Price-Earnings and Price-to-Book Anomalies: Tests of an Intrinsic Value Explanation*

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Abstract. Price deviations from basic valuation models based on accounting earnings and book value of owners' equity are used to test the intrinsic value explanation of the price-earnings and price-book value anomalies. Relative price deviations from the implied benchmark prices are used to assign years into high and low deviation groups. Traditional zero investment hedge portfolios are formed in each year, and the returns are compared across high and low deviation years. The high deviation years show significantly larger size- and risk-adjusted returns over four holding periods, providing strong evidence in favor of an intrinsic value explanation of the anomalies. The findings also indicate that the test periods chosen for earlier studies can play a role in the results generated.

Résumé. Les auteurs utilisent les écarts de prix dérivés des modèles d'évaluation de base fondés sur les bénéfices comptables et la valeur comptable des capitaux propres pour vérifier l'explication des anomalies relevées dans les rapports cours-bénéfice et cours-valeur comptable, qui repose sur la valeur intrinsèque. Les écarts relatifs des cours par rapport aux cours de référence implicites sont utilisés par les auteurs pour classer les années selon la nature élevée ou faible des écarts. Pour chaque année sont constitués des portefeuilles traditionnels dont les placements ne font l'objet d'aucune couverture, et les rendements sont soumis à une comparaison combinée des années présentant des écarts élevés et faibles. Les années présentant un écart élevé affichent des rendements supérieurs et ajustés pour tenir compte du risque au cours de quatre périodes de détention, ce qui milite clairement en faveur de l'explication des anomalies reposant sur la valeur intrinsèque. Les résultats indiquent également que les périodes de test choisies dans les études antérieures peuvent avoir influé sur les résultats obtenus.

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Introduction

Basu (1977) demonstrated that a trading strategy based on a ratio of price to accounting earnings (PE) yields positive returns over time. Subsequent research reviewed and extended in Jaffe, Keim, and Westerfield (1989) has shown the PE result to be quite robust. Similarly, Rosenberg, Reid, and Lanstein (1985) showed that a trading strategy based on a ratio of price to book value of owners' equity (PB) also yields positive returns over time. Two explanations for these findings are that (1) earnings (E) and book value (BV) separately provide useful measures of the "intrinsic value"[1] of a company and (2) the positive returns compensate for positive risk differences. Using measures based on an intrinsic value premise to evaluate the traditional PE (PB) trading strategies, we provide evidence in favor of an intrinsic value explanation of the phenomena. The research is intended to improve our understanding of the frequently cited anomalies, and, in particular, to move toward closure on the issue of investor irrationality as an explanation for the excess returns. The research design is such that the results do not necessarily constitute practical guidance on improving trading strategies.

The intuition that motivates the analysis is straightforward. If positive returns from a (zero net investment) hedge strategy are a result of deviations from some measure of intrinsic value, then the subsequent returns should correlate with the initial degree of deviation from that intrinsic value. Further, if the returns do reflect anomalous pricing, the anomaly will not necessarily be uniform over time. That is, prices may deviate from their intrinsic values more in some years than in others. In that case, the returns from a hedge strategy based on E (BV) should be highest in the years of highest price deviations.

Relative expected return measures are constructed from the cross-sectional distributions of PE (PB) ratios and used to split the 30-year sample period into periods of relatively high and low deviations.[2] Traditional hedge portfolio strategies are compared across the high and low deviation years over four holding periods.

The results of the tests indicate that the returns to the PE (PB) hedge portfolios are significantly higher when the portfolios are formed in years of large price deviations from intrinsic value. To provide additional evidence on the extent to which these results are attributable to known risk differences, the firm returns are adjusted for beta and size effects. These adjustments to raw returns, while reducing the magnitudes of the excess returns, increase the statistical significance of the remaining positive returns in favor of the intrinsic value explanation. The results may also explain why the PE hedge strategy generates different magnitudes of excess returns (Jaffe et al. 1989) in different time periods.

The intrinsic value models and hypothesis

As stated, the PE and PB anomalies have already been established in the literature. The implicit assumption underlying the research design in these studies is that if prices deviate from a constant multiple of earnings (book value), then a simple trading strategy based on ranked deviations generates excess returns. If the success of the trading strategies is interpreted from an intrinsic value perspective, it implies that earnings (book value)[3] represent a measure of intrinsic value, so that prices should not deviate "too far" from this value. As a corollary, when prices do deviate, the degree of deviation should correlate with the return that can be earned as prices revert toward the intrinsic value. If there is no correlation between a reasonable measure of deviation from intrinsic value and the excess return, the intrinsic value explanation seems implausible. This intuitive, but relatively simple, idea motivates the hypothesis and tests considered in this paper.

To motivate the tests that follow, we begin with the implicit pricing models from prior studies.[4]

$$P_{jt}/E_{jt} = F_t + \epsilon_{jt} \quad \text{(A)}$$
$$[P_{jt}/B_{jt} = H_t + \mu_{jt} \quad \text{(B)}]$$

where:

P_{jt} = The price of security j at time t ($j = 1,\ldots,N$),

E_{jt} = The accounting earnings of company j at time t,

F_t = The cross-sectional constant PE ratio of the N securities at time t (proxied by the median PE),

B_j = The book value of owners' equity of company j at time t,

H_t = The cross-sectional constant PB ratio of the N securities at time t (proxied by the median PB), and

$\epsilon_{jt}(\mu_{jt})$ = The deviation of price relative to earnings (book value) for company at time t.

Formation of portfolios on the basis of ranked PE (PB) ratios, as in Basu (1983) and Ou and Penman (1989), is consistent with this pricing structure.

The valuation model implied by equation A (B) is

$$P_{jt} = F_t E_{jt} + \epsilon_{jt} E_{jt} \quad \text{(A')}$$
$$[P_{jt} = H_t B_{jt} + \mu_{jt} B_{jt} \quad \text{(B')}]$$

The right-hand term $\epsilon_{jt} E_{jt}$ ($\mu_{jt} B_{jt}$) is a measure of the (relative) price deviation. If the price reverts over time toward its intrinsic value implied by $E_{jt}(B_{jt})$, then an index of the return that can be expected over that period is provided by $\epsilon_{jt} E_{jt}/P_{jt} \equiv IVE_{jt}$ ($\epsilon_{jt} B_{jt}/P_{jt} \equiv IVB_{jt}$).

Accordingly,

$$IVE_{jt} \equiv (P_{jt}/E_{jt} - F_t)/(P_{jt}/E_{jt})$$
$$[IVB_{jt} \equiv (P_{jt}/B_{jt} - H_t)/(P_{jt}/B_{jt})].$$

We emphasize that the notion of a cross-sectionally constant relationship between price and earnings is implicit in the PE (PB) anomaly studies.[5] Clearly, this is an extreme interpretation of the intrinsic value notion. A more reasonable argument is that P_{jt}/E_{jt} (P_{jt}/B_{jt}) should not deviate "too far" from the average.[6] Therefore, the following tests use only those firms in the extremes of the IVE_{jt} (IVB_{jt}) distribution.

