence the sample.

The findings support our first hypothesis that the relation between market values of start-up firms and traditional explanatory variables – book value of equity and earnings – changed significantly throughout the sample period. In the analysis, we separate earnings into positive and negative earnings, consistent with prior literature that documents differences in the valuation of profits and losses (e.g. Basu, 1997; Collins et al., 1997; Hayn, 1995). In 1999 and 2000, the years of the bubble and the bursting of the bubble, respectively, neither of the explanatory financial variables explains equity values. In 2001 and 2002, the years of the downturn on NASDAQ, there is an unusual increase in the power of book value of equity and earnings (positive earnings as well as negative) to explain equity values. In 2003, earnings lose their significance and the book value of equity remains the only accounting fundamental that is value relevant. In 2004, the coefficient on book value of equity also loses its significance; concomitantly, however, the coefficient on sales growth – which may be considered a proxy for growth opportunities – becomes significant. The results imply that at the peak of the bubble, investors in the market did not rely on accounting information for stock pricing, consistent with the expectation that during the bubble, investors evaluated start-up ventures based on expectations for the future rather than on measures of past performance. However, after the 'shock' of the bubble bursting, investors seem to want to rely solely on conservative measures in their valuations. Indeed, in the years where accounting fundamentals explain a sizable component of the levels of, and changes in, valuation of start-up firms, market values in fact are low. In 2003, with investors regaining confidence, accounting fundamentals (earnings and book values) gradually lose their relevance for the valuation of start-up firms, and firm values begin to rise as investors rely on growth expectations. We suggest that earnings first began losing their significance when NASDAQ recovered, because investors perceive earnings of start-up ventures to be of low persistence.

In addition to changes in value relevance of financial statement information, this study aims to explore the role of price multiples for valuation of start-up firms during the investigated period. Our findings imply that investors in the market evaluated start-up firms based on benchmark multiples of comparable firms throughout the entire sample period. Hence, the extent of investor reliance on price multiples of comparable firms for valuation of start-up firms did not decline after the bubble burst. This result implies that investors either do not realize the 'consequences' of evaluating a firm based on exaggeratedly inflated (or deflated) prices of comparable firms, or they are aware of over/under pricing effects, but in the absence of alternative valuation methods for start-up firms they employ the benchmark multiples method.

This study expands the value-relevance literature as well as the entrepreneurial finance literature by examining stock market bubble and post-bubble effects on the relation between traditional financial variables and equity values. While the several value-relevance studies that focus on high-tech industries yield mixed results (e.g. Callen et al., 2009; Core et al., 2003; Hirschey et al., 2001), the few studies focusing on the start-up subsector (e.g., Armstrong et al., 2006; Hand, 2005) show that financial information is value relevant in the post-IPO public equity market. Nonetheless, in the studies of both Armstrong et al. (2006) and Hand (2005), the post-IPO sample period is between 1996 and 2003, thus including the pre-bubble, bubble, bubble bursting, downturn and rebound on NASDAQ. Notably, while Hand and Armstrong et al. apply an aggregated analysis for the entire period of 1996–2003, we 'deconstruct' the sample period to identify changes within and between the studied years. We show that while an aggregated analysis indicates that financial variables are value relevant (consistent with Hand and Armstrong et al.), when applying a by-year

analysis conclusions are changed in concomitance with specific events in the market. Our results support Hand's (2005) inference that the value relevance of financial statements increases (decreases) as a firm's investment opportunities decline (increase). However, while Hand relates investment opportunities to firm maturity ('firms' investment opportunity sets decline as they mature', p. 616), our findings indicate that capital market cycles also affect investor perceptions of firms' investment opportunity sets and thus the value relevance of their financial statements. Hence, the by-year analysis presented in this study does not support Hand's conclusion that the value relevance of financial statements is robust to '…large differences in price-setting mechanisms, the importance of asset-in-place versus future investment opportunities, and the level of regulation, liquidity, uncertainty…' (p. 616). Finally, our sample includes the entire sector of start-up ventures, rather than a particular sub-sector such as biotechnology as in Hand (2005).[3]

Another study that explores time period effects on the value relevance of financial variables is that of Core et al. (2003). Specifically, they investigate whether the relation between traditional financial variables and equity value during the New Economy period (1996–1999) differs from previous periods. In their analyses, they examine changes in this relation for a broad sample of firms as well as for sub-samples of high-tech firms and young firms. It was found that the explanatory power of traditional financial variables declined in the New Economy period for all sub-samples; however, these variables still remain applicable to firms during this period. Our study expands on the one conducted by Core et al; whilst their research explored the New Economy period through to 1999, our study begins in this year and continues until the bubble burst, the years of the downturn in the capital market plus the years of the rebound. Finally, the study contributes to the literature by exploring the role of price multiples for valuation of start-up firms during the investigated period. The remainder of the paper proceeds as follows. Section 2 presents prior literature and develops the research hypotheses. Section 3 describes our sample, and Section 4 discusses our research methods and results. Section 5 concludes.

