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PROFITABILITY PATTERNS AND FIRM SIZE

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Abstract

Ten years of Compustat data on 1458 companies in 54 industries are used to validate the result first obtained by Bowman, that the level and variance of return on stockholders' equity tend to correlate negatively within industries. The data are then used to test whether firm size can be used to explain this correlation. Results confirm that there is a strong negative correlation between firm size and variance of return on equity and a moderate correlation between firm size and average level of return on equity, but the evidence does not support the hypothesis that firm size is the major intervening variable between level and variance of return on stockholders' equity.

PROFITABILITY PATTERNS AND FIRM SIZE*

There continues to be strong interest in the behavior of earnings of corporations. The corporate manager, the shareholder and the corporate lender all stand to gain by a better understanding of the mechanisms by which earnings are generated and of the patterns of earnings associated with particular circumstances. This knowledge could be used to make more profitable strategy decisions in the firm and to forecast more accurately future earnings. For example, a better understanding of the patterns of earnings would lead to more accurate forecasts of future earnings and to more accurate valuation of firms. This, in turn, would allow the investor to more accurately estimate personal wealth.

This paper examines the relationship between two measures of corporate success, the level and the variability of corporate profitability. In an earlier study, Bowman found that in general these two variables correlate negatively among firms within a particular industry.[1] This result is tested rigorously using a different time period and different industry definitions, and is found to gain further empirical support. Several possible explanations of the effect are offered and each is discussed in the context of supporting or discrediting evidence found in the research literature. Finally, one explanation is found to have substantial support from the literature, namely that the size of the firm relates directly to each of the two variables, level and variance

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* I am indebted to Professors E.H. Bowman, M.F. Van Breda, and S.C. Myers for many helpful suggestions on an earlier draft of this paper.

of returns on equity, and thus indirectly links level and variance of return. Under this hypothesis, the size of the firm acts as an intervening variable, creating the illusion of a direct causal link between level and variance of returns on equity. This explanation is tested empirically using Compustat data on 1458 companies in 54 industries and results indicate that although there are strong correlations between firm size and level and variance of return on equity, this explanation is not supportable.

The Association of Level and Variance of Return on Equity

Bowman has produced empirical evidence that he suggests is in disagreement with the well known result that risk and return are positively associated. The fundamental empirical result obtained is that in most industries the average level of return on equity is negatively correlated with the variance of the returns on equity.[2] This result was obtained in 58 of the 85 Value Line industries tested, while only 20 industries show a positive correlation. The balance had zero sample correlations. Similar negative correlations were obtained when all companies were merged into one sample.

Several possible explanations of Bowman's empirical results have been offered.[3]

. Good management is concerned with both higher returns and lower variability of returns. In firms with good management one would expect to find both higher levels of returns and lower variability

in those returns, while in poorly managed firms, lower levels of profitability and higher variation in returns would be expected.

. The better managers, those who achieve better results, are practicing income smoothing in an effort to achieve lower variation in returns. Those who achieve poorer returns cannot afford the costs of income smoothing.

. The size of the firm may be permitting both higher levels of profitability and lower levels of variation.

The empirical evidence linking level and variance of return on shareholders' equity is based upon a series of significant correlations. Strong correlations do not imply any kind of direct causality between the variables, only that those variables tend to move together. It is not easily understood how the level of return on equity could directly influence the variance of return on equity, or how variance could directly influence level of return. Each of the above explanations assumes the existence of some intervening variable with which both the level and the variability of returns on equity covary directly. For the first explanation, the intervening variable is good management, for the second it is the practice of income smoothing, and for the third it is the size of the firm.

The first explanation has some validity. There is evidence that a goal of many corporate managers is to lower the variability of earnings as they increase the level of profitability.[4] Therefore higher returns

on equity would usually be accompanied by lower variability in the profitability stream. Still, this does not explain the mechanism by which good managers would effect such a position. This is our interest in studying the relationship between level and variability of returns. What are the choices and the decisions, or the inevitable mechanisms, that would allow management to fulfill its dual objectives of higher levels and lower variation in profitability?

Income Smoothing As An Explanation

The income smoothing explanation is quite a plausible explanation of the basic empirical result obtained by Bowman. Income smoothing has been postulated as a common management activity as far back as 1953, when S.R.Hepworth suggested income smoothing as a method of reducing corporate taxation when corporations faced a graduated tax scale.

Two forms of income smoothing have been identified in the literature, real and artificial. Real income smoothing relies upon changing the timing of real transactions so that the effects of the transactions upon the accounting statements of the firm are felt in one period, rather than another. For instance, it may be possible to delay until the following year the purchase of some capital goods, thereby shifting the first depreciation charge into the following year. In times of poor financial results, it also may be possible to significantly decrease the advertising and research and development expenses by curtailing these activities. Artificial income smoothing relies solely upon accounting manipulations to smooth the periodic income of the

firm. Recognizing all of an investment tax credit in the present period[5] and increasing dividends from unconsolidated subsidiaries[6] have been used in the past to increase present period income.

Most of these studies of income smoothing have concentrated upon detecting actions to smooth the profits or net income stream rather than the profitability of return on shareholders' equity stream, because it was felt that:

> One, a rate of return on net assets is rarely found in corporation annual reports, suggesting that managers apparently do not intend to convey a notion of the success of operations in terms of that criterion. Two, financial analysts utilize a relationship between income and market value per share, not book value per share.[7]

Declining productivity growth rates and scarce capital have made profitability a key to success in recent years[8] and the smoothing of returns on shareholders' equity a much greater possibility. As well, studying the smoothing of profitability eliminates the difficulty of establishing a trend line to normalize the variance calculation because profitability ratios remained fairly stable over the period of study. In any event, the smoothing of profits and of profitability are intimately related, and the research results are generally applicable to both profit smoothing and profitability smoothing.

In the early years, many researchers tried, with mixed results, to detect instances of artificial income smoothing, without considering the smoothing effects of changing the timing of real transactions.[9] These efforts generally came to inconclusive results because many of the data bases were small and the effects they were trying to detect

were small. Later attempts at identifying both real and artificial income smoothing methods were more successful. Beidleman [10], Lev and Kunitzky [11], and Ronen and Sadan [12] all found evidence of income smoothing, particularly of real income smoothing.

