Multiples Used to Estimate Corporate Value

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We evaluated various multiples practitioners use to estimate company value. We found, first, that the asset multiple (market value to book value of assets) generally generates more precise and less biased estimates than do the sales and the earnings multiples. Second, although adjusting for companies' cash levels does not improve estimates of company value, using forecasted earnings rather than trailing earnings does. Third, the earnings before interest, taxes, depreciation, and amortization (EBITDA) multiple generally yields better estimates than does the EBIT multiple. Finally, the accuracy and bias of value estimates, as well as the relative performance of the multiples, vary greatly by company size, company profitability, and the extent of intangible value in the company.

The valuation of companies is a primary application of finance theory. The typical finance curriculum, therefore, devotes substantial time to this topic. The theoretical emphasis is usually on the discounted cash flow valuation (DCF) technique, but it is often cumbersome to use and is sensitive to a host of assumptions. Consequently, investment bankers and appraisers regularly use valuation by multiples, such as the P/E multiple, instead of or as a supplement to DCF analysis.

Despite the importance of valuation in a variety of contexts, surprisingly few studies have examined the accuracy of various valuation techniques. Alford (1992) studied the effect of the choice of matching (comparable) companies on valuation accuracy when the P/E multiple is used. Other studies, including Kaplan and Ruback (1995), Kim and Ritter (1999), and Gilson, Hotchkiss, and Ruback (2000) applied DCF and various multiples to value rather narrow subsets of companies, such as those that operate in bankruptcy or carry out initial public offerings (IPOs). To our knowledge, no study has explicitly examined the overall performance of different multiples. Indeed, Kaplan and Ruback suggested that "there is no obvious method to determine which measure of performance . . . is the most appropriate for comparison" (p. 1067). Similarly, Kim and Ritter stated that "there is no clear-cut answer for which multiples should be used" (p. 416). The purpose of the study reported here was to examine the bias and valuation accuracy of multiples based on earnings, sales, or book value of assets for several categories of companies.

Our research is relevant to practitioners, such as investment bankers and analysts, who use multiples to value companies, as well as to academic researchers. For instance, the stream of literature on the effect corporate diversification has on corporate value uses multiples to value individual segments of a company and then compares the estimated aggregate value with the market value to determine "excess value" created by diversification (Berger and Ofek 1995, 1996, 1999; Denis, Denis, and Sarin 1997). The results presented here may help such researchers choose multiples that minimize the potential bias embedded in the value measures, especially if the companies or company segments exhibit certain irregularities.

Related Literature

In theory, the valuation of a company is a straightforward matter accomplished via the DCF method. DCF analysis involves estimating the cash flows associated with the company and then discounting those cash flows by a discount rate commensurate with their risk level. Because accurately estimating the company's cash flows and choosing the appropriate discount rate are difficult, DCF analysis is often abandoned in favor of valuation by multiples. Valuation by multiples entails calculating particular multiples for a set of benchmark companies and then finding the implied value of the company of interest based on the benchmark multiples. Although many studies incorporate this approach,

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no multiple is uniformly accepted as the one on which to base valuation.

Alford used the P/E multiple to assess how the benchmark companies should be chosen. Using such criteria as industry, assets, return on equity, and combinations of these factors and a sample of 4,698 companies from 1978, 1982, and 1986, he examined seven potential sets of comparable companies. He found that choosing benchmark companies based on industry alone or in combination with ROE or total assets leads to the most accurate valuations and that the accuracy improves as the number of SIC digits used to define an industry is increased up to the third digit. Alford also found a positive relationship between company size and valuation accuracy. The median percentage errors in valuation ranged from 23.9 percent to 25.3 percent.

Kaplan and Ruback estimated valuations for a sample of highly leveraged transactions (HLTs) based on market value to EBITDA (earnings before interest, taxes, depreciation, and amortization). The benchmark multiples were the median multiples for companies in the same industry, companies that were involved in similar transactions, or companies in the same industry that were involved in similar transactions. For comparison, Kaplan and Ruback also computed valuations by using the DCF method. For their sample of 51 HLTs between 1983 and 1989, they found both the DCF and multiple methods to be useful valuation tools with similar levels of precision. Depending on the benchmark multiple used, 37–58 percent of the valuations fell within 15 percent of the actual HLT transaction value.

