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Abstract

In this study, I test the robustness of size and book-to-market effects on average stock returns reported by Fama and French (FF, 1992, 1993) using a sample that is less subject to survivorship bias and a longer sampling period. Specifically, I exclude NASDAQ stocks in the sample to reduce survivorship bias that has largely been induced by Compustat during an expansion project in 1978. Survivorship bias exists when the sustaining and successful firms are included in the data and those firms that fail or merge with other firms are omitted. Since NASDAQ stocks tend to have relatively smaller stocks than the NYSE and AMEX stocks, they were not included to mitigate such bias. I also test whether size and BE/ME factors are proxied by growth in earnings as studies like FF (1995) and Harris and Marston (1994) reported strong correlation between the two factors and growth.

There are two major findings from this study. First, I find that Fama and French results are period and sample specific. Size and book-to-market equity are only significant in the earlier subperiod from 1973 to 1984 but fail to capture variations in average stock returns over the most recent years. Furthermore, the exclusion of the NASDAQ stocks also contributes to the insignificance of size and value premiums as survivorship bias is reduced. Overall, the FF findings are largely driven by the returns of NASDAQ stocks and the earlier sampling period.

Second, although growth in earnings is significant in both subperiods, its opposite signs in each subperiod cancel each other's significance in the overall period. I also did not find that size and BE/ME are proxied by growth in earnings as it fails to absorb the significance of these factors. Finally, Beta is found to be insignificant in the presence of both size and value factors.

Key Words: Asset Pricing Model, Size Effect, Book-to-Market Effect, Growth in Earnings

JEL Classification No: G12, G14

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1. Introduction

The anomalies in the stock return literature have stirred voluminous empirical studies since the CAPM has been put into question. The evidence supporting that stock returns are predictable by variables besides beta has become overwhelming. Major studies by Fama and French (FF, 1992, 1993) document that size and book-to-market equity significantly capture variation in average stock returns and absorb other factors found in earlier studies.[1] However, Kothari, Shanken and Sloan (1995) raise the issue on the robustness of the FF results as they find that using an alternative data set to reduce survivorship bias, there is substantial significant ex post compensation for beta risk over the period FF study even when firm size is controlled. They further find that book-to-market equity is found at best weakly related to average stock returns.

In their later studies, FF (1995) analyse how these two variables are related to stock earnings and profitability in an attempt to lay down an economic foundation for the empirical relationship between size and book-to-market equity and expected stock returns. They reason that if stocks are priced rationally, not only must size and BE/ME proxy for sensitivity to common risk factors in returns, but they also must be driven by common factors in shocks to expected earnings that are related to size and BE/ME. Consistent with the prior, the growth variable is statistically significant in explaining portfolio returns and is also significant in relating to the market and size factor. In a similar vein, Harris and Marston (1994) focus their attention on the links among growth, book-to-market equity and beta. When growth is controlled for, the relationship between BE/ME and beta changes from negative to positive. They argue that this observation is consistent with rational pricing in which high BE/ME links to high risk. Moreover, when BE/ME is regressed on growth and beta, growth is more significant in explaining BE/ME.

These studies provide indirect evidence linking growth to the anomalies and ultimately, to expected stock returns. Such evidence motivates a direct examination on the role of growth in earnings along with size and BE/ME on stock returns. Therefore, the purpose of this study is two fold. First, to test the robustness of size and value premiums by using a data set with different sampling period that is less subject to survivorship bias. Second, to directly test whether size and book-to-markets factors are proxied by growth in earnings using FF methodology.

The structure of the paper is divided into 4 sections. Section 2 discusses the data and the methodology on forming portfolios and hypothesis testings. Section 3 presents the findings and last section concludes the paper.

2. Data and Methodology

The data sets in this study are the firms on the NYSE and AMEX return files from the Center for Research in Security Prices (CRSP) and the Compustat annual industrial files of income statement and balance-sheet from 1963 through 1996.[2] The reason that NASDAQ firms are not included in the sample is to reduce survivorship bias that has largely been induced by Compustat during an expansion project in 1978. Survivorship bias exists when the sustaining and successful firms are included in the data and those firms that fail or merge with other firms are omitted. Empirical results that are based on this type of data will yield findings that are skewed to those successful firms and may lead to erroneous conclusion. Since NASDAQ stocks tend to have relatively more small stocks than the NYSE and AMEX stocks, they were not included to mitigate such bias. Similarly, the year 1963 was chosen as the start date to reduce survivorship bias. As in this literature, Fama and French (1992) indicated that Compustat data for earlier years prior to 1962 are tilted toward large capitalized and historically successfully firms, and that the book value of common equity (Compustat item 60) is not generally available prior to 1962. The sampling period in this study is 34 years compared to 28 years of Fama and French (1992).