If price deviations are greater in some periods than in others, we argue that the expected return to the PE (PB) hedge strategy should also be greater in those periods. IVE_{jt} (IVB_{jt}) is interpreted as an index of how far a price has deviated from the intrinsic value implied by the accounting values. In turn, this implies that *IVE* (*IVB*) can be used as a basis for comparison of PE (PB)–based hedge strategy returns across years. Thus, the hypothesis to be tested is

> H_N: There is no difference in returns to zero-net-investment hedge portfolios formed in periods with high price deviations relative to earnings [IVE^H] (book values [IVB^H]), and returns to hedge portfolios formed in periods of low price deviations relative to earnings [IVE^L] (book values [IVB^L]).

The alternate hypothesis is that the returns to the hedge portfolios are positively correlated with IVE^H (IVB^H).

A link to Ohlson's valuation model

We try to provide additional insight into how both earnings and book value can measure intrinsic value by using the valuation model developed in Ohlson (1989, 1991). We emphasize that this model assumes market efficiency and does not predict anomalies; we adapt it and use it merely as an example to clarify the intuition underlying the empirical test.

The analysis in Ohlson (1989, 1991) shows that under specific assumptions, prices are a weighted average of capitalized earnings, current book values, and other information, formally:

$$P_{jt} = k\theta E_{jt} + (1 - k)B_{jt} - kd_{jt} + V_{jt} \quad (1)$$

where:

$0 \leq k \leq 1$;

θ = The capitalization factor, and $\frac{R_F}{(R_F - 1)}$, where R_F is 1 plus the risk-free rate of interest,

d_{jt} = Dividends of company *j* at time *t*,

V_{jt} = "Other" information that is not reflected in *E* or *B*, and all other variables are as previously defined.

The weight put on current earnings (k) depends on the extent to which current earnings are valuation relevant. If earnings are valuation sufficient, then $k = 1$, which is consistent with the traditional notion of earnings being perceived as "permanent" and with F_t being equal to θ. Similarly, if book value is valuation sufficient $k = 0$ and $H_t = 1$. Thus, k represents the importance of earnings for valuation, at least relative to book value. On the other hand, V_{jt} reflects all other information and would thus capture notions such as growth by defining the specific variables which predict growth.

To derive either of the pricing models used in our tests requires $V_{jt} = 0$ and $k = 0$ or $k = 1$. If the true V_{jt} is zero and the true k is 0, then deviation from book value will be identical to deviation from intrinsic value, and the PB strategy will generate excess returns. Alternatively, if the true $V_{jt} = 0$ and the true k is 1, then deviation from capitalized earnings will indicate mispricing, and the PE strategy will generate excess returns. It follows that if the true k varies over time, and/or the market's estimate of the true k varies over time, in any given year either a PE trading strategy or a PB trading strategy would generate excess returns. We illustrate two such cases in Table 1. In panel A of Table 1, we illustrate the pricing of three firms, all with book value of 100 but different earnings (and zero dividends), assuming that $k = 0.5$, $V_{jt} = 0$, and $R_f = 1.10$. For all the cases that follow, we use panel A as the benchmark and the correct pricing scenario. Recall that k reflects the (relative) valuation sufficiency of earnings.

For each case in panel B, we allow for a particular type of pricing error and show what the resulting PE and PB ratios would be, again based on the model in (1). We assume the price reverts to the intrinsic value after one period and report the expected excess returns, assuming that panel A represents the correct prices. The trading strategy is based on buying shares of firms with the lowest ratios and selling shares of firms with the highest ratios. Cases 1 and 2 represent situations in which either a PE or a PB strategy would generate excess returns but not both. In case 1, we assume the earnings weight (k) is too high. Investors overemphasize earnings by assuming that the current profitability will persist longer than it will. The price of the poor performer will be too low and that of the good performer too high. For our purposes, the important aspect is the effect on the PE and PB ratios. The PE range becomes tighter while the PB range increases. Furthermore, a trading strategy that requires one to go short if the ratio is above the median, or to go long if it is below the median will generate positive returns only if the PB ratio is used, and this is the ratio with the range that is "too large." Using the PE ratio would give the wrong signal. In case 2, we assume that the weight on earnings is too small. As a result, the PE range increases and the PB range diminishes, and only the PE trading rule will generate excess returns. Hence, cases 1 and 2 represent scenarios in which a PE trading rule or a PB trading rule might work in a particular year but does not allow for the possibility that both might generate excess returns in the same year. However, we know from prior empirical work that both the PE and PB strategies generate excess returns in samples pooled over time, raising the possibility that both may work in the same year. Thus, it is important to investigate whether it is plausible that both ratios sustain successful trading strategies in the same year within the context of the valuation model.

In the final two cases, we assume that the investors use the correct weights on

TABLE 1
Examples to illustrate price deviations and excess returns for price-to-earnings and price-to-book value ratios

Panel A: Prices are "correct", $k = 0.5$ and $V_{jt} = 0$.

Firm	ROE (i.e., E/B)	Price	PE ratio	PB ratio	Return to PE strategy	Return to PB strategy
A	0.060	83.0	13.83	0.83	—	—
B	0.091	100.0	11.00	1.00	—	—
C	0.160	138.0	8.63	1.38	—	—
Panel B — Case 1: The market's estimate of $k = 0.90$ is too high.						
A	0.060	69.4	11.57	0.69	−0.196	0.196
B	0.091	100.0	11.00	1.00	—	—
C	0.160	168.4	10.53	1.68	−0.181	0.181
Panel B —Case 2: The market's estimate of $k = 0.10$ is too low						
A	0.060	96.6	16.10	0.97	0.141	−0.141
B	0.091	100.0	11.00	1.00	—	—
C	0.160	107.6	6.73	1.08	0.283	−0.283

Panel B —Case 3:The market's estimate of $k = 0.5$ is correct but V_{jt} is incorrectly assumed to be non-zero and positively correlated with ROE.

