A Price To Book Model Of Stock Prices

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Peer reviewed

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More than twenty years ago Branch and Gale (1983) explored the behavior of the price-to-book ratio (PB, the ratio of a stock's price to its book value). They developed a PB model that explained over 70 percent of their sample's variability. Since the Branch-Gale paper appeared, PB has taken on increasing significance.

The PB or price-to-book ratio is a basic measure of the relative value that the market places on a share of stock. For all of its shortcomings, a stock's book value per share remains the best easily accessible measure of the assets which lie behind each share. Accordingly, the ratio of this per share book value to the stock's market price provides a very useful index of how much value the market places on the firm as a going concern (market price of stock) as opposed to the bundle of assets (book value per share) that the managers have to work with. The higher the PB, the more favorably the market views the company and its prospects. A PB below one suggests that the firm's value as a going concern is actually below the value its assets.

Herein we explore the factors that influence the level of PB. We then build and test a multivariate model that relates those factors to PB. Our study and the resulting model are designed to advance understanding of the determinants of PB as well as to provide a tool for those managers who wish effectively to pursue strategy designed to enhance their firm's PB.

Literature Background

The relation between the market and book value of the firm has long been of interest to researchers (e.g., Lindenberg and Ross, 1981; Smirlock, Gilligan, and Marshall, 1984). The issue had, however, been at the periphery of the literature until a series of articles by Fama and French in the 1990s. These authors noted "several empirical contradictions" to the presumed supremacy of market β in explaining cross-sectional returns.They referenced Banz (1981) who showed that market capitalization (size) adds to the explanatory power of β as well as Bhandari (1988) who showed that leverage added to the explanatory power of β and size. Next Fama and French followed Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) who showed that average cross-sectional returns of U.S. stocks were positively related to the book-to-market ratio. Finally, Fama and French (1992) invoked Basu (1983), who showed that the earnings-to-price ratio helped explain cross-section of average returns over and above size and market β.

In their first paper, Fama and French (1992) simultaneously examine the relative power of these "anomalies" in explaining average market returns of U.S. stocks during the 1962-1989 period. Their results challenge the central role of β in explaining cross sectional return variability. Rather, they develop empirical support for the view that the book-to-market ratio – (the reciprocal of our PB ratio) along with market capitalization - were better explainers of cross-sectional monthly returns than was β. In particular, they find no incremental relation between β and return once their two variables are entered into the equation. Instead, they find that book-to-market captures the effects of leverage, and that size and book-to-market together absorb the effects of the earning-to-price ratio in explaining average return. The authors go on to speculate that the book-to-market ratio - along with size - explain return because they proxy for unknown economic risk factors. Perhaps book-to-market acts as a proxy for bankruptcy risk while size acts as a proxy for liquidity risk.

In a later paper, Fama and French (1995) explore book-to-market factors further. They report that the ratio signals persistent properties (poor or strong) for future earnings: "High-

BE/ME stocks are less profitable than low-BE/ME for four years before and at least five years after ranking dates," although "the growth rates of earnings of low- and high-BE/ME stocks become more similar in the years after portfolio formation." As such, the authors claim, "size and BE/ME relate to economic fundamentals" (all quotes from page 132).

Clearly the work of Fama and French (1992, 1995) were major shots across the bow of the asset pricing model of Sharpe (1964), Litner (1965), and Black (1972). They brought the book-to-market ratio squarely into the middle of key debates within the finance literature. Their papers spawned a great deal of additional work. Researchers needed to grapple with this challenge to the deeply held belief in the centrality of β as a proxy for market risk. Whether or not the book-to-market ratio really is a proxy for economic risk and whether a high ratio is in fact a correct indicator of potential financial distress remains controversial. Kothari, Shanken, and Sloan (1995) argue, for instance that survivor bias seriously exaggerates the relation between average returns and book-to-market - a claim vigorously disputed by Fama and French (1996). Loughran (1997) then argues that "in the largest size quintile of all firms…book-to-market has no significant explanatory power on the cross-section of realized returns during the 1963-1995 period." Others have offered competing explanations for patterns observed in Fama and French data – such as data snooping (Black, 1993) and security mispricing (Lakonishok, Shleifer, and Vishny, 1994). In fact, the authors themselves acknowledge in their original paper that the underlying reasons for the observed empirical regularities so strongly presented remain mysterious (See Shleifer, 2000.).

Even though the existence of PB effects is not universally accepted, subsequent research has considered book-to-market – along with size – as an important factor in understanding returns. Barber and Lyon (1997), for instance, work with a holdout sample of financial firms (excluded from Fama and French, 1992) and find that the relation between size, book-to-market, and returns remains robust. They also find no evidence that survivorship bias or data snooping contaminated the results.

Other researchers have explored how the market-to-book ratio may be related to a range of other important variables. Fairfield and Harris (1993), for example, examined the relationship between the deviation from the median price-to-book and returns during subsequent four year holding periods. They formed portfolios in which they simulated a strategy of shorting stock of firms with the largest positive deviation and taking a long position in firms with largest negative deviation – a hedging strategy based on known PB anomalies in the literature. They found that portfolios with the highest deviations yielded greater returns even when β and size were included to adjust/control for risk.

Beaver and Ryan (2000) explored sources of variation in book value. Then they examined the influence of those sources of variation on the ability of book-to-market ratios to predict performance as measured by book return on equity. As in Fama and French (1995) and Bernard (1994), they show a negative relation between book-to-market components and future ROE.

Ryan (1995) showed that relative to market values, the book-to-market ratios move in "a series of relatively small-variance, predictable steps" (p. 109) – indicating perhaps that the book-to-market ratios are better suited than market values to explore patterns in valuation. As such, Penman (1996) examined the relation between PB and price-to-earnings ratios. He shows that the relation is not monotonic – that is, in approximately 34 percent of his sample, low (high) P/E firms also have high (low) PB ratios. He finds that the "P/E ratio indicates future growth in earnings which is positively related to expected future return on equity and negatively related to current return on equity. The P/B ratio reflects only expected future return on equity" and "because P/B reflects future profitability (and is unaffected by current profitability) it, not the P/E ratio, is nominated as the appropriate indicator of earnings growth" (p. 256). Following a similar line of thinking, Bullings and Morton (2001) decompose PB into a more persistent (bias) component and a delayed recognition (lag) component. They show that the lag component dominates both analyst expectations of future performance as well as future performance itself.

In short, a great deal of interest has been shown in the PB ratio and its apparent ability to anticipate growth (Brief and Lawson, 1992) as well as future profitability (Edwards and Bell, 1961; Feltham and Ohlson, 1995) as well as its apparent ability to proxy for risk of distress (Fama and French, 1992; Chan, Hamao, and Lakonishok, 1991). In spite of the burgeoning literature on the subject, however, surprisingly little research has been done on the contemporaneous and lagged determinants of the market to book value ratio itself. While the literature sheds useful light on the importance of the PB ratio, it is less than helpful in identifying discretionary variables that managers can control in order to influence the market valuation of the firms. What, one may ask, could managers do to ensure that their firm is correctly – and perhaps aggressively – valued in the financial markets?