For a firm in NYSE and AMEX to be qualified in the sample, first, it must have at least 24 out of 60 monthly returns before July of year t (for pre-ranking beta estimates). It also must have CRSP stock prices (to measure firm size and book-to-market equity) for both December of year t -1 and June of year t. Furthermore, the firms must have Compustat data on book value of common equity (to measure BE/ME ratio) for its fiscal year ending in calendar year t - 1. Finally, at least forty consecutive quarterly firm's earnings are required to provide measures of growth estimate.

Following the methodology established by FF, the portfolios will be formed according to size and then beta. This two-pass aggregate formation is designed to yield more disperse returns among the portfolios and to disentangle the effects of size and beta. During the formation period, individual stocks are first assigned to one of the 5 portfolios by their firm sizes. The smallest capitalized stocks are in the first portfolio while the largest capitalized stocks are in the fifth portfolio. Then within each size quintile, the pre-ranking betas of each stock are calculated and are subdivided into 10 portfolios according to the pre-ranking betas of individual stocks. Such arrangement yields a total of 50 portfolios.

Under the grouping procedure, I run the monthly cross-sectional regressions on the following equation:

$$R_{p,t} = a_1 b_{p,t-1} + a_2 g_{p,t-1} + a_3 Size_{p,t-1} + a_4 BE/ME_{p,t-1} + d_{p,t} \qquad (1)$$

where $R_{p,t}$ = return of portfolio p at month t. $b_{p,t-1}, g_{p,t-1}, Size_{p,t-1}$ and $BE/ME_{p,t-1}$ = beta, earnings growth, size and book-to-market equity estimates for portfolio p at month $t-1$ respectively.

While portfolio returns, beta, size and book-to-market equity are measured according to FF methodology, the expected growth rate is estimated from the modelling of firm's earning series and then extract the growth information from such series. A autoregressive (AR) process popularised by Box-Jenkin seems to be appropriate to model such a series as studies by Foster (1977), Griffin (1977), Watts (1978), and Brown and Rozeff (1979) find that several autoregressive processes can account for both the seasonal and other major time-series properties of the data. Among them, Foster (1977) proposes a time-series model $(1,0,0)(0,1,0)_4$,

$$\Delta_4 X_t = g + q \ \Delta_4 X_{t-1} \qquad (2)$$

where Δ_4 = the fourth differencing operator; g = the mean of the time series which can be interpreted as one-year expected growth rate of the earnings series. Foster (1977) finds that equation (2) is a good model in capturing a firm's quarterly earnings series from the Compustat data. The model can also be expressed in the level form,

$$X_t = g + X_{t-4} + q \ (X_{t-1} - X_{t-5}). \qquad (3)$$

In Foster's model, the AR process of fourth differencing is of order 1. In this study, a more general AR model of order p $(p,0,0)(0,1,0)_4$ is proposed.[3] Specifically,

$$\Delta_4 X_t = g + \sum_{i=1}^{p} q_i \ \Delta_4 X_{t-i} \qquad (4)$$

if p = 1, then the model in equation (4) reduces to Foster's model. By using the model above, one can fit the quarterly earnings series and estimate the annual growth rate g from such a time series. The quarterly earnings data are taken from Compustat for the period 1963 to 1996. The first initial forty quarterly earnings are used to fit the earnings time series on each qualified firm and to estimate its annual expected growth rate. This rate is then re-estimated (or updated) at the end of each year for every four quarters. Therefore, after every year in the sample period, four additional observations are updated to fit the earnings series. The annual expected growth rate of a portfolio is the equally weighted expected growth rate of individual stocks in that portfolio. The expected portfolio growth rate is then used as the measure of growth variable in the cross-sectional regressions in equation (1).

3. Empirical Results

Table 3.1 presents the averages of pre-ranking betas, post-ranking betas, firm size, post-ranking returns and the time-series growth of 50 portfolios formed by size and then beta.[4] In Panel A, the averages of pre-ranking betas range from 0.294 for the largest size and low beta portfolio to 1.862 for the smallest size and high beta portfolio. This large dispersion among pre-ranking betas is intended and achieved by sorting qualified individual stocks into the 50 portfolios. As expected, the post-ranking betas show the regression tendency towards the mean. While the dispersion is less than that of the pre-ranking betas, the averages of the post-ranking betas still range widely from 0.381 for the largest size and low beta portfolio to 1.707 for the smallest size and high beta portfolio.