Firm	ROE	V_{jt}	PRICE	PE Ratio	PB Ratio	Return to PE strategy	Return to PB strategy
A	0.060	−40	43.0	7.17	0.43	0.930	0.930
B	0.091	0	100.0	11.00	1.00	—	—
C	0.160	+40	178.0	11.13	1.78	0.225	0.225
Panel B —Case 4:The market's estimate of $k = 0.5$ is correct but V_{jt} is incorrectly assumed to be non-zero and negatively correlated with ROE.							
A	0.060	+40	123.0	20.50	1.23	0.325	0.325
B	0.091	0	100.0	11.00	1.00	—	—
C	0.160	-40	98.0	6.13	0.98	0.408	0.408

[1]The valuation model is derived from Ohlson (1989,1991):

$$P_{jt} = \theta k E_{jt} + (1 - k)B_{jt} - k\, d_{jt} + V_{jt}$$

where:
P_{jt} is the price of security j at time t ($j = 1,\ldots,N$),
E_{jt} is the accounting earnings of company j at time t,
B_{jt} is the book value of owners' equity of company j at time t,
θ is the capitalization factor and $0 < k < 1$,
d_{jt} is dividends of company j at time t,
V_{jt} is "other" information which is orthogonal to E and B
and for all examples we assume: $\theta = 11$ (i.e., $R_F/(R_F\text{-}1)$ with $R_F = 1.10$),
$B_{jt} = 100$ and $d_{jt} = 0$.

[2] The trading strategy is based on (correct price-price)/price, which is positive (negative) for the long (short) position. The values shown are the amounts contributing to the excess returns. So, for example, in panel B case, 1 below the return to the PB trading strategy is a positive 38 percent.

earnings and book value but choose (incorrectly) to use additional information to value the firms. We are assuming two correlation scenarios, but there are many others.

In case 3, we assume that the market incorrectly assumes that other information is positively correlated with the firms' current performance, while in case 4 we assume that it is negatively correlated. In both cases, we assume that the additional information is large enough to have a major effect on prices. The result is that for both cases 3 and 4, the PE range is high (relative to case 1 when the PE strategy is a poor one), and the trading strategy will yield positive excess returns. Similarly, in both cases, the PB range is high (relative to case 2 when the PB strategy is a poor one), and the trading rule will yield positive returns.

These cases represent only four examples of the possible permutations that could result from mispricing. They represent extreme versions of the phenomena that may lead to *IVE* (*IVB*) being sufficient to generate excess returns. The purpose of introducing them here is not to generate testable hypotheses but to illustrate when and how the individual ratios may reflect intrinsic values, and why PE and PB ratios do not necessarily provide equivalent indices of mispricing at all points of time.

Data and test procedures

Data

The sample is selected from the period 1950 to 1985. Observations are included if the following selection criteria are satisfied:

1 Annual earnings per share and owners' equity were available on the "Extended" (Standard and Poors) Compustat Annual Industrial File at The Center for Research in Security Prices (CRSP) at the University of Chicago at the time of data collection.
2 A firm's fiscal year end is December 31.
3 CRSP Monthly Master File has security price and adjustment factor available for the last trading day in March of the year following the fiscal year end.[7]
4 CRSP Monthly Return Files (American and New York Stock Exchanges) have monthly returns for at least 15 months following the fiscal year. The selection procedure results in a sample of observations with annual totals ranging from 257 in 1950 to 1061 in 1980. The price data are adjusted for stock splits and stock dividends in the period from the fiscal year-end to the price date.

The years used in the test are from 1950 to 1980 because 1980 is the last year for which data were available for four holding periods.

Test procedures

The following procedures were used to determine the extent to which prices deviate from the "fundamental" measures in any given portfolio formation year. The tests are not intended to represent an implementable strategy since the classification is made ex post.[8]

1 For each year, firms were ranked by PE (PB), and the median PE (PB) in each

year was chosen to represent the cross-sectionally constant ratio (i.e., F_t (H_t)) for that year. Firms with negative earnings (book values) in the portfolio formation year were excluded from the PE (PB) rankings.[9]

2 The index of the return to a PE (PB) deviation–based hedge strategy was calculated for each firm using IVE_{jt} (IVB_{jt}).[10]

3 To compare the price deviations across portfolio formation years, the IVE_{jt} (IVB_{jt}) for the firms at the 20th and 80th percentile in each year were calculated and their absolute values averaged. The 20th and 80th percentiles were chosen to provide a measure of the deviation from IV because (a) small deviations around the median PE (PB) ratio are more likely to reflect omitted variables relative to earnings or book values, (b) the returns to the hedge strategy were calculated using only firms in the top and bottom 20 percent of PE (PB) ratios each year, and (c) to compare the price deviations across years, use of the minimum deviation within the trading strategy portfolios limits potential biases from outliers in the sample.

4 Years were ranked according to the magnitude of this average absolute *IVE* (*IVB*), with the top eight classified as "high deviation" years and the bottom eight as "low deviation" years. The years ranked in the middle are omitted from the reported test results, although a split based on all years provides similar (albeit weaker) results.[11]

Tables 2 and 3 show the price deviations for the firms at the 20th and 80th percentiles and the average of their absolute values for each year, based on the PE and PB models, respectively. On each table, the annual value of F_t or H_t is shown and the year is identified as a year of high or low price deviation based on the magnitude of the average (absolute) *IVE* (*IVB*). High (low) deviation years do not necessarily correspond with high (low) K_t or H_t. Comparison of the years classified as high/low in tables 2 and 3 indicate that the two strategies do not classify years identically. For example, 1960 and 1961 are classified as "low deviation" years based on *IVE* but "high deviation" years based on *IVB*.

A zero investment (hedge) strategy is implemented by buying (long) the shares of firms in the lowest 20 percent of PEs (PBs) and selling (short) the shares of firms in the highest 20 percent of PEs (PBs) in each portfolio formation year. The annual returns are calculated for the four years (holding periods) following the formation year.[12] The initial tests use cumulative raw returns; subsequent tests adjust the raw returns for systematic risk and size effects. In all cases, the portfolios represent a "buy and hold" strategy; that is, there is no rebalancing of portfolios over the four years. To test the null hypothesis, the returns within each holding period are averaged for the high (IVE^H (IVB^H)) and low (IVE^L (IVB^L)) deviation years, and these average returns are compared.