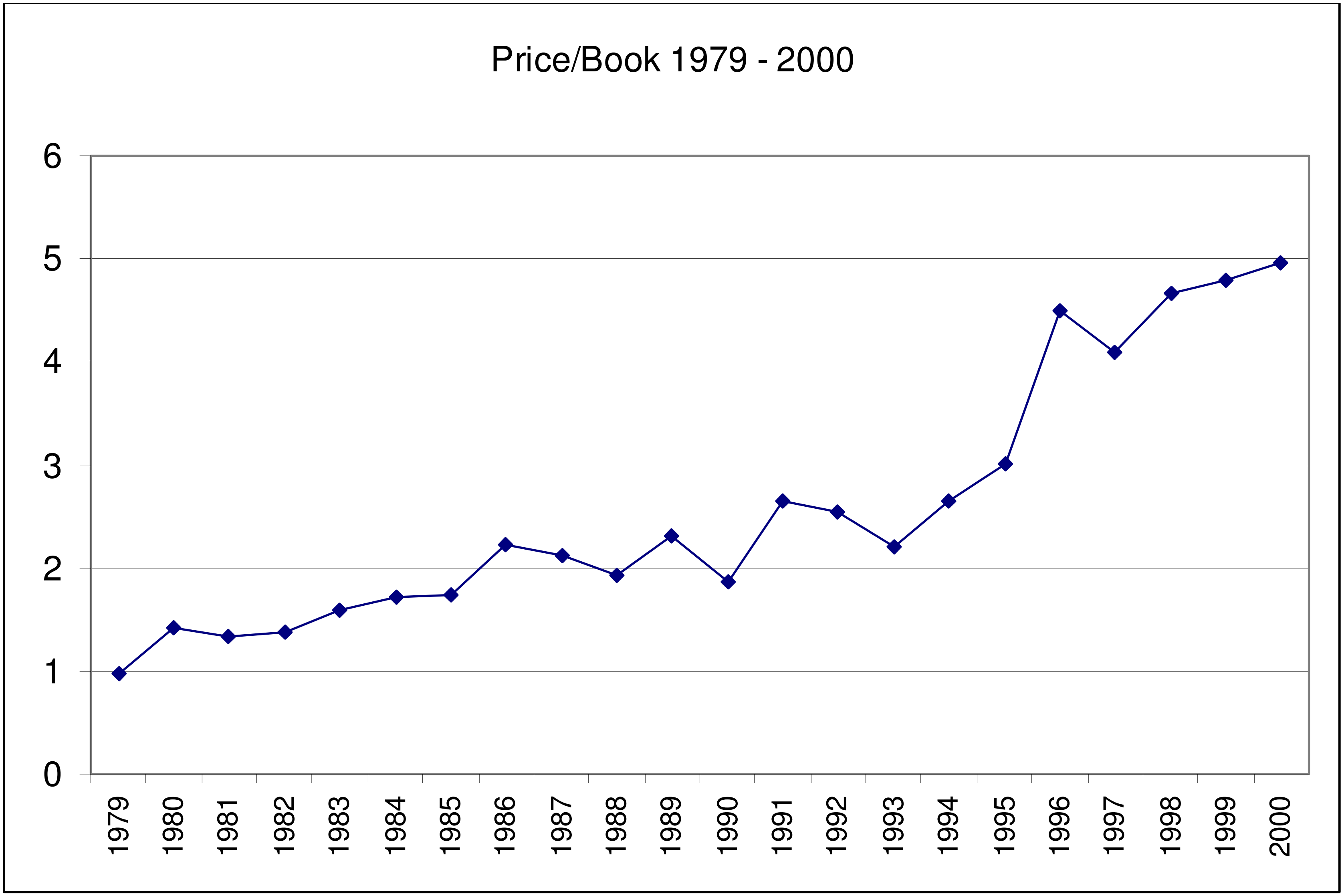
Data Base

To explore the behavior of PB we first used a COMPUSTAT to construct database consisting of the S&P 500 companies as it existed in 1979. Each year thereafter the membership of our sample was revised to reflect changes in the index's composition. We chose to construct this S&P based data base in an effort to minimize the risk of selection bias. The S&P index is very well known and carefully designed. Its components are selected to be representative of large publicly traded U.S. companies. Periodic updates of the index are utilized to maintain its basic character. By following the S&P's membership over time, we were thereby working with a set of companies which S&P believed to be most representative of the types of firms that its index was designed to reflect. Accordingly, our data set should be a well structured, representative sample of large to mid sized U.S. companies.

The earlier Branch-Gale study employed a group of 600 industrial COMPUSTAT companies for the 1968-81 period. Thus, the two studies used somewhat different but similar databases with the current study, which ends with 2000, beginning at about the point (1979) that the earlier study ends (1981).

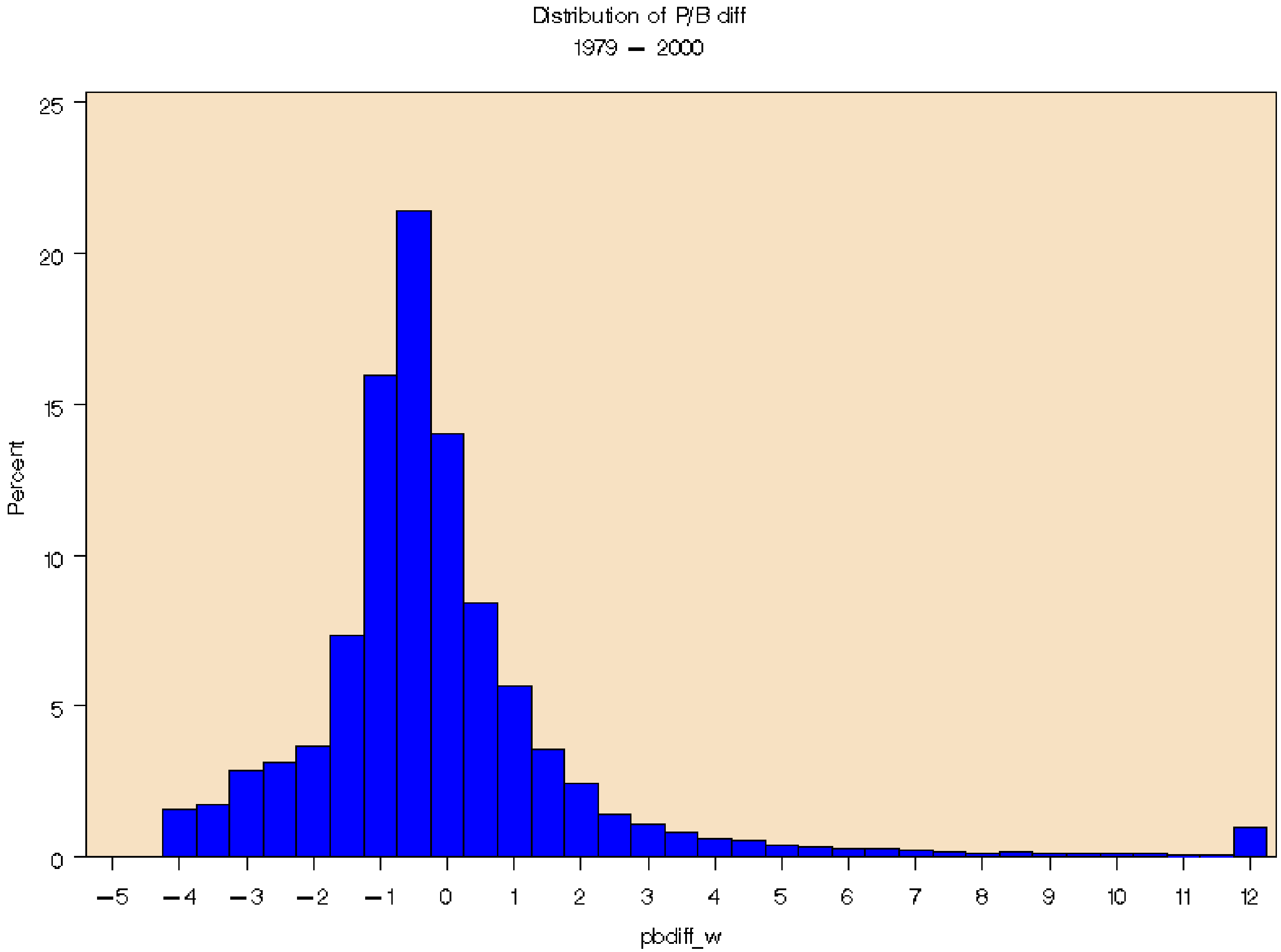
The 1979 average PB for our S&P 500 sample was approximately one (P = B) and rose to about 5.0 by 2000 (Exhibit 1). This performance represents a reversal of that for the Branch Gale (1968-1981) study during which the average PB value declined from about 2.3 to about 1.0.

Exhibit 1


Price/Book 1979 - 2000
0
1
2
3
4
5
6
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000

Clearly, yearly PBs of individual companies vary both in a time series and cross sectional way. Our primary focus herein is with the cross sectional variation. As such we need to remove most of the time series variability. For our univariate analysis we constructed the variable PBdiff, the difference between PB and that year's average sample PB value. PBdiff values tend to cluster near zero (Exhibit 2) but some depart by a substantial amount. We next examined the determinants of both the cross sectional and time series variability of PB.

Exhibit 2


Distribution of P/B diff
1979 – 2000
Percent
25
20
15
10
5
0
–5
–4
–3
–2
–1
0
1
2
3
4
5
6
7
8
9
10
11
12
pbdiff_w

Building a PB Model

We developed a theoretical framework for a PB model beginning with the steady state dividend discount (Gordon Growth) model:

$$P = D/(R-G) \tag{1}$$

Where:

P= market price of stock

D= next year's per share dividend payment

R= appropriate risk adjusted discount rate

G= long-term growth rate for per share dividends

Dividing equation (1) by per share book value yields:

$$P/B = [D/(R-G)]/B = (D/B)/(R-G) \tag{2}$$

Note that:

$$D = \Pi\text{-}RE$$

Where:

Π = Next Year's after tax profit per share

RE = Next Year's retained Earnings per share

Dividing D by B yield's

$$D/B = \Pi/B - RE/B \tag{3}$$

Also note that Π/B = ROE, return on book equity and (assuming no sale or repurchase of equity) RE/B = growth in book equity = G. Thus in the steady state (book equity growth rate = dividend growth rate) we have:

$$P/B = (ROE - G)/(R-G) \tag{4}$$

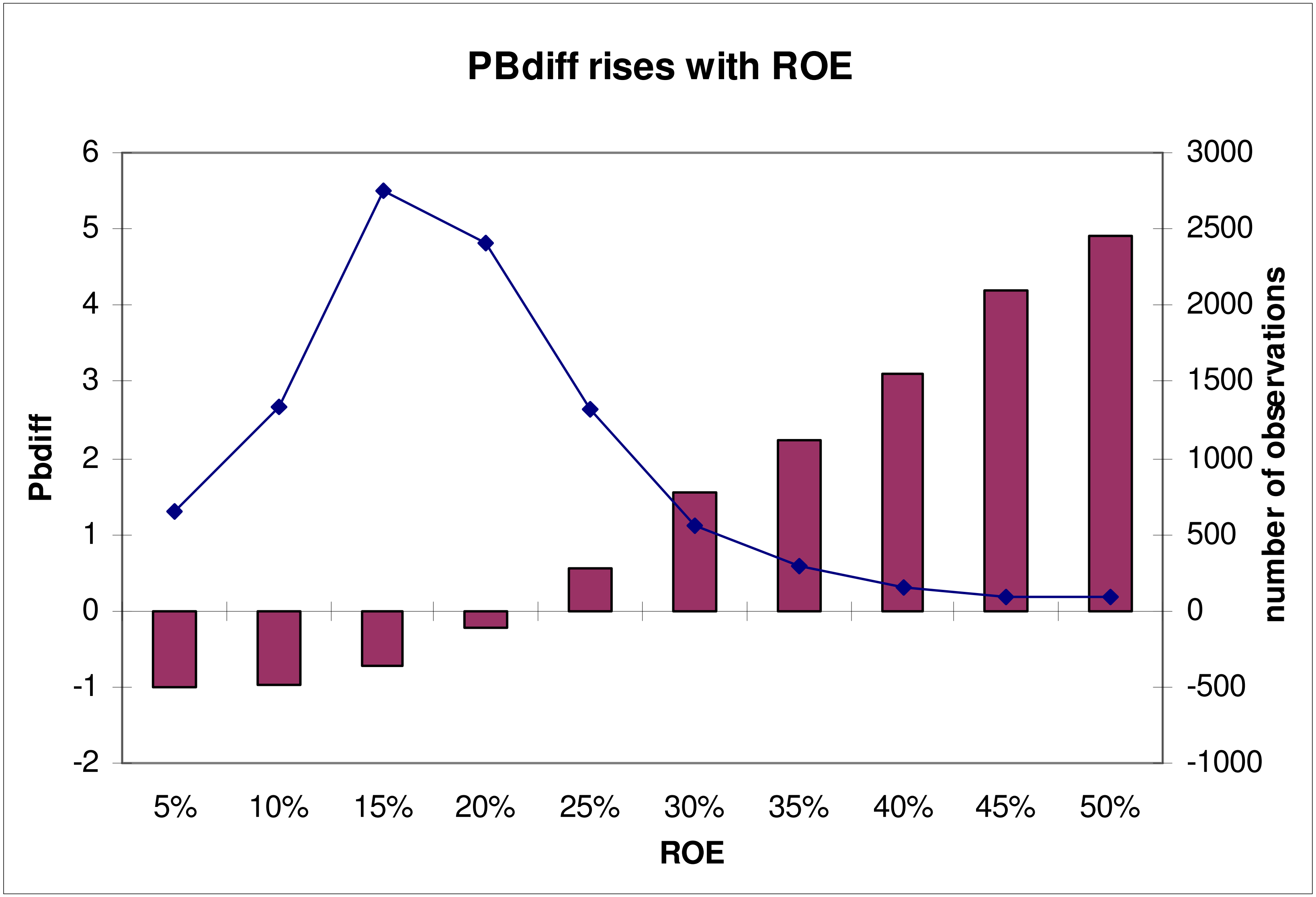
Therefore in equilibrium, PB is a function of ROE, G and R. The nominal risk free rate component of R is common to all firms. That common value does, however, vary over time. Cross sectionally, the variable R is a function of risk. Accordingly, the cross sectional variability in PB is a function of profitability (ROE), growth (G), and risk (embedded in R). We know that

R must be greater than G or the price, P, becomes infinite. We never observe any infinite stock prices. Similarly, ROE must be greater than or equal to G or P would be negative. Stock prices must always be non negative due to the limited liability of the corporate form. Moreover, P/B is generally greater than or equal to one indicating that the going concern value of the firm (per share stock price) is greater than its liquidation value (per share book value). This relationship would imply that (ROE-G) is generally greater than or equal to (R-G) which in turn implies that ROE is generally greater than or equal to R. Thus, for firms having going concern values greater than their liquidation values (which should encompass the vast majority of firms) and for firms having finite prices (all firms), we should have ROE > R > G. Under these circumstances PB would vary positively with ROE and G and negatively with risk (embedded in R). PB would also vary inversely with the nominal risk free rate (embedded in R).

Empirical Analysis

Exhibit 3 (below) illustrates the relationship between PB diff and ROE (bar chart) and ROE and its frequency (line graph). Most of the ROE values occur within the 0.05-0.30 range with a mean value of about 0.15. For ROE values above the mean level, PBdiff rises quite markedly. For ROEs below the mean value, however, PBdiff appears to decline with ROE but by no means as dramatically as it rises for above average ROEs. Note that PB itself can only be negative in the unusual circumstance of a negative book value and in general will not be very much below unity (or the firm becomes a candidate for liquidation). The liquidation value of a firm with a very low or negative ROE tends to place a floor on its market value. Thus, we should not be surprised to find that for ROEs above ROE's average value, ROE has a more favorable impact on PBdiff than is the negative impact on PBdiff of a below average ROEs. In further univariate analysis we found that PBdiff tends to rise with investment growth rates and varies inversely with interest coverage (an element of risk).

Exhibit 3



PBdiff rises with ROE
Pbdiff
number of observations
6
5
4
3
2
1
0
-1
-2
3000
2500
2000
1500
1000
500
0
-500
-1000
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
ROE

A Multivariate Model

The above reported univariate relationships are consistent with our expectations. We next, develop a more complete and robust set of relationships by shifting to the task of building a multivariate regression model. In the relationship:

$$P/B = (ROE - G)/(R-G) \quad (4)$$

the firm's ROE, G, and R are all long-term forward-looking expectations. Thus any proxies for those variables need to capture expectations of their future values.

The time series variability in PB is largely a function of the nominal risk free rate, the risk premium and earnings expectations for the economy. We use average annual PB for our sample of S&P 500 firms in order to reflect this variability. Current ROE is one useful proxy (predictor) for future ROE. We supplement current ROE with current Return on Capital, ROC. Together current ROE and ROC in both linear and non-linear formulations may better capture the relationship between PB and expected profitability than the linear ROE variable taken alone.

Obtaining a measure for the market's growth expectations is at least as difficult as measuring its profit expectations. Past growth rates in sales and profits are likely to be related to expected future growth as are the intensity and growth in R&D and advertising. Some insight into the market's risk perceptions may be revealed by such variables as payout and interest coverage.

We began our model building by assembling a group of variables (in linear form) that were designed to reflect our theoretical expectations. We then sought to enhance our model's explanatory power with a variety of procedures. Specifically:

1. We normalized each of our independent variables (except average PB) and then, created squares of the normalized variables to explore non-linear relations. Several of these squared terms were found to be significant are included in the final model.

2. We tested a number of interaction terms. Some of our interactions were designed to reflect the joint impact of profitability and growth. Other significant interaction effects were found for variables constructed with annual average PB and various independent variables. Such interactions allowed the slopes of the indicated variables to vary with the annual average value of PB. These interactions as a group added significant explanatory power to our equation.

3. We tried adding industry dummies using S&P's industry classifications. Once our basic explanatory variables were present, the industry dummies were found to be largely insignificant. The ones that were significant provided very little additional explanatory power. Our final model excludes industry dummies. Differences in PBs across industries are largely due to differences in profitability, growth and risk across industries.

4. We also refit our model to two sub-periods of 1979-1989 and 1990-2000. We arbitrarily divided the data into two equal length periods which roughly corresponded to the decades of the 1980s and 1990s. The sub-period models had much the same form as the full period model. We observed no advantage to working with sub-period equations.

We, therefore, continued to focus our efforts on developing an equation to fit the entire period.

5. We Windsorized our variables initially using a 1 percent screen. Thus, extreme values were truncated at the one percent and 99 percent level. We also tested 0.5 percent and 2 percent screens. These test levels were arbitrarily selected. We had no specific theoretical justification for testing Windsorazation using ½ percent; 1 percent; and 2 percent screens. The levels do, however, reflect reasonable focal point values. Results were similar for all three screens. We decided to stay with a one percent screen. That all three screens produced similar results, suggests to us that the screen selection has not biased our results.

6. We tried adding each company's estimated beta as an independent variable in our model but found it to be insignificant.

7. We examined the relationship between forward returns and the PB model value and its residual. We found very little relation. The variables were significant but added almost no explanatory power. Thus, our model does not appear to be useful in identifying misvalued securities.

The Regression Model

Using a stepwise regression procedure we initially obtained a model with 40 statistically significant (coincident) variables having an R^2 of .645. Winnowing the independent variable set back to 14, still left us with an R^2 of .633. Thus the 26 variables having the least explanatory power added only 1.3 percentage points to the R^2. We decided to work with the simpler 14 variable version of the model.