Panel C reports the averages of ln(ME) of each 50 portfolios and shows that size increases proportionally from top down but only varies slightly across beta deciles in all the size groups. This is consistent with what is reported by Fama and French (1992) who interpret it as the disentanglement between beta and size effect produced by the two-pass sort. The averages of post-ranking returns in Panel D present quite a similar pattern as in the averages of size in Panel C in that the return averages decrease as the size of the portfolio increases (top down) while they remain similar across the beta-sorted portfolios in a given size group. These statistical patterns seem to suggest that there is an inverse relation between size and average return, but after controlling for size, there is very little relationship between beta and average return.

The last panel in Table 1 documents the average values of earnings growth. In contrast to conventional wisdom, the time-series growth averages are positively related to size. That is, as the average size portfolios increase, their growth rate also increases. The relationship is consistent with studies that find value stocks outperform glamour stocks. On the other hand, there is little discernible pattern between beta and growth after size is factored into account, suggesting that there is little correlation between the two variables.

Table 2 reports the OLS results on the monthly cross-sectional regressions of portfolio returns on beta, growth, size and book-to-market value. The risk premiums for beta and growth are 0.563 percent and -0.00454 percent, respectively, for the full sample period. Beta is marginally significant with a *t*-statistic of 1.822 while growth fails to capture variation in stock returns. Further examination into the two sub-periods however tells a very different story. In the first sub-period from 1973 to 1984, beta is significant with *t*-statistics equals to 2.172 but its significance disappears in the second sub-period. For earnings growth, it is statistically significant in both sub-periods but in opposite signs (*t*-statistic = -2.210 and 2.073). As result, growth is not important in explaining stock returns in the whole sample period.

When size is regressed along with beta and growth, the risk premium and the t-statistic are -0.0074 percent and -1.421, respectively, in the full sample period. The overall insignificance is again due to the its insignificance in the second sub-period when size effect is strong in the earlier sub-period with risk premium of -0.214 percent and *t*-statistics of -2.633, respectively. The results thus cast serious doubt on the robustness of Fama and French findings that may be largely driven by the earlier sampling period. Furthermore, size effect is also weakened substantially here when NASDAQ stocks in Compustat are excluded in the

Table 1

Preranking Betas, Postranking Betas, Firm Size, Postranking Returns and Growth
For Portfolios Formed on Size and then b Using Equally-Weighted Market Index and
Quarterly Time-Series Growth:
July 1973 to June 1996

	Low-b	b-2	b-3	b-4	b-5	b-6	b-7	b-8	b-9	High-b
Panel A: Pre-Ranking Betas										
Small-ME	0.327	0.567	0.727	0.855	0.971	1.086	1.216	1.353	1.534	1.862
ME-2	0.308	0.530	0.676	0.815	0.931	1.041	1.166	1.309	1.479	1.822
ME-3	0.309	0.445	0.595	0.740	0.852	0.949	1.051	1.169	1.325	1.691
ME-4	0.314	0.470	0.630	0.753	0.851	0.946	1.036	1.138	1.282	1.572
Large-ME	0.294	0.454	0.582	0.684	0.768	0.845	0.933	1.023	1.132	1.416
Panel B: Post-Ranking Betas										
Small-ME	0.753	1.125	1.063	1.293	1.120	1.386	1.505	1.530	1.551	1.707
ME-2	0.641	0.888	0.974	0.932	1.137	0.984	1.266	1.285	1.552	1.559
ME-3	0.486	0.809	0.804	1.038	1.127	1.125	1.076	1.039	1.249	1.288
ME-4	0.407	0.710	0.836	0.900	0.958	0.882	0.890	0.990	1.068	1.182
Large-ME	0.381	0.515	0.630	0.730	0.658	0.703	0.746	0.869	0.816	1.080

Note: Portfolios are formed each year on June 30 from 1971 to 1995 using qualified stocks from NYSE and AMEX on CRSP and Compustat. The stocks are first allocated to 5 size portfolios. Each size portfolio is then subdivided into 10 b portfolios using pre-ranking betas of individual stocks. In Panel A, the stocks in each portfolio are estimated by regressing 24 to 60 monthly stock returns ending in June of each year on the equally weighted market portfolio consisting of all the stocks in the sample. In Panel B, the postranking beta for each portfolio is the slope coefficient from a time-series regression of annual postranking returns on an equally weighted market portfolio consisting of all stocks in the sample. In Panel C, size is measured as the natural logarithm of the average market value of equity (price x number of shares outstanding) of stocks in each portfolio in millions of dollars on June 30 of each year. For the extreme observations, the smallest and largest 0.5% of the observations on Size, BE/ME and Growth are set equal to the next largest or smallest values. On average, there are 20 stocks in a portfolio in a given year.