White [13] examined the relationship between the use of income smoothing techniques and the prior earnings pattern of the firm. The basic result found was that "companies faced with highly variable performance patterns or declining trends in earnings may be expected to base discretionary accounting decisions on a systematic normalization criterion."[14] The firms that had good levels and patterns of performance were found generally not to use income smoothing methods. Income smoothing was used by those firms with low levels of earnings and with high variability of earnings to decrease the variability of earnings.

Thus, although there is evidence of income smoothing practices by managers in industry, the evidence suggests that it is used in such a manner that it reduces rather than induces the negative association of level and variance of return on equity. In other words, income smoothing tends to be used by low profitability firms to decrease the erratic patterns of their results and this decreases the negative association of level and variance of profitability.

Firm Size As An Explanation

The firm size explanation is suggested by several pieces of research in the literature of earnings behavior. This explanation would postulate that firm size is an intervening variable in the relationship between level and variability of return on equity: larger firms tend to have higher levels of profitability and smaller variations in profitability.

The relationship between the relative market share of a business unit and the return on equity has been studied extensively as part of the PIMS research effort. The general conclusion of that work is that there is a strong, positive association between the level of profitability and the market share of the business within an industry. Some possible explanations of this result have been suggested by the primary researchers of the PIMS work.[15]

. Economies of scale. The larger firms are able to produce the same goods more cheaply because they have achieved more learning and greater cumulative experience and they are able to spread their fixed costs over a greater amount of production.

. Market power. Larger firms can extract premium profits because of their influence upon the industry. They are better able to bargain for more favorable factor costs and can more easily influence the price and quality standards for their goods.

. Quality of management. Similar to the argument advanced by Bowman is this explanation which suggests that quality management is able to achieve the dual goals of higher market share and higher profitability.

The PIMS study has empirically linked market share and profitability. It does not directly suggest that larger firms tend to be more profitable, but only that relative market position and profitability are positively associated. If larger firms tend to have larger relative market shares, then one theory explaining the positive association between firm size and profitability would suggest that larger firms tend to have larger relative market shares and that larger market share, for all the reasons suggested by the PIMS researchers, tends to produce higher levels of profitability.[16]

The firm size explanation of the association of level and variance of return on shareholders' equity has a second leg on which it stands. Not only is it postulated that the return on equity is positively associated with the size of the firm, but also that the variance of the return on shareholders' equity is negatively related to the size of the firm.

Alexander[17] provided some of the earliest empirical evidence that larger firms tend to have lower variation in their rates of return. He reasoned that if one were to consider larger firms as a collection of smaller independent units, then the variance of the rate of return would be 1/n of a smaller firm's variance, where n represents the ratio

of the size of the large firm to that of the smaller firm. His results indicated that the decrease in variance for larger firms was somewhat smaller than what this model would suggest.

Similar empirical evidence, on the relationship between variance of return and firm size, was obtained by Mansfield[18], Hymer and Pashigian[19], and Samuels and Smyth[20]. None obtained evidence that the decrease in variance for larger firms was as large as the Alexander model had predicted. This result is consistent with the earlier assertion that larger firms tend to have larger market shares. If that is the case, then the average size of the independent units of the larger firms would be bigger and larger firms would have fewer independent units relative to their size. Hence the variation of the average rate of return for the larger firms would be greater than 1/n that of the smaller firms, where n represents the ratio of the size of the larger firm to that of the smaller firm.

Differences in financial leverage may also have an effect in the relationship between firm size and variance of profitability. Larger firms tend to have lower debt to equity ratios and lower debt to equity ratios lead mechanistically to lower levels of variance in return on shareholders' equity.[21] A symmetric argument linking debt to equity ratios and level of return on shareholders' equity can be posited in the security market domain, but not in the accounting domain.[22] Thus, the effect of financial leverage upon the relationship between firm size and level of profitability is not predictable, but it probably tends to decrease the size of the association.

Firm size as an explanation of the negative association of level and variance of profitability has theoretical and empirical support from previous studies. It can be theorized that if larger firms are viewed as a collection of smaller independent units competing in different markets, and that the units of larger firms are on average larger than those of smaller firms, then larger firms' greater relative market share tends to result in higher profitability and the greater number of independent units of larger firms results in lower variation of rates of return.

The Empirical Study

A review of the previous literature has led to a reasoned explanation of the association between level and variance of return on shareholders' equity. This empirical study tested the proposition that the association between level and variance of return on shareholders' equity is negative and that this association occurs because firm size covaries directly with level of return on equity and inversely with variance of return on equity. It was not possible to test the theory at a finer level of analysis because the data for such a study was not available. For instance, it would have been of interest to consider the relationship between firm size and average market share and between average market share and profitability, but data for such a study is not available. We had to be satisfied with testing the relationship between firm size and profitability without analysis of possible intervening variables.

This proposition can be stated as a series of four null hypotheses.

H1: That the level and variance of return on shareholders' equity are not negatively associated, either across all firms or within industries.

H2: That the level of return on shareholders' equity and firm size are not positively associated, either across all firms or within industries.

H3: That the variance of return on shareholders' equity and firm size are not negatively associated, either across all firms or within industries.

H4: That the covariance of firm size with level and variance of return on shareholders' equity does not serve to explain a significant amount of the association between level and variance of return on shareholders' equity, either across all firms or within industries.

The study is based upon an analysis of data on 1458 companies within 54 industries, as obtained from the Compustat data base for the years 1966 to 1975. This period was chosen to maximize the number of firms that passed the data availability requirements while maintaining a sufficient period to calculate longitudinal variance of return on shareholders' equity. Any bias introduced by the selection of this time period could not be avoided.

Results were considered within industries as well as across all firms so that industry specific effects could be controlled. For instance, different industries have different standards of accounting, and have differant capital structures. Both these differences could potentially have effects upon the results. As well, by considering the data within industries, the patterns of profitability and firm size among direct competitors could be analysed.