The PB Model Stage I

The specific PB model (stage I) is reproduced below:

R-Square = 0.6324 and C (p) = 15.0

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	14	41813	2986.65948	1350.02	<.0001
Error	10985	24302	2.21230		
Corrected Total	10999	66115			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	0.14473	0.03710	33.66041	15.22	<.0001
db_nsq	0.15243	0.00785	834.45101	377.19	<.0001
mnpb_roc	0.18609	0.00853	1052.73574	475.86	<.0001
mnpb	0.71009	0.01246	7185.63499	3248.04	<.0001
mnpb_rocnsq	0.04273	0.00330	369.95582	167.23	<.0001
mnpb_capxintb	0.10940	0.00531	938.10523	424.04	<.0001
mnpb_advintb	0.12130	0.00547	1089.94518	492.86	<.0001
mnpb_revgrth	0.10914	0.00528	946.63988	427.90	<.0001
mnpb_rdintb	0.10193	.00475	1020.67421	461.36	<.0001
mnpb_shretn	0.07277	0.00421	661.25287	298.90	<.0001
shret_nsq	0.05107	0.00366	431.77908	195.17	<.0001
db_n	0.21771	0.01972	269.71610	121.92	<.0001
mnpb_cover	0.08114	0.00589	419.75133	189.74	<.0001
mnpb_roen	0.10239	0.00821	344.24375	155.60	<.0001
roe_abs	0.38990	0.02730	341.15349	154.21	<.0001

We see that the regression has an R^2 of about .6324. Recall that adding another 26 (marginal) variables increased the R^2 only by about .013 (to .6451). Thus, these additional 26 variables seem not worth the complexity that they add to the equation. Grouping the variables by category we find as follows:

Pure Time Series Variables

Rather than using PBdiff as our independent variable, we decided to use PB and enter average annual PB as a separate independent variable. This procedure allowed greater flexibility for the data to explain the time series impact.

MNPB, annual average PB (.120)

Thus, the model begins with about .71 of the average PB for that year. This variable by itself explains about 12 percent of the variability in the dependent variables. Thus, we found that about 12 percent of PB variability was due to time series variation. The partial contribution to R^2 appears in parentheses.

Profitability Variables

db_nsq = dividend/book squared (.238)

mnpb_roc = ROC interacted with average PB (.123)

mnpb_rocnsq = ROC squared interacted with annual average PB (.037)

roeabs = ROE absolute value interacted with annual average PB (.005)

db_w = dividend / book (.004)

mnpb_roe = ROE interacted with annual average PB (.004)

mnpb_shretn = change in stock price / change in retained earnings interacted with average PB (.004)

All of those variables have positive signs and are highly significant (at least at the 99 percent level). Together they imply that PB rises with dividend / book, ROE and ROC with a greater positive effect the higher the annual average value for PB. Moreover the impact of ROE and ROC above the mean values is greater than for below the mean values. These variables explain about 41 percent of the variability in PB. Note that the variable db (dividend/book) has both a profitability and a risk dimension (see below). Still, profitability appears to have a near dominant role in explaining PB.

Growth Variables

mnbp_rdintb = R-D intensity interacted with annual average PB (.020)

mnbp_revgrh = Revenue growth interacted with annual average PB (.017)

muph_advivt = Advertising x intensity interacted with annual average PB (.017)

The R&D intensity, advertising intensity and revenue growth variables interacted with annual average PB are highly significant, have positive signs and together explain about 5.4 percent of the variability in PB. Thus, expected growth does impact PB but appears to have a much smaller affect than does profitability.

Risk Variables

mnpb_cover = interests coverage ratio interacted with annual average PB (.004)

mnpb_capint = capital intensity interacted with annual average PB (.029)

Together these risk variables explain about 3.3 percent of the variability in PB. Note, however that db and db interacted with average PB, which were classified as profitability variables. Together those variables have a combined contribution of 24.2 percent. Such variables have both a profitability and risk component. Companies that pay dividends tend to have more stable earnings than those that do not. Thus the impact of risk on PB variability is greater than 3.3 percent.

Having fit our model to contemporaneous data, we next added a data set of lagged variables and refit our model. The lagged form of the dependent variable was found to dominate the result thereby overwhelming the impacts of many controllable variables. We decided to allow controllable, coincident, explanatory variables to have first shot at the data. Accordingly we fit the model in two stages. The first stage contains only contemporaneous variables (14). The second stage explains the residual from the first stage with our lagged data set. Working with a set of ten variables, we were able to explain 32 percent of the variability of the residual. Since our first stage explained 63 percent of the variability and the second stage explained 32 percent of the residual our combined explanatory power was about 75 percent [.63 + (1-.63)(.32) = .75].

The PB Model Stage II

In Stage II we fit a model to explain the residual for Stage I of our model. The independent variables of Stage II are lagged by one year from the dependent variable. The initial regression had 36 variables and an R^2 of .336. Windowing the variable set back to ten variables resulting in an R^2 of .342. The model is reproduced below:

R-square = .3241 c(p) = 11.000

Source	**DF**	**Squares**	**Square**	**F Value**	**Pr > F**
Model	10	6929.53723	692.95372	478.60	<.0001
Error	9979	14448	1.44787		
Corrected Total	9989	21378			

Variable	**Parameter Estimate**	**Standard Error**	**Type II SS**	**F Value**	**Pr > F**
Intercept	-0.29387	0.02976	141.14749	97.49	<.0001
pb_wlag	0.53050	0.00788	6554.82873	4527.23	<.0001
db_nsq	-0.11544	0.00672	427.08236	294.97	<.0001
mnpb	-0.36806	0.01272	1213.07839	837.84	<.0001
mnpb_advintb	-0.10156	0.00498	600.96239	415.07	<.0001
mnpb_cover	-0.08589	0.00500	427.20207	295.06	<.0001
rdintb_n	-0.24687	0.01273	544.84323	376.31	<.0001
mnpb_capxintb	-0.09097	0.00490	499.77688	345.18	<.0001
roc_n	-0.14525	0.01486	138.31389	95.53	<.0001
mnpb_revgrth	-0.05185	0.00483	166.95620	115.31	<.0001
db_n	-0.09517	0.01708	44.96924	31.06	<.0001

The Variables:

PB lagged has a coefficient of .53 and a partial R^2 contribution of .143. Thus over a third of the total R^2 of this stage comes from the lagged dependent variable. The next most important variable is $(\text{dividend/book})^2$ with a partial R^2 contribution of .049. The remaining variables have contributions in the range of 2 percent or less.

The Fit Of The Model:

Exhibit 4 (below) illustrates the distribution of the residual from our model. The residuals cluster near zero with most residuals having values between -2.0 and +2.0. Exhibit 5 plots the ratio of actual to predicted PBs. Over 30 percent of the ratios are 1.0 or very close to 1.0 (Actual = Predicted). Another 27 percent and 14 percent have actual-to-predicted ratios in the range of 1.25 and .75 respectively. Overall, about two thirds of the observations (.30 + .27 + .14 = .71) are in the vicinity of .75 to 1.25. About 13 percent of the remaining 29 percent of the observations are near 1.5.

Exhibit 4: Most P/B's are close to their model values.

