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The Valuation Accuracy of the Price-Earnings and Price-Book Benchmark Valuation Methods

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Abstract. This paper evaluates the valuation accuracy of the price-earnings (P/E), the price-book (P/B) and a combined price-earnings and price-book (P/E-P/B) benchmark valuation methods. Performance of the benchmark valuation methods relies on the definition of comparable firms. In this paper, comparable firms are selected based on industry membership, size and return on equity as well as combinations of industry membership with size and with return on equity. We find that within the P/E and P/B benchmark valuation methods, the best definition of the comparable firms are based on industry membership combined with return on equity. However, only the industry membership is necessary to define the comparable firms for the combined P/E-P/B method. In sum, the results suggest that, when firm's value is unknown, the combined P/E-P/B valuation approach selecting comparable firms based on industry membership performs the best among all the approaches evaluated in this paper.

We also find that the P/E benchmark valuation method performs better than the P/B benchmark valuation method and the combined method outperforms either the P/E or the P/B method. These results imply that earnings are more important than book value as a single-number firm valuator over our sample years (from 1973 to 1992) and that both earnings and book values are value relevant, one does not substitute perfectly for the other.

Key words: accounting, price-earnings, price-book, firm valuation

JEL Classification: M41, G19

I. Introduction

Benchmark valuation methods estimate a target firm's stock price based on the price multiples of that target firm's comparable firm. For example, the price-earnings (P/E) benchmark valuation method estimates a target firm's stock price as the product of its earnings and the benchmark P/E multiple of a comparable firm. To apply the benchmark valuation, a popular method is to identify a set of comparable firms based on various criteria (such as industry membership and size) for the target firm. The median price multiple for the set of comparable firms is then chosen as the benchmark price multiple for the target firm. The predicted stock price for the target firm is then derived by taking the product of the benchmark price multiple and the firm's actual accounting numbers.

The P/E valuation method is one of the most popular valuation methods in the investment community. Its usefulness relies on the view that the P/E ratio captures risk and growth of a stock; hence, a firm's value can be reasonably assessed based on the P/E ratio of its comparable firms with similar risk and growth. This benchmark valuation method is

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especially useful when a firm's value is not observable (Boatsman and Baskin, 1981; LeClair, 1990). The performance of the benchmark valuation method depends on the selection of the comparable firms. Alford (1992) explores several definitions for the comparable firms including size (a surrogate for risk), ROE (a surrogate for growth)[1] and industry membership. He reports that industry membership constitutes the major element that captures the cross-sectional differences in the P/E ratio and size and ROE do not have additional explanatory power beyond the industry membership.

While the price-multiple methods can be applied to many accounting variables, earnings have been considered as the most common divisor. However, recent academic research studies as well as practical investment analyses report the importance of book value and it is a nature extension to investigates the accuracy of the price-book value (P/B) in contrast to the price-earnings (P/E) benchmark valuation method. This paper evaluates the price-multiple methods focusing the usefulness of P/E and P/B ratios. First, this paper evaluates alternative prediction error measures. The measures are compared with respect to their performance in both the nonparametric and parametric accuracy tests. Second, this paper examines the valuation accuracy of the P/B benchmark valuation method based on various definitions for comparable firms, including size, ROE and industry membership. Third, this paper compares the valuation accuracy between the P/E and the P/B methods; in addition, it evaluates the performance of a combined method that uses both the P/E and P/B benchmark ratios. Lastly, it evaluates the effect of industry fineness[2] and firm size on valuation accuracy.

Studies have suggested that the P/B ratio is related to profitability as well as to risk and growth. Chan and Chen (1991) suggest that the P/B ratio reflects the production efficiency of a firm. Ohlson (1988, 1995) models the relation between the P/B ratio and accounting rate-of-return and suggests that the P/B ratio represents a firm's excess rate of return caused by a firm's superior performance. Feltham and Ohlson (1995) conceptualize the difference between book and market value being the goodwill for which current and anticipated operating profitability are crucial deterministic factors. Bernard (1994) argues that the variation in P/B ratios should be explained by future rates of profitability; however, he finds that there is only a weak relation between the P/B ratio and subsequent rates of profitability once current profitability is controlled for. He also suggests that the P/B ratio is related to discount rates, hence, related to risk and growth. In addition, Farma and French (1992) find that the P/B ratio explains the variation of returns more than does the market beta; this implies that there is a relation between risk and the P/B ratio. They (1995) also suggest that the P/B ratio is highly associated with firm's persistent profitability. Penman (1996) articulates the differences between the P/E and the P/B ratios and concludes that the P/B ratio reflects expected future return on equity.

Since the P/B ratio captures certain aspects of risk/growth and profitability, the valuation approach based on a benchmark P/B ratio should also be meaningful if the criteria used to identify the comparable firms is related to the determinants of the P/B ratio. Alford discuss the appropriateness of using *industry* membership, *size* (a surrogate for risk) and *ROE* (a surrogate for growth) to define the comparable firms for the P/E valuation approach based on the P/E-risk/growth relationship. If P/B is related to risk/growth, these variables are equally applicable to the P/B valuation approach. Furthermore, these variables may also affect P/B based on the P/B-profitability relationship. At different

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times, industries face varying degrees of operating advantages that result excess profitability; firms often increase *size* to improve their production efficiency (e.g. mergers and acquisition improve cost sharing) and *ROE* is typically considered as a profitability indicator (Bernard, 1994, already shows that the variation of the P/B ratio is explained by current ROE). Accordingly, it is plausible to assume that the variations of firms' P/B ratios, similar to the P/E ratios, should be related to industry membership, firm size and ROE even though might be for different reasons.

While both earnings and book value are value relevant items, a valuation methodology that combines both the earnings and book value information should perform better than the method using the earnings information only (the P/E method) or the book value information only (the P/B method). Hence, this paper evaluates a simple valuation approach that uses both the P/E and P/B benchmark ratios.[3] Not only can this combined P/E-P/B approach show the joint value relevance of earnings and book value, it also may have implication to value estimation for closely-held firms if we can infer the usefulness of accounting information by the public firms to closely-held firms.[4]

Section II describes the P/E, P/B and combined P/E-P/B benchmark valuation methods and alternative prediction error measures. Section III describes the sample selection and the definitions for the comparable firms, and provides descriptive statistics. Section IV evaluates alternative prediction measures and compares the valuation accuracy across different valuation methods. Section V evaluates the effect of industry fineness and size. Section VI summarizes and concludes the paper.

II. The P/E and P/B benchmark valuation methods and the predication error measures

The P/E valuation method estimates a firm's stock price by capitalizing earnings at a benchmark P/E multiple determined from a set of comparable firms (e.g., Alford, 1992). Similarly, the P/B valuation method estimates a firm's stock price by capitalizing book value at a benchmark P/B multiple determined from a set of comparable firms. Three valuation methods are evaluated in this paper, they are the P/E, the P/B and the combined P/E-P/B valuation methods.