For a company in the Compustat data base to be included in the study, there were three requirements:

. Data on assets, shareholders' equity, and net income had to be available for the entire ten year period.

. There could not have been a major merger that resulted in the formation of a new company, during the ten year period. Normal merger activity did not eliminate a firm from the sample. This constraint was included because in the rare event of a major corporate merger, the resultant new company could not have been considered a continuation of the old firm. Hence, data on either the old firm or the new firm was not available for the entire ten year period. Less than twenty firms were eliminated from the study by this constraint.

. At least one other firm in the same two digit industry classification must have passed the above two requirements, so that intra-industry tests could be performed.

The two digit industry classification numbers were used to group companies into industrial catagories because it was a standardized and apparently unbiased method of obtaining industry definitions. These industry definitions were unsatisfactory for a number of reasons. They provided an uneven division of industries, sometimes separating into two industries what would appear to be one (such as industry 13, crude petroleum, and industry 29, refining) and at other times lumping together industries that quite rightly would appear to be only incidentally related (such as including computer manufacturers and construction equipment manufacturers in the same industry 35, machinery). A second difficulty with the two digit industry classification numbers was that they placed many diversified companies into the industry of their main product. For instance, in the cigarette industry, number 21, most of the firms are widely diversified, but the grouping does not capture this information. In spite of these difficulties, the two digit industry numbers were the best available method of grouping firms.

Level of return on equity was measured as the ten year average of net profits after taxes divided by year end shareholders' equity. Variance of return on equity was measured as the statistical variance of the return on equity measure, over the ten year period. Firm size was measured by the average of the assets at the end of each year. No biasing of results due to these measures of the variables under consideration could be predicted or detected.

Non-parametric statistics were used throughout the study because parametric methods were not particularly well suited to the analysis of the data and becasue most previous studies in this area used non-parametric techniques.[23] The principle tools used in the analyses were linear correlations, which measure the degree of linear association between variables. The data used was decidedly non-linear. The operating results, both within industries and across all firms, tended to group around a median result, but there also existed extreme outliers whose inclusion in a parametric linear correlation would have severely biased the result. By considering the ranks of the operating results, rather than the values, it was possible to reduce the biasing effects of the outliers and it was unnecessary to resort to any attempt to "clean" the data. Non-parametric statistics were more suitable for the analyses for a second reason. The first three hypotheses under test were concerned with the signs of associations between two variables. These hypotheses are non-parametric, for they are not concerned with the size of the association, but only with whether there is a significant association in either direction. Non-parametric methods are perfectly suited for such tests.

Linear regression and analysis of variance techniques were inappropriate for two reasons. First, the direction of causality among and between variables was not at all clear. Therefore it was impossible to establish the independent variables. Second, there was a significant amount of multicollinearity among variables.

Significance levels for one and two sided tests of a correlation coefficients' difference from zero were obtained by comparing the statistic:

$$t = p * \text{SQUARE\_ROOT}\left\{ \frac{n-2}{1-p^*p} \right\}$$

n - sample size
p - sample rank correlation coefficient

with the student-T distribution with (n-2) degrees of freedom. It can be shown that for sample sizes greater than 10, this statistic has approximately a student-T distribution.[24] For the one-sided tests, in which there is a prior hypothesis as to the sign of the correlation coefficient, the significance is twice that of the two-sided test.

The Results

The first hypothesis (H1) was tested in several ways. The rank correlation coefficient over the entire population was computed. The value obtained, -0.288, was found to be significantly less than zero at the .0001 level of significance. At this level, the null hypothesis, that level and variance of return on equity are not negatively associated across all firms, can safely be rejected.

Rank correlation coefficients were also calculated for each industry. They are displayed in Table I, together with the significance level of the test that the correlation coefficient is less than zero. Industries are ordered by the significance of their correlations.

Twenty-two of the 54 industries were found to have correlation coefficients significantly different from zero, at the 5% level. Of the 32 industries for which a significant correlation did not obtain, only 15 had a sample size greater than ten. Nine of the samples included less than five data points each. These small sample sizes were insufficient for acceptance of all but the strongest correlations.

The effect observed by Bowman, that level and variance of return on equity are negatively associated, is evident from the data. Forty-three of the 54 industries had a correlation coefficient that was negative. If the association between variables was zero, we would expect a 50% chance of negative correlation, but if the association between variables was negative, the probability of a negative correlation would be greater than one-half. Using a binomial test of the probability of obtaining a negative correlation, the null hypothesis that the probability is one-half can be rejected in favour of the hypothesis that the probability is greater than one-half, at the .00001 level of significance.

For the 22 industries for which the correlation coefficient is significantly less than zero at the 5% level, 20 yielded negative correlations. Using the same binomial test of the probability of obtaining a negative correlation, we may accept the alternative hypothesis that the probability is greater than one-half at the .00006 level, and that the probability is greater than .74 at the 5% level.

The two industries for which a significant positive correlation was obtained, were the Utilities industry (industry 49) and the Apparel Retailing industry (industry 56). The Utilities industry's rates for its services are closely regulated, and so the profitability patterns within that industry are not determined by the normal market forces present in other industrial sectors.[25] This may account for the positive association of level and variance of return on equity within the Utilities industry. No similar explanation can be suggested for the result obtained for the Apparel Retailing industry. At the 5% level of significance, the expectation is that one in twenty tests will yield spurious results.

All of this evidence allows the rejection of the null hypothesis H1, in favour of the alternative, that the level and variance of return on shareholders' equity are negatively associated, both across all firms, and within industries.

