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Valuing IPOs☆

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Abstract

The use of accounting information in conjunction with comparable firm multiples is widely recommended for valuing initial public offerings (IPOs). We find that the price–earnings (P/E), market-to-book, and price-to-sales multiples of comparable firms have only modest predictive ability without further adjustments. This is largely due to the wide variation of these ratios for young firms within an industry. P/E multiples using forecasted earnings result in much more accurate valuations than multiples using trailing earnings.

JEL classification: G24

Keywords: Initial public offerings; Valuation; Comparable firms

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> [Bill] Gates had thought longest about the price. Guided by Goldman [Sachs], he felt the market would accord a higher price-earnings multiple to Microsoft than to other personal computer software companies like Lotus or Ashton–Tate, which have narrower product lines. On the other hand, he figured the market would give Microsoft a lower multiple than companies that create software for mainframe computers because they generally have longer track records and more predictable revenues. A price of roughly $15, more than ten times estimated earnings for fiscal 1986, would put Microsoft's multiple right between those of personal software companies and mainframers.
> ... By the end of the first day of trading, ... Microsoft's stock stood at $27.75.
> (Uttal, 1986, p. 26, describing the Microsoft initial public offering).

1. Introduction

Most firms conducting initial public offerings (IPOs) in the U.S. are young companies for which it is difficult to forecast future cash flows. To value these companies, discounted cash flow analysis is very imprecise, and the use of accounting numbers, in conjunction with comparable firm multiples, is widely recommended in both academic and practitioner publications and is standard practice in many IPO valuation case studies used in business schools.[1] Yet there has been no systematic study of the usefulness of this approach. This paper fills this gap.

We examine the use of price-earnings and other multiples of comparable firms as benchmarks for valuing IPOs. We find that this approach results in very little precision in the valuations when historical accounting numbers are used without further adjustments. The reason for such large valuation errors is simple: among publicly-traded firms in the same industry, price–earnings (P/E) ratios typically display such great variation that just about any price can be justified. When forecasted earnings are used for calculating P/E ratios, however, the accuracy of the valuation improves substantially.

We expand the multiples evaluated to include market-to-book, price-to-sales, enterprise value-to-sales, and enterprise value-to-operating cash flow ratios, where enterprise value is defined as the market value of equity plus the book value of debt, minus cash. We find these ratios are somewhat more accurate than the use of historical earnings, especially when adjustments are made reflecting differences between the profitability and growth rates of the firm going public and the comparable firms used.

[1] See, for example, the teaching note accompanying the F&C International IPO valuation case (Varaiya et al., 1997).

Our results demonstrate the value added by investment bankers in pricing issues. While they use accounting information and comparable firm multiples as benchmarks for choosing a preliminary offer price range, the additional information that they process about the market's demand results in much more accurate pricing. How much of this improvement in accuracy is due to superior fundamental analysis, and how much is due merely to canvassing market demand, is an open question.

While accounting information other than sales, earnings, operating cash flows, and book value is presumably useful in the pricing of IPOs, we focus on these accounting variables in conjunction with comparable firm multiples. Because publicly available accounting information about IPOs includes more than just these items, this sets a lower bound on the importance of comparable firm multiples using accounting data in the pricing of IPOs.

We examine the valuation accuracy of comparable firm multiples using two sets of comparable firms: recent IPOs in the same industry, and comparable firms chosen by a research boutique that specializes in valuing IPOs. For the latter set of comparable firms, we use not only historical earnings but forecasted earnings. Not surprisingly, the comparable firms chosen by the research boutique work better than the comparables chosen using a mechanical algorithm, and multiples using forecasted earnings work better than those using historical earnings.

There is a presumption that many firms going public have valuable growth options whose value is difficult to capture using one-year-ahead earnings forecasts, with this difficulty most severe for young growth firms. We test this idea by splitting the sample into young and old firms going public, using the comparable firms chosen by the research boutique. Consistent with the presumption that the young firms are most difficult to value, we find that the valuation errors of the comparable firm multiples are noticeably smaller for the older firms than for the younger firms, especially when using earnings.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. The topics include valuation methods used in practice and valuation studies in non-market settings. Section 3 describes the data. Section 4 presents the comparable firms approach and empirical results. Section 5 presents results using forecasted earnings and comparables chosen by practitioners. Section 6 provides a summary, conclusions, and limitations of the paper.

2. Related literature

There are a variety of situations in which the value of a firm must be established without referring to the market value. One example is the valuation of a closely held business for the purpose of determining gift and estate taxes or divorce settlements. Another example includes privately held corporations that

need to set an offering price for their IPOs, or for further venture capital financing. Corporate control transactions such as management buyouts also require the valuation of equity.

2.1. Alternative valuation frameworks

Reflecting the importance of firm valuation in practice, there is an extensive practitioner-oriented literature that discusses several valuation methods, including the comparable firms approach, which uses market multiples of a peer group; the discounted cash flow (DCF) approach; and the asset-based approach. Each of these methods has its advantages and disadvantages. For example, the comparable firms approach works best when a highly comparable group is available. While it can reduce the probability of misvaluing a firm relative to others, this approach provides no safeguard against an entire sector being undervalued or overvalued. The DCF approach is based on a firmer theoretical footing than any other approach, but in many situations it is difficult to estimate future cash flows and an appropriate discount rate. The asset-based approach looks at the underlying value of a company's assets to indicate value. The asset-based approach is more relevant when a significant portion of the assets can be liquidated readily at well-determined market prices if so desired. For most IPOs, the asset-based approach has little relevance, since most of their value comes from growth opportunities.

Among the alternative valuation approaches, the comparable firms approach is one of the most frequently cited.[2] The comparable firms approach is typically implemented by capitalizing the earnings per share (EPS) of the firm under consideration at the average or median price–earnings (P/E) ratio of comparable publicly traded firms. If earnings forecasts are available, these are commonly used for the comparables. Other market multiples, such as market-to-book, price-sales, price-operating earnings, enterprise value-to-sales, and enterprise value-to-operating earnings ratios, are sometimes employed.

Several academic studies examine the comparable firms approach, mainly using P/E ratios. Boatsman and Baskin (1981) compare the accuracy (measured by absolute values of prediction errors as a percentage of actual values) of two different types of P/E models. The first uses a random firm from the same industry, and the second uses the firm from the same industry with the most similar ten-year average growth rate of earnings. They find that the accuracy of the latter is greater.

[2] Practitioner-oriented discussions of the comparable firms approach for valuing a closely-held business (such as an IPO) include Pratt (1989), Joyce and Roosma (1991), and Buck (1990). Academic studies using comparable firm multiples include Kaplan and Ruback (1995), Berger and Ofek (1995), Eberhart (1998), and Gilson et al. (1998). Textbook discussions include Benninga and Sarig (1997).

Alford (1992) examines the accuracy of the P/E valuation method when comparable firms are selected on the basis of industry, firm size, and earnings growth, to see which factor is the most important for choosing comparable firms. He also investigates the effect of adjusting earnings for cross-sectional differences in leverage using a sample of Compustat-listed firms. His findings show that selecting comparable firms by industry, defined by three-digit SIC codes, is relatively effective. The median absolute prediction error, measured as $|P^* - P|/P$, where P^* is the predicted price and P is the actual price, when comparable firms are selected on the basis of industry, is 24.5%. The corresponding number is 29.4% when all other sample firms (that is, ignoring industry membership) are used as comparable firms. Alford also finds that a finer classification using size in addition to industry membership does not improve the accuracy of the P/E valuation method. Finally, his findings show that adjusting P/E multiples for differences in leverage across comparable firms *decreases* accuracy.

2.2. Valuation studies in a non-market setting

Valuation studies in non-market settings include the determination of an offer price in IPOs and corporate transactions such as management buyouts and hostile takeovers. It is often assumed that insiders of IPOs have better information about the expected value of their projects than outside investors do. Accordingly, most academic IPO studies have used signaling models to explain the valuation of IPOs, and the key variable has always been a signaling variable, such as the ownership retained by insiders, as in Leland and Pyle (1977). Studies by, among others, Ritter (1984), Kim et al. (1995), Klein (1996), and Van der Goot (1997) find that IPOs with a larger fraction of the equity retained by preissue shareholders have higher market valuations.