To evaluate the value created in acquisitions of bankrupt companies relative to nonbankrupt companies, Hotchkiss and Mooradian (1998) first used valuation by multiples to estimate the value of bankrupt companies. They then compared these values with the acquisition prices to determine the degree of discounting associated with the bankrupt companies. The multiples they applied were the ratios of enterprise value to sales and of enterprise value to assets, in which "enterprise value" was defined as the transaction price minus fees and expenses plus liabilities. They reported that bankrupt companies are acquired at discounts of 40–70 percent.

Kim and Ritter used several measures for the matching companies in the valuation of IPO companies.[1] The multiples used in their study were P/E, market value to book value, price to sales, enterprise value to sales, and enterprise value to EBITDA. Kim and Ritter found that all of these multiples yield positively biased estimates but that the EBITDA multiple results in the most precise valuation, particularly for the more established IPO companies. They also showed that valuations improve when forecasted earnings rather than historical earnings are used and when the comparable companies are chosen by a specialist research firm rather than a mechanical algorithm.

Gilson et al. compared the DCF valuation method and the use of multiples for valuation of companies emerging from bankruptcy. When they used EBITDA multiples based on the median of companies in the same industry, about 21 percent of the valuations fell within 15 percent of market values.[2] Although the value estimates generated by the earnings multipliers in the Gilson et al. study were generally unbiased, they exhibited a wide degree of dispersion. Gilson et al. suggested two primary causes of this dispersion. First, in comparing their findings with the earlier work of Kaplan and Ruback, the authors concluded that the HLT valuations are more precise than the bankruptcy valuations because of a greater degree of market involvement and, therefore, greater information availability in the case of HLTs. Second, the authors contended that valuation errors are greater when certain claimholders have incentives to incorrectly state company value so as to achieve better results from the bankruptcy process.

Data and Valuation Method

The companies in our analysis were all active (financial and nonfinancial) companies in the Compustat database at the time of the study. All of the financial data are from fiscal year 1998, whereas the earnings forecasts pertain to fiscal year 1999. The data were obtained from Standard & Poor's *Research Insight*, which includes data that are available in the conventional Compustat database as well as recent I/B/E/S earnings forecasts. Panel A of **Table 1** presents descriptive statistics for the 8,621 companies in the sample. The median company had a book value of assets of $136 million, sales of $92 million, and total enterprise value (i.e., book value of assets less book value of equity plus market value of equity) of $238 million. The median ratio of EBITDA to book value of assets was 0.077, and the median ratio of cash to book value of assets was 0.066. Note that the distributions for all of these financial characteristics are heavily skewed, as indicated by the large differences between the means and medians.

The Multiples. We estimated values on the basis of 10 multiples; the following 6 multiples were used unadjusted:

- P/E—price of the company's common equity at the end of the fiscal year scaled by earnings per share for the same year,[3]
- forecasted P/E—price of common equity scaled by the median forecast of next year's EPS from I/B/E/S,
- enterprise value/sales—enterprise value at the end of the fiscal year scaled by total revenues,
- enterprise value/book value—enterprise value scaled by book value of assets,
- enterprise value/EBITDA, and
- enterprise value/EBIT—enterprise value scaled by earnings before interest and taxes.

Unlike net income, both EBIT and EBITDA are independent of capital structure, so differences in capital structure among companies should not introduce bias when one is using the EBIT and EBITDA multiples to estimate total enterprise value. What is not clear is whether one should subtract depreciation and amortization from the earnings measure, which is why we examined two different earnings multiples.

In their estimation of total value, Kaplan and Ruback and Kim and Ritter subtracted the cash and cash equivalents, which makes sense for two reasons. First, cash and cash equivalents are easy to value because the book and market values should be identical, so multiples are not needed to value these assets. Second, excess cash can often be paid out to shareholders without affecting normal operations. Multiples based on earnings and sales will yield the same value regardless of the cash level, however, so companies with a great deal of cash will be undervalued relative to companies with little cash. Consequently, we also reestimated the multiples involving enterprise value after adjusting for the cash and cash equivalents:

- adjusted enterprise value/sales,
- adjusted enterprise value/adjusted book value,
- adjusted enterprise value/EBITDA, and
- adjusted enterprise value/EBIT.