TABLE I

AVERAGE RETURN VARIANCE OF RETURN RANK CORRELATION	SIGNIFICANCE OF CORRELATION	INDUSTRY NUMBER	SAMPLE SIZE	INDUSTRY
-0.527	<0.001*	36	89	Electric Equip.
-0.433	<0.001*	35	109	Machinery
-0.685	<0.001*	54	29	Retail Grocery
-0.427	<0.001*	20	87	Food
-0.758	<0.001*	42	19	Trucking
-0.434	<0.001*	37	68	Autos,Planes
-0.752	<0.001*	99	18	Conglomerates
-0.394	<0.001*	28	82	Chemicals,Drugs
-0.636	0.001*	30	23	Rubber + Plastic
-0.410	0.001*	34	55	Heat+Plumb. Equ.
-0.587	0.001*	73	26	Tech. Service
-0.850	0.003*	31	9	Shoes,Leather
0.190	0.008*	49	159	Utilities
-0.511	0.026*	24	15	Lumber + Wood
-0.612	0.032*	58	10	Retail Eating
-0.323	0.033*	38	34	Instruments
-0.482	0.036*	51	15	Whsl. Food,Drugs
-0.315	0.037*	13	34	Petroleum
-0.283	0.042*	32	39	Glass,Cement
-1.000	0.042*	80	4	Hospitals
0.643	0.044*	56	8	Retail Apparel
-0.395	0.050*	45	25	Air Transport
-0.352	0.055	50	22	Whsl. Durables
-0.515	0.065	21	10	Cigarettes
-0.274	0.072	26	30	Paper + Boxes
-0.657	0.079	61	6	S + L,Finance
-0.222	0.097	23	36	Apparel

* - significant at the 5% level

TABLE I
(continued)

AVERAGE RETURN VARIANCE OF RETURN RANK CORRELATION	SIGNIFICANCE OF CORRELATION	INDUSTRY NUMBER	SAMPLE SIZE	INDUSTRY
-0.476	0.119	78	8	Movie Production
-0.304	0.120	39	17	Toys,Pens,Misc.
0.241	0.130	48	24	Phone,Radio,TV
-0.417	0.134	12	9	Coal,Lignite
-0.319	0.145	25	13	Furniture
-1.000	0.167	44	3	Water Transport
1.000	0.167	67	3	Real Estate Inv.
-0.188	0.185	22	25	Textile Mills
-0.300	0.186	16	11	Engin. Const.
0.118	0.232	29	41	Refining
-0.119	0.255	59	33	Retail Miscel.
0.111	0.273	10	32	Metal Mining
-0.400	0.300	52	4	Retail Lumber
-0.400	0.300	72	4	Cleaning
0.300	0.313	75	5	Auto Service
-0.500	0.337	57	3	Retail Furniture
-0.500	0.337	79	3	Amusements
-0.500	0.337	89	3	Engin,Architec.
0.127	0.365	40	10	Railroads
-0.200	0.400	47	4	Transport Servic
-0.095	0.412	15	8	Contractors
0.033	0.428	53	33	Department Store
0.024	0.435	33	49	Steel + Iron
0.048	0.456	70	8	Hotels,Motels
-0.036	0.459	65	11	Real Estate Dev.
-0.001	0.498	27	31	Printing,Publish
-1.000	0.500	17	2	Special Const.

Hypothesis H2, that the average level of profitability is positively associated with firm size, was tested across all firms and within industries. Across all industries, both the absolute and relative size of the firm within its industry, could have been exerting separate effects and it was undertaken to examine each.

A rank correlation of absolute average asset size and average return on shareholders' equity produced a correlation coefficient of 0.136, which was significantly greater than zero at the .0001 level of significance.

The relative size of the firm within its industry was measured as the ratio of the average asset size of the firm over the ten year period to the average asset size of all firms within the industry, taken over all ten years. A rank correlation of average level of return on shareholders' equity and relative firm size yielded a correlation coefficient of 0.162, which was also significantly greater than zero at the .0001 level of significance.

The explanatory power of the relative asset size variable was 42% greater than that of the absolute asset size (2.6% of variation accounted for, as against 1.8%), but the minute power of these variables to predict the level of profitability, makes this difference quite insignificant. The rank correlation of absolute and relative asset size was 0.824, indicating a very high degree of collinearity between the variables. Therefore, there was very little discretionary power between the variables and it was not possible to conclude whether absolute asset size, relative asset size, or a combination of both, was influencing the level of profitabliity. All that can be concluded is that evidence was found that relative asset size tends to be more strongly associated with level of profitability than does absolute asset size.

At the levels of significance obtained for the correlations of level of profitability and firm size, the null hypothesis that the level of return on shareholders' equity and firm size are not positively associated across all firms, can be rejected in favour of the alternative.

Rank correlation coefficients were also calculated for each industry and the results are displayed in Table II, together with the significance level of the test that the correlation coefficient is greater than zero. Industries are ordered as in Table I.

Only 15 of the 54 industries were found to have correlation coefficients significant at the 5% level. Of these, 13 had positive correlations. Using the binomial test of the probability of obtaining a positive correlation coefficient, we may accept the alternative hypothesis that the probability is greater than one-half at the .0037 level, and that the probability is greater than .63 at the 5% level.

Across all industries, 41 of 54 had positive correlations. This would allow acceptance of the alternative hypothesis, that the probability of obtaining a positive correlation coefficient was greater than one-half, at the .0001 level.

Among the 22 industries for which a significant association between level and variance of return on equity was found, 8 had correlations between level of profitability and firm size that were significant at the 5% level. All were positive.

It is evident that the null hypothesis, H2, can be rejected in favour of the alternative, that level of return on shareholders' equity is positively associated with firm size.

Both the industries for which a significant and negative association was obtained (industry 48, Telephone, Radio and TV, and industry 33, Steel and Iron) were industries for which a positive correlation between level and variance of profitability obtained. Thus, they were supportive of both null hypotheses, H1 and H2.