Table 1-continued

	Low-*b*	*b*-2	*b*-3	*b*-4	*b*-5	*b*-6	*b*-7	*b*-8	*b*-9	High-*b*
Panel C: Average Size (Ln (ME))										
Small-ME	3.419	3.289	3.498	3.394	3.336	3.363	3.394	3.263	3.345	3.357
ME-2	5.114	5.115	5.077	5.034	5.066	5.035	5.027	5.055	4.995	5.035
ME-3	6.119	6.105	6.139	6.149	6.119	6.120	6.165	6.173	6.099	6.098
ME-4	7.065	7.067	7.074	7.074	7.083	7.091	7.065	7.062	7.056	7.027
Large-ME	8.438	8.611	8.662	8.536	8.524	8.439	8.314	8.238	8.197	8.113
Panel D: Postranking Returns (percent)										
Small-ME	1.274	1.323	1.417	1.534	1.570	1.936	1.759	1.934	1.643	1.739
ME-2	1.324	1.483	1.147	1.576	1.606	1.505	1.542	1.524	1.402	1.453
ME-3	1.121	1.325	1.279	1.419	1.426	1.407	1.379	1.372	1.445	1.457
ME-4	1.131	1.141	1.142	1.350	1.425	1.363	1.393	1.249	1.294	1.420
Large-ME	1.143	1.062	1.240	1.222	1.037	1.086	1.117	0.882	0.961	0.839
Panel E: Average Annualized Growth Rate (percent)										
Small-ME	-0.525	-2.072	-1.220	-2.238	-3.550	-3.302	-2.999	-2.409	-2.169	-2.781
ME-2	0.270	1.038	0.506	0.760	-1.113	-0.604	-0.711	-0.763	-2.404	-2.136
ME-3	0.346	0.401	1.238	1.078	0.825	0.140	0.472	0.622	0.532	-0.098
ME-4	2.153	1.477	2.755	1.582	0.712	1.125	2.085	2.214	1.234	0.708
Large-ME	4.037	3.635	5.289	5.050	5.252	3.812	3.932	4.256	4.065	4.706

sample to reduce survivorship bias. Table 2 also shows that although earnings growth is important in explaining average stock returns in both sub-periods, it is not the fundamental factor proxied by size effect. When size is added to the regressions, growth is absorbed by size and the average slopes lower from -0.0517 percent to -0.00879 percent (*t*-statistics drops from -2.210 to -0.487).

A similar story can be told about book-to-market value. While BE/ME is marginally significant (*t*-statistics of 1.861) in the full sample period when regressed with beta and growth, it is driven by its significance (*t*-statistics of 2.967) in the first sub-period. Therefore, similar to size effect, the value effect is also period specific. I also find it is unlikely that earnings growth is the common factor for BE/ME. From 1973 to 1984, when book-to-market value is included in the regressions, the average slopes of growth drop from -0.0517 percent to -0.0204 percent (*t*-statistics = -1.117). The tests further find that when size along with book-to-market equity are the only independent variables, the significance of ln(BE/ME) disappears. The evidence thus shows that book-to-market value tends to be more adversely affected by the exclusion of NASDAQ stocks than size. [5]

4. Conclusion

Several observations can be drawn from the empirical analysis above. First, earnings growth cannot explain away size and book-to-market value effect. Both effects, especially the size effect, are still significant after taking into account the growth rate. Therefore, they could be proxied by other fundamental variables that are not tested here. Second, the regression results cast doubt on the robustness of size and book-to-market effect since both effects are only significant in the earlier period and disappear in the more recent sub-period. The finding is consistent with the notion that, both effects could be, to a great extent, driven by the survivorship bias inherent in the Compustat during the data expansion period from 1973 to 1978 where Compustat added mostly successful firms into its database. It may consequently lead to excess returns on the small and high book-to-market value firms. Last, the risk premiums of growth, size and BE/ME reverse itself in the second sub-period from 1985 to 1996. Such reversals may have implications on market efficiency.