Another non-market setting for valuations is leveraged buyouts. DeAngelo (1990) provides evidence from a large sample of fairness opinions on management buyouts and a small sample of investment bankers' working papers that indicates that investment bankers' valuation techniques make extensive use of accounting data. She also shows that major investment bankers rely heavily on the comparable firms approach.

Kaplan and Ruback (1995) examine the DCF approach in the context of highly leveraged transactions such as management buyouts and recapitalizations. They find that transaction prices are close to the present value of projected cash flows, although they are unable to reject the hypothesis that the projections are made to justify the price. Kaplan and Ruback report that a CAPM-based DCF valuation approach has approximately the same valuation accuracy as a comparable firms valuation approach with earnings before interest, taxes, depreciation, and amortization as the accounting measure being capitalized. Their sample firms are typically large, mature firms, unlike our firms

going public. Gilson et al. (1998) also find that, for firms emerging from bankruptcy, DCF valuations have about the same degree of accuracy as valuations based upon comparable firm multiples. They show that the economic interests of various parties in the bankruptcy proceedings affect the cash flow forecasts that are used.

3. Data

We use a sample of 190 domestic operating company IPOs from 1992 to 1993 meeting the following criteria in our empirical work. We restrict our sample to 1992–1993 IPOs because of changes in market multiples over time when longer time periods are used. Firms must have positive earnings per share (EPS) for the most recent 12 months prior to the IPO, positive book value per share prior to the IPO ($BPS_{preissue}$), as well as information on the preliminary offer price (POP), final offer price (OP), first closing market price (P_{market}), and the four-digit SIC code. Second, IPO dates and SEC filing dates of preliminary prospectuses must be available. Third, to achieve a more homogeneous sample, we also exclude unit offerings, best efforts offerings, financial companies, 'reverse LBOs', issues raising less than $5 million, and issues with an offer price of less than $5.00. The earnings screen, in particular, excludes many young firms, where the historical accounting information is presumably most problematic for valuing IPOs. Finally, we require that there has been at least one other IPO in the same (four-digit SIC code) industry during the prior 12 months. Panel A of Table 1 reports the number of issues excluded as a result of the various sample-selection criteria.

We obtain EPS, book values, IPO dates, SIC codes, and SEC filing dates from the Securities Data Company (SDC) new issues database for 1992–1993. Missing and suspicious accounting numbers are checked (and, if necessary, corrected) in the prospectus (using the *Laser D* compact disk dataset). The first closing market price is also taken from SDC or, if omitted there, from Standard and Poor's *Daily Stock Price Record*.

We use earnings, book value, and sales throughout the paper, measured as

EPS: earnings per share (fully diluted) before extraordinary items and discontinued operations for the most recent 12 months prior to the IPO, adjusted for stock splits.

$BPS_{preissue}$: the book value per share reported in the prospectus.

$BPS_{postissue}$: the book value per share as adjusted for the net proceeds and primary shares from the IPO. In measuring this, we assume that overallotment options are not exercised.

Sales: sales for the last 12 months reported in the prospectus.

Panel B of Table 1 presents descriptive statistics for 190 IPOs from the 1992 to 1993 sample period. The median P/E multiple using the offer price is 24.0, and

Table 1
Description of the sample of 190 IPOs during 1992–1993

Earnings per share (EPS) and sales are for the most recent 12 months reported in the prospectus, as recorded by Securities Data Company (SDC). SDC records the EPS numbers reported in the prospectus summary financial statements, which are usually earnings after extraordinary items (and not *pro forma*). We calculate the postissue numbers assuming that no overallotment options are exercised.

Panel A: Sample selection criteria

	N
Universe of firm commitment, nonunit, nonfinancial domestic operating company IPOs	832
Exclusion of reverse LBOs and total divestiture of subsidiaries	164
Remaining	668
Exclusion of IPOs with proceeds < \$5 million or offer price < \$5.00	56
Remaining	612
Exclusion of firms with EPS $\leqslant 0$ in the 12 months prior to the offer	194
Remaining	418
Exclusion of firms with preissue book value $\leqslant 0$	48
Remaining	370
Exclusion of IPOs when there is no IPO in the same (four-digit) industry in prior 12 months	180
	190

Panel B: Descriptive statistics for the 190 IPOs

Variable	Mean	Minimum	Percentiles			Maximum	Standard deviation
			25th	50th	75th		
Preliminary offer price	\$11.70	\$5.00	\$10.00	\$11.125	\$14.00	\$25.00	\$3.12
Offer price (OP)	\$12.30	\$5.00	\$9.50	\$12.50	\$15.00	\$24.375	\$4.08
First market price	\$14.74	\$4.50	\$10.125	\$13.50	\$18.125	\$38.25	\$6.60
Proceeds, millions	\$40.3	\$5.0	\$16.2	\$25.0	\$42.0	\$968.0	\$77.8
Earnings per share	\$0.55	\$0.07	\$0.29	\$0.48	\$0.70	\$5.47	\$0.47
Preissue book value/share	\$2.06	\$0.01	\$0.67	\$1.49	\$2.48	\$24.44	\$2.39
Postissue book value/share	\$4.16	\$0.49	\$2.84	\$3.68	\$4.92	\$24.44	\$2.33
Sales (mm)	\$78.4	\$0.7	\$21.9	\$40.6	\$74.5	\$1,539.0	\$152.3
P/E (OP/EPS)	33.5	3.3	15.3	24.0	42.5	200.0	26.9
M/B_{pre} (OP/$BPS_{preissue}$)	37.6	1.0	4.2	8.1	16.3	1147.4	138.1
M/B_{post} (OP/$BPS_{postissue}$)	3.5	1.0	2.3	3.0	4.0	32.4	2.6
P/S (OP/sales)	2.7	0.3	1.2	2.1	3.6	13.6	2.3
$MV_{postissue}$ at OP (mm)	\$131.5	\$8.2	\$49.6	\$77.0	\$146.4	\$1,738.0	\$183.1

the median preissue market-to-book (M/B) multiple using the offer price is 8.1. Reflecting the addition of equity to both the numerator and denominator of the M/B ratio, the median postissue M/B multiple is lower, at 3.0. The median price-to-sales (P/S) ratio is 2.1. The standard deviation of the P/E multiple is very large (27), partly due to some outliers. In our empirical work, we constrain all values of P/E over 100 to equal 100 and all values of M/B and P/S over 10 to equal 10.

4. The pricing of IPOs using comparable firm multiples

4.1. The comparable firms approach

Much of the literature on IPOs suggests that the starting point for pricing an IPO is to compare its operational and financial performance with that of several publicly-owned companies in the same or a similar industry. The firm and its underwriters base their pricing decision on an analysis of the market price ratios, with adjustments for firm-specific differences, and determine a minimum and maximum offer price. After that, they gather more recent information about the IPO market and set a final offer price.

Many market multiples can be used in the comparable firms approach, including industry-specific ratios such as market value per cable subscriber, market value per barrel of proved reserves, and market value per scientist. Amir and Lev (1996), for example, provide a valuation study of the wireless communication industry. They show that the primary determinant of company value is the population of the franchise territory, rather than financial variables. While there is no clear-cut answer for which multiples should be used, the value-relevance of P/E and M/B ratios can be readily drawn from theoretical models, and t heir value-relevance has been demonstrated by empirical studies. Zarowin (1990) examines several determinants of E/P ratios and shows that long-term growth is very important in determining E/P ratios, while short-term growth and risk are relatively less important. Liu and Ziebart (1994) also examine the cross-sectional variability in E/P ratios and find a significant relationship between E/P ratios and growth, dividend payout, and size. They do not find a significant relationship between E/P and systematic risk. Ohlson's (1995) model shows that the M/B ratio is a function of the firm's abnormal earnings generating power and thus reflects the firm's growth potential.