Prior literature and hypotheses development

A large empirical literature examines the value relevance of accounting data for high-tech firms. These studies yield mixed results. While some studies find that both the book value of equity and earnings are value relevant (e.g. Hirschey et al., 2001 for high-tech firms in general; Hand, 2003 for internet firms; Hand, 2004 for biotech firms), others show that neither is value relevant (e.g. Amir and Lev, 1996 for cellular firms). Additional studies indicate that earnings are value relevant, while book value is not (e.g. Core et al., 2003 for high-tech firms). Jorion and Talmor (2001) and Rajgopal et al. (2003) find the opposite results for internet and e-commerce firms, i.e. that book values (earnings) are (in)significantly associated with the market values of these firms.

Callen et al. (2010) and Ely et al. (2003) show that market values of biotech firms are positively related to book values and R&D expenditures, but not significantly related to earnings before R&D. The main explanation for value irrelevance (or reduction in relevance) of financial statement information in an economy that increasingly relies on technology-based industries is that these industries are characterized by large investments in intangibles, such as R&D and intellectual capital, which are generally immediately expensed in financial statements. As a result, reported earnings and book values are generally depressed, often appearing unrelated to market values.[4]

Thus far, only a few value relevance studies have focused on the start-up and new technological firm subsector (Gavious and Schwartz, 2009; Armstrong et al., 2006; Hand, 2005). While the studies of Armstrong et al. (2006) and Hand (2005) relate changes in the value relevance of financial statements to a firm's maturity, as measured on the basis of time (firm age), Gavious and Schwartz

(2009) find evidence that the main factor affecting this value relevance is the firm's degree of market penetration. Armstrong et al. and Hand show that financial information is value relevant in the post-IPO public equity market (as well as in the pre-IPO).

Thus, there is a substantial literature which explores whether financial accounting is appropriate for a changing economy, which increasingly relies on science-based emerging industries. However, a related important question – whether and how this suitability has been affected by the bubble, and the fluctuations that occurred in the market following the bursting of the bubble – has not been dealt with thus far. We predict that the market is adaptive in that, concomitance with the occurrence of major events, investors experience a learning curve, which is reflected in changes in the (and importance of the) role accounting variables play as proxies for expectations of future cash flows. We expect that the relations between accounting information and equity values have undergone unusual changes since the time of the bubble. Specifically, we expect that the relevance of conservative accounting decreases (increases) in times of euphoria or an upturn (crash or a downturn) in the market.

We point out that the role of the balance sheet versus the income statement in explaining market values depends on the investors' perception of earnings persistence (see also, for example, De Franco et al., 2008). Specifically, if investors suspect lower persistence of earnings – which is the case in our setting of start-up ventures – the relative weight on earnings versus book value of equity in explaining pricing of start-ups is lower.

The lack of consensus on the value relevance of financial information for high-technology firms, together with the lack of evidence on the effect of the bubble and the following market fluctuations on the value relevance of financial variables, leads to our first hypothesis expressed in the alternative:

> H1: *Ceteris paribus*, the relations between financial information and equity values of start-up firms have undergone changes since the time of the bubble.

More specifically,

> H1a: Financial variables were value-irrelevant during the bubble, regained their relevance after the busting of the bubble and during the downturn in NASDAQ, and lost their relevance when the market rebounded.

> H1b: Earnings were first to lose their significance when NASDAQ recovered, followed by book value of equity.

In our second research question we examine changes in the role of multiples for valuation of start-up firms throughout the sample period, i.e. to what extent did investors rely on price multiples of comparable firms in each of the investigated sub-periods? When estimating a firm's stock price based on the price multiples of other firms, the result is directly affected by overpricing or underpricing cycles in the industry, the sector, and even the capital market. Nonetheless, investors may not realize the 'consequences' of evaluating a firm based on exaggeratedly inflated (or deflated) prices of comparable firms. Furthermore, other valuation approaches, such as the net asset value and discounted cash flows (DCF), are not relevant in the case of start-up firms. The former is generally used to evaluate firms whose value derives mainly from their tangible assets (past and current investments). Although DCF accounts for future investment options, this valuation method is frequently not applicable in the case of a start-up firm, because of the high uncertainty regarding future cash flows (this uncertainty is also related to the fact that many start-up firms report losses).

Thus, this type of firm is generally evaluated using benchmark valuation methods. We thus do not form a prediction in regards to changes in the extent of investor reliance on benchmark multiples for valuation of start-up firms across the investigated sub-periods.

Data

We obtain a sample of 40 companies, backed by venture capital funds, that went IPO on NASDAQ between 1993 and 1999 from the Israel Venture Capital (IVC) Online database.[5] The companies are mainly from the industries of communications, internet, electronics, and biotechnology. Financial information for the sample period, 1999–2004, includes data from the firms' financial statements, daily share prices, and NASDAQ index. Information from financial statements was extracted from the database of Yif'at Capital Disc Co. Market information was obtained from the Yahoo Finance database.