<u>Table 2</u>

Cross-Sectional Regressions of Monthly Returns on Beta, Growth, Size and Book-to-Market Equity For Portfolios Formed on Size and then *b* Using Equally-Weighted Market Index and Quarterly Time-Series Earnings Growth:
July 1973 to June 1996

Intercept	*b*	Growth	Ln(ME)	Ln(BE/ME)
		Panel A. 1973 - 1996		
0.769 (3.035)***	0.563 (1.822)*	-0.00454 (-0.308)		
1.381 (3.092)***	0.343 (1.040)	0.041 (0.341)	-0.0074 (-1.421)	
0.881 (3.487)***	0.386 (1.310)	0.0055 (0.472)		0.411 (1.861)*
1.687 (3.564)***			-0.0642 (-1.195)	0.248 (0.985)
		Panel B. 1973 -1984		
0.322 (0.789)	1.106 (2.172)**	-0.0517 (-2.210)**		
2.083 (3.007)**	0.529 (1.059)	-0.00879 (-0.487)	-0.214 (-2.633)***	
0.634 (1.612)	0.699 (1.546)	-0.0204 (-1.117)		0.970 (2.967)***
2.543 (3.154)***			-0.201 (-2.303)**	0.404 (1.041)

Note: Time-series averages of estimated coefficients from the monthly cross-sectional regressions below from 1973 to 1996 (Panel A), from 1973 to 1984 (Panel B) and from 1985 to 1996 (Panel C) are reported.

Table 2 - continued

Intercept	b	Growth	Ln(ME)	Ln(BE/ME)
Panel C. 1985 - 1996				
1.179	0.066	0.0377		
(2.875)	(0.182)	(2.073)		
0.738	0.171	0.0159	0.0519	
(1.29)	(0.258)	(0.991)	(0.788)	
1.567	0.099	0.0292		-0.101
(3.426)	(0.258)	(1.997)		(-0.344)
0.902			0.0616	0.105
(1.734)			(0.983)	(0.321)

$$R_{pt} = g_0 + g_{1t} b_p + g_{2t} Growth_{pt-1} + g_{3t} Size_{pt-1} + g_{4t} B/M_{pt-1} + e_{pt}$$

where R_{pt} is the monthly return for portfolio p during the year beginning from July 1 of year t to June 30 of year t+1; b_p is the full sample postranking beta of portfolio p and is the slope coefficient from a time-series regression of postranking portfolio returns on the returns on an equally-weighted portfolio consists of all the stocks in the sample; $Growth_{pt-1}$ is the quarterly time-series earnings growth rate of the stocks in the portfolio from the past 10 years. $Size_{pt-1}$ is the natural log of the average market capitalization in millions of dollars on June 30 of year t for portfolio p; B/M_{pt-1} is the natural log of the average of the ratio of book over market equity on December 31 of year t for portfolio p. For extreme observations, the smallest and largest 0.5% of the observations on Size, BE/ME and Growth are set equal to the next largest or smallest values. The number of firms in the sample range from 584 in 1973 to 1359 in 1996. On average, there are 1027 stocks in the monthly regressions from July 1973 to June 1996.

The associated t-statistics of the coefficients are obtained according to:

$$t_{c,p} = \frac{\bar{g}_{c,p}}{S(g_{c,p}) / \sqrt{T-1}}, c = 1,2,3,4, \qquad \bar{g}_{c,p} = \frac{1}{T}\sum_{t=0}^{T} g_{c,p,t},$$

$$S(g_{c,p}) = \frac{1}{T-1}\sum_{t=0}^{T}(g_{c,p,t} - \bar{g}_{c,p})^2 .$$

where T is the number of months where the coefficients are calculated.

*,**,and *** represent significance at the 10%, 5%, and 1% levels, respectively.

Notes

1. Variables like earnings yield, leverage, cash flow/price, and past sales growth have been the earlier focus of anomalies.
2. Fama and French (1992) exclude financial firms in their tests because they examine leverage variables which might have different interpretations for financial and nonfinancial firms. However, recent studies find that the distinction between them does not matter.
3. The SAS program can be written to select the best possible fit (AR of order *p*) for each individual firm in a given period. Therefore, each firm may have a separate model for each estimate period and the model for each firm may be different from period to period.
4. I have also sorted portfolios by beta and then by size and the results are similar to those formed by size and then beta.
5. Kothari, Shaken and Sloan (1995) also find that when survivorship bias is mitigated, book-to-market effect is not significant

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