Panel B of Table 1 provides summary statistics for the 10 multiples. Note that the median P/E multiple based on current earnings is 16.5, whereas the median based on forecasted earnings is 15.6. Similarly, the median ratio of total enterprise value to EBITDA is 12.9, whereas for EBIT, the median ratio is 18.3. The multiples based on book value of assets and sales are naturally much lower. The median value-to-sales ratio is 2.1, and the median market-to-book ratio is 1.3. The multiples that use values adjusted for cash levels differ slightly from the multiples that use unadjusted values, as expected. All of the means are greater than the

Table 1. Summary Statistics

Measure	Mean	Median	25th Percentile	75th Percentile
A. Descriptive statistics				
Book value of assets ($ million)	3,047	136	27	716
Sales ($ million)	1,259	92	19	449
Total enterprise value ($ million)	4,728	238	51	1,182
EBITDA/book value of assets	–0.008	0.077	–0.010	0.149
EBIT/book value of assets	–0.055	0.042	–0.052	0.102
Cash/book value of assets	0.163	0.066	0.019	0.222
B. Multiples used in later analyses				
P/E	31.1	16.5	11.9	25.4
Forecasted P/E	25.6	15.6	11.5	23.1
Value/sales	21.8	2.1	1.0	6.0
Value/book value	2.0	1.3	1.0	2.0
Value/EBITDA	28.3	12.9	9.0	25.2
Value/EBIT	54.3	18.3	12.7	35.8
Adjusted value/sales	19.6	1.8	0.9	5.4
Adjusted value/adjusted book value	3.3	1.3	1.0	2.3
Adjusted value/EBITDA	25.5	11.9	8.4	23.0
Adjusted value/EBIT	50.5	17.2	11.8	33.1

Note: Total enterprise value was estimated as total assets less book value of equity plus the product of price per common share and number of common shares outstanding. For the multiples in Panel B, "value" is total enterprise value, "adjusted value" is total enterprise value less cash and cash equivalents, and "adjusted book value" is book value less cash and cash equivalents.

medians, suggesting that the distributions of multiples are positively skewed.

Identification of Comparable Companies. Alford examined the effect of the choice of the companies to be used as matching companies and found that comparable companies chosen on the basis of industry yielded the smallest estimation errors when valuing companies by use of the P/E multiple. To minimize the estimation errors in our analysis, we thus chose matching companies on the basis of industry. In particular, for each company whose value we were trying to estimate, we identified all companies with the same three-digit primary SIC code with available data to estimate multiples. If fewer than five companies were identified, we relaxed the industry requirement to companies with the same two-digit SIC code, and then if necessary, to companies with the same one-digit SIC code.

To the extent that companies operate in several industries, our procedure for identifying matching companies is not optimal. Presumably, valuation accuracy could be improved if we could replicate a portfolio of each company's segments by using comparable companies from different industries. Although such replication can be done in practice, the procedure is impractical in a study such as ours because of the subjectivity involved in choosing the matching companies and the tremendous labor needed for the large number of valuations we conducted. Furthermore, a refinement of our procedure for generating matching companies would not affect the *relative* performance of the various multiples.

Estimation of Value. We estimated value by multiplying the median multiple for comparable companies by the relevant financial figure for the company (e.g., EBIT in the case of the EBIT multiple). For the two P/E multiples, the result was estimates for the value per share of common equity; for the other multiples, this procedure yielded estimates for the total enterprise value. When the multiples were adjusted for cash levels, the resulting estimates of total enterprise value were net of cash. Therefore, to facilitate comparisons of the multiples that yielded total enterprise value estimates, we added back cash. Following Kaplan and Ruback, Kim and Ritter, and Gilson et al., we calculated the valuation error as the natural logarithm of the ratio of the estimated value to the market value.

Empirical Results

Statistics for the valuation errors for the whole sample are reported in Panel A of **Table 2**. The mean and median statistics indicate the extent to which the valuation estimates are biased (i.e., zero indicates no bias). The medians suggest that the various multiples do not yield biased estimates for the overall sample; the means suggest that all multiples yield negative biases. In the remainder of the analysis, we will focus on the medians as an indication of bias so as to mitigate the effect of outliers.

The other statistics describe the distribution of the valuation errors and will be used as measures of the accuracy of the estimates. All of these statistics (i.e., the mean and median absolute errors, the fraction of errors that are less than 15 percent, and the first and third quartiles) yield similar information. In particular, they all give the same rank order of the various valuation methods. Consequently, we will also focus on the fraction of errors that are less than 15 percent (the row "Fraction within 15%"). This approach allows our findings to be compared with those of Kaplan and Ruback, Kim and Ritter, and Gilson et al., who all used the same measure of accuracy.

The fraction within 15 percent in Panel A of Table 2 varies from about 0.23 to 0.35. The comparable data for Kaplan and Ruback (using the EBITDA multiple for a sample of highly leveraged transactions) were 0.37 to 0.58, for Kim and Ritter (using various multiples for a sample of IPOs), 0.12 to 0.27, and for Gilson et al. (using the EBITDA multiple for a sample of bankrupt companies), 0.21.