Define:

$$\overline{PE}_{it} = \text{median}_{j \in \Psi_{it}} \left\{ \frac{P_{jt}}{E_{jt}} \right\} \tag{1}$$

$$\overline{PB}_{it} = \text{median}_{j \in \Psi_{it}} \left\{ \frac{P_{jt}}{B_{jt}} \right\} \tag{2}$$

where $\overline{PE}_{it}$ is the benchmark P/E multiple and $\overline{PB}_{it}$ is the benchmark P/B multiple for the target firm i at time t. The benchmark P/E and P/B multiples are the medians calculated over all firms j in the set of comparable firms for target firm i, i.e., $j \in \Psi_{it}$. P_{jt} represents firm j's stock price at time t, E_{jt} represents firm j's earnings at time t, and B_{jt} represents firm

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j's book value at time t. The values estimated by the P/E, the P/B, and the combined P/E-P/B valuation methods for the target firm i are:

$$\hat{P}_{it}^{P/E} = E_{it} \times \overline{PE}_{it} \tag{3}$$

$$\hat{P}_{it}^{P/B} = B_{it} \times \overline{PB}_{it} \tag{4}$$

$$\begin{aligned} \hat{P}_{it}^{P/E-P/B} &= (\hat{P}_{it}^{P/E} + \hat{P}_{it}^{P/B})/2 \\ &= (E_{it} \times \overline{PE}_{it} + B_{it} \times \overline{PB}_{it})/2 \end{aligned} \tag{5}$$

where $\hat{P}_{it}^{VM}$ represents the estimated firm value by applying the P/E, the P/B or the combined P/E-P/B valuation methods (VM represents P/E, P/B or P/E-P/B). The combined method takes the simple average of the valuations from the P/E and the P/B approaches. The equal weights to earnings and book value may be suboptimal; however, they are adopted as a starting point in this paper for combining earnings and book value information into one valuation method. The optimal weights can be searched to improve the benchmark valuation method; we leave the investigation to future studies.

The absolute value of the prediction error for each of these methods is defined as:

$$u_{it}^{VM} = |P_{it} - \hat{P}_{u}^{VM}|. \tag{6}$$

For cross-sectional comparisons of the magnitude of errors, the prediction error needs to be scaled to control for the size effect. When the actual price is used as the scaling factor, the scaled error measurements for under- or over-predictions will differ for the same absolute prediction errors. While many earnings forecasts (e.g., Foster, 1977; Bathke, Lorek, and Willinger, 1989) use the actual value as the scaling factor for forecasting errors, its appropriateness does not necessarily apply to the benchmark valuation methods evaluated in this paper. The reason is illustrated below.

Using the P/E valuation method as an example, the percentage absolute error scaled by actual price (PAE/A) can be restated below.[5]

$$\frac{u_{it}^{P/E}}{P_{it}} = \frac{|P_{it} - \hat{P}_{it}^{P/E}|}{P_{it}} = \frac{|P_{it}/E_{it} - \overline{PE}_{it}|}{P_{it}/E_{it}}. \tag{7}$$

Equation (7) shows that the PAE/A is equivalent to the absolute value of the difference between the actual P/E and the benchmark P/E multiple (the median for the set of comparable firms) scaled by the actual P/E. If two firms share the same benchmark P/E multiple because their sets of comparable firms are similar,[6] then firms with P/E multiples below the median will on average have larger PAE/A than firms with P/E multiples above the median. Hence, by construction, firms with smaller P/E (the over-prediction cases) will have larger forecasting errors than firms with larger P/E (the under-prediction cases).[7] The existence of this asymmetric measure of prediction error makes sense only if we believe that the utility function of the user of the valuation is consistent with the notion that over-

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prediction is worse than under-prediction, however, there are no apparent reasons for this belief. To correct the problem of the asymmetry the scaling factor in the PAE/A can be changed to from the actual price to the predicted price (PAE/P). Two firms having P/E ratios with the same distance to the benchmark P/E ratio (i.e., the median) but on different sides (over-or under-prediction) will have the same PAE/P.

For a symmetric sample, we should observe similar PAE/P statistics between the under- and over-prediction cases. However, asymmetry of the prediction errors may still exist for PAE/P due to outliers. The PAE/A always has a value between zero and one for the under-prediction cases (because the under-prediction error never exceeds the actual price); however, it will have extremely large values of outliers for the over-prediction cases (for extreme small actual price). The PAE/P always has a value between zero and one for the over-prediction cases (because the over-prediction error never exceeds the predicted price); however, it may have extreme large values of outliers for the under-prediction cases (for extreme large actual price). An investigation of our sample reveals that both measures are skewed with PAE/A being more severely skewed (refer to note 14). Due to the extreme outliers of the error measures, simple averages are not meaningful, accordingly, nonparametric tests have to be used. To simplify many tests that are conducted for this paper and for potential future studies, an error measure with the same error rankings but has symmetric distribution with smaller outliers than the other economically meaningful measures should improve effectiveness and efficiency for statistical analysis by being able to apply the parametric tests.

To mitigate the problems caused by extreme outliers existed in PAE/P, the error measure is modified by adding the numerator to the denominator. This procedure does not change the directional difference between any two errors[8] with the advantages of restricting the error magnitude between 0 and 1. The adjusted percentage absolute error (APAE) is defined as:

$$e_{it}^{VM} = \frac{u_{it}^{VM}}{\hat{P}_{it}^{VM} + u_{it}^{VM}} \tag{8}$$

where e_{it}^{VM} is the APAE for the valuation method VM (representing P/E, P/B or P/E-P/B). Since $\hat{P}_{it}^{VM}$ is positive and u_{it}^{VM} is greater or equal to zero, by construction, the APAE is greater or equal to zero and less than 1.

The APAE does not have an economic meaning for all observations except the denominator of equation (8) equals the actual price for under-prediction cases. The APAE is simply a transformation of the PAE/P to regulate the error value to be between 0 and 1, which reduces the adverse effect of extreme large outliers on parametric test statistics. However, extremely large actual price (i.e., extreme large absolute prediction error) may still cause the distribution of the APAE to be right-skewed. To reduce the skewness, the APAE can be further transformed by applying power transformation. We take the square root of the APAE and find that it is not right-skewed (refer to note 14); however, the results for the square root test statistics are similar to those using the APAE. Since the APAE has economic meanings for the under-prediction cases (i.e., the absolute percentage error weighted by the actual value) and the square root is more remote to relate to a direct

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explanation of the error magnitude, even it is not skewed, we choose to report our main statistics based on APAE.

III. Sample selection and definition of comparable firms

Sample selection

All firm observations that have data available from the 1992 Industrial Compustat database are selected. The data used in this study include earnings per share before extraordinary items, book values of the common equity, year-end total assets, year-end stock price and year-end number of common shares outstanding. Only positive earnings and book values are included; there are a total of 30,310 observations over 20 years.[9] The P/E ratio is derived by dividing the end-of-year stock price by earnings before extraordinary items per share, the P/B ratio is derived by dividing the end-of-year stock price by the end-of-year common equity per share. Return on equity (ROE) is derived by dividing earnings before extraordinary items by the end-of-year common equity.[10]

Descriptive statistics. Table 1 presents the medians and interquartile ranges for the P/E ratio, the P/B ratio, ROE and total assets across 20 years (1973 to 1992). The average, the standard deviation and the coefficient of variation (standard deviation divided by the mean) of the yearly medians are provided at the bottom of the table. By comparing the trend of the medians through twenty years, it can be easily seen that the P/E ratio, the P/B ratio and total assets experience a continuing growth; however, ROE increases in the first ten years and decreases in the second ten years. Investigating the coefficient of variation (the standard deviation divided by the average), the medians of the P/E ratio vary roughly 20% more than the medians of the P/B ratio. The variation of ROE is much more stable than the other two ratios.