Test results

Results from the PE strategy

The average annual returns across all years from implementing the PE hedge strategy described above are reported at the top of Table 4. The results indicate

TABLE 2
Price deviations (in percent) implied by price-to-earnings ratios

Year	20th percentile	80th percentile	Mean of absolute value	Classification	Ft
1950	49.2	−33.0	41.1	High	7.2
1951	36.8	−31.7	34.3	—	8.5
1952	40.8	−29.3	35.1	—	9.5
1953	43.3	−30.1	36.7	—	9.4
1954	29.9	−26.2	28.1	Low	12.8
1955	32.0	−26.6	29.3	Low	12.0
1956	31.0	−28.1	29.6	Low	10.6
1957	36.5	−26.9	31.7	—	10.8
1958	34.9	−30.2	32.6	—	18.1
1959	35.6	−32.5	34.1	—	14.0
1960	25.8	−34.5	30.2	Low	17.5
1961	26.9	−31.3	29.1	Low	18.8
1962	36.4	−29.7	33.1	—	16.3
1963	33.3	−28.3	30.8	Low	16.8
1964	38.9	−27.3	33.1	—	16.0
1965	29.7	−30.5	30.1	Low	15.1
1966	37.1	−35.1	36.1	—	13.9
1967	32.0	−40.1	36.1	—	15.2
1968	35.5	−42.0	38.8	—	17.9
1969	33.0	−45.0	39.0	High	13.4
1970	43.6	−39.5	41.6	High	17.2
1971	50.3	−46.0	48.2	High	16.7
1972	36.3	−45.2	40.8	High	11.1
1973	40.0	−41.5	40.8	High	7.6
1974	43.7	−40.8	42.3	High	6.5
1975	39.2	−38.0	38.6	—	8.9
1976	30.7	−32.5	31.6	—	7.8
1977	28.9	−29.9	29.4	Low	7.5
1978	32.2	−35.5	33.9	—	7.4
1979	36.3	−39.2	37.8	—	6.1
1980	45.9	−40.8	43.4	High	9.0

F_t is the cross-sectional median value of the price-to-earnings ratio for the firms in the sample in period t.

that on average a PE hedge strategy yields positive returns (6.2 percent) within one year and that the average return increases through the fourth holding period to 36.9 percent. These results are consistent with the findings in Basu (1977) and Ou and Penman (1989).

The earnings-based intrinsic value hypothesis suggests that the return to a PE strategy should be largest in those years when the price deviations based on PEs are greatest, that is, for IVE^H years. To test the first hypothesis, the average returns for two partitions of the sample are calculated. The first partition splits

TABLE 3
Price deviations (in percent) implied by price to book value ratios

Year	20th percentile	80th percentile	Mean of absolute value	Classification	*Ft*
1950	54.8	−39.1	47.0	Low	1.03
1951	54.1	−38.9	46.5	Low	1.04
1952	47.2	−38.7	43.0	Low	0.98
1953	62.0	−38.1	50.0	—	0.96
1954	53.4	−42.7	48.1	—	1.32
1955	52.4	−44.0	48.2	—	1.46
1956	58.7	−43.2	51.0	—	1.30
1957	67.8	−42.2	55.0	—	1.14
1958	65.1	−39.2	52.2	—	1.60
1959	68.5	−45.2	56.9	High	1.41
1960	66.6	−46.5	56.6	High	1.51
1961	67.1	−45.1	56.1	High	1.54
1962	63.0	−45.1	54.1	—	1.31
1963	61.5	−45.4	53.5	—	1.48
1964	63.9	−44.1	54.0	—	1.64
1965	59.2	−43.2	51.2	—	1.84
1966	64.0	−48.1	56.1	High	1.76
1967	59.1	−51.0	55.1	High	1.87
1968	59.8	−43.0	51.4	—	2.20
1969	64.0	−46.7	55.4	High	1.49
1970	62.5	−45.1	53.8	—	1.58
1971	75.8	−46.8	61.3	High	1.59
1972	68.1	−44.7	56.4	High	1.16
1973	58.0	−43.1	50.6	—	0.86
1974	55.5	−42.0	48.8	—	0.71
1975	51.3	−40.0	45.7	Low	0.93
1976	53.8	−34.7	44.3	Low	0.95
1977	52.5	−32.9	42.7	Low	0.96
1978	42.8	−41.7	42.3	Low	0.97
1979	46.7	−49.1	47.9	Low	0.82
1980	59.1	−49.5	54.3	—	1.15

H_t is the cross-sectional median value of the price-to-book ratio for the firms in the sample in period t.

the sample into the eight highest and eight lowest (8/8) price deviation years. To increase the power of the tests, the sample was also partitioned into the four highest and four lowest (4/4) price deviation years.[13] The returns, and the differences between them, are reported in Table 4. The results for the 8/8 split reported in panel A of Table 4 show that for all four holding periods, the returns for the IVE^H years are larger than for the IVE^L years. The difference increases as the holding period lengthens and is statistically significant for the last three holding periods. By the fourth holding period, the difference totals 43.4 percent. Not only is the

TABLE 4
Average cumulative (in percent) returns from the price earnings (PE) hedge strategy when years are classified as years of high or low price deviations

	Holding period in years			
	1	2	3	4
All years	6.2	14.8	23.7	36.9
Panel A —Eight/eight year split				
High deviation years*	9.6	20.9	32.5	60.7
Low deviation years†	2.0	3.5	9.9	17.3
Difference	7.6	17.4	22.6	43.4
t-statistic	(1.19)	(1.87‡)	(1.85‡)	(2.99‡)
Randomization probability§	0.15	0.04	0.04	0.004
Panel B —Four/four year split:				
High deviation years▼	11.1	25.7	36.6	67.3
Low deviation years#	0.4	-4.9	-0.6	4.5
Difference	10.7	30.6	37.2	62.8
t-statistic	(0.93)	(2.13‡)	(1.75**)	(2.70‡)
Randomization probability	0.21	0.06	0.07	0.03

* The eight high deviation years are 1950, 1969, 1970–1974, and 1980.
† The eight low deviation years are: 1954, 1955, 1956, 1960, 1961, 1963, 1965, and 1977.
‡ *t*-statistic is significant at 5 percent confidence level
§ The "randomization probability" is the probability of obtaining the reported difference in the holding period returns, based on a distribution formed from mean differences estimated from randomly assigning firms to one group. The distribution is based on 1000 iterations of the random assignment.
▼ The four highest deviation years are: 1970, 1971, 1974, and 1980.
The four lowest deviation years are: 1954, 1955, 1961, and 1977.
** t-statistic is significant at 10 percent confidence level.