A direct comparison of the multiples that provide estimates of equity value versus those that provide estimates of total enterprise value may not be entirely fair, but several comparisons of these data in Panel A do provide valuable insights. First, the data for the fraction within 15 percent indicate that the P/E multiple based on forecasted earnings provides more accurate estimates than the P/E based on historical earnings. This finding is consistent with what Kim and Ritter found in the context of IPOs. Second, adjusting for the cash levels has an ambiguous and marginal effect on valuation accuracy. Thus, in the remainder of this article, we ignore the multiples with such adjustments. Third, of the total enterprise value multiples, the asset multiple provides the most accurate and the sales multiple provides the least accurate estimates. The earnings-based multiples provide accuracy in-between, and the multiple based on EBITDA provides better estimates than that based on EBIT. Apparently, therefore, depreciation expenses distort the information value of earnings, perhaps because depreciation schedules do not accurately reflect the actual deterioration of asset value. This result is quite persistent throughout our analysis,

Table 2. Valuation Errors for the Total Sample

	Equity Valuation		Total Enterprise Valuation							
			Unadjusted				Adjusted for Cash Levels			
Measure	P/E	Forecasted P/E	Value/ Sales	Value/ Book Value	Value/ EBITDA	Value/ EBIT	Value/ Sales	Value/ Book Value	Value/ EBITDA	Value/ EBIT
A. All companies										
Mean	–0.058	–0.063	–0.114	–0.079	–0.119	–0.135	–0.053	–0.086	–0.082	–0.089
Median	0.002	–0.001	0.001	0.000	–0.001	–0.001	0.000	0.001	0.000	0.000
Mean absolute error	0.507	0.457	0.637	0.387	0.456	0.485	0.554	0.408	0.411	0.435
Median absolute error	0.342	0.305	0.429	0.259	0.297	0.308	0.407	0.269	0.280	0.295
Fraction within 15%	0.250	0.289	0.225	0.351	0.285	0.269	0.232	0.341	0.295	0.280
25th percentile	–0.361	–0.323	–0.439	–0.301	–0.349	–0.369	–0.415	–0.312	–0.317	–0.334
75th percentile	0.324	0.285	0.418	0.228	0.262	0.270	0.400	0.237	0.254	0.267
Number of observations	5,418	4,171	7,820	7,959	5,932	5,696	7,794	7,925	5,930	5,695
B. Companies with positive earnings										
Mean	–0.049	–0.049	–0.014	–0.057	–0.053	–0.096	–0.003	–0.056	–0.038	–0.060
Median	0.002	–0.001	0.002	0.003	0.000	–0.001	0.003	0.002	0.001	–0.001
Mean absolute error	0.489	0.406	0.469	0.332	0.365	0.429	0.447	0.345	0.343	0.390
Median absolute error	0.334	0.283	0.344	0.224	0.258	0.285	0.332	0.226	0.248	0.277
Fraction within 15%	0.255	0.310	0.273	0.392	0.320	0.288	0.275	0.388	0.331	0.291
25th percentile	–0.358	–0.297	–0.338	–0.245	–0.282	–0.327	–0.319	–0.242	–0.271	–0.309
75th percentile	0.319	0.270	0.349	0.208	0.239	0.256	0.342	0.213	0.233	0.251
Number of observations	5,107	3,654	5,107	5,107	5,107	5,107	5,106	5,106	5,106	5,106

Note: Fraction within 15 percent is defined as the fraction of valuation errors whose absolute value is less than 0.15.

which suggests that any earnings-based multiple generally should use EBITDA rather than EBIT.

Panel B pertains only to companies with positive earnings (i.e., all definitions of earnings had to be positive for both the companies for which we estimated value and any comparable companies). We carried out this analysis because we feared that the differences in accuracy among the multiples was attributable to different samples. In particular, earnings-based multiples require positive earnings, so the sample sizes in Panel A differ widely among the multiples. Panel B shows that, although restricting the sample to companies with positive earnings improved the accuracy of the estimates for all the multiples, the performance of the multiples vis-à-vis one another remained the same.

Because of the liquid nature of their assets, financial companies are likely to be easier to value than nonfinancial companies. Thus, combining financial and nonfinancial companies could cloud the results. Therefore, we separated the sample into nonfinancial and financial companies and examined the two company types separately.