Selection of the set of comparable firms

The following six definitions are used to select the set of comparable firms for each target firm; they are applied to all observations within each year.

(1) MARKET: All sample firms except the target firm.
(2) INDUSTRY: The comparable firms are selected on the basis of 4-digit SIC codes if the resulting industry contains at least six other firms. If the 4-digit SIC industry does not contain at least six other firms, fewer SIC digits are used until at least six other firms are identified.
(3) TA: Out of all the observations in each year, the six firms whose total assets are closest in size to the target firm are selected.
(4) ROE: Out of all the observations in each year, the six firms whose ROE is closest to that of the target firm are selected.

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Table 1. Medians and interquartiles of P/E, P/B, ROE and total assets (number of observations = 30,310)

Year	Number of Observations	P/E		P/B		ROE		Total Assets	
		Median	Interquartile	Median	Interquartile	Median	Interquartile	Median	Interquartile
73	1,250	8.132	6.947	0.919	0.898	0.123	0.062	157	784
74	1,224	5.382	4.303	0.602	0.517	0.124	0.074	189	953
75	1,224	7.667	5.721	0.825	0.699	0.119	0.070	204	1,026
76	1,277	8.676	4.808	1.022	0.753	0.127	0.067	213	1,101
77	1,300	7.858	4.154	0.995	0.668	0.134	0.073	221	1,210
78	1,360	7.173	4.103	0.916	0.710	0.142	0.075	256	1,337
79	1,366	7.150	4.665	0.994	0.943	0.152	0.077	294	1,463
80	1,398	8.355	7.206	1.092	1.328	0.142	0.079	326	1,584
81	1,433	7.903	6.102	1.046	1.059	0.141	0.076	345	1,636
82	1,386	10.624	9.514	1.186	1.194	0.130	0.076	370	1,788
83	1,457	12.318	9.759	1.430	1.265	0.131	0.072	379	1,810
84	1,539	10.334	7.390	1.308	0.938	0.139	0.075	389	1,923
85	1,536	13.506	9.300	1.541	1.166	0.131	0.078	396	2,119
86	1,630	14.133	9.236	1.640	1.178	0.126	0.080	395	2,186
87	1,789	11.813	8.826	1.354	1.060	0.128	0.089	408	2,141
88	1,812	11.724	7.681	1.458	1.131	0.138	0.095	511	2,397
89	1,850	13.379	9.602	1.568	1.396	0.129	0.096	538	2,505
90	1,814	11.706	9.024	1.281	1.214	0.119	0.085	548	2,570
91	1,810	16.625	13.367	1.635	1.399	0.112	0.088	566	2,556
92	1,835	16.965	11.905	1.786	1.450	0.116	0.087	589	2,556
Statistics of yearly medians:									
Average		10.571		1.230		0.130		365	
Standard deviation		(3.174)		(0.311)		(0.010)		(131)	
Coefficient of variation		30%		25%		8%		36%	

Notes: P/E: End-of-year stock price divided by earnings per share before extraordinary items.
P/B: End-of-year stock price divided by end-of-year common stock equity.
ROE: Earnings before extraordinary items divided by end-of-year common stock equity.
Total Assets: End-of-year total assets, in millions.

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(5) IND + TA: In each INDUSTRY, the six firms with the closest measure of total assets to the target firm are selected. For INDUSTRY containing only six other firms, the INDUSTRY and IND + TA are identical.
(6) IND + ROE: The six firms in the set INDUSTRY that have the closest measure of ROE to the target firm. Similar to IND + TA, the INDUSTRY and IND + ROE are identical for INDUSTRY containing only six other firms.

The definitions are very similar to those used in Alford except TA and ROE only contain six other firms instead of thirty firms. The reason for considering six firms only for TA and ROE is for a direct comparison between TA (ROE) and IND + TA (IND + ROE) because the latter only consider six other firms in each INDUSTRY. While we are not certain of the optimum number of firms to be selected to form the set of comparable firms based on TA or ROE, constraining TA and ROE to have the same number of comparable firms as IND + TA and IND + ROE may control for the possible advantages or disadvantages that would be created if more firms were included in TA and ROE than in IND + TA and IND + ROE. In other words, this is to assure that the difference in performance between TA(ROE) and IND + TA(IND + ROE) is not due to the different number of firms included, but is related to the advantages provided by industry restriction.

When defining INDUSTRY, the restriction of at least six other firms serves two purposes: one is to have enough firms for applying IND + TA and IND + ROE definitions, another one is to mitigate the potential prediction error due to not having enough firms in INDUSTRY. The main impact of this selection is the way INDUSTRY is defined for the target firms. When the number of firms restricted gets larger, more target firms have INDUSTRY with fewer SIC digits; in other words, the industry fineness evaluated by the composition of SIC codes gets worse. Alford reports that 4-digit SIC codes do not perform significantly better than 3-digit codes, however, 4-digit and 3-digit SIC codes perform significantly better than fewer SIC codes. Apart from the purpose of having enough firms for defining IND + TA or IND + ROE, a trade-off exists in establishing the number of firms in INDUSTRY: increasing the minimum required number of firms will increase prediction error due to its adverse effect on the composition of SIC codes, at the same time, it may decrease the prediction error because enough firms are included in INDUSTRY to make the benchmark prediction meaningful.

Table 2 reports the percentage of observations in my sample with respect to the resulted numbers of firms (from 1 to 11) in each industry when INDUSTRY is defined based on 1-digit to 4 digit SIC codes. The cumulative percentages are also reported. For any selected number, the percentage of observations using 1-digit to 4-digit SIC codes can be derived by comparing the cumulative percentages. For example, when at least seven firms (i.e., six other firms) in an industry are required, we will have 0.07%, 4.32% (= 4.39%−0.07%), 26.08% (= 30.47%−4.39%), 15.96% (= 46.43%−30.47%) and 53.57% (= 100%−46.43%) using 0-digit to 4-digit SIC codes respectively. When at least eleven firms in an industry are required, the observations used are 0.07%, 9.75% (= 9.82%−0.07%), 36.87% (= 46.69%−9.82%), 15.86% (= 62.55%−46.69%) and 37.45% (= 100%−62.55%) for 0-digit to 4-digit SIC codes, respectively. When we do not restrict the least number of firms available (that is, as long as there is one other firm in the

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Table 2. Data availability based on number of firms available for various industry definitions total number of observations: 30,310