In our empirical work, we use two groups of firms for our comparables: (i) recent IPOs, and (ii) firms chosen by a research boutique. When we use recent IPOs, we use firms in the same industry, as determined by four-digit SIC codes. Although SIC codes are frequently used to classify firms by industries, they are not without problems. The number of multiproduct firms and the prevalence of diversification make classification by product difficult and sometimes arbitrary.

Fortunately, many newly public firms have a single line of business, facilitating their use as comparables for subsequent IPOs.

When we use recent IPOs as comparables, we choose our comparable firms using an algorithm that does not necessarily pick the best comparable firms that a practitioner would choose. The advantage of this algorithm is that we unambiguously choose comparables that are not influenced by an attempt to justify a high or a low multiple. In practice, investment bankers who suspect that they have a hot deal on their hands may be tempted to choose comparables with high multiples to justify a high price. Furthermore, they will generally pick comparables that will not make the IPO look overpriced. We instead want to make sure that the causality flows in only one direction, from the valuation of the comparables to the valuation of the IPO, rather than flowing in both directions. A disadvantage of our algorithm is that, by restricting our comparables to firms in the same SIC code, we are subject to the arbitrariness of these classifications. Furthermore, by restricting our comparables to recent IPOs, we ignore many potential comparables.

Using price–earnings ratios, the comparable firms approach for empirical analysis is expressed as

$$P/E_i = a_0 + a_1(P/E)_{\text{comp},i} + e_i, \tag{1}$$

where $(P/E)_{\text{comp},i}$ = the median price/earnings ratio, using the most recent 12 months of pre-IPO earnings for comparable IPOs and the most recent four quarters of earnings for the research boutique's comparables. When we use market-to-book ratios,

$$M/B_{\text{postissue},i} = a_0 + a_1(M/B)_{\text{comp},i} + e_i, \tag{2}$$

where $(M/B)_{\text{comp},i}$ = the median M/B ratio, using the postissue book value of equity for comparable IPOs. The research boutique does not use market-to-book ratios. It does, however, use price-to-sales ratios, which we implement in the following way:

$$P/S_i = a_0 + a_1(P/S)_{\text{comp},i} + e_i, \tag{3}$$

where sales are the trailing 12-month sales, as reported in the preliminary prospectus for the IPOs and as reported in the most recent financial statements for the other comparable firms. In Eqs. (1)–(3), we calculate the market multiples for the comparable firms using the closing market prices on the day prior to the offer date.

The null hypothesis in Eqs. (1)–(3) is that a_1 equals one, because a firm going public in an industry in which comparables are selling at high multiples should also have its earnings, book value, and sales capitalized at high multiples. In Figs. 1 and 2, we illustrate the logic of using comparable firm multiples, and the reality.

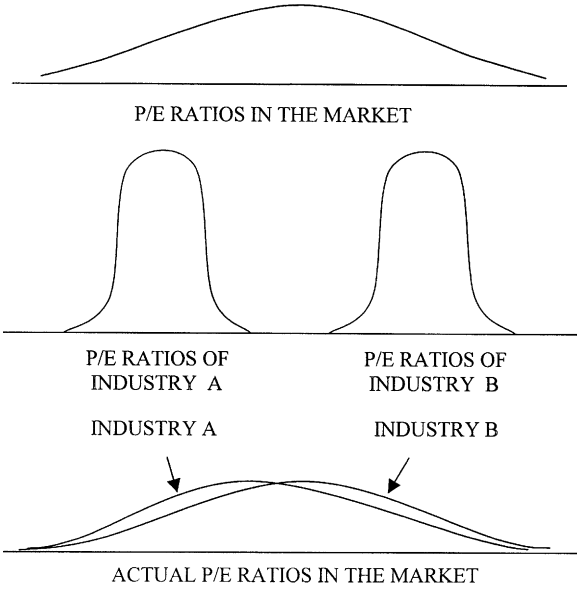

Fig. 1. The rationale behind the use of comparable firms, and the reality. In the top illustration, there is a fairly wide distribution of price/earnings ratios in the market at a point in time. As illustrated in the middle, the rationale behind the use of comparable firms for valuation is that there is a tighter distribution of P/E ratios once industry is controlled for. In the bottom illustration, the conditional distributions are almost as diffuse as the unconditional distribution.

In addition to using a regression approach, we also use a 'simple multiple' approach, in which the predicted multiple of the IPO is simply the mean or median of the multiples of the comparable firms. The simple multiple approach is equivalent to constraining the intercept and slope coefficients in Eqs. (1)–(3) to be, respectively, zero and one.

4.2. Recent IPOs as comparable firms

For our use of recent IPOs as comparables, we choose comparable firms that went public no more than 12 months prior to the IPO's offer date and have the same four-digit SIC codes. If there are more than five qualifying firms, then the five IPOs with the closest last 12 months' sales are selected.

We use the EPS, book value, and sales numbers from the prospectuses for the IPO comparables instead of those available from more recent financial statements, since earnings for the first year after going public typically include substantial amounts of interest income. Newly public firms usually use the proceeds of the offering to repay much of their debt, invest a portion of the proceeds in their businesses, and put the balance in money market instruments.

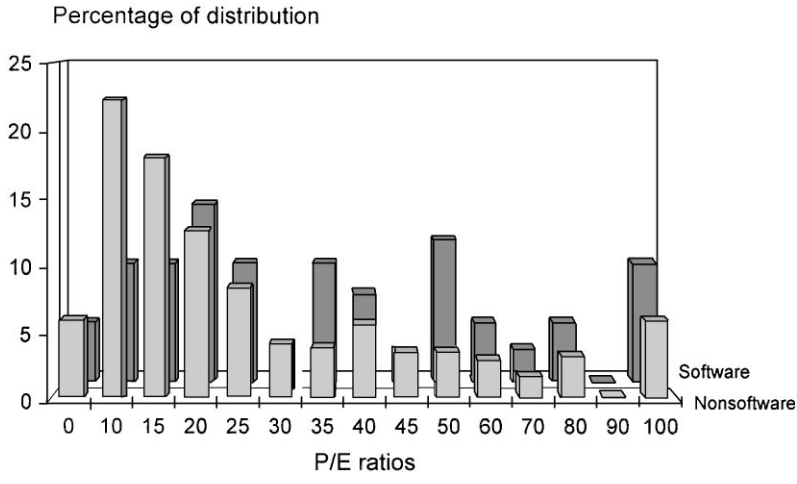

Fig. 2. The distribution of P/E ratios for 43 software (SIC 737) and 327 non-software IPOs with positive earnings during 1992–1993. We calculate P/E ratios as the offer price divided by the earnings per share for the 12 months prior to issuing, with the sample restricted to firms with positive earnings, positive preissue book value of equity, an offer price of at least \$5.00, proceeds of at least \$5 million, and other criteria being satisfied. These other criteria exclude unit offers, ADRs, financial companies, reverse LBOs, and best efforts offers. The P/E categories are defined by their lower bounds: firms with a P/E of between 0 and 9.99 are included in the 0 category. The highest category is for firms with a P/E ratio of 100 and above.

Interest income generated in this case is unlikely to reflect the firm's future growth potential. We therefore use the earnings prior to the comparable firm's IPO instead of its more updated earnings to control for a potential difference in income sources before and after the IPO. Foster (1977) and others examine the role of different components of income on security prices. Their results show that different components of income are assigned different weights in security valuation. We have also performed our empirical analysis using the most recent four quarters of accounting information available on the quarterly Compustat tapes for the comparable firms, with qualitatively similar results.

Table 2 contains an example of how the comparable firms algorithm is implemented using recent IPOs as comparables.

In Tables 3 and 4, where we use comparable firm multiples, we calculate M/B ratios using postissue book values. The rationale for using the postissue multiples, in spite of the endogeniety (because the proceeds affects the postissue book value per share), is that investors are buying the postissue shares, with postissue multiples.