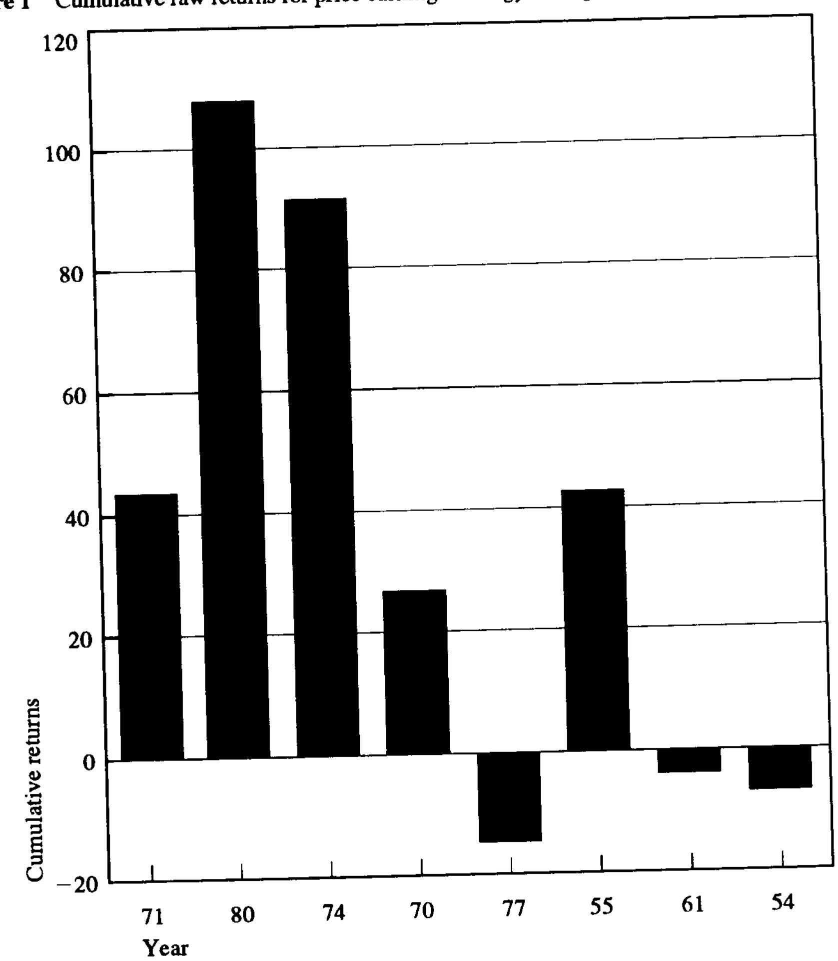
average cumulative return from the hedge strategy in the IVE^H years more than 60 percent, but also the return is more than three times the average cumulative return for the IVE^L years. The returns for the most extreme pricing deviation years in the 4/4 split are reported in panel B of Table 4. The differences are positive and increasing over all holding periods. The difference increases from 10.7 percent in the first holding period to 62.8 percent in the fourth holding period; the difference is statistically significant for the last three holding periods. For the 4/4 split, the differences are considerably larger than the differences reported for the 8/8 split, providing evidence that the returns to the PE trading strategy are correlated with the degree of price deviations at the time of portfolio formation. The differences reported in Table 4 could be influenced by a large return in one of the years, particularly for the 4/4 split. Figure 1 shows the cumulative returns (through four holding periods) for each of the eight years. It is clear that the pattern is consistent in the high and low deviation years.

The conclusion using raw returns is that there appear to be significantly higher returns to a PE trading strategy when the strategy is implemented in years of large price deviations. Consideration of whether these returns are attributable to identifiable risk variables is deferred to the next section.

Results from the PB strategy

The average annual returns from implementing the PB hedge strategy are reported at the top of Table 5. Consistent with Rosenberg, Reid, and Lanstein (1985), the PB strategy yields positive average returns for all four holding periods. The average returns range from 6.3 percent over one holding period to 48.6

Figure 1 Cumulative raw returns for price earnings strategy through four holding periods



percent over four holding periods. To test the hypothesis that returns to the PB hedge strategy are related to the magnitude of the price deviations in the portfolio formation years, the returns for the eight IVB^H and eight IVB^L years (8/8) are compared. The results are reported in panel A of Table 5. As in the case of *IVE*, the differences in returns are positive for all four holding periods ranging from 8.7 to 23.1 percent and are statistically significant for a one-year holding period.

As is the case in the tests based on *IVE*, the sample was further partitioned into the four highest and four lowest (4/4) price deviation years. The returns from these partitions are reported in panel B of Table 5. The differences for the

TABLE 5
Average cumulative (percent) returns from the price to book value (PB) hedge strategy when years are classified as years of high or low price deviations

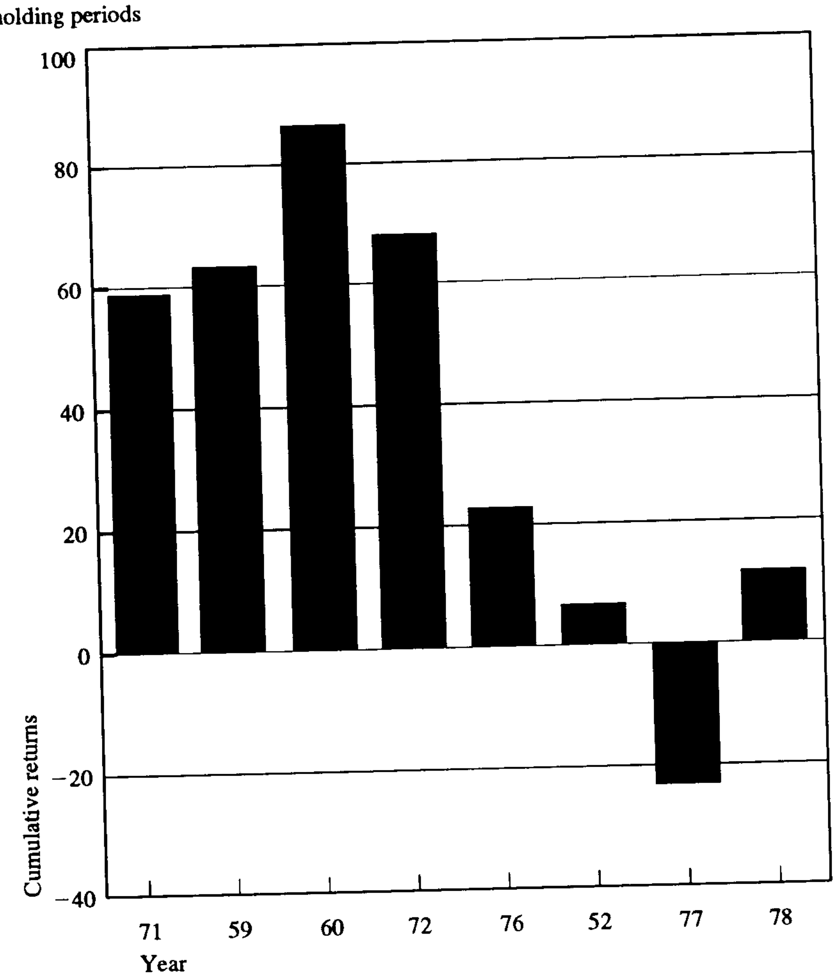
	Holding period in years			
	1	2	3	4
All years	6.3	16.6	30.4	48.6
Panel A —Eight/eight year split				
High deviation years*	8.2	22.0	32.6	53.5
Low deviation years†	−0.5	6.2	16.3	30.4
Difference	8.7	15.8	16.3	23.1
t-statistic	(1.50‡)	(1.40)	(0.89)	(1.33)
Randomization probability§	0.08	0.08	0.18	0.08
Panel B —Four/four year split				
High deviation years▼	1.6	19.5	41.0	68.6
Low deviation years#	−2.4	−4.3	−14.6	4.5
Difference	4.0	23.8	55.6	64.1
t-statistic	(0.43)	(1.37)	(3.35**)	(5.57**)
Randomization probability	0.38	0.11	0.02	0.01

* The eight high deviation years are: 1959–1961, 1966, 1967, 1969, 1971, and 1972.
† The eight low deviation years are: 1950-1952, 1975–1979.
‡ *t*-statistic is significant at 10 percent confidence level.
§ The "randomization probability" is the probability of obtaining the reported difference in the holding period returns, based on a distribution formed from mean differences estimated from randomly assigning firms to one group. The distribution is based on 1,000 iterations of the random assignment.
▼ The four highest deviation years are 1959, 1960, 1971, and 1972.
The four lowest deviation years are 1952, 1976, 1977, and 1978.
** *t*-statistic is significant at 5 percent confidence.