Number of Firms Available Per Year Per Industry	SIC 1-Digit Industries		SIC 2-Digit Industries		SIC 3-Digit Industries		SIC 4-Digit Industries	
	%	Cumulative Percentage	%	Cumulative Percentage	%	Cumulative Percentage	%	Cumulative Percentage
1	0.03	0.03	0.10	0.10	3.03	3.03	6.51	6.51
2	0.04	0.07	0.37	0.47	5.08	8.11	8.59	15.10
3			0.72	1.19	5.31	13.42	8.86	23.96
4			1.36	2.55	5.15	18.56	7.68	31.64
5			0.91	3.46	5.99	24.55	8.30	39.94
6			0.93	4.39	5.92	30.47	6.49	46.43
7			0.93	5.32	6.61	37.08	6.86	53.29
8			1.29	6.61	3.74	40.82	4.28	57.57
9			1.36	7.97	3.36	44.18	2.97	60.54
10			1.85	9.82	2.51	46.69	2.01	62.55
> 11	99.93	100.00	90.18	100.00	53.31	100.00	37.45	100.00

industry), the distribution of industry definitions will be 0.03%, 0.07%, 2.93%, 3.48%, and 93.49% for 0-digit to 4-digit SIC codes respectively.

Since industry is the most crucial factor that affect valuation accuracy as reported by Alford, the effect of applying the restriction on least number of firms to determine INDUSTRY will be evaluated. In addition, the effect of number of firms in an industry on valuation accuracy will also be evaluated.

IV. Valuation accuracy

Accuracy of the P/E valuation method—contrasts of percentage error measures

The PAE/A favors under-prediction and would be a biased measure for investigating the differences between cases of over- and under-predictions.[11] However, the bias may not be serious in comparing the relative valuation accuracy if the extent of bias does not differ among various methods. Table 3 reports the performance of the P/E benchmark valuation method using both the PAE/A (Panel A) and the APAE (Panel B) error measures.[12] The averages of the medians and the 90th percentiles over twenty years (1973 to 1992) for each of the six definitions of comparable firms are reported. The ranks based on the average medians are also reported. Comparing Panel A and Panel B, the ranks are consistent between the two measures. According to the ranks reported in Table 3, the performance of the six methods are in the following order: IND + ROE, INDUSTRY, IND + TA, ROE, MARKET and TA.

The nonparametric tests (the Friedman test)[13] are applied here. The average *t*-statistics using the nonparametric tests over twenty years are reported in the bottom half of each panel in Table 3. The positive sign indicates that the column is more accurate than the row. The signs and the magnitudes of the *t*-statistics are similar between the two prediction error measures as reported in Panel A and Panel B. The signs of the *t*-statistics reported

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Table 3. The P/E valuation method : percentage absolute errors and t-statistics using nonparametric tests

Panel A: Percentage absolute error scaled by actual value (PAE/A)

	Comparable-Firm Portfolio					
	MARKET	INDUSTRY	TA	ROE	IND + TA	IND + ROE
Average median	0.335	0.276	0.353	0.315	0.287	0.264
Average 90th percentile	0.874	0.881	1.026	0.900	0.937	0.847
Ranks based on average median	5	2	6	4	3	1
Average *t*-statistic[1]						
INDUSTRY	− 6.14					
TA	3.33	9.32				
ROE	− 0.80	4.85	− 3.90			
IND + TA	− 3.74	2.23	− 6.92	− 2.69		
IND + ROE	− 7.94	− 2.12	− 10.95	− 6.55	− 4.15	

Panel B: Percentage absolute error scaled by adjusted value (APAE)

	Comparable-Firm Portfolio					
	MARKET	INDUSTRY	TA	ROE	IND + TA	IND + ROE
Average median	0.239	0.213	0.255	0.236	0.219	0.208
Average 90th percentile	0.586	0.528	0.521	0.489	0.581	0.501
Ranks based on average median	5	2	6	4	3	1
Average *t*-statistic[1]						
INDUSTRY	− 6.57					
TA	2.99	9.38				
ROE	− 1.59	4.40	− 4.33			
IND + TA	− 4.42	1.96	− 7.23	− 2.51		
IND + ROE	− 8.68	− 2.45	− 11.30	− 6.40	− 4.21	

Notes: [1]A positive average *t*-statistic indicates that the column is more accurate than the row. Average are taken over 1973 to 1992. The individual *t*-statistic is computed in each year using the nonparametric Friedman test; the pairwise comparison is based on the *t*-statistics of the per-firm ranks of the six methods. MARKET: All other firms. INDUSTRY: Firms in target firm's SIC *n*-digit industry, *n* is determined based on the restriction of at least six other firms in the SIC *n*-digit industry. TA: The six closest firms in MARKET in terms of total assets. ROE: The six closet firms in MARKET in terms of return on equity. IND + TA: The six closest firms in INDUSTRY in terms of total assets. IND + ROE: The six closest firms in INDUSTRY in terms of return on equity.

here are also consistent with the ranks reported in both Panel A and Panel B. The magnitude of the *t*-statistics indicates that IND + ROE, the most accurate definition, is significantly better than all the other five definitions. The second most accurate definition, INDUSTRY, is significantly better than the other four definitions. The third most accurate definition, IND + TA, is significantly better than the other three definitions. The fourth most accurate definition, ROE, is significantly better than TA, the worst definition. The fifth most accurate definition, MARKET, is also significantly better than TA.

Overall, the results in Table 3 show that the ranking of the six definitions evaluated in this paper is the same as that reported by Alford, however, this paper reports higher *t* test

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scores. In addition, the signs of the *t* tests in Table 3 are consistent with the simple ranking based on the average medians while the signs of Alford's *t*-statistics (though not significant) are not consistent with the simple ranking. The stronger test results are likely due to more observations being included in our sample, twenty years instead of three years.

Table 4 reports the means and parametric test scores for the P/E valuation method; Panel A reports for PAE/A and panel B for APAE. Averages of means across twenty years, ranks based on the average means and average *t*-statistics based on pairwise comparisons are all provided. Due to the extreme values of outliers in PAE/A, the results are unstable and are totally different from those reported in Panel A of Table 3 (i.e. the nonparametric results). However, when APAE is used, the ranks based on the means and the average *t*-statistics are very similar to those reported in Panel B of Table 3. This provides evidence that APAE is an appropriate measure to be used for parametric tests.

In sum, the ranks of the six methods based on the medians are the same between our study and Alford's and all of us find that the best method is the IND + ROE method.