Table 3 presents the distribution of IPO multiples and median comparable multiples for 190 IPOs meeting our sample selection criteria. (For example, an IPO on February 11, 1992 would use as potential comparables IPOs from

Table 2
Illustration of comparable firms procedure for Banyan Systems

IPOs for the same four-digit SIC code (7372), with positive earnings per share (EPS) in the 12 months prior to going public and positive pre-issue book value per share (BPS), are listed in chronological order. IPOs with offer dates more than 12 months before the offer date are excluded from consideration. If more than five firms meet these criteria, the five with the closest sales (12-month revenues prior to the IPO, as listed in the prospectuses) are used as comparable firms. Four ratios are computed: price–earnings (P/E), price-to-sales (P/S), and two market-to-books (M/B), calculated using the market prices on the day prior to the offer date of August 6, 1992. The median of these market multiples is then used as the comparable firms multiple for Banyan Systems. Banyan Systems' P/E, M/B, and P/S ratios are computed using the offer price of $10.50. The comparable firm median multiples that are used are the P/E, M/B (postissue), and P/S ratios of 47.6, 5.6, and 4.00.

Company	Offer date	EPS	Sales (millions)	BPS		August 5, 1992				
				Pre-	Post-	Market price	P/E	M/B		P/S
								Pre-	Post-	
Banyan Systems	**920806**	**$0.37**	**$106.7**	**$2.32**	**$2.97**	**$10.50**	**28.4**	**4.5**	**3.5**	**1.50**
VMark Software	920514	$0.37	$13.9	$1.14	$2.49	$7.25	19.6	6.4	2.9	3.14
The Learning Co.	920428	$0.27	$16.1	$1.78	$3.23	$11.25	41.7	6.3	3.5	3.84
Walker Interactive System[a]	920325	$0.32	$44.7	$2.03	$3.74	$16.50	51.6	8.1	4.4	4.26
Bachman Info Systems[a]	911126	$0.21	$34.6	$1.81	$4.32	$10.00	47.6	5.5	2.3	2.22
Broderbund Software[a]	911125	$0.75	$55.8	$3.52	$3.52	$19.75	26.3	5.6	5.6	3.22
IMRS[a]	911025	$0.46	$34.3	$0.55	$2.89	$16.75	36.4	30.5	5.8	4.00
Sybase[a]	910813	$0.27	$131.8	$2.16	$3.56	$29.75	110.2	13.8	8.4	4.08
Median ratio							47.6	8.1	5.6	4.00

[a]Denotes the five comparables with the closest sales. The median ratios are based upon these five firms.

Table 3
Distribution of multiples for IPOs from 1992 to 1993 and their comparable firms using recent IPOs, and prediction errors

IPOs and their comparable firms are restricted to firms with positive preissue book value of equity and positive earnings, where earnings are measured for the most recent 12 months prior to going public. There are 190 IPOs with at least one prior IPO (on the filing date) in the same four-digit SIC code with positive EPS during the 12 months before it went public to use as a comparable. If there are more than five qualifying IPOs to use as comparables, we use the five IPOs with the closest sales. Price–earnings (P/E), postissue market-to-book (M/B), and price-sales (P/S) ratios are calculated using the offer price for the IPOs, and the market prices on the day before issuing for the comparable firms. In calculating the median P/E, M/B, and P/S ratios for the comparable firms, if there is an even number of firms, we use the midpoint of the adjacent ratios. All M/B and P/S ratios above 10 are set equal to 10 and all P/E ratios above 100 are set equal to 100. The means of the IPO distributions are lower than those reported in Panel B of Table 1 because the means in this table are computed after the aforementioned adjustments of extreme values have occurred. The prediction error is measured as the natural logarithm of the median comparables multiple minus the natural logarithm of the IPO multiple. The absolute prediction error is the absolute value of the prediction error. The percentage of predicted valuations within 15% of the actual multiple is computed as $|\log(\text{predicted}) - \log(\text{actual})| < 0.15$. For these last calculations, the IPO multiples are calculated using both the offer price (OP) and the first closing market price (P_{market}).

Panel A: Distribution of multiples

	IPOs				Comparable firms medians			
	Mean	Percentile of distribution			Mean	Percentile of distribution		
		25th	50th	75th		25th	50th	75th
P/E	32.6	15.3	24.0	42.5	39.9	20.1	31.6	55.6
M/B	3.3	2.3	3.0	4.0	4.6	2.7	4.0	5.8
P/S	2.7	1.2	2.1	3.6	3.2	1.5	2.7	4.1

Panel B: Prediction errors

	Prediction error		Absolute prediction error		Percentage of predicted valuations within 15% of actual multiple using	
	Mean (%)	Median (%)	Mean (%)	Median (%)	OP (%)	P_{market} (%)
P/E	21.7	32.8	68.6	55.9	12.1	11.1
M/B	26.2	26.4	50.3	41.2	21.6	21.6
P/S	16.3	10.5	69.4	51.2	16.2	12.0

Table 4
OLS regressions with IPO multiples as the dependent variables using comparable firm multiples as explanatory variables

The sample contains 190 IPOs from 1992–1993 with at least one IPO from the previous 12 months in the same (four-digit SIC) industry and meeting the selection criteria listed in Table 1. The median price/earnings (P/E), price/sales (P/S), and postissue market-to-book (M/B) ratios of other IPOs in the same industry that went public during the prior 12 months are used for issuing firm i. No more than five firms are used to calculate the median; if more than five recent IPOs qualify, we use the five firms with the closest 12-month revenues as the comparables. For both the issuer and the comparable firms, earnings per share is defined as the EPS in the 12 months prior to going public, and book value per share is defined as the postissue BPS. For the percentage of valuations within 15% of the actual multiples, OP is the offer price and P_{market} is the first closing market price. The prediction errors are measured as the natural log of the ratio of the predicted multiple to the actual multiple, using the regression for the prediction; t-statistics are in parentheses.

$$P/E_i = a_0 + a_1 P/E_{\text{comp},i} + e_i$$

$$M/B_i = a_0 + a_1 M/B_{\text{comp},i} + e_i$$

$$P/S_i = a_0 + a_1 P/S_{\text{comp},i} + e_i$$

Dependent Variable	Coefficient estimates		R^2_{adj} (%)	Absolute prediction errors		Percentage within 15% of actual multiple using	
	a_0	a_1		Mean (%)	Median (%)	OP (%)	P_{market} (%)
(1) P/E	24.07 (7.79)	0.216 (3.30)	5.0	56.5	49.9	14.2	17.4
(2) M/B	2.61 (10.81)	0.168 (3.64)	6.1	33.1	30.6	27.4	22.1
(3) P/S	1.87 (6.84)	0.275 (4.02)	8.4	62.4	51.5	13.2	12.0

February 11, 1991 to February 10, 1992.) Inspection of Table 3 shows that the comparable firms multiples are typically higher than the multiples for the firms going public, partly because we are using market prices for the comparable firms and offer prices for the IPOs. Because of the short-run underpricing phenomenon (the average first-day return in our sample is 12%), we would expect the IPO multiples to be discounted by about 12%.

In the bottom panel of Table 3, we report mean and median prediction errors and absolute prediction errors for our three different valuation multiples. Prediction errors are measured as the natural logarithm of the ratio of the median comparable firms multiple divided by the IPO multiple, the metric used by Kaplan and Ruback (1995). (Note that log(predicted/actual) = log(pre-

dicted) − log(actual)). Reflecting the IPO underpricing phenomenon, the mean and median prediction errors are positive. We also report the percentage of predicted valuations within 15% of the actual multiple. For the IPOs, we calculate the multiples using both the offer price and the first closing market price. The percentage of valuations within 15% of the actual is relatively insensitive to which price is used in the calculation. Using any of the measures in Table 3, the valuation accuracy is less than in Kaplan and Ruback, in which more mature firms are valued.