Nonfinancial Companies. Within the category of nonfinancial companies, defined as those with a primary SIC code starting with a number other than 6, we broke down the group further by size and by level of earnings. The errors for the size categories are in Panels A–C of **Table 3**. Several results are noteworthy. First, consistent with Alford, based on the fraction within 15 percent, the valuations were more accurate for large companies. This result might not be surprising, because small companies often have erratic earnings and their values are derived from a small set of projects. In contrast, large companies can be viewed as a large portfolio of projects; their values continuously fluctuate, but the fluctuations tend to offset each other in the aggregate, so the total value is reasonably stable. Second, the medians suggest that the valuation bias was positive for small companies and negative for large companies. In other words, our valuation procedures tended to overvalue small companies and undervalue large companies. Third, for all company sizes, the asset multiple yielded the most accurate assessments whereas the sales multiple yielded the least accurate. For example, for medium-sized companies (Panel B), the fraction within 15 percent gives this multiple as roughly 0.20 and 0.30 for, respectively, the sales and asset multiples. A minor exception is large companies, for which the EBITDA multiple provided marginally more accurate values than did the asset multiple.

Next, we examined the performance of the multiples for different levels of earnings. Panels D–G of Table 3 provide results for companies with, respectively, negative earnings, low earnings (EBITDA scaled by assets between 0.00 and 0.05), medium earnings (EBITDA scaled by assets between 0.05 and 0.15), and high earnings (EBITDA scaled by assets above 0.15). In Panel D, the numbers for the earnings-based multiples are, naturally, missing. For companies with low or medium earnings, the asset multiple provided the most precise estimates, although they tended to be positively biased. In contrast, the earnings-based multiples provided very poor estimates when earnings were low. For companies with low earnings, Panel E indicates the fraction within 15 percent was only 0.01 for the EBITDA multiple, compared with 0.24 for the asset multiple. Furthermore, the earnings-based multiples provided estimates that are severely negatively biased. Consequently, earnings-based multiples should be avoided when assessing the value for companies with low but positive earnings because these multiples generally give unrealistically low estimates. This problem probably arises because the multiple based on matching companies is multiplied by earnings that are uncharacteristically and/or temporarily low. Consistent with this line of reasoning, using forecasted rather than trailing earnings is considerably more helpful when earnings are low, as indicated by the results for the P/E multiples.

For companies with high earnings (Panel G), the earnings-based multiples performed as well as or better than the other multiples. For example, the fraction within 15 percent was about 0.25 and 0.27, respectively, for the asset and the EBITDA multiples.

A concern with the earnings-based multiples, however, is that they yield estimates that are positively biased. Conversely, the sales and asset multiples are negatively biased. These opposite biases suggest that a combination of multiples would perform better than individual multiples. As a test of this conjecture, we estimated a new set of values by weighing equally the values generated by the asset and EBITDA multiples. Indeed, this hybrid performed better than the individual multiples. We found the mean and median valuation errors for the hybrid to be, respectively, –0.077 and –0.052 for companies with high earnings, which suggests that the hybrid's bias is smaller than for the other multiples. Moreover, we found the fraction within 15 percent for the hybrid to be 0.28, which is slightly higher than the fractions for the other multiples given in Panel G.

Financial Companies. The results for the financial companies (defined as companies whose

Table 3. Valuation Errors for Nonfinancial Companies

	Equity Valuation		Total Enterprise Valuation			
Measure	P/E	Forecasted P/E	Value/ Sales	Value/ Book Value	Value/ EBITDA	Value/ EBIT
A. Small companies (book value of assets ≤ $100 million)						
Mean	0.025	0.053	–0.133	–0.053	–0.151	–0.152
Median	0.139	0.144	0.137	0.055	0.037	0.071
Fraction within 15%	0.148	0.178	0.113	0.208	0.178	0.171
Number of observations	1,384	754	3,033	3,143	1,692	1,455
B. Medium companies ($100 million < book value of assets ≤ $1 billion)						
Mean	–0.089	–0.079	–0.095	–0.089	–0.098	–0.120
Median	–0.001	0.004	–0.003	–0.007	0.023	0.019
Fraction within 15%	0.244	0.263	0.198	0.299	0.286	0.271
Number of observations	1,726	1,545	2,146	2,158	1,942	1,814
C. Large companies (book value of assets > $1 billion)						
Mean	–0.143	–0.141	–0.205	–0.144	–0.150	–0.195
Median	–0.073	–0.069	–0.165	–0.061	–0.059	–0.090
Fraction within 15%	0.291	0.334	0.231	0.385	0.389	0.315
Number of observations	1,020	1,002	1,160	1,160	1,127	1,079
D. Companies with negative earnings (EBITDA/book value of assets < 0)						
Mean	—	—	–0.644	–0.122	—	—
Median	—	—	–0.304	0.013	—	—
Fraction within 15%	—	—	0.100	0.185	—	—
Number of observations	—	—	1,546	1,659	—	—
E. Companies with low earnings (0 < EBITDA/book value of assets ≤ 0.05)						
Mean	–0.929	–0.281	0.101	0.196	–1.445	–1.896
Median	–0.691	–0.134	0.190	0.237	–1.254	–1.727
Fraction within 15%	0.114	0.198	0.116	0.244	0.012	0.010
Number of observations	175	162	491	491	491	208
F. Companies with medium earnings (0.05 < EBITDA/book value of assets ≤ 0.15)						
Mean	–0.126	–0.081	0.102	0.079	–0.091	–0.263
Median	–0.027	0.005	0.114	0.096	–0.030	–0.125
Fraction within 15%	0.229	0.284	0.198	0.352	0.330	0.273
Number of observations	2,081	1,532	2,409	2,409	2,409	2,275
G. Companies with high earnings (EBITDA/book value of assets > 0.15)						
Mean	0.111	–0.014	–0.072	–0.326	0.171	0.194
Median	0.090	0.010	–0.060	–0.271	0.184	0.204
Fraction within 15%	0.232	0.271	0.184	0.246	0.265	0.244
Number of observations	1,809	1,422	1,860	1,860	1,860	1,841