Table 4. The P/E valuation method: percentage absolute errors and *t*-statistics using parametric tests

Panel A: Percentage absolute error scaled by actual value (PAE/A)

	Comparable-Firm Portfolio					
	MARKET	INDUSTRY	TA	ROE	IND + TA	IND + ROE
Average mean	1.646	1.371	1.583	1.448	1.405	1.379
Ranks based on average mean	6	1	5	4	3	2
Average *t*-statistic[1]						
INDUSTRY	− 1.39					
TA	5.11	5.32				
ROE	0.68	1.43	− 3.27			
IND + TA	0.87	3.48	− 3.10	0.22		
IND + ROE	− 2.15	− 1.57	− 5.43	− 2.11	− 3.42	

Panel A: Percentage absolute error scaled by adjusted value (APAE)

	Comparable-Firm Portfolio					
	MARKET	INDUSTRY	TA	ROE	IND + TA	IND + ROE
Average mean	0.281	0.255	0.289	0.260	0.258	0.245
Ranks based on average mean	5	2	6	4	3	1
Average *t*-statistic[1]						
INDUSTRY	− 7.21					
TA	2.53	8.39				
ROE	− 4.64	1.04	− 5.82			
IND + TA	− 5.80	1.40	− 7.25	− 0.39		
IND + ROE	− 8.85	− 3.50	− 9.93	− 3.12	− 4.15	

Notes: [1]A positive average *t*-statistic indicates that the column is more accurate than the row. Averages are taken over 1973 to 1992. The individual *t*-statistic is computed in each year using the parametric pairwise comparison. The *t*-statistic is based on the difference of the prediction error for each pairwise comparison. Refer to Table 3 for definitions of the comparable-firm portfolios.

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However, our results show that IND + ROE is significantly better than all the other definitions while Alford shows that the superior performance of IND + ROE over INDUSTRY is not significant. Note that even if PAE/A is biased and is affected by outliers, the results based on nonparametric tests (Table 3) are still valid. However, the parametric tests are not applicable to PAE/A.

Although APAE may mitigate bias and outlier problems, it is still right-skewed. The square root of the APAE measure corrects the skewness problems.[14] The parametric tests reported in Table 4 are also applied to the square-root measure and the results are qualitatively the same as APAE. In the later analysis of valuation accuracy, we focus on APAE.

Accuracy of the P/B and the combined P/E-P/B valuation methods

Panel A in Table 5 reports the performance of the P/B valuation method with respect to different definitions of the comparable firms. According to the ranks based on the average means, the performance of the six definitions are in the following order: IND + ROE, ROE, INDUSTRY, IND + TA, MARKET and TA. Unlike the P/E valuation method, ROE outperforms both INDUSTRY and IND + TA and becomes the second most accurate definition. The other definitions maintain similar rankings as under the P/E valuation method. According to the *t*-statistics, IND + ROE is significantly better than all the other definitions. ROE, INDUSTRY and IND + TA do not differ significantly; however, they are all significantly better than MARKET and TA, and MARKET is still significantly better than TA. The improved performance of ROE for the P/B valuation approach over that for the P/E valuation approach is consistent with Bernard's (1994) finding that current ROE explains a good portion of the variations in P/B.

Panel B in Table 5 reports the performance for the combined P/E-P/B valuation method. The performance ranking of the definitions becomes: INDUSTRY, IND + ROE, IND + TA, MARKET, ROE and TA. The *t*-statistics show that INDUSTRY, IND + ROE and IND + TA are not significantly different; however, they are significantly better than MARKET, ROE, and TA. MARKET and ROE perform similarly and perform significantly better than TA. One interesting phenomenon is that while IND + ROE performs best for both the P/E and the P/B valuation approaches respectfully, INDUSTRY is the best definition for the combined P/E-P/B valuation method. This implies that the information contained in ROE is very much captured by the process of combining the P/E and P/B, hence, IND + ROE loses its superior advantages over INDUSTRY. This finding implies that two ratios out of P/E, P/B and ROE are needed for firm valuation, the other one just articulates the difference (e.g., Penman, 1996).

Comparison of the P/E, the P/B and the combined P/E-P/B valuation methods

Table 6 contrasts the performance between the P/E, P/B and the combined P/E-P/B valuation approaches for each of the definitions of comparable firms. The averages of the means of the APAE reported in previous tables are summarized first. For each definition of

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Table 5. The P/B valuation method and the combined P/E-P/B valuation method: percentage absolute error scaled by adjusted value (APAE) and *t*-statistics using parametric tests

Panel A: The P/B valuation method

	Comparable-Firm Portfolio					
	MARKET	INDUSTRY	TA	ROE	IND + TA	IND + ROE
Average mean	0.298	0.267	0.307	0.260	0.269	0.241
Ranks based on average mean	5	3	6	2	4	1
Average *t*-statistic[1]						
INDUSTRY	− 7.60					
TA	2.86	8.87				
ROE	− 7.91	− 1.25	− 9.20			
IND + TA	− 6.41	1.18	− 7.94	1.76		
IND + ROE	− 12.17	− 7.92	− 13.46	− 4.23	− 8.04	

Panel B: The combined P/E-P/B valuation method

	Comparable-Firm Portfolio					
	MARKET	INDUSTRY	TA	ROE	IND + TA	IND + ROE
Average mean	0.259	0.227	0.267	0.260	0.229	0.228
Ranks based on average mean	4	1	6	5	3	2
Average *t*-statistic[1]						
INDUSTRY	− 8.43					
TA	2.63	9.62				
ROE	0.39	7.79	− 1.66			
IND + TA	− 7.25	1.07	− 8.69	− 6.91		
IND + ROE	7.47	0.82	− 8.75	− 7.35	− 0.18	

Notes: [1]A positive average *t*-statistic indicates that the column is more accurate than the row. Averages are taken over 1973 to 1992. The individual *t*-statistic is computed in each year using the parametric pairwise comparison. The *t*-statistic is based on the difference of the prediction error for each pairwise comparison. Refer to Table 3 for definitions of the comparable-firm portfolios.

comparable firms, pairwise comparisons between the three valuation approaches are conducted. The average of the pairwise *t*-statistics are reported based on the pairwise comparisons of P/E versus P/B, P/E versus P/E-P/B, and P/B versus P/E-P/B. The positive sign of the average *t*-statistic indicates the first method is more accurate than the second method in the pairwise comparison.

The results reported in Table 6 indicate that the P/E approach is significantly more accurate than the P/B approach for most of the definitions of comparable firms except ROE and IND + ROE. When IND + ROE is applied, even though not significantly different, the P/E method becomes worse than the P/B method. The combined P/E-P/B method is better than either the P/E or the P/B method no matter what definition of comparable firms is used. The differences are significant except when comparable firms are selected based on ROE. It is interesting to note that when the ROE definition is applied, the advantage of P/E and P/E-P/B valuation approaches over the P/B disappears. This implies that the superior performance of the P/E and the P/E-P/B over the P/B method is due to the earnings

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Table 6. Comparison of the valuation accuracy of the P/E, P/B and combined P/E-P/B valuation method: percentage absolute error scaled by adjusted value (apae) and *t*-statistics using parametric tests

	Comparable-Firm Portfolio					
	MARKET	INDUSTRY	TA	ROE	IND + TA	IND + ROE
Average mean						
The P/E valuation method	0.281	0.255	0.289	0.260	0.258	0.245
The P/B valuation method	0.298	0.267	0.307	0.260	0.269	0.241
The combined P/E-P/B valuation method	0.259	0.227	0.267	0.260	0.229	0.228
Average *t*-statistic[1]						
The P/E valuation method versus the P/B valuation method	3.09	2.22	3.21	0.35	2.13	− 0.90
The P/E valuation method versus the combined P/E-P/B valuation method	− 5.10	− 6.60	− 5.08	− 0.34	− 6.78	− 5.51
The P/B valuation Method versus the combined P/E-P/B valuation method	− 12.01	− 12.12	− 11.71	− 0.90	− 11.93	− 5.36

Notes: [1]A positive average *t*-statistic indicates that the first method is more accurate than the second method Averages are taken over 1973 to 1992. The individual *t*-statistic is computed in each year using the parametric pairwise comparison. The *t*-statistic is based on the difference of the prediction error for each pairwise comparison.
Refer to Table 3 for definitions of the comparable-firm portfolios.

information, and since ROE captures the information contained in earnings, the P/E and P/E-P/B valuation methods lose their comparative advantage over the P/B valuation approach when ROE is applied.