4/4 split are generally larger than those for the 8/8 split, increasing from 4.0 percent in holding period 1 to 64.1 percent in holding period 4. The differences for holding periods of three and four years for the 4/4 split are statistically significant. Figure 2 shows the cumulative returns through four holding periods for each of the eight years. It is clear that the difference of the mean cumulative return reflects the pattern for all the years in the 4/4 split.

These results using raw returns suggest that the PB trading strategy generates higher returns when portfolios are formed in years of relatively high price deviations. Although these results are not as pronounced as the PE results, together they provide supporting evidence for the intrinsic value hypothesis. However,

Figure 2 Cumulative raw returns for price-to-book value strategy through four holding periods



the results might also be attributable to different risk characteristics of the portfolios across the years. The role of well-known risk measures in explaining the results is considered in the next section.

Tests for risk

Previous research (Banz 1981; Reinganum 1981; Jaffe et al. 1989) has suggested that differences in size or other risk characteristics across the two sides of the hedge portfolio may contribute to the returns to the hedge strategy. However, given the research design, such differences may exist on average and contribute to the positive mean return to the hedge portfolios without causing a rejection of the intrinsic value hypothesis. The basic results reported in tables 4 and 5 are compromised only if the contribution of such factors to the observed returns is higher in high deviation years than in low deviation years. If no such correlation is observed, the intrinsic value hypothesis is a plausible explanation of the higher observed return to the hedge strategy in the high deviation years.

The most commonly used measure of risk is beta, the coefficient that captures the impact on a firm's return from a change in the market's return. Some studies use (beta) risk-adjusted returns in their trading strategies (e.g., Banz 1981; Basu 1983). Further, Beaver and Morse (1978) find annual shifts in the betas of high and low PE portfolios across years, which they ascribe to the "transitory" component of earnings.[14] Banz (1981) and Reinganum (1981) argue that the PE anomaly observed by Basu (1977) is attributable to a difference in size. This coincides with a perception that size proxies for risk. Although Basu (1983) and Jaffe et al. (1989) present evidence that the PE anomaly remains after controlling for size, it nonetheless affects the returns from the hedge strategy. To incorporate the size and beta effects, the hypothesis tests reported in the previous section were repeated for returns adjusted for both factors.[15] First, the raw returns were adjusted by $\beta_{jt}R_{mt}$, where R_{mt} is the return on the market as a whole in period t. The betas were estimated over a 60-month period with 48 months prior to the price date and 12 months after the price date. Given that this study is an ex post descriptive analysis, the time period for beta estimations was chosen to ensure that the betas were not biased by focusing only on pre-earnings announcement data. The size adjustment process is the same as that used in Ou and Penman (1989). For each year, firms were placed into 10 portfolios based on their size (market value), and each firm's beta-adjusted return in each year was reduced by the mean beta-adjusted return of the size-based portfolio of which it was a member.

Results from the PE strategy with beta- and-size adjusted returns

The average beta- and-size adjusted returns for all years and all four holding periods for the PE strategy are reported at the top of Table 6. As expected, these returns are considerably smaller than the unadjusted returns reported in Table 4, although the average returns to the trading strategy are still positive over all four holding periods.

The adjusted returns and differences for the high and low deviation years

TABLE 6
Cumulative beta- and size-adjusted (percent) returns from the price to earnings (PE) hedge strategy when years are classified as years of high or low price deviations

	Holding period in years			
	1	2	3	4
All years	5.2	9.8	14.6	20.0
Panel A—Eight/eight year split				
High deviation years*	8.9	17.1	24.4	41.6
Low deviation years†	1.4	1.2	5.8	5.7
Difference	7.5	15.9	18.6	35.9
t-statistic	(1.58‡)	(2.12§)	(2.34§)	(3.53§)
Randomization probability▼	0.09	0.02	0.01	0.00
Panel B—Four/four year split				
High deviation years#	11.7	24.0	28.2	55.7
Low deviation years**	1.5	−3.5	1.0	2.9
Difference	10.2	27.5	27.2	52.8
t-statistic	(1.14)	(2.25§)	(1.95§)	(3.20§)
Randomization probability	0.12	0.04	0.04	0.01

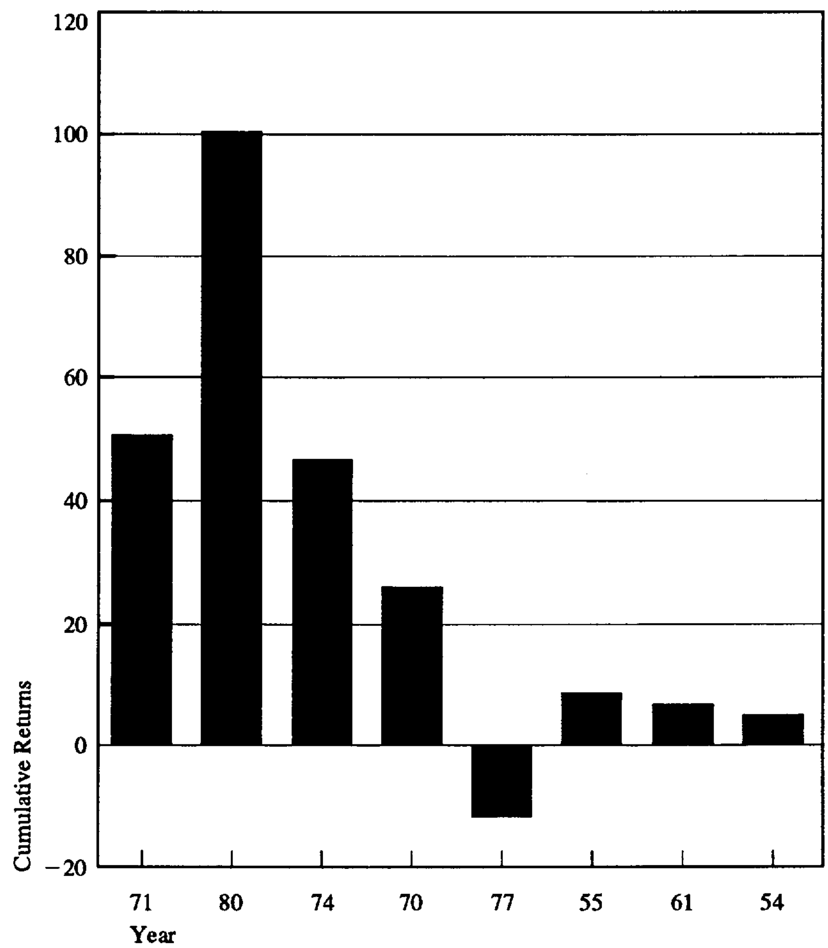
* The eight high deviation years are 1950, 1969, 1970–1974, and 1980.
†Δ25 The eight low deviation years are 1954, 1955, 1956, 1960, 1961, 1963, 1965, and 1977.
‡t-statistic is significant at 10 percent confidence level.
§t-statistic is significant at 5 percent confidence level.
#The four highest deviation years are 1970, 1971, 1974, and 1980.
▼ The "randomization probability" is the probability of obtaining the reported difference in the holding period returns, based on a distribution formed from mean differences estimated from randomly assigning firms to one group. The distribution is based on 1,000 iterations of the random assignment.
** The four lowest deviation years are 1954, 1955, 1961, and 1977.