TABLE II

AVERAGE RETURN AVERAGE ASSETS RANK CORRELATION	SIGNIFICANCE OF CORRELATION	INDUSTRY NUMBER	SAMPLE SIZE	INDUSTRY
0.160	0.068	36	89	Electric Equip.
0.310	0.001*	35	109	Machinery
0.090	0.322	54	29	Retail Grocery
0.335	0.001*	20	87	Food
0.332	0.083	42	19	Trucking
0.032	0.398	37	68	Autos,Planes
0.086	0.368	99	18	Conglomerates
0.191	0.044*	28	82	Chemicals,Drugs
0.467	0.013*	30	23	Rubber + Plastic
0.113	0.206	34	55	Heat+Plumb. Equ.
0.293	0.073	73	26	Tech. Service
-0.083	0.416	31	9	Shoes,Leather
0.027	0.368	49	159	Utilities
0.132	0.321	24	15	Lumber + Wood
0.636	0.024*	58	10	Retail Eating
0.409	0.009*	38	34	Instruments
0.154	0.292	51	15	Whsl. Food,Drugs
0.614	<0.001*	13	34	Petroleum
0.292	0.037*	32	39	Glass,Cement
-0.400	0.300	80	4	Hospitals
0.190	0.327	56	8	Retail Apparel
-0.039	0.427	45	25	Air Transport
0.355	0.053	50	22	Whsl. Durables
0.394	0.132	21	10	Cigarettes
0.052	0.393	26	30	Paper + Boxes
0.314	0.273	61	6	S + L,Finance
0.010	0.477	23	36	Apparel

* - significant at the 5% level

TABLE II
(continued)

AVERAGE RETURN AVERAGE ASSETS RANK CORRELATION	SIGNIFICANCE OF CORRELATION	INDUSTRY NUMBER	SAMPLE SIZE	INDUSTRY
-0.333	0.211	78	8	Movie Production
-0.277	0.142	39	17	Toys,Pens,Misc.
-0.461	0.012*	48	24	Phone,Radio,TV
0.667	0.025*	12	9	Coal,Lignite
0.484	0.048*	25	13	Furniture
-1.000	0.167	44	3	Water Transport
0.500	0.337	67	3	Real Estate Inv.
0.202	0.168	22	25	Textile Mills
0.800	0.002*	16	11	Engin. Const.
0.087	0.295	29	41	Refining
0.059	0.373	59	33	Retail Miscel.
0.401	0.012*	10	32	Metal Mining
-0.400	0.300	52	4	Retail Lumber
0.200	0.400	72	4	Cleaning
-0.400	0.253	75	5	Auto Service
-0.500	0.337	57	3	Retail Furniture
0.500	0.337	79	3	Amusements
1.000	0.167	89	3	Engin,Architec.
0.527	0.060	40	10	Railroads
0.200	0.400	47	4	Transport Servic
0.214	0.306	15	8	Contractors
-0.066	0.359	53	33	Department Store
-0.329	0.011*	33	49	Steel + Iron
0.048	0.456	70	8	Hotels,Motels
0.573	0.035*	65	11	Real Estate Dev.
-0.013	0.473	27	31	Printing,Publish
1.000	0.500	17	2	Special Const.

* - significant at the 5% level

Hypothesis H3, concerning the association of variance of return on equity and firm size, was tested across all data. The rank correlation coefficient obtained between variance of return on equity and absolute asset size was -0.456, significant at the .0001 level. The rank correlation coefficient between variance of return on equity and relative asset size was -0.307, also significant at the .0001 level.

These results are supportive of the alternative hypothesis that variance of profitablity and firm size are negatively associated across all firms.

In this instance, absolute asset size was more strongly associated than relative asset size. The explanatory power of the absolute asset size variable was more than twice as great as that of relative asset size (20.8% of variation accounting for, as against 9.4%). The difference was quite significant, suggesting that larger firms enjoy lower variability of return on equity, in part because of their absolute size. This is consonant with the model of earnings variability first postulated by Alexander.

The results of an intra-industry analysis of the correlation coefficients are found in Table III, together with the significance level of the test that the correlation coefficient is greater than zero. Industries are ordered as in Table I.

It may be observed that 46 of the 54 industries have a negative correlation coefficient, 7 have a positive coefficient, and one has a zero sample correlation coefficient. Using a binomial test of the probability of obtaining a negative correlation, we may accept the alternative hypothesis that the probability is greater than one-half at the .0000001 level.

Twenty-six of the 54 coefficients were found to be significant at the 5% level. All 26 had negative correlations. This allows acceptance of

the alternative hypothesis, that the probability of obtaining a negative correlation coefficient is greater than one-half, at the .00000002 level. The hypothesis that the probability is greater than .89 may be accepted at the 5% level.

Of the eight industries that obtained significant correlations in Tables I and II, only industry 32, Glass and Cement, failed to have a negative correlation coefficient significant at the 5% level.

TABLE III

VARIANCE OF RETURN AVERAGE ASSETS RANK CORRELATION	SIGNIFICANCE OF CORRELATION	INDUSTRY NUMBER	SAMPLE SIZE	INDUSTRY
-0.358	<0.001*	36	89	Electric Equip.
-0.467	<0.001*	35	109	Machinery
-0.116	0.275	54	29	Retail Grocery
-0.621	<0.001*	20	87	Food
-0.486	0.019*	42	19	Trucking
-0.283	0.010*	37	68	Autos,Planes
-0.416	0.044*	99	18	Conglomerates
-0.402	<0.001*	28	82	Chemicals,Drugs
-0.745	<0.001*	30	23	Rubber + Plastic
-0.404	0.001*	34	55	Heat+Plumb. Equ.
0.000	0.500	73	26	Tech. Service
-0.017	0.483	31	9	Shoes,Leather
-0.180	0.011*	49	159	Utilities
-0.146	0.302	24	15	Lumber + Wood
-0.758	0.006*	58	10	Retail Eating
-0.477	0.003*	38	34	Instruments
-0.379	0.082	51	15	Whsl. Food,Drugs
-0.390	0.012*	13	34	Petroleum
-0.238	0.073	32	39	Glass,Cement
0.400	0.300	80	4	Hospitals
-0.452	0.132	56	8	Retail Apparel
-0.699	0.046*	45	25	Air Transport
-0.460	0.017*	50	22	Whsl. Durables
-0.564	0.046*	21	10	Cigarettes
-0.183	0.168	26	30	Paper + Boxes
-0.371	0.235	61	6	S + L,Finance
-0.382	0.011*	23	36	Apparel

* - significant at the 5% level

TABLE III
(continued)