V. Effect of industry fineness and size

Impact of restrictions on numbers of firms for industry on valuation accuracy

When defining INDUSTRY for each target firm, specifying the least number of firms (LNOF) to constitute the industry affects the composition of the number of SIC digits included for the INDUSTRY portfolio. Section III reports the sample distribution for various number of SIC digits with respect to LNOF's ranging from 1 to 11. When the LNOF increases, more firms are captured by applying fewer SIC digits to define the INDUSTRY. However, the increasing LNOF for INDUSTRY may improve prediction because we have more relevant observations to estimate the population median. This section evaluates the trade-off between these effects when restricting the number of firms required for INDUSTRY.

Table 7 reports the APAE when LNOF ranges from two to eleven for all three valuation approaches. The means and the standard deviations of the APAE as well as the incremental differences by increasing the LNOF's are provided. When the LNOF increases from two to seven, the valuation accuracy improves; however, valuation accuracy decreases when

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Table 7. Percentage absolute error scaled by adjusted value (APAE) for different least numbers of firms restricted in defining industry

Least Number of Firms Restricted in each INDUSTRY	P/E Method		P/B Method		Combined P/E-P/B Method	
	Level[1] mean(std.)	Incremental[2] mean(std.)	Level[1] mean(std.)	Incremental[2] mean(std.)	Level[1] mean(std.)	Incremental[2] mean(std.) *
2	26.37% (20.57%)			27.43% (19.16%)	23.39% (16.54%)	
3	(26.04%) (20.41%)	− 0.33% * (5.67%)	26.99% (18.93%)	− 0.44% * (6.16%)	22.98% (16.33%)	− 0.41% * (5.57%)
4	25.89% (20.45%)	− 0.16% * (5.27%)	26.90% (19.04%)	− 0.09% * (5.65%)	22.81% (16.42%)	− 0.16% * (5.27%)
5	25.75% (20.48%)	− 0.14% * (4.51%)	26.78% (18.96%)	− 0.12% * (4.86%)	22.69% (16.42%)	− 0.12% * (4.39%)
6	25.63% (20.47%)	− 0.12% * (3.95%)	26.69% (18.93%)	− 0.08% * (4.16%)	22.60% (16.37%)	− 0.09% * (3.73%)
7	25.56% (20.43%)	− 0.07% * (3.77%)	26.60% (18.80%)	− 0.10% * (4.28%)	22.56% (16.30%)	− 0.05% ! (3.75%)
8	25.57% (20.46%)	0.01% (3.69%)	26.62% (18.86%)	0.02% (4.13%)	22.59% (16.37%)	0.03% (3.71%)
9	25.59% (20.47%)	0.02% (3.12%)	26.64% (18.94%)	0.01% (3.69%)	22.61% (16.42%)	0.03% (3.31%)
10	25.62% (20.47%)	0.03% (2.80%)	26.66% (19.00%)	0.03% (3.53%)	22.64% (16.47%)	0.02% (3.13%)
11	25.67% (20.53%)	0.06% * (2.92%)	26.72% (19.02%)	0.06% * (2.97%)	22.71% (16.52%)	0.08% * (2.81%)

Notes:[1] The mean and standard deviation of the percentage absolute error scaled by adjusted value (APAE) over all the observations in the sample.

[2]The mean and standard deviation of the incremental difference in the APAE between $n+1$ least-number-of-firms-restricted and n least-number-of-firms-restricted, a negative difference indicates that the mean for $n+1$ least-number-of-firms-restricted is lower than that for n least-number-of-firms-restricted.

*the incremental difference is significant at 0.01 significance level.

! the incremental difference is significant at 0.05 significance level.

more than seven firms are required. The improvement of valuation accuracy is significant for each of the increments from number two to seven. This conclusion is applicable across all three valuation approaches.

In sum, the analysis in this section provides a rule of thumb for defining INDUSTRY for a target firm: when an industry definition based on n-digit SIC codes can not generate at least ''six'' other firms (which gives seven in total), the industry should be defined with fewer SIC digits until at least six other firms can be identified.

Effects of number of firms and firm size in target firm's industry on valuation accuracy

Alford investigates the effect of composition of SIC codes on the accuracy of the P/E valuation approach. He finds that the valuation accuracy is greater for industry definitions that rely on four or three SIC digits (as opposed to fewer digits). We compare the valuation

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accuracy of 1–4 digit SIC definitions of INDUSTRY and also find that 3-digit definition performs similar to 4-digit and are significantly better than 2-digit and 1-digit SIC codes. This is true across all valuation approaches. In addition to the definition of industry, the effects of number of firms (NOF) in the target firm's SIC 4-digit industry on valuation accuracy are also examined.

The NOF brings several aspects of industry characteristics into the analysis of valuation accuracy. One aspect is that the benchmark ratio derived from a large number of observations in an industry may tend to be more accurate than the benchmark ratio based on a smaller number of observations. In other words, the sample median in an INDUSTRY may better approximate the population mean/median for that INDUSTRY when there are more observations. Another aspect is that NOF may serve as a surrogate for several industry characteristics, such as entry barriers, competition, and degree of maturity of an industry. While the effect of entry barriers and competition on valuation accuracy is hard to assess, the NOF may surrogate for some of these aspects. One argument for the NOF effect could be that a small NOF may be a surrogate for a less mature industry which tends to have more growth firms and unstable performance measures; hence, the valuation gets harder. On the other hand, an alternative argument is that when an industry reaches maturity, NOF in that industry may start to decrease due to competition, market saturation, merger and acquisition; when changes occur, firms' performance measures may also become unstable.

Closely-held firms are usually smaller than publicly-traded firms. Understanding the prediction error behavior for smaller firms may bring insights into application of the research results of the publicly-traded firms to the closely-held firms. Table 8 reports the mean APAE for five firm-size portfolios and five NOF portfolios. The firm-size portfolios are formed based on total assets of the target firm and the NOF portfolios are formed based on the number of firms in the target firm's SIC 4-digit industry. The portfolios are all formed on a yearly basis. Panel A reports the means of the observations for each of the five firm-size portfolios and Panel B for each of the NOF portfolios. In addition to prediction errors, total assets as well as the number of firms are reported. Mean APAE for MARKET, INDUSTRY and IND + ROE are reported for all three valuation approaches.