based on IVE are reported in panels A and B of Table 6 for the 8/8 and 4/4 splits, respectively. Comparison is made to the equivalent unadjusted returns reported in Table 4. For both splits, the absolute value of the differences in all holding periods is lower for the adjusted returns than for the unadjusted returns. For example, by holding period 4 the comparative differences are 35.9 (Table 6) versus 43.4 (Table 4) percent for the 8/8 split and 52.8 (Table 6) versus 62.8 (Table 4) percent for the 4/4 split. However, the statistical significance of the differences increases as does the essentially increasing monotonic pattern across holding periods and degree of partitioning. Figure 3 shows the cumulative beta- and size-adjusted returns through four holding periods for each year included in the 4/4 split. The consistency in returns for each of the high and low error years is quite apparent. What is particularly interesting is that the adjusted returns to the trading strategy are so close to zero in the four lowest IVE years.

The test results reported in Table 6 indicate that beta and size do not explain the differences between returns from trading strategies from IVE^H and IVE^L portfolios.

Results from the PB strategy with beta- and-size adjusted returns
Table 7 reports the results for the PB hedge strategy using beta- and size-adjusted returns. As in the PE case, the adjustment procedures reduce the absolute values of the returns from the PB hedge strategy, and in some cases the differences in the returns between the high and low deviation years. Nevertheless, through all four holding periods and for all partitions, the differ-

Figure 3 Cumulative adjusted returns for price-to-earnings strategy though four holding periods



ences in the returns between high and low deviation years are positive and increasing over time. A comparison of tables 5 and 7 indicates that the size and beta adjustments, rather than eliminating the price deviation effect, have made it more pronounced. The differences reported in Table 7 are statistically significant over all holding periods for the 8/8 split and over holding periods of two, three, and four years for the 4/4 split.

The results in Table 7 show that risk, as measured by beta and size, cannot explain all the differences in PB hedge strategy returns between portfolios formed in high and low deviation years. The cumulative beta- and size-adjusted returns through four holding periods from the PB trading strategy are shown for the 4/4 split in Figure 4. The consistency in the pattern for the high and low error years is noticeable. It is also interesting to note that the cumulative adjusted returns are actually negative in all four low error years. The tentative conclusion based on raw

TABLE 7
Cumulative beta- and size-adjusted (percent) returns from the price to book (PB) hedge strategy when years are classified as years of high or low price deviations

	Holding period in years			
	1	2	3	4
All years	2.4	6.3	12.2	17.1
Panel A—Eight/eight year split				
High deviation years*	7.6	16.3	24.5	34.1
Low deviation years†	−0.9	0.2	4.3	3.7
Difference	8.5	16.1	20.2	30.4
t-statistic	(2.29‡)	(2.68‡)	(2.24‡)	(2.97‡)
Randomization probability§	0.02	0.01	0.02	0.01
Panel B—Four/four year split				
High deviation years▼	5.0	16.7	30.8	43.9
Low deviation years#	−3.1	−4.9	−10.3	−9.4
Difference	8.1	21.6	41.1	53.3
t-statistic	(1.36)	(2.13‡)	(4.69‡)	(6.85‡)
Randomization probability	0.10	0.03	0.01	0.01

* The eight high deviation years are 1959–1961, 1966, 1967, 1969, 1971, and 1972.
† The eight low deviation years are 1950–1952, 1975–1979.
‡ *t*-statistic is significant at 5 percent confidence.
§ The "randomization probability" is the probability of obtaining the reported difference in the holding period returns, based on a distribution formed from mean differences estimated from randomly assigning firms to one group. The distribution is based on 1,000 iterations of the random assignment.
▼ The four highest deviation years are 1959, 1960, 1971, and 1972.
The four lowest deviation years are 1952, 1976, 1977, and 1978

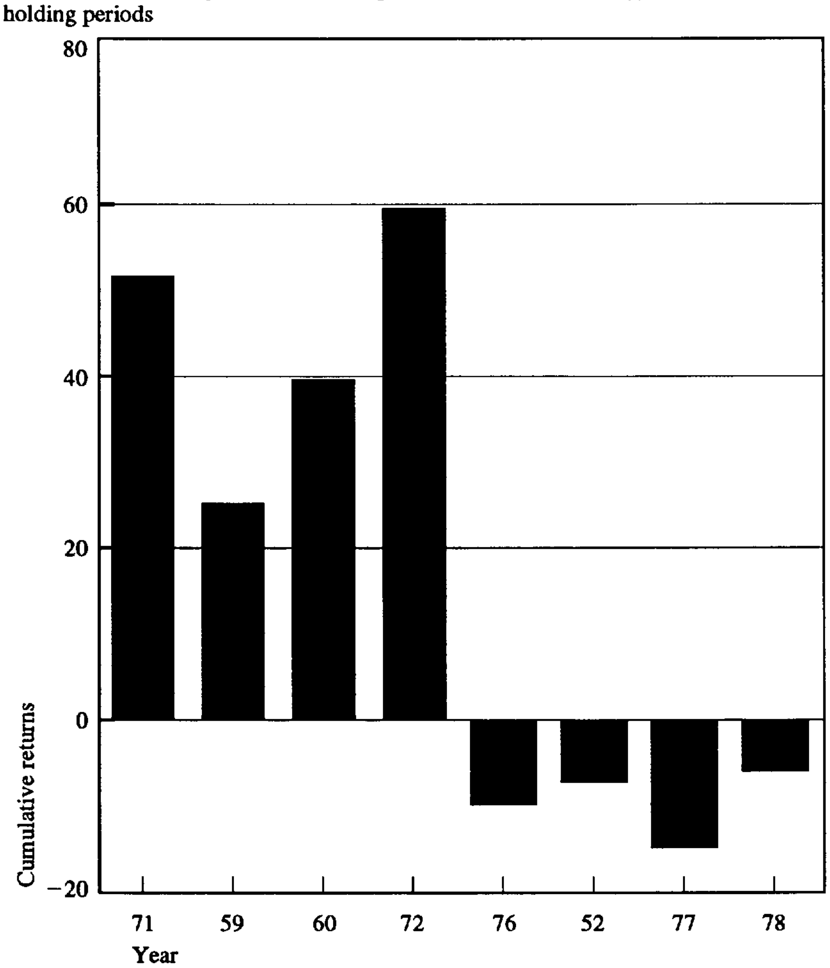
returns that the intrinsic value hypothesis is supported by the evidence is not compromised by the introduction of known risk attributes into the research design.[16]