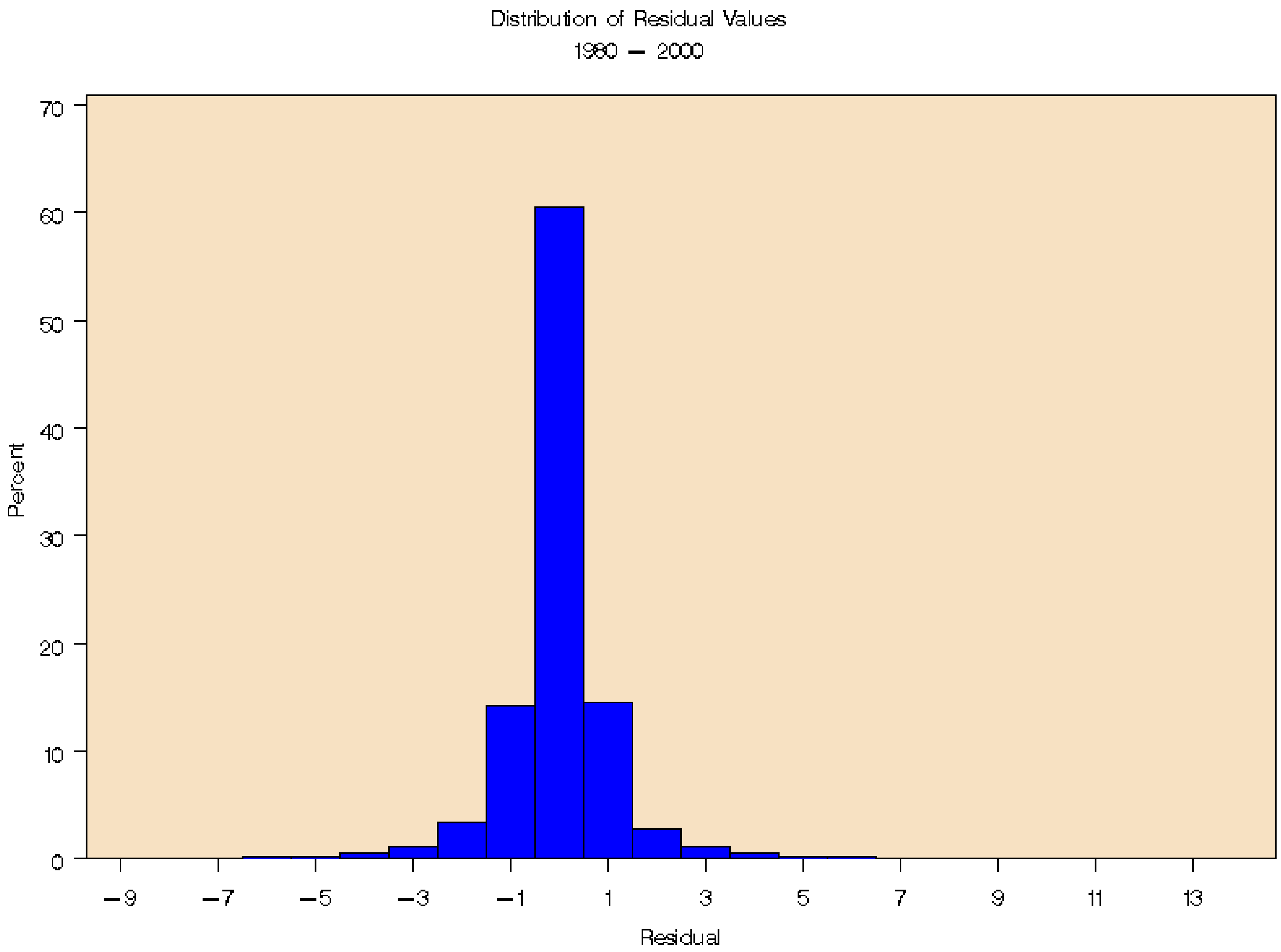
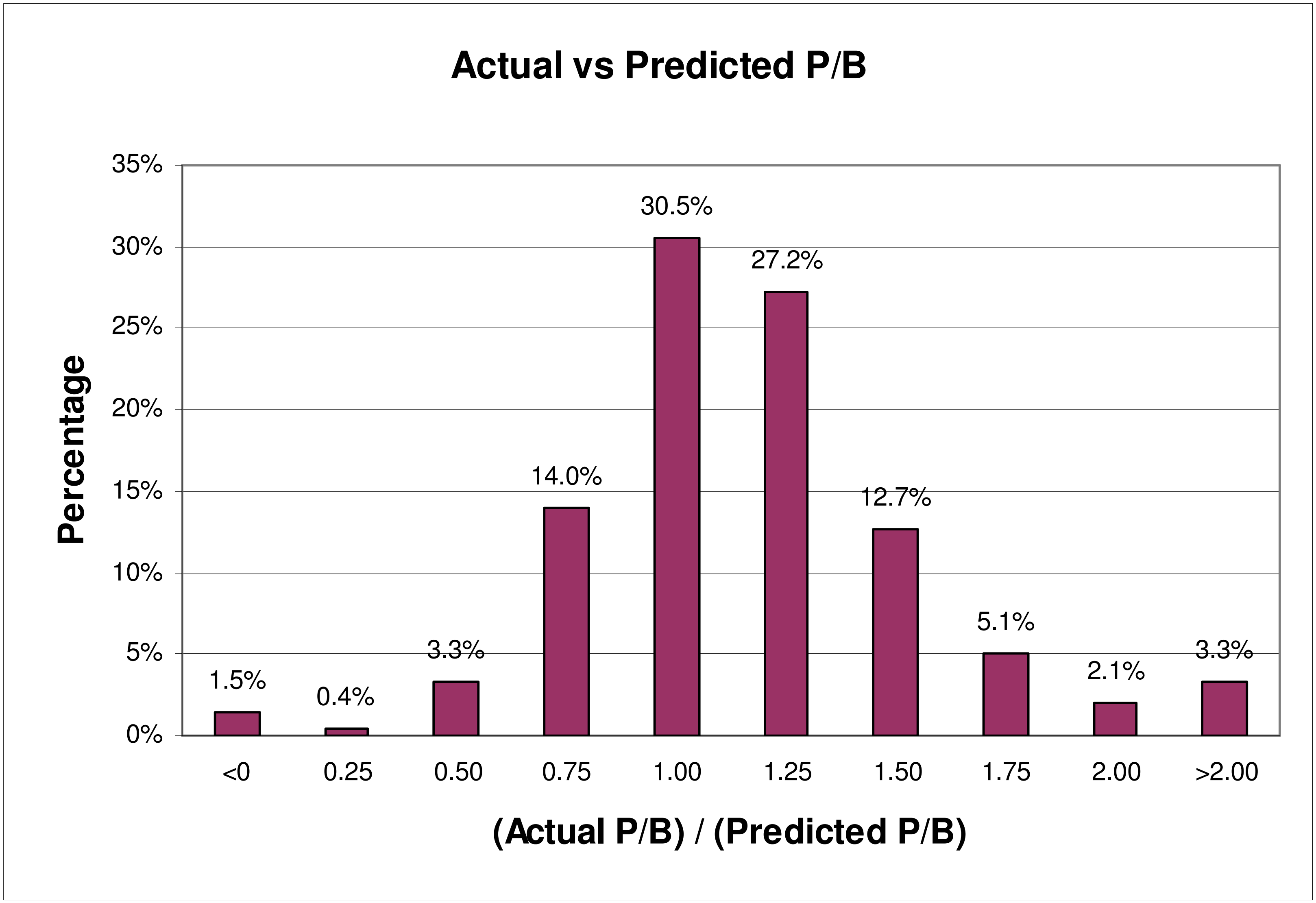


Exhibit 5


Actual vs Predicted P/B
Percentage
35%
30%
25%
20%
15%
10%
5%
0%
1.5%
0.4%
3.3%
14.0%
30.5%
27.2%
12.7%
5.1%
2.1%
3.3%
<0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
>2.00
(Actual P/B) / (Predicted P/B)

Note that while we started with a large number of independent variables in a variety of forms, we did not dump variables willy nilly into the computer to see what came out. Each variable in each formulation had a theoretical basis for being tested. The final version of our model only contains variables for which we had a firm theoretical justification. Not only must each included variable have the expected sign but it must also be statistically significant and add meaningful explanatory power to our model.

Dynamic Behavior

We see from the above reported results that our model explains our dataset rather well. Now let's explore the model's dynamic properties. Exhibit 6 (below) illustrates the tendency for the ratio of actual to predicted PB to migrate toward one over time. If the beginning actual is below the predicted, the ratio tends to rise and if the actual begins above the predicted, the ratio tends to fall. Put another way observations with large residuals tend to have smaller residuals in the subsequent period. Exhibit 7 decomposes the dynamic impacts. It reveals that companies whose actual to predicted PB ratio is low (high) in year t tend to have their actual increase (decrease) and predicted decrease (increase) for the year t +1. The change in the predicted is, however, significantly larger than the change in the actual PB. Thus, the model values move toward the actual more than the actuals move toward the model.