Panel A of Table 8 reports that the mean APAE decreases from one firm-size portfolio to the next firm-size portfolio for each of the three methods no matter which definition of comparable firms is used. When the P/E approach is applied, the size effect is significant for every comparison between adjacent size portfolios. When the P/B and the P/E-P/B approaches are applied, the differences are significant for most firm-size-portfolio comparisons except the changes from portfolio 2 to portfolio 3. To compare the size effects between the valuation approaches and different definitions of comparable firms, the differences of the means between the smallest and the largest size portfolios are computed which are also expressed in a percentage format for a relative comparison (means of portfolio 1 are used as the denominators for the percentage computation). When MARKET definition is used, the percentage changes from size portfolio 1 to size portfolio 5 are 29.8%, 28.4% and 25.3% for the P/E, P/B and P/E-P/B approaches respectively, with the P/E approach having the highest percentage change. When INDUSTRY (IND + ROE) is used, the changes are 37.2%−33.3%−34.2% (37.2%−35.4%−34.9%), again with the P/E approach having the highest size effect. It is worth mentioning that the size effect for

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Table 8. The effect of firm size and number of firms in a sic 4-digit industry (NOF) on valuation accuracy means of the percentage absolute error scaled by adjusted value (APAE) by quintiles of firm size and NOF portfolios

			Means of the Adjusted Percentage Absolute Prediction Error								
			MARKET			INDUSTRY			IND + ROE		
Portfolio	Total Assets (millions)	Number of firms in SIC-4 digit industry	P/E	P/B	P/E-P/B	P/E	P/B	P/E-P/B	P/E	P/B	P/E-P/B
Panel A: The portfolios based on firm sizes											
1	33	9.6	0.343	0.347	0.301	0.322	0.318	0.275	0.305	0.292	0.278
2	137	11.3	0.300	0.310	0.265	0.277	0.282	0.238	0.264	0.256	0.241
3	413	12.0	0.276	0.307	0.263	0.254	0.281	0.234	0.246	0.248	0.234
4	1,494	20.0	0.252	0.276	0.238	0.224	0.237	0.201	0.215	0.215	0.204
5	12,815	27.2	0.241	0.249	0.225	0.202	0.212	0.181	0.192	0.189	0.181
		Difference[1]	0.102	0.099	0.076	0.120	0.106	0.094	0.114	0.104	0.097
		Percentage Change[2]	29.8%	28.4%	25.3%	37.2%	33.3%	34.2%	37.2%	35.4%	34.9%
Panel B The portfolios based on number of firms in the SIC 4-digit industry											
1	1,479	1.9	0.302	0.320	0.271	0.296	0.308	0.259	0.284	0.276	0.265
2	1,270	4.3	0.303	0.328	0.279	0.282	0.298	0.251	0.272	0.265	0.254
3	2,690	7.4	0.284	0.322	0.266	0.265	0.292	0.243	0.260	0.274	0.240
4	4,101	17.2	0.296	0.310	0.275	0.252	0.254	0.217	0.238	0.228	0.220
5	5,487	49.9	0.226	0.207	0.199	0.182	0.176	0.156	0.167	0.157	0.159
		Difference[1]	0.076	0.113	0.072	0.114	0.132	0.104	0.117	0.119	0.106
		Percentage Change[2]	25.1%	35.3%	26.5%	38.4%	42.8%	40.0%	41.2%	43.1%	40.2%

Notes: [1]Difference in the mean prediction error between portfolio 5 and portfolio 1. The positive sign means portfolio 5 has smaller prediction error.
[2]Percentage change of the mean prediction error from portfolio 1 to portfolio 5 with portfolio 1 as the 100% base. The positive percentage indicates the prediction error in portfolio 5 is smaller than portfolio 1 as a percentage of portfolio 1's prediction error.

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MARKET definition is less than the size effects for INDUSTRY and IND + ROE. This indicates that large firms enjoy more valuation accuracy when sophisticated definitions are used to identify comparable firms.

The averages of total assets and NOF for each of the firm-size portfolios reported in Panel A indicate that size and NOF are positively correlated, so it is possible that valuation accuracy is positively associated with NOF just because of the size effect. However, Panel B implies that the size effects do not substitute perfectly for NOF effects. The averages of the total assets of the NOF portfolios reported in Panel B are much more evenly distributed than those of the size portfolios reported in Panel A. In addition, the NOF effects on valuation accuracy behave differently than the size effects. Like the size effect, the results in Panel B generally show that firms in industries with large numbers of firms will have higher valuation accuracy and the effects are especially strong when INDUSTRY and IND + ROE are used to define comparable firms. Unlike the P/E approach having the strongest size effect, the P/B approach has the strongest NOF effect. Particular interesting is the fact that the mean APAE for NOF portfolio 5 using the P/B approach gets smaller than that using the P/E approach. This implies that while, in general, the P/E method is a better valuation approach than the P/B method, it loses its comparative advantage for firms in high-NOF industries (NOF portfolio 5 has an average of approximately 50 firms). This phenomenon may complement the argument that the P/B ratio measures superior performance or goodwill (Bernard, 1994; Penman, 1992, 1993; Feltham and Ohlson, 1995), which tend to fluctuate less in a more mature or competitive industry that contains a large number of firms. This issue deserves further research.

VI. Summary and concluding remarks

This paper evaluates the P/E, the P/B benchmark valuation method and a combined P/E-P/B valuation method. We examine the valuation accuracy of all three valuation methods when comparable firms are selected based on industry membership (INDUSTRY), size (TA) and return on equity (ROE), and combinations of industry membership with size (IND + TA) and ROE (IND + ROE). Four prediction error measures are analyzed; percentage absolute error scaled by the actual price (PAE/A), percentage absolute error scaled by the predicted price (PAE/P), percentage absolute error scaled by the adjusted price (APAE), and the square root of APAE. When nonparametric tests are used, the statistical results on the relative valuation accuracy of various definitions of comparable firms and of various valuation approaches are robust with respect to all of these four performance measures. In other words, the potential bias contained in PAE/A does not affect the main conclusion on the comparison of performance across different set of comparable firms. However, this does not mean that the PAE/A can be used for other type of comparisons. For example, larger firms tend to have higher P/E, hence smaller PAE/A, than do the smaller firms. Accordingly, the smaller PAE/A for larger firms will be partly due to such a bias. Even PAE/P corrects this bias, it still has extreme large outliers and parametric tests are not applicable; the parametric tests are only applicable to APAE and the square root of APAE. A measure that parametric tests can apply increases

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effectiveness and efficiency for many tests conducted in this paper. We focus on using APAE.

Like Alford, our analysis of the P/E method shows that valuation accuracy follows the order of IND + ROE, INDUSTRY, IND + TA, ROE, MARKET, and TA. Our results also show that IND + ROE performs significantly better than INDUSTRY whereas Alford reports that IND + ROE performs better but not significantly better than INDUSTRY. The valuation accuracy ranking of the definitions of comparable firms for the P/B approach is IND + ROE, ROE, INDUSTRY, IND + TA, MARKET and TA and the ranking for the combined P/E-P/B approach is INDUSTRY, IND + ROE, IND + TA, MARKET ROE and TA. Like the P/E approach, IND + ROE is the best definition for the P/B approach; however, ROE loses its advantage to when applied to the combined P/E-P/B approach.