primary SIC code starts with the number 6), grouped as in the previous section, are given in **Table 4**. In general, the valuations are more accurate for financial companies than for nonfinancial companies. The major trends are similar, however, for the two types of companies.

For all company sizes, Table 4 indicates that the asset multiple apparently provides the best estimates of value. The superior performance of this multiple is most pronounced for large companies (Panel C), for which the fraction within 15 percent is a high 0.83 and the median valuation error is only –0.01. For medium-sized and large companies, the sales multiple provided better estimates than the earnings-based multiples did—a result that differs from the result for nonfinancial companies.

For companies with low or medium earnings (Panels E and F), the asset multiple provided the best estimates of value. For companies with low earnings, more than 0.91 of the values derived from the asset multiple fell within 15 percent of the actual value; the corresponding figure for the sales multiple is roughly 0.69, but the figures for the earnings-based multiples are less than 0.40.

Table 4. Valuation Errors for Financial Companies

	Equity Valuation		Total Enterprise Valuation			
Measure	P/E	Forecasted P/E	Value/ Sales	Value/ Book Value	Value/ EBITDA	Value/ EBIT
A. Small companies (book value of assets ≤ $100 million)						
Mean	0.025	–0.154	0.046	–0.229	–0.055	–0.092
Median	0.037	–0.108	0.105	–0.026	0.019	0.121
Fraction within 15%	0.163	0.239	0.180	0.336	0.220	0.176
Number of observations	160	46	267	277	177	182
B. Medium companies ($100 million < book value of assets ≤ $1 billion)						
Mean	–0.035	–0.020	0.008	–0.037	–0.048	–0.052
Median	0.027	0.022	0.019	0.013	0.024	0.018
Fraction within 15%	0.322	0.327	0.575	0.741	0.378	0.362
Number of observations	574	349	633	640	519	603
C. Large companies (book value of assets > $1 billion)						
Mean	–0.060	–0.058	–0.105	–0.037	–0.114	–0.129
Median	–0.043	–0.015	–0.037	–0.011	–0.029	–0.038
Fraction within 15%	0.399	0.434	0.540	0.831	0.341	0.355
Number of observations	554	475	581	581	475	563
D. Companies with negative earnings (EBITDA/book value of assets < 0)						
Mean	—	—	–0.477	–0.163	—	—
Median	—	—	–0.362	–0.028	—	—
Fraction within 15%	—	—	0.108	0.333	—	—
Number of observations	—	—	111	120	—	—
E. Companies with low earnings (0 < EBITDA/book value of assets ≤ 0.05)						
Mean	–0.085	–0.046	–0.053	0.002	–0.204	–0.222
Median	–0.008	–0.002	–0.009	0.004	–0.052	–0.066
Fraction within 15%	0.393	0.449	0.687	0.909	0.383	0.347
Number of observations	753	564	802	802	802	789
F. Companies with medium earnings (0.05 < EBITDA/book value of assets ≤ 0.15)						
Mean	0.035	–0.030	0.133	–0.042	0.117	0.107
Median	0.055	–0.012	0.089	–0.019	0.105	0.132
Fraction within 15%	0.238	0.273	0.223	0.470	0.271	0.257
Number of observations	235	154	251	251	251	249
G. Companies with high earnings (EBITDA/book value of assets > 0.15)						
Mean	0.195	–0.121	0.297	–0.685	0.387	0.388
Median	0.142	–0.103	0.153	–0.487	0.390	0.403
Fraction within 15%	0.190	0.203	0.195	0.178	0.186	0.169
Number of observations	116	74	118	118	118	118

For companies with high earnings, the various multiples generated estimates that are roughly equally precise. The asset multiple provided negatively biased estimates, however, while the other valuation measures provided positively biased estimates. This result suggests that, as for nonfinancial companies, a combination of multiples would yield the best estimates.