Table 1 provides descriptive statistics on major financial information items for our sample firms, by year. In Panel a of Table 1, we present unscaled financial variables. Market value of equity, measured three months after fiscal year-end, declined from an average (median) of $2991 (363) million in 1999 to $579 (78) million in 2000, indicating a loss of approximately 80% of market value. The decline in market values continued in 2001 and 2002, reaching $241 (32) millions. In 2003, however, we see an upturn in market valuations, which continued in 2004, reaching to $541 (111) million. Panel a of Table 1 also shows that the annual cross-sectional variation of market values decreased significantly after the bubble burst; from a peak of $8934 million in the bubble, standard deviation of market values declined to $744 million in 2002. Again, in 2003 and 2004, with the recovery in firm valuations, the variation of market values also increased to $1210 million.

The book value of equity (total assets) increased during the sample period from an average of $87 (104) million in 1999 to $135 (232) million in 2004, though the median generally remained the same. At the same time, the variation of book values and total assets increased during this period. It is evident that book values are disconnected from market values. The book value of equity and the total assets from the balance sheets are affected by accepted accounting principles (US GAAP) rather than by investor expectations. Thus, these values generally do not account for future growth options; in the case of start-up ventures, future growth options are a primary value driver. The higher the investor expectations for the firm, the greater the discrepancy between market values and book values. Additionally, the accounting measures are not affected by capital market anomalies, which may also explain discrepancies between market values and book values. Notably, in this study we seek to identify the changes in the relations between market values and traditional financial statement variables during a period in which the market has undergone unusual fluctuations. Finally, sales increased in the year the bubble burst, but decreased in the following two years (2001–2002), leading to negative reported earnings. Some improvement in the firms' performance appears to be indicated in 2003.

In Panel b of Table 1, we present scaled financial variables. The first scaled variable is *P/B*, which measures the ratio between the market value and the book value of equity. Consistent with the patterns described above for market values and book values, *P/B* (mean, median and variation) peaked after the end of 1999, dramatically declined in 2000 through 2002, and upturned in 2003. This pattern is again related to the fact that book values are disconnected from market values, and thus during an upturn (downturn) in the market, *P/B* ratios increase (decrease). The ratio of Enterprise Value to Sales, *EV/Sales*,[6] displays same pattern throughout the sample period. The percentage change in sales indicates a mean (median) annual growth of 79.3% (54.6%) in 2000 – higher

Table 1. Descriptive Statistics

Panel a. Unscaled financial variables (in $millions)

Year	MV			BV			TA			Sales			Earnings			R&D		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
99	2,991	363	8,934	87	59	76	104	62	103	55	30	61	5	0.3	26	8	5	7
00	579	78	2,122	104	75	108	154	92	209	72	37	90	3	0.4	50	11	9	8
01	397	64	1,345	104	55	167	166	72	276	65	27	122	−20	−12	99	13	12	9
02	241	32	744	96	49	218	156	62	301	62	20	102	−10	−10	78	10	8	10
03	502	156	1,203	121	49	279	196	62	450	68	21	120	9	−4	52	11	9	11
04	541	111	1,210	135	50	310	232	66	492	91	23	159	8	−2	50	14	10	16

Panel b. Scaled financial variables

Year	P/B			EV/ Sales			Sales _ch(%)			R&D/Sales		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
99	19.053	6.808	31.718	38.320	14.017	52.804	0.463	0.395	0.293	0.220	0.154	0.173
00	2.117	0.988	4.061	4.279	2.108	5.362	0.793	0.546	0.922	0.290	0.239	0.317
01	1.621	1.083	1.950	3.434	2.446	3.076	−0.051	−0.041	0.373	0.359	0.298	0.286
02	1.864	0.731	3.762	2.955	2.234	3.403	0.069	−0.171	1.055	0.390	0.312	0.409
03	6.251	3.010	11.081	17.598	5.343	41.847	0.096	0.059	0.424	0.747	0.252	1.758
04	4.575	2.675	5.718	30.801	4.254	100.245	0.442	0.249	1.223	1.903	0.254	6.767

Notes: This table provides descriptive statistics on the main variables used in the analyses. SD is standard deviation. Panel a presents unscaled variables in $ millions. *MV* is market value of equity three months after fiscal year-end; *BV* and *TA* is book value of equity and total assets, respectively, at fiscal year-end; Earnings is annual earnings before extraordinary items; *Sales* is total revenues and *R&D* is research and development expenditures. Panel b presents scaled variables. *P/B* is market value of firm's equity three months after fiscal year-end divided by book value of equity at fiscal year-end; *EV/ Sales* is market value of firm's equity plus total liabilities less current liabilities divided by annual sales; *Sales _ch(%)* is percentage change in annual earnings; *R&D/Sales* is R&D intensity measured as R&D expenditures divided by sales. The sample size is 240 firm-years observations.

than the growth in 1999 of 46.3% (39.5%) respectively. In 2001 and 2002, however, firms displayed a negative performance (-5.1% [-4.1%] and 6.9% [-17.1%], respectively). In 2003 there was again improvement, which continued in 2004 (9.6% [5.9%] and 44.2% [24.9%], respectively). Despite the reduction in sales and negative earnings in 2001 and 2002, R&D intensity (research and development expenditures divided by sales) increased, indicating the firms' efforts to regain growth.