4.3. Regression results using the comparable firms approach

Table 4 reports the results from regressions using price-to-earnings, market-to-book, and price-to-sales as the dependent variables. In none of the three regressions is the adjusted R^2 above 8%. For all three rows, the null hypothesis is that the slope coefficient should be unity. In other words, IPOs with high comparable firms multiples should have their earnings, book value, or sales capitalized at a higher rate than those of other IPOs. Yet the empirical relation is tenuous: in Row (1), where P/E multiples are used, the coefficient estimate is a meager 0.216. In Row (2), where M/B multiples are used, the slope coefficient is also far below unity, at 0.168. In Row (3), where P/S multiples are used, the slope coefficient is 0.275. Furthermore, in unreported results, if E/P and B/M ratios are used to reduce the effect of outliers, the slope coefficients and R^2s remain quite low.

One reason that the slope coefficients are below one is errors in the variable bias. If the explanatory variable is measured with error (reported accounting earnings are noisy estimators of true economic earnings), the estimated slope coefficient a_1 has an expected value of $\alpha_1/(1 + \sigma_e^2/\sigma_x^2)$, where α_1 is the true slope coefficient, σ_e = the standard deviation of the measurement error, and σ_x = the standard deviation of the true explanatory variable.

The relatively low explanatory power of the regressions in Table 4 is disconcerting, but in another sense it would be troubling if it was too good. The functional fixation hypothesis asserts that the market mechanically capitalizes reported EPS numbers, without adjusting for the quality and/or persistence of the earnings. The modest explanatory power is inconsistent with the functional fixation hypothesis. Independent evidence from Friedlan (1994) and Teoh et al. (1998a,b), however, suggests that the market does not fully incorporate the information content of discretionary accruals in valuing new issues, a result which is consistent with the functional fixation hypothesis.

Table 4 also reports the mean and median absolute prediction errors and the percentage of predicted multiples within 15% of the IPO multiple. We report the percentage within 15% using IPO multiples calculated using both the offer price and the first closing market price. In no case are more than 27% of the predictions within 15% of the actual multiples, which is consistent with the

relatively low R^2s in the regressions. For comparison, Kaplan and Ruback (1995; see Table 2) report that 37–47% of their logged valuations using comparable firm multiples are within 15% of the actual logged valuations for their sample of highly leveraged transactions. Gilson et al. (1998) report that 21–27% of their logged valuations of bankrupt firms are within 15% of the realized logged values when the firms emerge from Chapter 11.

The percentage of valuations within 15% of the actual multiples reported in Table 4, where a regression approach is used, is of the same order of magnitude of the percentages reported in Table 3, where a simple multiples approach is used. This is partly a manifestation of the fact that the distribution of predictions is fairly diffuse, but it also suggests that the common industry practice of using the simple multiples approach rather than a regression approach is justified.

Of the three multiples used, the valuation accuracy is highest with market-to-book ratios, where the mean absolute prediction error is only 33%, considerably below the numbers for P/E and price-to-sales ratios. This is not too surprising, however, because the post-issue market-to-book ratio includes the proceeds of the offering in both the numerator and denominator. Because of this endogeneity, we do not use market-to-book ratios in any further work.

In sum, the performance of the comparable firms approach is surprisingly weak. What can we infer from the results of the comparable firms approach? First, the historical earnings of IPOs may be very transitory in nature and as a result they have little value relevance.[3] The weak results from the comparable firms approach suggest that the market multiples using past data (historical earnings, sales, and post-issue book value) have an intrinsic limitation, since accounting data for a young firm may not reflect expectations of the firm's future performance. Second, using comparable firm multiples without further adjustments for differences in profitability and growth may ignore too much relevant information. Third, the comparable firms may have been chosen inappropriately. In Section 5 below, we address all three of these potential weaknesses.

4.4. The relative importance of multiples at different stages of the offering

To examine the role of accounting information at each stage of the IPO pricing, we use three separate prices to compute the market value of equity. The first is the preliminary offer price (POP), defined as the midpoint of the minimum and maximum offer prices from the preliminary prospectus. The second is the final offer price (OP). The third is the first market price (P_{market}), measured by the closing bid or transaction price.

[3] Lang (1991) examines the capitalization of earnings on IPOs by focusing on the earnings response coefficients for the earnings announcements in the quarters after the offering.

It is common for the preliminary offer price range to be adjusted before a final offer price is set. Underwriters usually contact potential buyers, get information about the market demand, and try to augment the demand through the road show. This additional information affects the final offer price, which may or may not be within the preliminary offer price range. It is unlikely that the historical accounting data of the IPO or its comparable firms' market multiples subsumes this incremental information. Market multiples calculated using the preliminary offer price are therefore likely to have smaller percentage absolute valuation errors than are multiples calculated using the final offer price. Using similar logic, we expect that multiples using the final offer price will have lower absolute valuation errors than those using the first market price. Thus, the following relation is expected to hold:

$$\mathrm{AVE}_{\mathrm{POP}} < \mathrm{AVE}_{\mathrm{OP}} < \mathrm{AVE}_{\mathrm{market}}, \tag{4}$$

where $\mathrm{AVE}_{\mathrm{POP}}$ = the average absolute valuation error obtained from Eq. (1) with POP used in the dependent variable, where AVE = |log(predicted multiple, using the regression) − log(actual multiple)|, where logs are natural logarithms; $\mathrm{AVE}_{\mathrm{OP}}$ = average absolute valuation error obtained from the regression with OP used in the dependent variable; and $\mathrm{AVE}_{\mathrm{market}}$ = average absolute valuation error obtained from the regression with P_{market} used in the dependent variable.

Table 5 reports results from OLS estimation of the comparables model using P/E ratios. Consistent with expectations, Table 5 shows a pattern of increasing absolute valuation errors as the market value is calculated using POP, OP, and P_{market}. It should be noted, however, that the valuation errors are large for all specifications.

5. Valuation using earnings forecasts and comparables from Renaissance Capital

Up to now, we have used a mechanical algorithm for choosing comparable firms. Clearly, one can do a better job at picking comparable firms than by just using recent IPOs with the same SIC codes. Earlier, we argued that investment bankers or analysts can be tempted to choose comparables to either justify a given valuation ex post or to make their valuation of an IPO look conservative. An alternative source for comparables is the research reports prepared by Renaissance Capital of Greenwich, Connecticut. Renaissance Capital is a 'boutique' firm specializing in IPO research for 'buy-side' clients. Its web site is at http://www.ipo-fund.com.

5.1. Renaissance Capital

Renaissance Capital produces a one-page research report on most IPOs with an expected market capitalization of over $50 million, in which the company

Table 5
OLS regressions calculating P/E ratios using the preliminary offer price, the final offer price, and the first closing market price

Earnings are for the most recent 12 months reported in the prospectus, as recorded by Securities Data Company (SDC). SDC records the earnings per share (EPS) numbers reported in the prospectus summary financial statements, which is usually earnings after extraordinary items (and not pro forma). The sample IPOs are from 1992–1993 and meet the following sample selection criteria: proceeds of at least \$5.0 million and an offer price of at least \$5.00 per share, with trailing 12-month EPS and preissue book value of equity greater than zero. ADRs, reverse LBOs, unit offerings, total divestitures of subsidiaries, and IPOs of financial corporations (SIC = 6) are excluded. The three alternative price/earnings (P/E) ratios are calculated using the preliminary offer price (POP), computed as the mean of the filing price range; the final offer price (OP); and the first closing market price (P_{market}). The $P/E_{\text{comp},i}$ is the median P/E of the comparable firms for IPO i. For the regressions using the preliminary offer price, P/E_{comp} is computed using the market prices of comparable firms on the day prior to the filing date. For the regressions using the offer price and the first market price, we compute P/E_{comp} using the market prices of comparable firms on the day prior to the offer date. We use IPOs from the same industry during the prior 12 months as comparables. The prediction errors are measured as the natural log of the ratio of the predicted multiple to the actual multiple, using the regression for the prediction. The percentage of predictions within 15% of the actual is measured two ways: using the regression prediction ('Regression'), and using a simple multiples approach ('Simple'). The simple multiples approach uses the geometric mean of the comparables' multiple as the forecast, which is equivalent to a zero intercept and slope of 1 in the regression. The standard deviation of the mean absolute prediction error is 2.53% in Row (1), 2.82% in Row (2), and 3.22% in Row (3). The mean prediction error is significantly higher (at the 1% level) in Row (3) than in Row (2), which in turn is significantly higher (at the 5% level) than in Row (1), assuming independence and normality of the observations; t-statistics are in parentheses.