VARIANCE OF RETURN AVERAGE ASSETS RANK CORRELATION	SIGNIFICANCE OF CORRELATION	INDUSTRY NUMBER	SAMPLE SIZE	INDUSTRY
-0.143	0.369	78	8	Movie Production
-0.191	0.232	39	17	Toys,Pens,Misc.
-0.710	<0.001*	48	24	Phone,Radio,TV
-0.550	0.064	12	9	Coal,Lignite
-0.692	0.005*	25	13	Furniture
1.000	0.167	44	3	Water Transport
0.500	0.337	67	3	Real Estate Inv.
0.041	0.423	22	25	Textile Mills
-0.291	0.193	16	11	Engin. Const.
-0.401	0.005*	29	41	Refining
-0.435	0.006*	59	33	Retail Miscel.
-0.342	0.029*	10	32	Metal Mining
0.400	0.300	52	4	Retail Lumber
-0.800	0.100	72	4	Cleaning
0.600	0.144	75	5	Auto Service
-0.500	0.337	57	3	Retail Furniture
0.500	0.337	79	3	Amusements
-0.500	0.337	89	3	Engin,Architec.
-0.273	0.224	40	10	Railroads
-1.000	0.042*	47	4	Transport Servic
-0.071	0.434	15	8	Contractors
-0.424	0.007*	53	33	Department Store
-0.380	0.004*	33	49	Steel + Iron
-0.929	<0.001*	70	8	Hotels,Motels
-0.482	0.068	65	11	Real Estate Dev.
-0.165	0.188	27	31	Printing,Publish
-1.000	0.500	17	2	Special Const.

* - significant at the 5% level

Hypothesis H4, that covariance of firm size with level and with variance of return on equity does not serve to explain a significant amount of the association between these two variables, was tested by comparing the simple rank correlation coefficients of level and variance of return on shareholders' equity with the rank correlation coefficients obtained when the firm size effects are controlled.

If firm size can explain a significant amount of the association, then the rank correlation coefficients controlled for firm size should not be able to reject the null hypothesis, H1, at a significant level. That is, the rank correlation coefficients controlled for firm size would not be significantly negative, and the change in correlation coefficients would be toward zero.[26]

The power of one variable to account for the variation in another can be measured by the square of the correlation coefficient, often referred to as the 'R-squared'. Thus, the change in the explanatory power of the correlation coefficient of level and variance of return on equity can be measured as the difference between the squares of the correlation coefficients before and after controlling for firm size. That is:

$$\text{Change} = S^2 - P^2$$

S - simple rank correlation
P - rank correlation controlled for firm size

Rank correlation coefficients of level and variance of return on shareholders' equity, controlled for firm size, can be computed using partial correlations. A partial correlation is a correlation of two variables, say X1 and X2, adjusted for the linear regression of each on a third variable, say X3. It is computed as the correlation of the predicted values of X1 from the regression of X1 on X3 with the predicted value of X2 from the regression of X2 on X3.[27] The usual computational form for the partial correlation of X1 and X2, holding the effects of X3 constant, is given by:

$$p12.3 = \frac{(p12 - p13*p23)}{\text{SQUARE\_ROOT}\{(1-p13*p13)*(1-p23*p23)\}}$$

pij - sample correlation between variables i and j
p12.3 - sample correlation of variables 1 and 2 controlling for variable 3

In the test of hypothesis H1, the simple correlation coefficient of level and variance of return on equity across all firms was found to be -0.288. This was significantly less than zero at the .0001 level and accounted for only 8.3% of the variation between variables. The rank correlation coefficient, controlled for firm size, across all firms is -0.256, which is also significant at the .0001 level, but accounts for only 6.6% of the variation, an absolute change of 1.7%. Thus, it is found that controlling for asset size across all firms does reduce the strength of the correlation between level and variance of return on shareholders' equity, but only marginally. Across all firms, firm size does not serve to explain a significant amount of the association between level and variance of return of shareholders' equity.

Rank correlation coefficients controlled for firm size were also computed for each industry. The results are displayed in Table IV, together with the simple correlation coefficients and the change in explanatory power between the coefficients. Industries are ordered as in Table I.

The number of non-negative correlation coefficients controlled for firm size is 15, two greater than the number obtained for simple correlation coefficients. This allows rejection of the null hypothesis, in favour of the alternative that the probability of a negative correlation is

greater than one-half, at the .001 level, rather than the .00001 level. There remains firm evidence that the null hypothesis H1 can be rejected. This supports hypothesis H4, that firm size does not serve to explain a significant amount of the association of level and variance of return on shareholders' equity.

Among the 22 industries for which the simple correlation coefficient was significant at the 5% level, there was no change in sign of any coefficient. Hence, no effect on the association of level and variance of return on shareholders' equity, of controlling for firm size, can be detected with this test.

Figure 1 summarizes the change in correlation values.

Figure 1

	P > S	P < S
S < 0	NUMBER OF INDUSTRIES = 29 AVERAGE CHANGE = -13.2% 25.2% TO 12.0%	NUMBER OF INDUSTRIES = 13 AVERAGE CHANGE = +15.0% 23.4% TO 38.4%
S > 0	NUMBER OF INDUSTRIES = 7 AVERAGE CHANGE = +13.9% 8.3% TO 22.2%	NUMBER OF INDUSTRIES = 3 AVERAGE CHANGE = -0.9% 1.9% TO 1.0%

S - Simple Rank Correlation
P - Rank Correlation Controlling for Firm Size

Among the 43 industries with negative simple correlations of level and variance of return on equity, one industry had no change in correlation coefficient value, 29 industries correlation coefficients became less negative, when controlled for firm size, and 13 industry correlation coefficient values became more negative. There was little difference in initial explanatory power between the two main groups of industries (25.2% versus 23.4%) and the average effect of controlling for firm size was equal in magnitude (13.2% versus 15.0%), but opposite in direction.

For the 11 industries with positive simple correlations, one industry had no change in correlation coefficient value, 7 industries increased their correlation coefficients, when controlling for firm size, and 3 industries decreased their correlation coefficient values. The initial explanatory power of the two main groups was quite different (8.3% versus 1.9%), as was the average effect of controlling for firm size (13.9% versus -0.9%).