Research methods and results

Price level analysis

Studies on value relevance of financial information generally investigate the association of equity prices or returns with a set of accounting data, where value relevance is defined as the information content (measured by the R-square) of the examined data set. We initially employ a price level analysis to explore changes in the value relevance of financial statement information for start-up ventures throughout the sample period. The price regressions are based on a version of the Ohlson (1995) model, where we regress the market value of equity on the book value of equity, current earnings, and proxies for expected growth (see also Collins et al., 1997; Core et al., 2003; Dechow et al., 1999; among others). Upon regressing prices on the financial variables, we separate earnings into positive and negative earnings. This differentiation between value implications of positive and negative earnings is based on prior literature that documents differences in the valuation of profits and losses (e.g. Basu, 1997; Collins et al., 1997; Hayn, 1995). The model we employ is:

$$P_{it} = \beta_0 + \beta_1 BV_{it} + \beta_2 E_{it} + \beta_3 NEG\_E_{it} + \beta_4 R\&D_{it} + \beta_5 SALESCH_{it} + \varepsilon_{it} \quad (1)$$

where P is the price per share three months after fiscal year-end; BV is the book value of equity per share; E represents earnings per share before extraordinary items; NEG_E is negative earnings per share before extraordinary items, 0 otherwise;[7] $R\&D$ is research and development expenditures per share; and $SALESCH$ is the annual change in sales per share. $R\&D$ and $SALESCH$ serve as proxies for expected earnings growth.[8] Consistent with the literature (e.g. Collins et al., 1997; Hand, 2005), we define value relevance as the adjusted R-square from the regression. In each regression, we include intercept dummies for industry to control for industry fixed effects. To mitigate the effect of outliers, we winsorize observations in the top and bottom one percent of the dependent and independent variables, by year. We winsorize outliers instead of deleting them to conserve data. Results do not change qualitatively when outliers are deleted. The regressions include White's (1980) correction.

Table 2 reports results for our price regression model. The first column shows aggregated regression for the full sample period. In this regression we add dummy variables for each year to capture time effects. The rest of the columns show the by-year regressions. As stated, applying by-year regression analysis allows us to test the hypothesis that the valuation relevance of financial statement information has undergone vicissitudes throughout these years. The aggregated regression results indicate that accounting fundamentals are value relevant for start-up ventures in the post-IPO public equity markets. Specifically, the signs of the estimated coefficients are consistent with prior research; the coefficients on BV and E are significantly positive whereas the coefficient on NEG_E is significantly negative. As for $R\&D$ and $SALESCH$, the coefficients are positive, consistent with these variables capturing expected growth, however statistically insignificant. We further discuss the implications of the signs and significance of the explanatory variables in our

Table 2. Price Regressions

	Aggregate	1999	2000	2001	2002	2003	2004
Intercept	41.633	89.359	11.079	3.608	3.198	9.578	11.795
	(0.000)	(0.008)	(0.492)	(0.568)	(0.345)	(0.204)	(0.235)
BV	2.016	4.766	0.354	1.528	1.256	4.476	−0.526
	(0.000)	(0.295)	(0.838)	(0.019)	(0.003)	(0.000)	(0.820)
E	3.062	83.734	4.540	17.403	15.254	0.570	22.263
	(0.024)	(0.167)	(0.639)	(0.005)	(0.001)	(0.697)	(0.127)
NEG_E	−2.788	−82.586	−4.132	−17.307	−14.698	1.467	−28.172
	(0.030)	(0.138)	(0.721)	(0.006)	(0.004)	(0.763)	(0.175)
R&D	4.083	29.609	8.255	1.824	2.808	10.380	0.326
	(0.164)	(0.574)	(0.551)	(0.667)	(0.279)	(0.109)	(0.974)
SALESCH	0.505	4.969	1.551	0.615	0.552	0.967	7.198
	(0.278)	(0.129)	(0.665)	(0.743)	(0.475)	(0.648)	(0.098)
Adj_R^2	0.443	0.045	0	0.580	0.702	0.506	0.258
F-value	9.173	1.437	0.551	6.138	8.071	4.463	1.971
	(0.000)	(0.284)	(0.806)	(0.000)	(0.000)	(0.002)	(0.099)