$$P/E_i = a_0 + a_1 P/E_{\text{comp},i} + e_i$$

P/E Calculated using	Parameter estimates		R^2_{adj} (%)	Absolute prediction error		Percentage within 15%		N
	Intercept	P/E		Mean (%)	Median (%)	Regression (%)	Simple (%)	
(1) POP	25.47 (9.32)	0.126 (2.24)	2.1%	51.2%	43.6%	14.7%	12.6%	190
(2) OP	24.07 (7.79)	0.216 (3.30)	5.0%	56.5%	49.9%	14.2%	17.4%	190
(3) P_{market}	28.09 (7.66)	0.252 (3.24)	4.8%	64.2%	58.0%	10.5%	12.6%	190

lists the 'street' estimate (i.e., the consensus earnings forecast) for current fiscal year and next year EPS, as well as the latest 12 months' EPS numbers, for the IPO and two comparable firms. These research reports are typically produced immediately after the preliminary prospectus is issued and faxed to clients.

Renaissance Capital uses this information to calculate three P/E ratios (using the midpoint of the preliminary offer price range (POP) for the IPO) using the last 12 months, current fiscal year's forecast, and next year's forecast, of EPS. Renaissance Capital also calculates these three P/E ratios for each of the two comparable firms, using the closing market price of the stock on the day before the report is issued.

Frequently, Renaissance Capital chooses its comparables based upon firms mentioned in the prospectus as the major competitors of the firm going public. In choosing comparable firms, Renaissance Capital does not restrict itself to companies with the same SIC codes. For example, for the November 1993 IPO of Gateway 2000 (a direct marketer of PCs assembled from purchased components), it chose Dell Computer (another direct marketer of PCs) and AST Research (a PC manufacturer, although not a direct marketer). Gateway 2000 had an SIC code of 596 (nonstore retailers), while both Dell Computer and AST Research have SIC codes of 357 (office and computing machines manufacturing). All three firms had 12-month sales of \$1.5 to \$2.6 billion.

To examine whether our valuation accuracy can be improved by incorporating better comparables, earnings forecasts, and adjustments reflecting differences in profitability and growth, we use a subsample of 143 IPOs from September 1992 to December 1993 for which evaluations are available from Renaissance Capital, and for which we have comparable firm multiples for other firms in the industry from Compustat. We start in September 1992 because Renaissance Capital did not begin operations until mid-1992. During this sample period, the Dow Jones average was below 4000. Since we exclude IPOs with negative trailing earnings, negative pre-issue book value, or small expected market capitalization, or where there are no Compustat-listed firms in the same industry, this sample is tilted towards IPOs for which the comparable firms methodology should work best.

5.2. *Valuations using forecasted earnings, and for young and old firms*

While historical earnings contained in the prospectus are available to all market participants, practitioners also frequently use earnings forecasts for valuation purposes. To examine the degree to which forecasted earnings, on both the IPOs and their comparables, can be used for valuation purposes, in Table 6 we use the geometric mean of the Renaissance Capital comparable firm P/E multiples as the explanatory variable in regressions using the three P/E ratios of the IPOs as dependent variables. When one of the comparable firms has a negative EPS, we use the other comparable's P/E ratio exclusively. We constrain all IPO and comparable firm midpoint P/E ratios to be no greater than 100. The geometric mean of, for example, ratios of 4 and 46 is the square root of the product of 4 times 46, or 13.56. The geometric mean is used because it puts less weight on extreme values than using the midpoint of two ratios.

Table 6
OLS Regressions with P/E as the dependent variable and comparable firm P/Es as the explanatory variable using EPS forecasts and comparable firms from Renaissance Capital

The sample contains 143 IPOs from September 1992 to December 1993 with positive trailing 12-month earnings and a research report from Renaissance Capital containing earnings per share (EPS) forecasts. The EPS numbers used are, respectively, positive trailing 12-month earnings, and mean street EPS forecasts for the current fiscal year and the next fiscal year. In general Renaissance Capital does not cover small IPOs for which there is little institutional interest. The mean gross proceeds of the sample is \$45.4 million, with a range of \$11.3 million to \$299.3 million, exclusive of overallotment options. All reverse leveraged buyouts are excluded. The P/Es for each IPO are calculated using the offer price, while the P/Es for each comparable are calculated using the market price at the time of the Renaissance Capital research report (typically shortly after the preliminary prospectus is issued). For each IPO, two comparable firms are used, with the P/E_{comp} calculated as the geometric mean of the two P/Es. If one of the comparables has a negative EPS, the P/E_{comp} is equal to the other comparable's P/E. All IPO ratios, and the mean of the comparables' ratios, are capped at 100. $\text{Dummy}_{\text{fastgrowth}}$ is a 0, 1 dummy variable taking on the value one if the sales growth rate of the IPO during the prior year is higher than the midpoint of the sales growth rates for the two comparable firms. Rows (8) and (9) divide the sample on the basis of whether the firm going public was founded in 1982 or earlier (old firms) or in 1983 or later (young firms). The mean P/E_{comp} is 32.7 for the 12-month historical EPS, 24.2 for the current year forecast EPS, and 16.8 for the next year forecast EPS. The prediction errors are measured as the natural log of the ratio of the predicted multiple to the actual multiple. We measure the percentage of predictions within 15% of the actual in two ways: using the regression prediction and using a simple multiples approach. The simple multiples approach uses the geometric mean of the comparables' multiple as the forecast, which is equivalent to a zero intercept and slope of one in the regression. In Rows (5)–(7), the dummy variable term is also added on; t-statistics are in parentheses.

$$\left(\frac{P}{E}\right)_i = a_0 + a_1\left(\frac{P}{E}\right)_{\text{comp},i} + a_2\,\text{DUMMY}_{\text{fastgrowth},i} + e_i$$

EPS used	Parameter estimates			R^2_{adj} (%)	Absolute prediction errors		Percentage within 15%		N
	Intercept	PE_{comp}	$D_{\text{fastgrowth}}$		Mean (%)	Median (%)	Regression (%)	Simple (%)	
(1) 12-month historical	22.71 (6.23)	0.343 (3.71)	–	8.3	55.0	52.1	15.4	18.9	140
(2) Current year forecast	13.93 (4.59)	0.412 (3.71)	–	8.3	43.7	40.1	18.9	27.3	143

(3)	Next year forecast	7.30 (4.93)	0.478 (5.84)	–	18.9	28.5	22.2	36.4	28.0	142
(4)	12-month historical using comparables chosen by SIC codes	19.10 (2.83)	0.678 (2.32)	–	3.0	59.5	59.6	11.2	15.4	143
(5)	12-month historical	17.30 (3.74)	0.367 (3.97)	7.80 (1.88)	9.9	52.4	48.5	21.0	18.2	140
(6)	Current year forecast	11.51 (3.06)	0.433 (3.85)	3.20 (1.09)	8.4	42.9	38.2	19.6	21.0	143
(7)	Next year forecast	5.97 (3.48)	0.496 (6.03)	1.72 (1.53)	19.7	28.4	21.7	37.8	25.2	142
(8)	Next year forecast (young firms)	8.09 (3.08)	0.537 (3.63)	–	14.6	31.9	26.2	29.2	25.0	72
(9)	Next year forecast (old firms)	6.00 (4.74)	0.449 (6.56)	–	37.5	23.0	18.8	40.8	31.0	71

Comparing the regressions using, respectively, historical earnings, the current year's forecasted earnings, and the next year's forecasted earnings, the average absolute prediction errors fall from 55.0% to 43.7% to only 28.5%, and the percentage of firms that are valued within 15% of the actual multiple increases. Thus, as expected for these predominately young firms, forecasted earnings work better than historical earnings. It should be noted, however, that the 'street' earnings forecasts for the IPOs are typically provided by analysts who are affiliated with investment bankers, so there may be a conflict of interest. Nonetheless, the slope coefficients, while significantly above zero, are all significantly below 1.0, the value that would be predicted if the implementation of the comparable firms approach worked perfectly.