The size of the effect induced by the control of firm size is significant. Among those industries for which the average change in explanatory power is positive, the average absolute change is 14.6%, from 18.1% to 32.7%, which represents almost a doubling of the explanatory power of the correlation between the main variables. For those industries with a negative change in explanatory power, the average change in explanatory power is -12%, from 23.0% to 11.0%, a halving of the explanatory power of the correlation.

The direction of change in the correlation coefficients after controlling for firm size is significantly positive for both groups and for the two groups combined. At the .001 level, one can reject the hypothesis that the probability of a positive change in correlation coefficient value equals one-half. Although significantly greater than one-half, the probability of positive change in the correlation coefficient value after controlling for firm size, is not strong enough for the effects of controlling for firm size to be evident across all industries. For the group of 43 industries with negative simple correlation coefficients, the average absolute effect was -4.4%, reducing the explanatory power of the correlation from 26.4% to 22.0%, a change of only one-sixth. For the other group, with positive simple correlation coefficients, the average absolute effect was greater, 8.6%, increasing the explanatory power of the correlation from 14.9% to 23.5%.

Thus, controlling for firm size has a significant impact upon the association of level and variance of return on equity in some industries, but not across all industries. Controlling for firm size tends to increase the value of the correlation coefficient, making negative coefficients less negative and smaller in absolute value and positive coefficients larger. If firm size could explain a significant amount of the association between level and variance of return on equity for both groups, then one would expect that in each group, the correlation coefficient value would tend towards zero, as the explanatory powers of the correlations in each group decreased. This did not occur. Firm size does not appear to be acting as an

intervening variable between level and variance of return on shareholders' equity.

Similar and supporting results were obtained when only industries with simple correlation coefficients significantly greater than zero, at the 5% level, were considered. The results are summarized in Figure 2.

Figure 2

	P > S	P < S
S < 0	NUMBER OF INDUSTRIES = 14 AVERAGE CHANGE = -6.9% 25.5% TO 18.6%	NUMBER OF INDUSTRIES = 5 AVERAGE CHANGE = +6.0% 39.5% TO 45.5%
S > 0	NUMBER OF INDUSTRIES = 2 AVERAGE CHANGE = +14.1% 22.5% TO 36.6%	NUMBER OF INDUSTRIES = 0 AVERAGE CHANGE = -----

S - Simple Rank Correlation
P - Rank Correlation Controlling for Firm Size

In summary, the evidence does not allow rejection of the null hypothesis H4, either across all firms or by industry. The correlations of level and variance controlled for firm size can strongly reject the null hypothesis H1, both across all firms and within industries. Although there is evidence that firm size has an effect upon the association of level and variance of profitability, the evidence also suggests that firm size is not acting as an intervening

variable, since its control tends to increase the value of all correlations, rather than bringing them toward zero. Controlling for the size of the firm does not significantly change the basic result that shows a tendency for the level and variance of profitability to negatively correlate.

TABLE IV

S: AVERAGE RETURN VARIANCE OF RETURN RANK CORRELATION	P: AVERAGE RETURN VARIANCE OF RETURN PARTIAL RANK CORRELATION CONTROLLED FOR SIZE	CHANGE: $(S^2 - P^2) \times 100$	INDUSTRY NUMBER	SAMPLE SIZE
-0.527	-0.510	-1.801	36	89
-0.433	-0.343	-6.994	35*	109
-0.685	-0.682	-0.422	54	29
-0.427	-0.296	-9.442	20*	87
-0.758	-0.724	-5.075	42	19
-0.434	-0.443	0.814	37	68
-0.752	-0.791	5.945	99	18
-0.394	-0.353	-3.067	28*	82
-0.636	-0.488	-16.596	30*	23
-0.410	-0.401	-0.741	34	55
-0.587	-0.614	3.236	73	26
-0.850	-0.854	0.764	31	9
0.190	0.198	0.317	49	159
-0.511	-0.501	-0.968	24	15
-0.612	-0.258	-30.793	58*	10
-0.323	-0.159	-7.890	38*	34
-0.482	-0.463	-1.766	51	15
-0.315	-0.104	-8.842	13*	34
-0.283	-0.230	-2.726	32	39
-1.000	-1.000	0.000	80	4
0.643	0.832	27.923	56	8
-0.395	-0.591	19.317	45	25
-0.352	-0.227	-7.223	50	22
-0.515	-0.386	-11.641	21	10
-0.274	-0.269	-0.250	26	30
-0.657	-0.613	-5.582	61	6
-0.222	-0.236	0.646	23	36

* - industry correlation coefficients in Tables I, II, and III all found significant at the 5% level

TABLE IV
(continued)

S: AVERAGE RETURN VARIANCE OF RETURN RANK CORRELATION	P: AVERAGE RETURN VARIANCE OF RETURN PARTIAL RANK CORRELATION CONTROLLED FOR SIZE	CHANGE: $2 \quad 2$ $(S - P)$ x 100	INDUSTRY NUMBER	SAMPLE SIZE
-0.476	-0.561	8.823	78	8
-0.304	-0.378	5.078	39	17
0.241	-0.138	-3.900	48	24
-0.417	-0.081	-16.739	12	9
-0.319	0.025	-10.113	25	13
-1.000	0.000	-100.000	44	3
1.000	1.000	0.000	67	3
-0.188	-0.201	0.489	22	25
-0.300	-0.117	-7.630	16	11
0.118	0.168	1.414	29	41
-0.119	-0.104	-0.338	59	33
0.111	0.288	7.077	10	32
-0.400	-0.286	-7.837	52	4
-0.400	-0.408	0.667	72	4
0.300	0.736	45.241	75	5
-0.500	-1.000	75.000	57	3
-0.500	-1.000	75.000	79	3
-0.500	0.000	-25.000	89	3
0.127	0.331	9.364	40	10
-0.200	0.000	-4.000	47	4
-0.095	-0.082	-0.232	15	8
0.033	0.006	-0.106	53	33
0.024	-0.116	1.280	33	49
0.048	0.250	6.044	70	8
-0.036	0.334	11.059	65	11
-0.001	-0.003	0.001	27	31
-1.000	0.000	-100.000	17	2

Summary

Evidence has been provided that the level and variance of return on shaereholders' equity tend to associate negatively, both within industries and across all firms. Further data show that each of these variables covary significantly with firm size. Level of profitability relates directly with firm size while variance of profitability relates

inversely. The latter relation was found to be the strongest.