Notes: The table shows the regression results of market value of equity on financial variables. The dependent variable is price per share three months after fiscal year-end. *BV* is book value per share at fiscal year-end; *E* is annual earnings per share before extraordinary items; *NEG_E* is negative earnings per share before extraordinary items, zero otherwise; *R&D* is research and development expenditures per share; *SALSECH* is 1 year change is sales per share. The 'Aggregate' regression includes dummy variables for each year to capture time effects. In each regression, we include intercept dummies for industry to control for industry-specific effects. To mitigate the effect of outliers we winsorize the top and bottom 1% of the regression variables. The regressions include White's (1980) correction. P-values of the coefficients are presented in parentheses.

analysis of the by-year results. For 1999 and 2000, the year of the bubble and the year the bubble burst, respectively, the results show that financial statement information is irrelevant for market valuations of start-up firms. Neither of the accounting variables contributes to the explanation of the variation in market values. In the two years that followed – 2001 and 2002 – however, accounting fundamentals become value relevant. In these years, the book value of equity and earnings explain 58% and 70%, respectively, of the variation in market values. Notably, while the coefficient on positive earnings is, as expected, significantly positive, the coefficient on negative earnings (sum of *E* and *NEG_E*) is not significantly different from zero. The value irrelevance of negative earnings may imply investor uncertainty with respect to the future prospects of these firms; i.e. the negative earnings may precede either positive future cash flows due to the transitory nature of losses (see Core et al., 2003) or a downfall. Furthermore, while current positive earnings are value relevant, proxies for expected growth in future earnings – R&D expenditures and sales growth – are value irrelevant. It seems that while investors may be willing to attach a higher price to a proven ability to generate higher earnings, they are not willing to risk attaching a higher price based on expectations for the future, particularly since the bubble burst. In 2003, the coefficient on earnings loses its significance, and the book value of equity remains the only accounting fundamental that is value relevant. Adj. R^2 declines from 70.2% to 50.6%. In 2004, the coefficient on book value of equity also loses its significance; concomitantly, however, the coefficient on sales growth becomes significant. Adj. R^2 declines to 25.8%. It seems that with the recovery in NASDAQ, accounting fundamentals (earnings and book values) gradually lose their relevance for the valuation of start-up firms, however the change in sales – a proxy for growth opportunities – becomes

relevant. As the role of the balance sheet versus the income statement in explaining market values depends on investors' perception of earnings persistence, our finding that earnings were the first to lose their significance when NASDAQ recovered, followed by book value of equity, may be explained by investors suspecting lower persistence of earnings in start-up ventures. We also point out that R&D expenditures are value irrelevant throughout the sample period. This is consistent with Armstrong et al. (2006), who show that public equity market valuations do not necessarily increase with the magnitude of R&D, and that reliable inferences regarding the valuation implication of R&D in the case of venture-backed companies cannot be drawn.

To explore whether our results are robust to sample size, we also run a two-year regression analysis for 1999–2000 and 2001–2002, and obtain the same qualitative results (untabulated) as those obtained from the one-year regressions (1999, 2000, 2001, and 2002). In particular, robustness of the by-year analysis increases our confidence with respect to regression results for 2003 and 2004, as these imply changes in investor response to firms' financial information either within or between the years.

Returns analysis

In this section we establish the value relevance of financial statement information using narrow- and wide-window returns analyses. First, we examine the association of the three- and seven-day abnormal returns centered on annual earnings announcement date (CAR (-1,1) and CAR (-3,3), respectively) with the level and change in earnings. Second, we examine the association of annual returns with the level and change in earnings.

The narrow return windows' regressions are based on prior literature (e.g. Amir and Lev, 1996; Callen et al., 2010). Utilizing Easton and Harris's (1991) return version of the Ohlson (1995) model, we run the following regression:

$$CAR_{it} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 \mathrm{D}E_{it} + \varepsilon_{it} \tag{2}$$

where *CAR* is the cumulative abnormal returns of firm i in the three or seven days centered on the earnings announcement; *E* is the annual earnings per share (before extraordinary items) deflated by beginning of year price per share; and ΔE is the change in earnings per share (before extraordinary items) from the previous year deflated by the beginning of year price per share. In the annual return regressions, cumulative abnormal returns are computed from nine months before fiscal year-end to three months after fiscal year-end. The regressions include intercept dummies for industry to capture industry-specific effects.

Table 3 reports the by-year results of our abnormal return regression model (2). Panel a (b) shows the results from the three (seven)-day return windows. The results support those obtained from the price levels analysis. For 1999 and 2000, the coefficients on the earnings variables are statistically insignificant, as are the F-values (zero R-square). In 2001 and 2002, both coefficients – on the level of earnings and on the change in earnings – are positive and significant. In 2003 and 2004, the coefficients lose their significance. An annual returns analysis, displayed in Table 4, provides similar results. Additionally, two-year regressions run for 1999–2000, 2001–2002 and 2003–2004 provide the same qualitative inferences as those obtained from the annual analysis. Again, it seems that the precision of results from the by-year analysis is not affected by the relatively small sample size (40 observations per year).