For comparison, we also report regression results using the median P/E ratio of comparable firms in the same industry listed on Compustat for the 143 IPOs in this subsample. The Renaissance Capital comparables do a slightly better job at explaining the cross-sectional dispersion of IPO P/E ratios than comparables chosen using SIC codes do. This suggests that the main source of better predictions is from using earnings forecasts, rather than from picking more appropriate comparable firms.

One reason that the R^2s are below 100% and the slope coefficients are below 1.0 in Table 6 is that the comparable firms have different growth rates than the IPOs. The standard growing perpetuity valuation model (assuming a 100% payout rate),

$$P_0 = \frac{\mathrm{EPS}_1}{r - g}, \tag{5}$$

where r is the required return and g is the growth rate of earnings, would predict that firms with more rapid growth rates should have higher P/E ratios. In Rows (5)–(7) of Table 6, we add a dummy variable, which takes on the value 1 if the sales growth rate of the IPO is higher than the midpoint of the sales growth rates of the comparable firms. The prediction is that this dummy variable should be positive if the earnings of fast-growing firms are capitalized at higher multiples. Inspection of these three rows shows that this dummy variable has the predicted sign, but is not significant at conventional levels. Alternative specifications, such as the difference in logarithms of the sales growth rates, or using an interactive term in which the dummy variable is multiplied by the comparables' P/E, yield qualitatively similar results. One possible reason that differences in growth rates have such modest explanatory power is that the rapidly growing firms going public may be viewed by the market as having a higher transitory component in their earnings. In other words, a lower 'quality' of earnings may partly offset differences in growth rates.

In Rows (8) and (9), we segment the sample on the basis of the age of the issuer at the time of its IPO. The presumption is that older firms will be easier to value,

since more of their value is represented by capitalized earnings than by expectations about future growth rates, which can vary substantially from firm to firm. Consistent with this presumption, the mean absolute prediction error for firms that are less than ten years old at the time they go public is higher than that for older firms: 31.9% for young firms in Row (8), versus 23.0% for older firms in Row (9).

5.3. Valuations using multiples that are invariant to leverage

Renaissance Capital does not use M/B ratios in its comparable firms analysis. Linda Killian, a co-founder of the firm, told us that they feel that the arbitrariness of book values (and the large change from before the issue to after) makes M/B ratios poor valuation metrics. Renaissance Capital does, however, calculate several other multiples, including price-to-sales and enterprise value to operating cash flow, where enterprise value = market value of equity + book value of debt − cash. Enterprise value is analogous to total firm value, but is neutral with respect to the cash raised in an equity offering. The proceeds of an equity offering would boost the market value of equity, but if the proceeds are retained as cash, these two effects cancel each other out. Operating cash flow (also known as EBITDA, earnings before interest, taxes, depreciation and amortization) is not affected by leverage, so enterprise value/operating cash flow permits comparisons between firms with different degrees of leverage. Using the enterprise value that Renaissance Capital computes, we also compute the ratio of enterprise value-to-sales, using the last twelve month sales. In making these computations, we calculate the market value of equity for the firm going public using the midpoint of the file price range, and other *pro forma* (as adjusted for the proceeds of the offering) values are used. Comparable firms' values are computed using accounting information and the market price at the time the IPO is valued (immediately after the dissemination of the preliminary prospectus).

In Table 7, we report regression results using market value-to-sales, enterprise value-to-sales, and enterprise value-to-operating cash flow ratios. The dependent variable is the ratio for the IPOs, and the chief explanatory variable is the geometric mean of the ratios for the two comparable firms used by Renaissance Capital. As in Table 6, we report regression results for the entire sample of 143 IPOs covered by Renaissance Capital and, in some specifications, we include a dummy variable taking on the value of one if the sales of the IPO are growing faster than the midpoint of the comparable firms' growth rates, interacted with the comparable firm multiple. The advantage of this interactive approach is that the slope coefficient can be interpreted as a percentage shift (after multiplying by 100%). With an additive term, as we use in Table 6, we are implicitly assuming that the absolute increase in a multiple should be as large for a firm in an industry with low multiples as in an industry with high multiples.

Table 7
OLS regressions using the multiples of comparable firms chosen by Renaissance Capital

Enterprise value (EV) is defined as the market value (MV) of equity (using the *pro forma* number of shares and the midpoint of the filing price range) plus the *pro forma* book value of debt, minus *pro forma* cash. Sales are the last 12 months sales. For all three panels, the comparable firms' multiple is computed as the geometric mean of the multiples for the two comparable firms used by Renaissance Capital, with the market value computed as of the time of the analysis (after the preliminary prospectus is issued). Operating cash flow (OCF) is defined as EBITDA for the last 12 months. The dummy variable, which is interacted with the comparable firms' multiple, takes on a value of 1 if the percentage increase in sales in the prior year of the IPO is higher than the midpoint of the percentage increase in sales for each of the two comparable firms, and zero otherwise. The sample contains 143 IPOs from September 1992 to December 1993 meeting certain criteria described in Table 6. Young firms are those founded in 1983 or later. IPO market values are computed using the preliminary offer price. The mean MV/Sales ratio is 2.2, the mean EV/Sales ratio is 2.1, and the mean EV/OCF ratio is 13.7. The percentage of predicted valuations within 15% of the actual multiple is based on the log ratio of predicted to actual multiples. Absolute prediction errors are the absolute values of these prediction errors; *t*-statistics are in parentheses.

	Parameter estimates			R^2_{adj} (%)	Absolute Prediction errors		Percentage within 15%		N
	Intercept	Comparable firms multiple	$D_{fastgrowth}$ • multiple		Mean (%)	Median (%)	Regression (%)	Simple (%)	
Panel A: $\frac{MV}{Sales}i = a_0 + a_1\frac{\overline{MV}}{Sales}i + a_2 DUMMY_{fastgrowth} \bullet \frac{\overline{MV}}{Sales}i + e_i$									
(1)	1.35	0.366	—	26.2	56.0	46.3	13.3	20.3	143
	(7.96)	(7.18)							
(2)	1.29	0.327	0.122	27.1	54.6	44.0	15.4	18.9	143
	(7.48)	(5.84)	(1.65)						
(3) Young	1.61	0.326	—	24.6	52.4	48.0	19.4	27.8	72
	(4.77)	(4.91)							
(4) Old	1.11	0.407	—	24.6	56.3	44.9	21.1	12.7	71
	(4.75)	(4.89)							

Panel B: $\frac{\text{EV}}{\text{Sales}}i = a_0 + a_1\frac{\overline{\text{EV}}}{\text{Sales}}i + a_2\text{DUMMY}_{\text{fastgrowth}} \bullet \frac{\overline{\text{EV}}}{\text{Sales}}i + e_i$

(5)	1.10	0.432	—	35.2	52.8	42.6	16.1	20.3	143
	(7.08)	(8.83)							
(6)	1.05	0.397	0.110	35.9	52.1	41.8	13.3	22.4	143
	(6.65)	(7.42)	(1.60)						
(7) Young	1.38	0.381	—	31.1	50.4	41.0	18.1	20.8	72
	(5.78)	(5.75)							
(8) Old	0.82	0.497	—	37.6	51.6	42.1	18.3	19.7	71
	(4.08)	(6.57)							