Exhibit 6

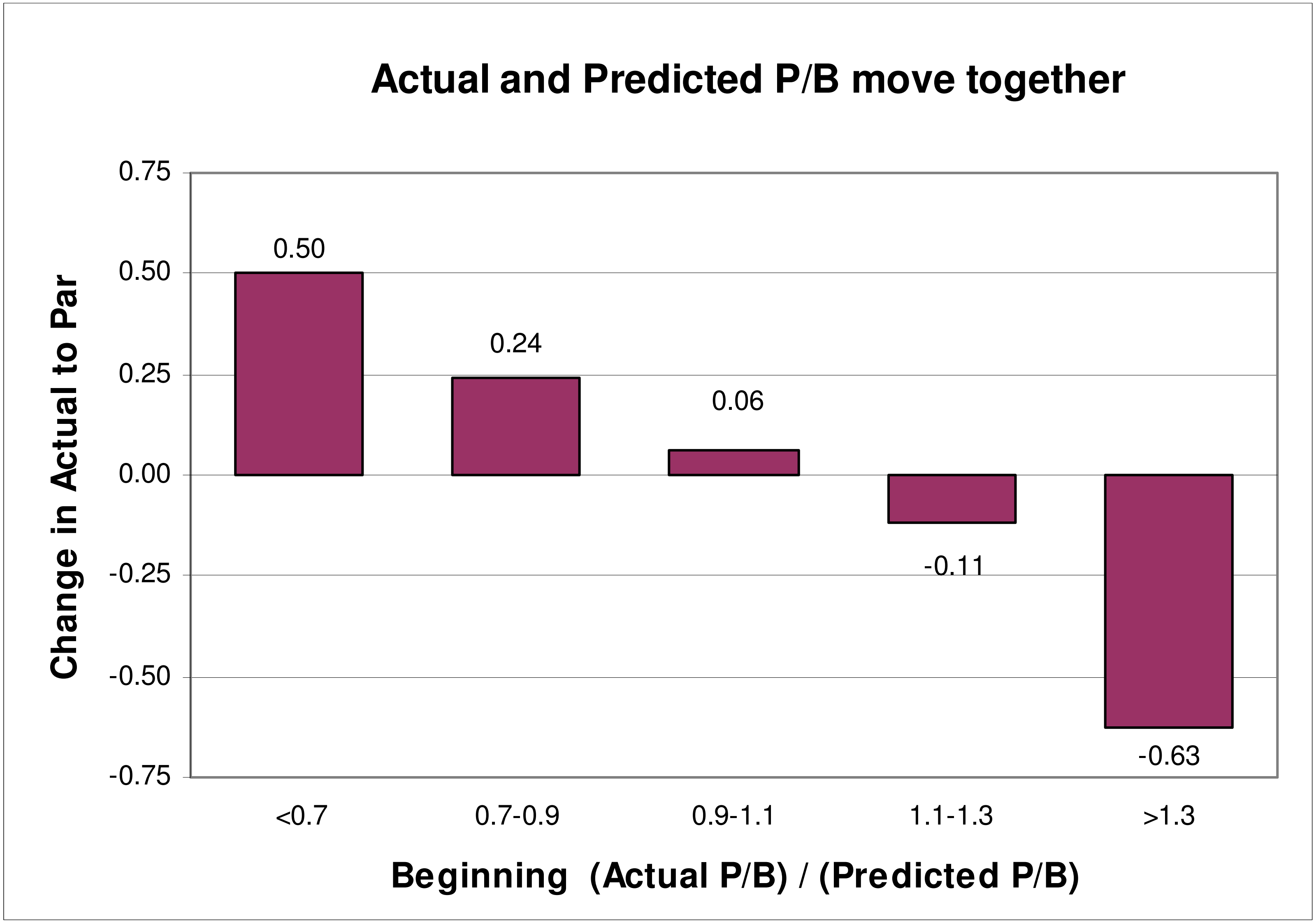
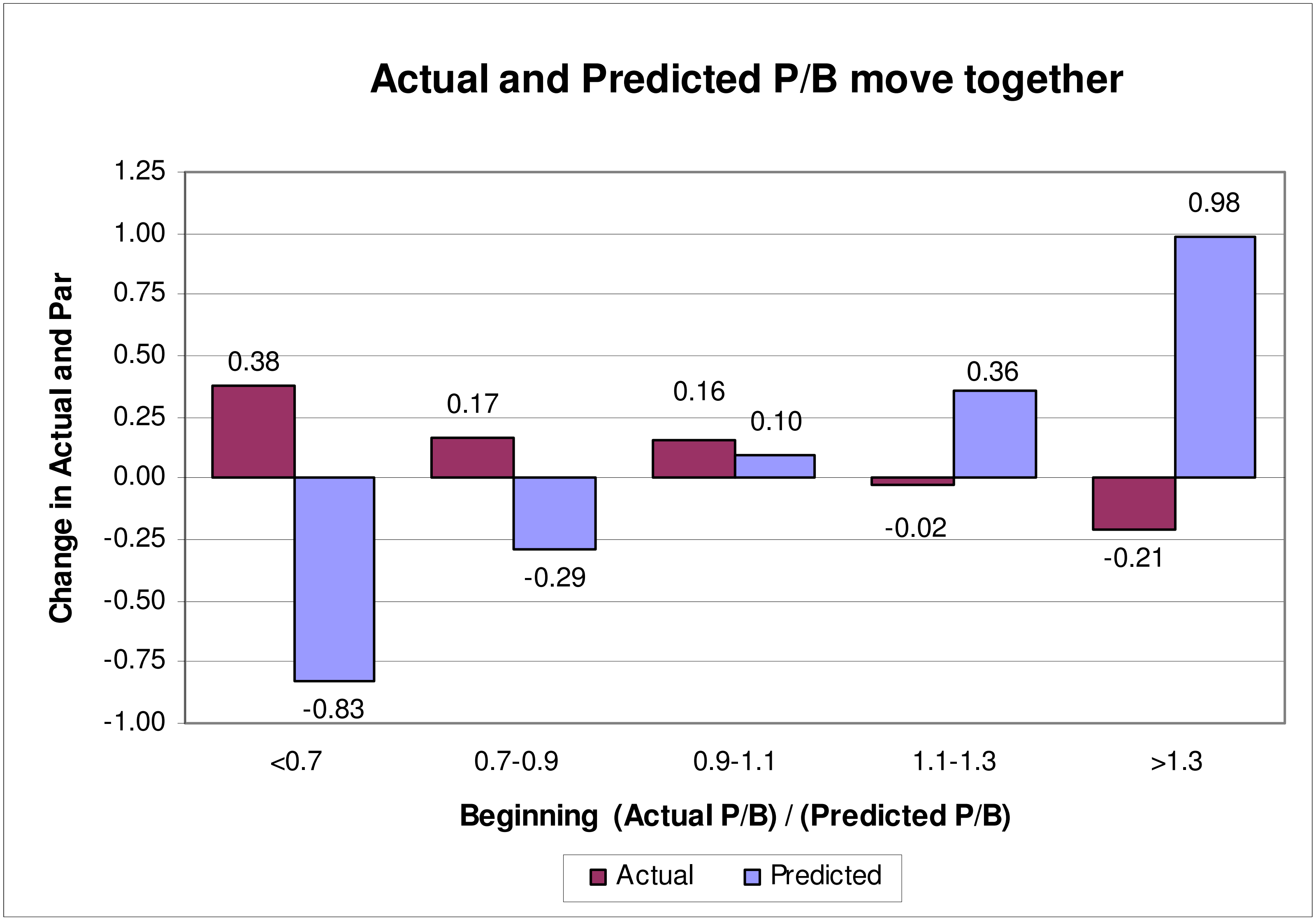

Actual and Predicted P/B move together
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
Change in Actual to Par
0.50
0.24
0.06
-0.11
-0.63
<0.7
0.7-0.9
0.9-1.1
1.1-1.3
>1.3
Beginning (Actual P/B) / (Predicted P/B)

Exhibit 7



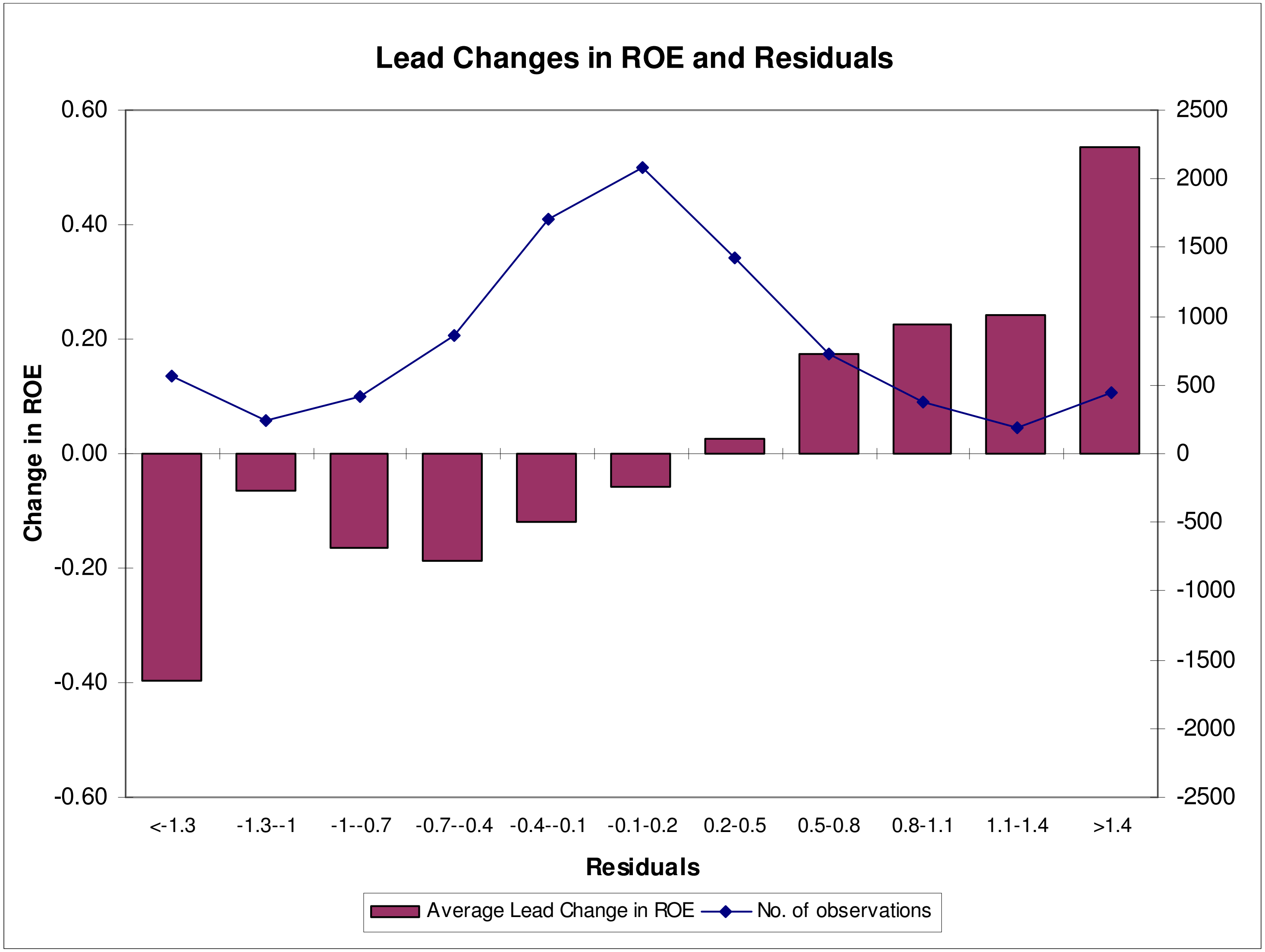
Actual and Predicted P/B move together
Change in Actual and Par
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
0.38
-0.83
0.17
-0.29
0.16
0.10
-0.02
0.36
-0.21
0.98
<0.7
0.7-0.9
0.9-1.1
1.1-1.3
>1.3
Beginning (Actual P/B) / (Predicted P/B)
Actual
Predicted