The returns analyses indicate that inferences drawn from the price analysis regarding changes in the role of earnings for valuations of start-up ventures are robust. GAAP-based earnings were

Table 3. Regressions of Abnormal Returns Surrounding Earnings Announcements

Panel a. Dependent variable is cumulative abnormal return in the three days centered on earnings announcements (CAR (−1,+1))

	1999	2000	2001	2002	2003	2004
Intercept	0.009	−0.082	0.147	0.063	0.057	−0.017
	(0.955)	(0.425)	(0.429)	(0.478)	(0.476)	(0.848)
E	0.299	0.330	0.571	0.265	0.042	0.057
	(0.695)	(0.832)	(0.019)	(0.002)	(0.705)	(0.800)
ΔE	0.212	0.544	0.678	0.143	0.041	0.002
	(0.674)	(0.600)	(0.001)	(0.090)	(0.680)	(0.793)
Adj_R^2	0	0	0.422	0.523	0	0
F-value	0.527	0.704	20.388	8.857	0.614	0.197
	(0.723)	(0.642)	(0.000)	(0.000)	(0.717)	(0.974)

Panel b. Dependent variable is cumulative abnormal return in the seven days centered on earnings announcements (CAR (−3,+3))

	1999	2000	2001	2002	2003	2004
Intercept	0.310	−0.096	0.178	0.016	0.120	−0.005
	(0.129)	(0.270)	(0.101)	(0.885)	(0.199)	(0.960)
E	0.386	0.034	0.330	0.163	0.020	0.062
	(0.637)	(0.979)	(0.032)	(0.090)	(0.877)	(0.814)
ΔE	0.554	0.514	0.225	0.191	0.018	0.002
	(0.510)	(0.549)	(0.048)	(0.071)	(0.875)	(0.868)
Adj_R^2	0	0	0.544	0.551	0	0
F-value	0.864	0.649	10.200	7.351	0.505	0.170
	(0.544)	(0.674)	(0.000)	(0.000)	(0.799)	(0.982)

Notes: The dependent variable is the cumulative abnormal return in the three and seven days centered on earnings announcements. E is annual earnings per-share before extraordinary items and ΔE is the change in E, both deflated by initial period price per share. The change in earnings per share is computed as earnings minus the earnings reported in the preceding year. In each regression, we include intercept dummies for industry to control for industry-specific effects. To mitigate the effect of outliers we winsorize the top and bottom 1% of the regression variables. P-values of the coefficients are presented in parentheses.

irrelevant for market valuations of start-up firms' equity during the bubble as well as right after the bubble burst. In the years that followed (2001 and 2002), accounting earnings become relevant. However in 2003 this relevance wanes.

The valuation accuracy of benchmark valuation methods

The analyses above show that the role of financial statement items in the valuation of start-up ventures has changed throughout the sample period. At this stage of the analysis, we seek to explore whether the role of the price-multiples method for valuation of start-up firms has changed during this period. In other words, to what extent did investors rely on price multiples of comparable firms

Table 4. Regressions of Annual Returns

	1999	2000	2001	2002	2003	2004
Intercept	2.959	–0.786	2.031	4.625	–0.563	–0.065
	(0.044)	(0.009)	(0.084)	(0.031)	(0.170)	(0.868)
E	1.951	0.330	4.778	6.935	0.461	1.427
	(0.729)	(0.232)	(0.027)	(0.023)	(0.189)	(0.164)
Δ*E*	1.073	0.025	4.340	6.929	0.140	0.032
	(0.869)	(0.968)	(0.012)	(0.011)	(0.711)	(0.434)
Adj_R^2	0.026	0.054	0.365	0.410	0.001	0.009
F-value	0.438	1.721	6.617	7.478	0.814	1.040
	(0.658)	(0.199)	(0.000)	(0.000)	(0.569)	(0.427)

Notes: The dependent variable is annual returns. It is computed from 9 months prior to fiscal year-end to 3 months after fiscal year-end. E is annual earnings per-share before extraordinary items and is the change in E. The independent variables are deflated by the beginning of year stock price. In each regression, we include intercept dummies for industry to control for industry-specific effects. The number of observations is affected by winsorization of outliers in the dependent and independent variables (top and bottom 1%). P-values of the coefficients are presented in parentheses.