For most definitions of comparable firms, the P/E valuation method performs better than the P/B method. This implies that, in the past twenty years, earnings has been the most important single-number firm valuator (more important than the book value), despite recent theoretical work and empirical evidence regarding the importance of book value. As expected, the combined P/E-P/B approach performs better than either the P/E and the P/B approach. This implies that both earnings and book values are value relevant, one does not substitute perfectly for the other. In sum, the results suggest that, when a firm's value is unknown, the best valuation approach among all the methods we evaluated is to select comparable firms based on industry membership and use the combined P/E-P/B valuation method.

We also investigate the effects on valuation accuracy of restrictions on the minimum number of firms used to define industries. We find that at least six other firms to define the target firm's industry is a good rule of thumb for restriction. We also find that valuation accuracy increases with firm size and increases as the number of firms in the target firm's industry (NOF) increases. Similar conclusions can be generated regardless of the definition used to identify comparable firms and regardless of the valuation approach applied. One thing worth noting is that size has its strongest effect on valuation accuracy when using the P/E approach. However, the strongest NOF effect comes when using the P/B approach. The reason that the P/B approach performs better than the P/E approach for firms in industries with many companies is an issue worth exploring.

The benchmark valuation approach has implications for research on the relation between accounting numbers and stock prices. While the variation of the P/E multiple and the P/B multiple can be investigated by using regression methods (Litzenberger and Rao, 1971; Beaver and Morse, 1978; Cheng, Hsu and Etherridge, 1995), the benchmark valuation method has several advantages. First, it does not require an explicit regression model (either linear or nonlinear) in evaluating the relationship between price and accounting information. Second, it provides valuation accuracy measures for each of the observations instead of relying on regression coefficients that have to be constant across all the observations in the regression model. In addition, the role of the P/E and P/B ratios combined can be easily evaluated using the benchmark valuation approach.

The valuation approaches investigated in this paper have practical implications, especially for valuing closely-held firms if the research results of the publicly-traded firms are applicable. The results may assist in devising criteria for selecting comparable firms and in suggesting practical valuation approaches. While this paper shows that a

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combination of P/E and P/B performs better than the P/E and the P/B approaches, the improvement of the combined P/E-P/B method can be further explored. For example, instead of using equal weights, rules of thumb based on theory and empirical results can be developed for assigning optimal weights to the P/E and P/B predictions; in addition, other information (beyond book value) may also be added to improve the accuracy of firm valuation. This constitutes an alternative way of testing the additional information content of other accounting information.

Notes

1. Alford uses firm size (measured by total assets) as a surrogate for risk and return on equity (ROE, measured by the ratio of earnings before extraordinary items to the book value of common equity) as a surrogate for growth. While there may be better surrogates, it is not our focus to explore the optimal surrogates to achieve the essential purpose of this paper: comparison of the P/E and P/B methods. Moreover, other factors such as the accounting method, ownership control, earnings stability can also be used to define comparable firms. Exploration of optimal definition for comparable firms can be endless, we focus on extending Alford's P/E benchmark valuation method to the P/B benchmark valuation method using the similar definitions of comparable firms. Justification of using Alford's definition for the P/B approach is provided in a later paragraph.
2. The ''industry fineness'' is used to describe the sample composition of SIC codes (0-digit to 4-digit) for the industry definition and the effect of the number of firms in an industry on industry definition.
3. We use a simple average, i.e., equal weights, of the P/E and P/B valuations. Optimal weights can be affected by many factors and deserve further research.
4. Closely-held firms are usually smaller than publicly-traded firms. Observing the differences between large and small publicly-traded firms may provide insights to the application of the research results to small closely-held firms.
5. Note that only positive earnings are considered because the P/E ratio is meaningful only when earnings are positive. This paper compares the performance of the P/E and P/B valuation approach and restricts our sample observations to be identical for these two methods. For negative earnings, the P/B approach should be more useful simply because the P/E approach is not available. Due to the omission of negative earnings, our conclusion on the superior performance of the P/E approach over the P/B approach has its limitation. An interesting question for negative earnings would be how well does the P/B valuation approach perform.
6. Instead of the sets of comparable firms being exactly the same for two firms, it is more likely that they differ as to one firm, i.e., themselves. For example, firm i's set of comparable firms may include firm j and $n-1$ other firms and firms j's set of comparable firms may include firm i and $n-1$ other firms.
7. For example, a set of comparable firms for two target firms has a median of 16. Two target firms' P/E ratios are 12 and 20 respectively. The PAE/A is then 0.33 ($|12-16|/12$) for the over-prediction case and 0.20 ($|20-16|/20$) for the under-prediction case.
8. For any set of two errors a/b and c/d, adding the numerator into the denominator will not change the directional difference Assuming $a/b - c/d > 0$, this implies $ad > bc$. When $ad > bc$, we will observe $a/(b+a) - c/(c+d) > 0$, as we do for $a/b - c/d > 0$.
9. We can include negative earnings and negative book values, however, our main focus is for comparing the effectiveness of using the P/E and P/B benchmark valuation method. Studies have shown that negative earnings do not explain price well, including them may bias our results for performance of P/B method. Our results are restricted to assess relative usefulness for positive earnings and book values only. We leave the investigation on the effectiveness of P/E versus P/B valuation method for negative earnings/book value for future research.
10. Our sample criteria is different from Alford, however, our results are similar.
11. When actual price is used as the scaling factor (PAE/A), the average medians when MARKET (IND + ROE) is applied are 0.362 (0.298) and 0.314 (0.243) for the over- and under-prediction cases respectively. This implies that the over-prediction cases (i.e., small P/E relative to median) have larger prediction errors than do

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the under-prediction cases (i.e., large P/E relative to median). However, when predicted price is used as the scaling factor (PAE/P), they are 0.264 (0.228) and 0.461 (0.323) respectively. That is, over-prediction cases have smaller prediction errors than do the under-prediction cases, exactly opposite from the PAE/A measure. If the distribution of P/E is symmetric, we should observe similar prediction errors under the PAE/P measure. The larger errors for the under-prediction cases imply that large PE's are more dispersed than small PE's. This distribution issue is interesting and deserves further research.

12. The test results of using the percentage absolute error scaled by the predicted price (PAE/P) are not reported, they are similar to the results using PAE/A. This implies that even PAE/A is a biased measure by construction, it does not bias the statistical results when comparing prediction errors across different sets of comparable firms. We focus on using APAE (the adjusted PAE/P) for most of our tests because it effectively eliminates the outlier problem without deleting outliers and it facilitates the use of parametric tests. The purpose of Table 3 and Table 4 is to confirm the usefulness of APAE. More over, the test results of using the square root of APAE are not reported even it is less skewed than APAE since they are similar to the results using APAE.
13. Refer to footnote 8 in Alford for a description of the Friedman test.
14. For the MARKET definition using the P/E valuation approach, the skewness measures of PAE/A and PAE/P are 156.08 and 89.33 respectively (zero implies no skewness). APAE and the square root of APAE have skewness of 1.23 and 0.25, respectively, with the latter having an almost perfect score for zero skewness.

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