Companies with High Intangible Value. Companies with a large part of their value in intangible "assets," such as high-technology companies and companies with substantial research and development activities, may be particularly hard to value because such a small portion of their value lies in assets in place whereas a large portion derives from uncertain future growth opportunities. A further complication with such companies is that their high R&D expenses reduce current earnings, even though R&D projects could be perceived as investments for the future; in such a case, current earnings may be a bad predictor of value.

To assess the performance of the valuation multiples for companies with high intangible

value, we first identified companies in our sample whose names ended with ".com." Dot-com companies are typically small companies that are associated with the Internet. They rarely report positive earnings, and most of their value is tied to their potential to become major players on the Internet in the future, in which case they will presumably generate massive earnings. The valuation errors for dot-coms are reported in Panel A of **Table 5**. The 27 dot-coms included in the analysis are spread among 14 three-digit industries. Because only two of the companies reported positive earnings, we report results for multiples based only on sales and book value of assets.

The valuation errors for dot-coms are severe. None of the estimated values is within 15 percent of the actual values. The median valuation error of –0.71 for the asset multiple suggests that the actual value is roughly twice as large as the estimated value; the –1.51 median valuation error for the sales multiple suggests that the actual value is more than four times larger than the estimated value. The high actual values of dot-coms relative to estimated values are consistent with Cooper, Dimitrov, and Rau (2001), who reported that companies roughly double their value when they change their name to include a ".com." Our results suggest that multiples are not suitable for valuing these companies. Instead, investors might have to resort to valuing the vast real options embedded in these companies' assets (see, for example, Trigeorgis 1996).

As an alternative to using ".com" to identify companies with high intangible value, we identified those companies whose R&D expenses exceeded 10 percent of their book value. The valuation errors for these companies are reported in Panel B of Table 5. The results are similar to those for dot-coms, albeit not as extreme. The fraction within 15 percent varies from 0.11 to 0.17—generally lower than the data for other nonfinancial companies reported in Table 3. All our methods generated estimates that tend to be lower than actual values, presumably because the valuation procedures fail to fully capture the value of future growth opportunities created by the R&D activities. The negative valuation bias is smallest for the asset multiple and largest for the sales multiple, although the valuation accuracy as determined by the fraction within 15 percent is actually best for the EBITDA multiple.

A potential problem with assessing the valuation procedure for companies with high R&D expenses is that these companies probably operate in R&D-intensive industries, so the matching companies on which the multiples are based have

Table 5. Valuation Errors for Companies with High Intangible Value

	Equity Valuation		Total Enterprise Valuation			
Measure	P/E	Forecasted P/E	Value/ Sales	Value/ Book Value	Value/ EBITDA	Value/ EBIT
A. Dot-com companies						
Mean	—	—	–1.348	–0.503	—	—
Median	—	—	–1.511	–0.713	—	—
Fraction within 15%	—	—	0.000	0.000	—	—
Number of observations	—	—	25	27	—	—
B. Companies with high R&D expenses (R&D/book value of assets > 0.10)						
Mean	–0.260	–0.210	–0.400	–0.197	–0.302	–0.307
Median	–0.130	–0.127	–0.190	–0.094	–0.160	–0.147
Fraction within 15%	0.152	0.153	0.114	0.153	0.166	0.138
Number of observations	388	365	998	1,033	435	377
C. Pharmaceutical companies with high R&D expenses (R&D/book value of assets > 0.10)						
Mean	–0.445	–0.295	–0.695	–0.165	–0.499	–0.582
Median	–0.326	–0.202	–0.471	–0.202	–0.361	–0.272
Fraction within 15%	0.129	0.156	0.089	0.124	0.212	0.259
Number of observations	31	32	192	218	33	27
D. Pharmaceutical companies with low R&D expenses (R&D/book value of assets ≤ 0.10)						
Mean	0.174	0.067	0.617	0.190	0.168	0.053
Median	0.127	0.016	0.736	0.315	0.234	0.136
Fraction within 15%	0.298	0.314	0.103	0.115	0.183	0.193
Number of observations	57	51	78	78	60	57