in each of the investigated sub-periods? To answer this question, we evaluate the valuation accuracy of two multiples commonly used in the investment community: Price-Book (*P/B*) and the Enterprise Value to Sales (*EntV/Sales*). The multiples valuation method estimates the value of the firm as a product of its accounting measure (either book value of equity or sales) and a benchmark multiple (either *P/B* or *EntV/Sales*, respectively) of a set of comparable firms.[9] Book value of equity and sales for the target firm are taken from its annual financial statements. For each comparable firm, we calculate *P/B* ratio and *EntV/Sales* ratio, where *P* is market price of firm's equity three months after fiscal year-end, *B* is book value of equity at fiscal year-end, *EntV* is price of firm's equity plus total liabilities less current liabilities, and *Sales* is annual sales. The benchmark multiple is usually calculated as the median price multiple of the set of comparable firms. Median multiple is generally preferred over the mean multiple to avoid the effect of extreme multiples. We follow prior literature which advocates definition of the comparable firms based on industry membership (see, e.g. Alford, 1992; Cheng and McNamara, 2000). For our sample, industry membership is defined in the IVC database. We identify five industries, each of which includes at least six start-up ventures: biotechnology, internet, electronics, software and communications. Thus, for each firm in our sample, at least five public comparable firms are identified. We also perform the analyses where in cases in which the industry includes more than five other firms, the five firms whose ROE is closest to that of the target firm are selected (i.e. definition of comparable firms based on industry membership combined with return on equity; see also Alford, 1992 and Cheng and McNamara, 2000). The results remain qualitatively the same.

Table 5 presents the discrepancies between estimated values using the multiples valuation methods ($V_{ESTIMATED}$) and market values (*MV*), by year. In panel a (b) equity values are estimated using *P/B* (*EntV/Sales*) valuation method. We find that the percentage difference between $V_{ESTIMATED}$ and *MV* is not significantly different from zero for each of the sample years and for both multiples. Hence, the multiples valuation approach performs well in the bubble, after the bubble burst, and during the downturn and the upturn. An implication of this result is that investors in the market evaluated start-up firms based on benchmark multiples of comparable firms throughout the sample period. Notably, stock prices estimated based on comparable firms' price multiples are directly

Table 5. Discrepancy between Estimated Values using Multiples Valuation Method and Market Values

Panel a. Equity value estimated using P/B multiple

	Mean	Median	SD
$Ln(V_{ESTIMATED}/MV)$			
1999	−0.1124	−0.0004	0.5642
	(0.396)	(0.444)	
2000	−0.0490	0.0001	0.6118
	(0.664)	(0.704)	
2001	0.0559	0.0018	0.5490
	(0.563)	(0.586)	
2002	−0.0450	0.0028	0.6108
	(0.680)	(0.925)	
2003	−0.0124	−0.0004	0.5776
	(0.906)	(0.860)	
2004	−0.0047	−0.0001	0.5801
	(0.966)	(0.982)	

Panel b. Equity value estimated using *EV/Sales* multiple

	Mean	Median	SD
$Ln(V_{ESTIMATED}/MV)$			
1999	0.1243	−0.0002	0.7332
	(0.470)	(0.904)	
2000	−0.0688	−0.0003	0.7010
	(0.595)	(0.614)	
2001	0.1092	0.0006	0.8916
	(0.494)	(0.667)	
2002	0.0920	0.0009	1.1524
	(0.650)	(0.754)	
2003	−0.0368	−0.0015	0.7131
	(0.776)	(0.597)	
2004	−0.0183	−0.0001	0.7814
	(0.901)	(0.991)	

Notes: The table presents the percentage difference between estimated values using multiples valuation method $(V_{ESTIMATED})$ and market values three months after fiscal year-end *(MV),* by year. In panel a (b) equity values are estimated using *P/B (EntV/Sales)* valuation method. Book value of equity and sales for the target firm are taken from its annual financial statements. For each comparable firm, we calculate *P/B* ratio and *EntV/Sales* ratio, where P is market price of firm's equity three months after fiscal year-end, B is book value of equity at fiscal year-end, EntV is price of firm's equity plus total liabilities less current liabilities, and *Sales* is annual sales. The benchmark multiple is calculated as the median price multiple of the set of comparable firms.

Values in brackets represent the p-value for the t-test (Wilcoxon test) that the mean (median) value differs significantly from zero.

affected by overpricing or underpricing cycles in the industry, the sector, and even the capital market. For example, during the bubble, with share prices exaggeratedly inflated, application of the multiples valuation method results in an exaggeratedly inflated estimated price for the target company. Hence, if investors realize the consequences of evaluating a firm based on exaggeratedly inflated (or deflated) prices of comparable firms, then their reliance on price-multiple benchmarks

should have declined as they became aware of the magnitude of the bubble. Our results imply that investors may be unaware of these over/under pricing effects or, that even being aware of these effects, in the absence of alternative valuation methods for start-up firms, price-multiples benchmark valuation methods remain the accepted tool employed by investors, despite their deficiencies.