The hypothesis that the size of the firm serves to explain negative association of level and variance of return on shareholders' equity within an industry, is not supported by the empirical evidence obtained from an analysis of ten years of Compustat data on 1458 companies in 54 industries. It is other factors which are acting as intervening variables between level and variance of return to create the apparent negative association.

It is probable that no single factor will be found to explain the association. Rather, a number of factors may be required in a model that captures several of the important situational variables that affect the patterns of profitability of the firm. Our evidence suggests that although the size of the firm does not explain the majority of the negative association between level and variance of return on equity, it does appear to explain some of the effect, since a comparison of the partial rank order correlations with the simple rank order correlations reveals that in a great majority, the partial correlation was more positive or less negative than the simple correlation.

Further research should be aimed at establishing the most important situational variables so that we may gain a better understanding of the mechanisms by which earnings are generated and the patterns of earnings that evolve.

FOOTNOTES

[1] See Bowman (1977) and (1980).

[2] Neumann, Bobel, and Haid (1979) have provided self-contradictory evidence on the association between level and variance of return on shareholders' equity. In their recent study of 334 West German firms, they concluded that for the sample of 64 larger firms, the correlation between level and variance of return on equity was significantly positive, while for a sample of 270 other firms, the correlation was negative. The authors were unable to provide an explanation of these puzzling results, although they were led to conclude that variance of return on equity was a poor measure of risk for smaller firms.

[3] See Bowman (1977) p. 13.

[4] For example, see the discussions of Beidleman (1973), Copeland (1968), and Gonodes (1972).

[5] Gordon, Horwitz, and Meyers (1966) explored the use of investment tax credits to smooth periodic income.

[6] Copeland and Licastro (1968) and Dascher and Malcom (1970) each explored the use of dividends from unconsolidated subsidiaries for the smoothing of periodic income. Only Dascher and Malcom were able to find evidence of this behavior.

[7] Zeff (1966) p. 250.

[8] See McConnell (1978) and Malkiel (1979) for recent discussions of the productivity malaise. Searby (1975) gives evidence that capital scarcity will lead companies to place a greater emphasis upon return on net equity, rather than earnings per share. This shift in emphasis is from profits to profitability.

[9] Several of these earlier papers have been included in the references. See, for examples, Gordon, Horwitz, and Meyers (1966), Copeland and Licastro (1968), Cushing (1969), Simpson (1969), and Dascher and Malcom (1970).

[10] Beidleman (1973) found strong evidence that pension and retirement expenses and incentive compensation were strongly associated with higher earnings and that research and development expenses and sales and advertising expenses were also significantly correlated with earnings.

[11] Lev and Kunitzky (1974) explored the smoothing of input and output factors to the firm. They argued that firms with lower risk should have smoother input and output streams and they provided supporting empirical evidence.

[12] Ronen and Sadan (1975) provided evidence that firms classify potential extraordinary items in such a way that they tend to dampen

fluctuations over time of ordinary income before extraordinary items.

[13] See White (1970).

[14] ibid p. 273.

[15] Two excellent discussions of the PIMS work have been published in the Harvard Business Review. See Schoeffler, Buzzell, and Heany (1974) for an overall description of the project, and Buzzell, Gale, and Sultan (1975) for a description of the market share - profitability findings.

[16] There is also evidence that the relationship between profitability and firm size is negative, not positive as PIMS might suggest. Samuels and Smyth (1968) have reported on their study of the operating results of 186 large British companies. They measured profitability as the return on net assets, after depreciation but before taxes, and obtained the result that profit rates and firm size were inversely related. Larger firms tended to have lower rates of profits. This result may have been caused by a number of factors peculiar to their measure of profitability. Larger firms tend to be more highly leveraged than smaller firms and thus pay higher interest expenses, which can justifiably be viewed as a return to capital. Hence, their measure distorts the true return on assets in favor of the smaller firms. Larger firms are also generally more capital intensive, having higher relative depreciation expenses, which can again be viewed as a return to capital. Finally, investments for which there are important tax advantages tend to be made by larger firms, such as are found in the energy sector, and so the return on net assets after taxation would yield results more favorable to the larger firms.

[17] See Alexander (1949).

[18] See Mansfield (1962).

[19] See Hymer and Pashigian (1962).

[20] See Samuels and Smyth (1968).

[21] The relationship between variance of return on shareholders' equity and debt to equity ratios can be demonstrated quite simply.

Let A,E, and D represent total assets, shareholders' equity, and total debt respectively, and let r_i represent the return to 'i'.

Then: $A = E + D$

$r_a A = r_e E + r_d D$

Hence: $r_e = r_a (1 + D/E) - r_d D/E$

If D/E and r_d are assumed constant through time for a particular firm:

$$\text{Variance}(r_e) = (1 + D/E)^2 \text{Variance}(r_a)$$

Hence, variability of return on shareholders' equity varies directly with financial leverage.

[22] Using the previous notation, we have that:

$$r_e = r_a (1 + D/E) - r_d D/E$$

$$= r_a + (r_a - r_d)(D/E)$$

Hence, the direction of the profitability change caused by a change in financial leverage depends upon the sign of the difference between r_a and r_d.

In the security markets, the asset base adjusts so that the difference is always positive, but in the accounting realm assets are fixed by their historical costs, less depreciation, and it is entirely possible that the return to debt could exceed the return to total assets for an extended period of time.

[23] Bowman (1977) and (1980), Samuels and Smyth (1968), and Alexander (1949) all use non-parametric techniques in their analysis.

[24] See Robert L. Winkler and William L. Hays, "Statistics: Probability, Inference, and Decision," (Holt, Rinehart, and Winston, 1975) p. 870.

[25] Bowman obtained similar results for the Utilities industry in his 1977 study.

[26] See Simon (1954) p. 468 for a fuller discussion of this point.

[27] See Winkler and Hays (1975) p. 687.

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