Actual versus Model Values and Subsequent Firm Performance

We next explore the market's ability to anticipate future company performance, particularly future profitability and growth. When the market price of a company's actual PB is above its model value, the market probably expects the company's performance to improve. Similarly, a company with an actual PB below its model value suggests that the market is concerned that the company's performance is likely to deteriorate. In order to test this hypothetical set of relationships we assembled a database consisting of the residuals from our model (second stage residuals) and various subsequent (one year post) performance variables.

Exhibit 8 (below) illustrates the relationship between the beginning period residual and the change in ROE in the following year. We see that the more positive the residual (the more actual PB exceeds its model value) the more ROE tends to rise. Similarly, the more negative the residual is, the greater the tendency for ROE to fall.

Exhibit 8



Lead Changes in ROE and Residuals
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
Change in ROE
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
<-1.3
-1.3--1
-1--0.7
-0.7--0.4
-0.4--0.1
-0.1-0.2
0.2-0.5
0.5-0.8
0.8-1.1
1.1-1.4
>1.4
Residuals
Average Lead Change in ROE
No. of observations

Exhibit 9 (below) illustrates the relation between beginning period residual and subsequent change in revenue growth. The more positive the residual, the more the revenue growth rate tends to increase. Finally Exhibit 10 illustrates the joint association of profitability and growth with the residual. Firms whose ROEs and revenue growth rates are both rising tend to have very positive beginning period residuals.

Exhibit 9

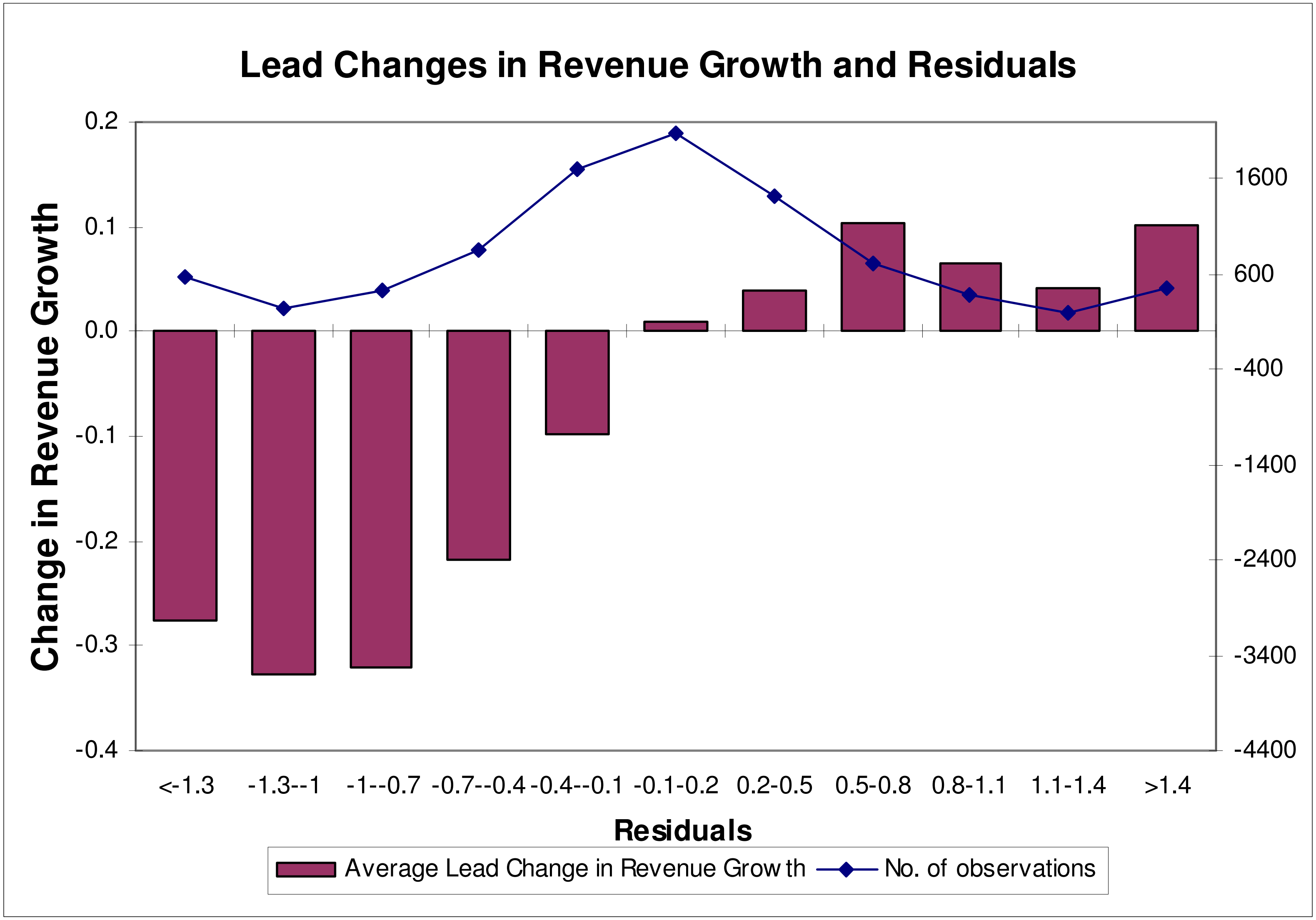
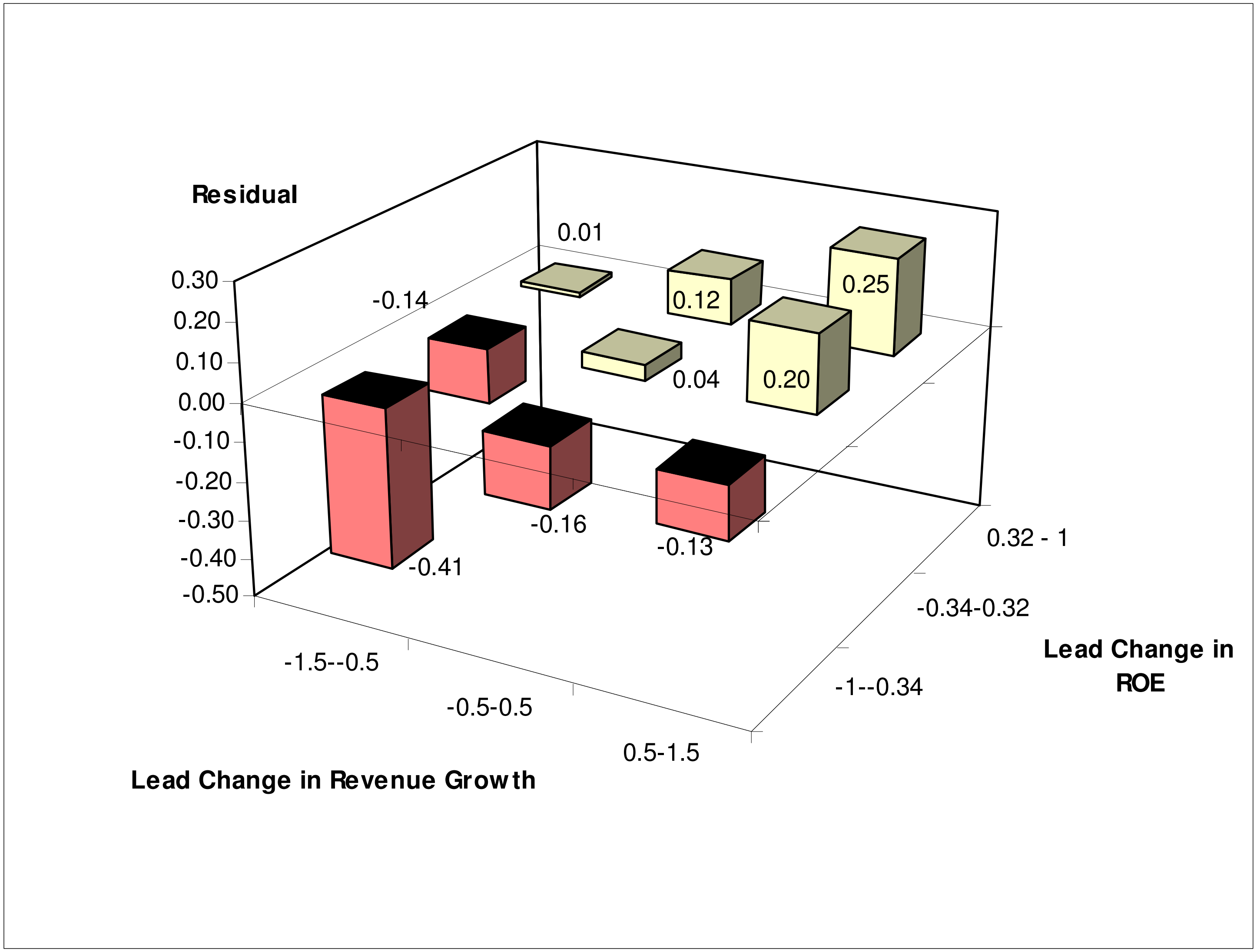