Summary and conclusions

The present study probes an issue of current interest to researchers and practitioners; namely the appropriateness of standard accounting measures for valuation of publicly traded start-up companies. The analysis of the value relevance of accounting information is particularly appealing in start-up companies because of the considerate complexity of these firms' technology, innovation and probability of success in particular. Previous studies have yielded conflicting findings with respect to the value relevance of accounting information for high-tech companies. The present study adds a dynamic dimension to this research strand. Notably, the study suggests that over time, concomitant with market cycles, investors undergo a process of learning and adjustment, subsequently reflected in market values. In particular, a stock market bubble and bursting of a bubble are potential boosters of this process that investors undergo. Furthermore, some of the conflicting findings in prior studies may be attributable to the dynamic nature of this process. Our findings support this premise.

Employing both levels and changes analyses, we examine differences in the fit of price and return regression models, respectively, across the six-year sample period. We find that during the bubble, investors did not rely at all on accounting variables for valuation of start-ups. The bursting of the bubble made investors overly conservative, relying primarily on the standard accounting fundamentals of book value of equity and earnings. In the following years, the process seems to stabilize, with investors gradually moving away from the measures of earnings and book value towards growth in sales, which is considered proxy for technological feasibility and market potential.

This study is also the first to explore the effect of market cycles on investor reliance on multiples. Our results indicate that comparable firms' benchmark multiples remain the accepted tool in valuating start-up firms, whether investors realize the 'consequences' of over/under pricing effects of evaluating a firm based on exaggeratedly inflated/deflated prices of comparable firms, and whether they do not. In the absence of a learning process with regards to over/under pricing effects when using comparable firms' benchmark multiples, over/under-pricing market cycles are inevitable.

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Notes

1. See, e.g. Asness, 2005; Ljungqvist and Wilhelm, 2003; Ofek and Richardson, 2002.
2. Prior value relevance studies for high-technology, science-based industries employed both price and return analyses (e.g. Amir and Lev, 1996; Armstrong et al., 2006; Callen et al., 2010). Kothari and Zimmerman (1995, p. 34) explain that '…use of both return and price models has the potential to yield more convincing evidence'.

3. The study of Armstrong et al. (2006) is based on a sample of venture-capital-backed firms from six different industries.
4. Some of the studies mentioned above also examine the value relevance of nonfinancial information and the relationship between financial and nonfinancial information in explaining stock pricing (e.g. Amir and Lev, 1996; Callen et al., 2010; Ely et al., 2003; Hand, 2005). The examination of nonfinancial information is possible when focusing on a specific industry within the high-tech sector (e.g. telecommunications, biotechnology, e-commerce) because each industry is characterized by different value-relevant nonfinancial data (i.e. nonfinancial information is typically industry-specific; for example, drug development stage for biotech firms, market penetration (number of subscribers) for cellular firms, etc.). Our study, on the other hand, is based on start-up firms from various industries which make an investigation of the value relevance of nonfinancial information impractical. See also, Amir and Lev (1996), p.6.
5. The IVC Online database is a comprehensive database on Israel's high-tech industry created by the Israel Venture Capital Research Center. It includes information on Israeli high-tech companies, venture capital and private equity funds, investment companies, professional service providers, foreign investors, and technological incubators. The list of companies in the IVC Online database included six additional firms that are not included in the analyses. As their entire outstanding shares were acquired by another high-tech firm, we were not able to obtain full information for the sample period.
6. Enterprise Value (*EV*) is measured as market value of firm's equity plus total liabilities less current liabilities.
7. We define *NEG_E* as earnings per share before extraordinary items, if earnings per share before extraordinary items <0, 0 otherwise. Thus, *NEG_E* takes on only non-positive values. We also include in the regressions a dummy variable that equals 1 if earnings before extraordinary items are negative, 0 otherwise. The dummy is nonsignificant for all years (untabulated). Additionally, in an untabulated analysis, we add to regression model (1) an interaction variable of *NEG_E* with *BV* to inquire whether the coefficient on the book value of equity is different for loss firm-years. We find that the coefficient on the interaction variable in statistically insignificant with the other coefficients in the model similar to those reported in our tables.
8. Additional proxies for expected earnings growth used in prior studies include advertising expenditures and capital expenditures (see, e.g. Core et al., 2003; Demers and Lev, 2001; Morck et al., 1988). Both proxies are less relevant for the case of start-up ventures. For example, while R&D expenditures capture expected growth in earnings due to investments in *intangible* assets, capital expenditures capture expected growth in earnings due to investments in *tangible* assets (Core et al., 2003). Indeed, when included in the regressions, we find that these variables (advertising and capital expenditures) do not contribute incrementally to the explanation of market values.
9. Another commonly used multiple is Price-Earnings (*P/E*, see for example, Cheng and McNamara, 2000). We do not apply this multiple in our analysis because many start-up firms report losses and thus the *P/E* valuation method is not applicable. As our sample is restricted to positive book value firms beforehand, all observations are retained in the use of *P/B* (as well as *EntV/Sales)*.

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