similarly high R&D expenses. Consequently, isolating the effect of R&D on the valuation errors is difficult. To alleviate this problem, we turned our attention to companies in the pharmaceutical industry. This industry consists of both generic producers and brand-name producers, which require different levels of R&D. We partitioned the companies in this industry into those with R&D scaled by assets more than 0.10 and those with R&D scaled by assets less than 0.10. The valuation errors for the two groups are reported in Panels C and D, respectively, of Table 5. For pharmaceutical companies with high R&D expenses (Panel C), the median valuation errors are negative for all multiples, which is consistent with the results in Panels A and B, and they range from about –0.20 for the asset multiple to –0.47 for the sales multiple. Valuation accuracy as measured by the fraction within 15 percent ranges from 0.09 for the sales multiple to 0.26 for the EBIT multiple. Note, however, that because of the substantial R&D expenses for these companies, earnings were usually negative, so we could obtain values based on earnings multiples for only about 15 percent of the companies. Thus, comparisons of earnings multiples with other multiples is difficult.

For pharmaceutical companies with low R&D expenses, the valuation bias is, not surprisingly, the opposite of that for companies with high R&D expenses. In particular, Panel D indicates that the estimated values tend to be higher than actual values for all multiples. This bias might arise because the comparison companies used to generate multiples often have substantial intangible value, thereby positively biasing the multiples.

Another interesting observation for pharmaceutical companies is that the EBIT multiple generates more accurate and less biased value estimates than the EBITDA multiple, which contradicts results for other categories of companies reported in this study.

Conclusion

Although practitioners and academic researchers frequently use multiples to assess company values, there is no consensus as to which multiple performs best. To our knowledge, this study is the first to compare the performance of various multiples.

From our estimates of the value for the universe of Compustat companies based on various multiples, we have documented several results that should be of great interest to practitioners and researchers. Our main results are as follows:

First, in general, all the multiples yield estimates that are somewhat negatively biased. That is, the mean valuation errors are slightly negative and the median valuation errors are roughly zero.

Second, the asset value multiple generally yields better (i.e., more precise and less biased) estimates of value than do sales and earnings multiples, especially for financial companies but also for nonfinancial companies.

Third, adjusting for companies' cash levels does not improve the value estimates.

Fourth, using forecasted earnings rather than trailing earnings improves the estimates of the P/E multiple.

Fifth, the EBITDA multiple generally yields better estimates than does the EBIT multiple, except for pharmaceutical companies.

Finally, the accuracy and bias of the value estimates varied greatly according to company size, profitability, and the extent of intangible value. For several company categories, we found that the asset multiple does not yield the best estimates. Valuations were more precise for large companies, although the bias was also more negative than for medium and small companies. For all company sizes, the asset multiple performed the best and the sales multiple performed the worst.

Valuations based on the asset multiple seem most precise for companies with mediocre or low earnings and about equally as precise as valuations based on other multiples for companies with high earnings. The bias for the different earnings groups varied among the multiples. For companies with high earnings, earnings-based multiples produced positive valuation biases whereas the asset multiple yielded negative biases, and vice versa for companies with low earnings. These results suggest that, for some companies, a combination of multiples with opposite biases might perform better than individual multiples.

Valuations tend to be more accurate for financial than for nonfinancial companies, presumably because financial companies have substantial liquid assets that are easier to value. Finally, we found the valuation estimates to be generally worse for companies with high intangible assets, especially for the dot-coms. Presumably, the reason is that the estimates do not fully capture the growth opportunities and other intangibles associated with these companies.

Notes

1. The use of multiples is standard practice to value IPOs because the companies are typically so young that forecasting cash flows is difficult.
2. The difference between the EBITDA multiple used by Kaplan and Ruback and that used by Gilson et al. is that the EBITDA was a historical figure in the Kaplan–Ruback study and a forecast in the Gilson et al. study.
3. All of the market value figures were taken from the end of the fiscal year. It can be argued that the price at that point does not fully capture the financial information for that year because the fourth quarter results had not yet been released. Nonetheless, we believe that the capital market can fairly accurately estimate the revenues and earnings for the year, even if some figures are yet to be officially released. We considered using market values a few months after the end of the fiscal year to ensure that all of the financial information for the year was embedded in the market value, but we were concerned that consequential events or announcements might have occurred in the interim, thereby making these values less appropriate for our tests.

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