Lead Changes in Revenue Growth and Residuals
Change in Revenue Growth
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1600
600
-400
-1400
-2400
-3400
-4400
<-1.3
-1.3--1
-1--0.7
-0.7--0.4
-0.4--0.1
-0.1-0.2
0.2-0.5
0.5-0.8
0.8-1.1
1.1-1.4
>1.4
Residuals
Average Lead Change in Revenue Growth
No. of observations

Exhibit 10



Residual
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
0.01
-0.14
0.12
0.25
0.04
0.20
-0.16
-0.13
-0.41
0.32 - 1
-0.34-0.32
-1--0.34
Lead Change in ROE
-1.5--0.5
-0.5-0.5
0.5-1.5
Lead Change in Revenue Growth

Explaining the Residual in Terms of Subsequent Performance

We also fitted a multivariate regression in which we attempted to explain our model's residual using subsequent performance variables. We found that an equation containing 13 independent variables could explain about 9.6 percent of the variation in the residuals. Of the 9.6 percentage point change in ROE accounted for about 6 percent and a change in revenue growth about one percent.

Our basic model is based entirely on contemporarily available (current are lagged) financial information. To the extent that market prices reflect expectations not present in the current financial data, market prices will deviate from our model values. Accordingly, we next explore the relations between the residuals from our model (Stage II) and a group of performance variables.

A positive residual (actual PB above model value) suggests that the market is anticipating improving performance. Similarly, a negative residual implies a market expectation of deteriorating performance. To test this proposition a group of performance variables is regressed on the residual. The model is reproduced below:

R-Squared = 0.0961 and C(p) = 14.0000

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	13	1055.28466	81.17574	71.40	< .0001
Error	8733	9928.82012	1.13693		
Corrected Total	8746	10984			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	0.70952	0.12033	39.52589	34.77	<.0001
change_roe_lead	0.24404	0.01983	172.23987	151.50	<.0001
change_revgrth_lead	0.14802	0.01433	121.24671	106.64	<.0001
change_roc_lead	0.11476	0.02568	22.70556	19.97	<.0001
change_ros_w	-1.21428	0.34109	14.40902	12.67	0.0004
change_a_e_w	-0.04112	0.00888	24.37653	21.44	<.0001
eps_ratio_w	-0.02570	0.00642	18.19716	16.01	<.0001
mnchroe	7.69098	1.07184	58.53823	51.49	<.0001
mnchrevgrth	-2.99294	0.47042	46.02057	40.48	<.0001
mnchroc	-2.32575	1.11563	4.94106	4.35	0.0371
mnchrdintb	2.50592	0.38427	48.35014	42.53	<.0001
mnchros	21.91296	2.28977	104.12449	91.58	<.0001
mnchs_a	-1.94605	0.62531	11.01152	9.69	0.0019
mneps	-0.76906	0.12199	45.18223	39.74	<.0001

We see that change in ROE is by far the most important explanatory variable explaining about six percent of all variability, in the residual (Compared with an overall explanatory power of a model of 9.61 percent). The second explanatory variable in terms of contributions to R^2 change in revenue growth. That variable adds about 1.19 percent to the R^2. Other variables in the model add relatively little explanatory power.

An Out-of-Sample Test

All of the above reported results are derived from an in-sample analysis. That is, we constructed our model and then tested it on the same data set. Such a procedure leaves open the possibility that data snooping has upwardly biased the significance of our results. Accordingly, to test the stability of our model we repeated our tests on a parallel data set. Our second data set consists of the 500 largest non S&P 500 firms in COMPUSTAT for each year from 1979 to 2000. We used the model developed on the S&P 500 data set to explore the behavior of PB on the second data set. Rather than refit the model to the second data set, we used the existing coefficients to explore PB behavior in light of our model. We produced a set of exhibits on the second data set that paralleled these developed for the first. The following table provides a statistical comparison of the two data sets:

Table 1

S&P Verses Second Data Set

Variable	**S&P**		**Second**	
	Average	**SD**	**Average**	**SD**
Sales	$6, 812	$12,713	$4,432	$11,496
Market Value	$7, 398	$20, 264	$4, 936	$14, 218
Total Assets	$13, 336	$37, 537	$10, 840	$41, 330
ROE	13.7%	1.55%	15.2%	1.7%

We see that our two data sets have relatively similar characteristics. The S&P 500 set is composed of somewhat, but not dramatically larger, firms on the average. The average ROE for the second data set is, however, somewhat higher than for the S&P 500. An exhibit by exhibit comparison revealed a remarkably similar picture.

Finally, we collected the residual for the second stage of our model for the second data set and explored its relation to subsequent performance. Once again we found that the residuals did have an ability to predict future performance. Again, change in ROE in period t+1 was found to be highly correlated with the period t residual. A regression with two variables had an R^2 of .056 and one with 14 variable .082 (compared with .071 and .096 in the S&P data set).

A Second Out-of-Sample Test

The above reported tests explore our model's behavior in two different data sets but from the same time period. In a second out-of-sample test, we refit our model to the 1979-1990 time period and then simulated its performance over the 1991-2000 time period. The model values for our 1979-1990 regression when applied to the 1991-2000 period yielded a correlation coefficient of .75. The same methodology and functional form applied to the second data set produced a correlation coefficient of .53. So, once again we found a rather impressive ability on the part of our model to explain out-of-sample data.

2001 Data

As time passed, 2001 data became available. We decided to take advantage of these additional data to perform an out of sample test on a data set that differed primarily in the term dimension. This test provided a further check on the reliability of our model. Using the 1979-2000 model parameters, we found that the model value had a .74 correlation with actual PBs. Thus our model did a rather effective job of explaining subsequent behavior.

Summary, Conclusion, and Direction for Further Work

We have developed a PB model and explored its properties. Using the foundation of the dividend discount model we have derived an empirical model of two stages which explain about 75 percent of the variation in annual PB levels for the S&P 500 companies. A study of the time series behavior of the residuals reveals that observations with large residuals in period t tend to have smaller residuals in period t+1. This movement is a result of both the predicted moving toward the actual and the actual moving toward the predicted. The change in the predicted (model value) was on the average greater than that of the actual.

Finally we looked at the ability of the market to anticipate changes in firm performance. We found that those observations with positive residuals (actual greater than model value PB) tended to experience higher next period profitability (ROE) and more rapid growth (in revenue). The performance of those with negative residuals tended to deteriorate. Thus the market price appears to reflect anticipatory information not present in the model value.

We assembled a parallel data set of the 500 largest non S&P 500 firms covering the same time period as our existing data set. Results for the second sample were largely consistent with our reported results. Similarly, the model explains our out-of- sample data; both a second data set for the same time period and 2001 data.

Our PB model focuses on four basic forces to explain both cross section and time series variability in PB. First, the time series variability in the yearly average PB picks up most of the market variability. This average PB variable accounts for about 12 percent of the PB variability in our sample. Second, various profitability related variables explain about 41 percent of PB variability. Profitability levels above its mean value tends to have a greater impact on PB than profitability levels below its mean. Third, growth variables explain about 5.4 percent of PB variability. Finally risk variables explain about 3.3 percent of PB variability. Clearly, profitability has a very powerful affect on PB. Note, however, that certain of the variables classified as profitability have risk and growth components. Moreover, the market may be reacting to factors not reflected in our model and thereby anticipating growth and risk factors that we have not been able to quantify. Still, we do find that profitability is particularly powerful in explaining variability in PB. Thus, the primary key to a healthy stock price is a healthy profit picture.

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