Panel C: $\frac{\text{EV}}{\text{OCF}}i = a_0 + a_1\frac{\overline{\text{EV}}}{\text{OCF}}i + a_2\,\text{DUMMY}_{\text{fastgrowth}} \bullet \frac{\overline{\text{EV}}}{\text{OCF}}i + e_i$

(9)	11.18	0.180	—	4.7	43.2	37.5	20.3	25.2	143
	(9.62)	(2.82)							
(10)	9.77	0.153	0.249	8.9	41.6	34.1	21.7	23.8	143
	(7.83)	(2.42)	(2.74)						
(11) Young	15.55	0.086	—	− 0.2	48.2	42.7	18.1	20.8	72
	(8.36)	(0.93)							
(12) Old	5.88	0.349	—	32.9	28.2	18.3	38.0	29.6	71
	(6.22)	(5.95)							

Using price-to-sales ratios, Panel A of Table 7 shows that the average absolute prediction error is of the same order of magnitude as when historical earnings were used in Table 6. When the dependent variable is changed to deleverage firms (enterprise value-to-sales) in Panel B, the average absolute prediction errors drops a bit. In Panel C, where enterprise value-to-operating cash flow ratios are used, the valuation accuracy improves to about the same level as when P/E ratios using current year earnings forecasts are used. Not surprisingly, the enterprise value-to-operating cash flow ratio works substantially better for older than younger firms.

Finally, using enterprise value-to-sales ratios, in Table 8 we report regression results that adjust for differences in cash flow per dollar of sales as well as growth rates, with both of these variables interacted with the comparable firms multiple. As a measure of differences in profitability, we use the logarithm of the ratio of operating cash flow per dollar of sales for the IPO relative to its comparable firms, interacted with the enterprise value-to-sales multiple. In Row (2), the coefficient of 0.218, with an associated t-statistic of 4.18, indicates that adjusting for differing levels of profitability is important. This coefficient suggests that a 20% premium for firms that are twice as profitable as average is warranted. The sales growth rate dummy variable, interacted with the enterprise value-to-sales multiple, has a coefficient of 0.199. This suggests that a 20% premium for fast-growing firms going public is also warranted. These results are consistent with industry practice of starting with comparable firm multiples and adding (or subtracting) 10–20% adjustments for differences in profitability or differences in growth. When we split the IPOs into young and old firms, we achieve greater valuation accuracy for older firms. Not surprisingly, for older firms profitability differences are very important and sales growth rate differences are unimportant. Still, the valuation accuracy as measured by average absolute prediction errors is not as good as when the next year's earnings forecasts are used in Table 6.

As yet another measure of the valuation accuracy implied by our regression results, equation of Table 8 can be used to predict an enterprise value-to-sales ratio for each IPO. We can then use this ratio to come up with a predicted offer price, which can be compared with the actual first closing market price. Doing this, in unreported calculations, the median absolute prediction error, calculated as $|P_{\text{market}} - P_{\text{predicted}}|$, is \$6.85 per share. This compares with a median absolute prediction error of \$2.50 between the market price and the midpoint of the file price range, and a median absolute prediction error of \$1.50 between the market price and the final offer price. These numbers are consistent with our assertion that investment bankers add value in pricing new issues. (All three of the above numbers change by no more than a dime if an adjustment is made to account for the short-run underpricing phenomenon.)

Table 8
OLS regressions with enterprise value to sales as the dependent variable with adjustments for relative profitability and growth rates

Enterprise value is defined as the market value of equity (using the *pro forma* (post-issue) number of shares and the midpoint of the filing price range) plus the *pro forma* book value of debt, minus *pro forma* cash. Sales is the last 12 months sales. The comparable firms multiple is the geometric mean of the enterprise value (EV) to sales multiples for the two comparable firms used by Renaissance Capital, with the market value computed at the time of the Renaissance Capital research report (after the preliminary prospectus is issued). The cash flow ratio (PROFITABILITY) is defined as the natural logarithm of (the operating cash flow to sales ratio for the IPO divided by the geometric mean of this ratio for the two comparable firms). The dummy variable takes on a value of 1 if the percentage increase in sales in the prior year of the IPO is higher than the midpoint of the percentage increase in sales for each of the two comparable firms, and zero otherwise. The sample contains 143 IPOs from September 1992 to December 1993 with an expected (based upon the preliminary prospectus) market valuation of equity of at least $50 million and positive trailing last 12 months earnings. Young firms are those founded in 1983 or later. The percentage of predicted valuations within 15% of the actual multiple is based on the log ratio of the predicted to actual multiples. The Regression predictions are from using the predicted values from the regressions. The Simple predictions are computed by using the geometric mean of the comparables' multiple with the interaction term or terms added, which is equivalent to a zero intercept and slope of one on the comparable firms multiple in the regression, with the other slope coefficients unchanged.

$$\frac{\mathrm{EV}}{\mathrm{Sales}}i = a_0 + a_1\frac{\overline{\mathrm{EV}}}{\mathrm{Sales}}i + a_2\,\mathrm{PROFITABILITY} \bullet \frac{\overline{\mathrm{EV}}}{\mathrm{Sales}}i + a_3\,\mathrm{DUMMY}_{\mathrm{fastgrowth},} \bullet \frac{\overline{\mathrm{EV}}}{\mathrm{Sales}}i + e_i$$

		Parameter estimates				R^2_{adj} (%)	Absolute prediction error		Percentage within 15%		N
		Intercept	Comparable firms multiple	Profitability •multiple	$D_{\mathrm{fastgrowth}}$ •multiple		Mean (%)	Median (%)	Regression (%)	Simple (%)	
(1)		1.12 (7.47)	0.440 (9.31)	0.171 (3.37)	—	39.6	50.3	40.4	18.2	21.0	143
(2)		1.03 (6.93)	0.378 (7.46)	0.218 (4.18)	0.199 (2.90)	42.6	48.8	40.1	18.9	25.9	143
(3)	Young	1.28 (5.30)	0.317 (4.63)	0.176 (2.71)	0.233 (2.29)	37.2	48.5	42.2	18.1	19.4	72
(4)	Old	0.58 (3.65)	0.607 (8.75)	0.726 (7.00)	− 0.022 (− 0.27)	63.0	38.2	31.9	25.4	26.8	71

6. Conclusions

This paper examines the pricing of IPOs using comparable firm multiples, a procedure that is widely recommended by academics and practitioners and is standard practice in IPO valuation case studies used in business schools. We find that valuing IPOs on the basis of the price-to-earnings, price-to-sales, enterprise value-to-sales, and enterprise value-to-operating cash flow ratios of comparable firms is of only limited use if historical numbers rather than forecasts are used. Within an industry, the variation in these ratios is so large, both for public firms and IPOs, that they have only modest predictive value. Many idiosyncratic factors are not captured by industry multiples unless various adjustments for differences in growth and profitability are made. Using earnings forecasts improves the valuation accuracy substantially. The valuation accuracy is higher for older firms than for young firms.

Using historical accounting information and controlling for leverage effects, the enterprise value-to-sales ratio works reasonably well for both young and old firms. Additional adjustments that reflect differences in sales growth rates and differences in profitability per dollar of sales improve the fits even more. This is consistent with the industry practice of starting with an industry multiple and adding or subtracting adjustments of 10–20% to reflect differences in growth rates, profitability, quality of earnings, etc.

The difficulty of using comparable firm multiples for valuing IPOs, without further adjustments, leaves a large role for investment bankers in valuing IPOs. Because using the midpoint of the offer price range results in smaller prediction errors than using comparables, investment bankers apparently are able to do superior fundamental analysis. In addition, investment bankers are able to achieve additional valuation accuracy by canvassing market demand before setting a final offer price. While much attention has been focused on the wide variation between the offer price and subsequent market prices that occurs in practice, our results suggest that the pricing precision would be much worse if a mechanical algorithm was used instead.

Finally, we should note that in this paper we use the same multiples for all industries. In practice, analysts place more weight on a given multiple for some industries than others. Taking this into account would probably show that comparable firm multiples result in more accurate valuations than our work suggests.

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