Summary and conclusion

The objective of this research was to improve our understanding of and contribute to a resolution of the debate on whether the PE and PB anomalies are attributable to (1) the usefulness of earnings and/or book value of owners' equity as measures of intrinsic value or (2) omitted risk variables.

The accounting measures and test procedures used in the paper are quite crude. For example, no analysis is done of the "quality" of earnings, nor is any attempt made to use the intrinsic value measures to decide when to close out the hedge strategy positions. More sophisticated methods might increase the returns

Figure 4 Cumulative adjusted returns for price-to-book value strategy through four holding periods



to the trading strategy but may be subject to criticism of statistical overfitting. Nevertheless, the present results suggest that even the crude measures used are consistent with an intrinsic value explanation.

Research of this nature is always subject to criticism that there are correlated omitted risk variables. Testing for the effects of risk always presents a problem in asset pricing studies. The argument may be made that it is just a question of identifying the correct measure of risk. This argument is well understood, but the risk measures evaluated (beta and size) do not explain the differences in trading strategy returns between high and low price deviation years. Thus, PE and PB would have to proxy for some unknown risk factors.[17] If, however, these results are to be attributed to risk, the following observations may be made on the nature of that risk: (1) there must be at least two dimensions to it, the "PE" dimension and the "PB" dimension and (2) the risk premia must vary over time.

In sum, it appears that the price-to-earnings and the price-to-book value ratios are useful for estimating future returns, which argues in favor of an intrinsic value explanation.

Endnotes

1 Graham, Dodd, and Cottle (1962) define intrinsic value as "that value which is justified by the facts (e.g., assets, earnings, dividends, definite prospects including the factor of management"—p. 28). Cottle, Murray, and Block (1988) state that "intrinsic value is in essence the central tendency in price" (p. 43), and go on to say that "price may be expected to converge on intrinsic value" (p. 47).

2 To ensure robustness, the tests were also run independently for two 15-year "subperiods." These tests yielded results qualitatively equivalent to the full period results.

3 In this paper, earnings and book value of owners' equity are considered as separate measures of intrinsic value. If both measures of intrinsic value can be used to form portfolios that generate excess returns and these measures are not perfectly correlated, then some combination of the two could also provide positive returns to a hedge strategy (see the next section for additional discussion). Fairfield and Harris (1991) provide preliminary evidence that a combination of PE and PB ratios can be used to construct successful hedge strategy portfolios. No attempt is made to use such a combination here because this paper focuses on relative deviations that are difficult to construct within the multivariate intrinsic value framework. Also, it is unclear that any additional insights can be obtained with respect to the research questions being addressed in this paper by considering the combined effects.

4 In the next section we link these pricing models to the valuation model in Ohlson (1989, 1991).

5 This assumption is also maintained in much of the research estimating cross-sectional returns-earnings (response) coefficients (e.g., Collins and Kothari 1989).

6 In the context of earnings response coefficients, as Easton and Zmijewski (1989) contend and demonstrate that there will be firm-specific coefficients. The assumption made in this paper is that the distribution of such coefficients should not vary substantially from year to year. If they do, this would show up in the measure of IVE.

7 The choice of three months after the fiscal year-end should ensure that the annual report data have been made publicly available.

8 To provide insight into the significance of the bias introduced by our ex post classification, we also performed tests using a ranking based on the normalized deviation of

a given year from the average IVE (IVB) of the preceding 5 or 10 years, which allows a classification into high or low deviation years. These tests yield similar (though weaker) results.

9 Jaffe, Keim, and Westerfield (1989) find that the anomalous nature of the return from a PE trading strategy differs for stocks with negative earnings.

10 If the true valuation model incorporates both earnings and book values, the pricing errors identified by our procedure incorporate both a true pricing error and an omitted variable. This in turn suggests that the returns to a trading rule using only one variable will be inferior to a trading rule incorporating both variables. Preliminary analysis considering both variables is found in Fairfield and Harris (1991).

11 The tests were also repeated using (separate) rankings within two equal subperiods (1950–1965 and 1966–1980). The results from these tests were qualitatively equivalent to the full-period test results and are not reported here.

12 The choice of four years is somewhat arbitrary. The length of time necessary for prices to revert to the intrinsic value is unknown but may be "long." Fama and French (1988) show that mean reversion in stock prices takes place over a three-to five-year horizon, suggesting that this may also be an appropriate horizon over which to evaluate price reversions to intrinsic values.

13 The number of years used in each partition is arbitrary. The choice was based on an initial split into quartiles and then an equal splitting of the previous partition.

14 Another risk variable, leverage, was also considered as a potential contributing factor to the observed returns. Preliminary tests revealed that there was no difference in the average debt-equity ratios of the long and short portfolios between high and low deviation years. As a result, financial leverage effects do not appear to affect the results and are therefore not reported here.

15 The tests were repeated using returns that were adjusted only for size and again using returns adjusted only for systematic risk. Each procedure led to a stronger rejection of the null hypothesis than the results reported using raw returns. Of the two procedures, the size adjustment had the most pronounced effect on the results, especially in the case of the PB strategy. These results are available upon request from the authors.

16 As a further test for an omitted variable, the spread between the AAA and BAA corporate bond yields (default risk) and the level of AA corporate bond yield were considered. Although the average default risk was higher in high error years, the difference between the high and low error years was not statistically significant.

17 Fairfield and Sweeney (1991) investigate this hypothesis within the context of the arbitrage pricing model.

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