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STRATEGIC RISK AND CORPORATE PERFORMANCE: AN ANALYSIS OF ALTERNATIVE RISK MEASURES

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This study demonstrates that the various measures of corporate risk strategic management research has used reflect different risk factors. Factor analysis of nine measures of risk yielded three factors: income stream risk, stock returns risk, and strategic risk. The factors were stable over time. Income stream and strategic risk in a given five-year period reduced firm performance in the next five years; however, the strength of the effect varied across industries and between high- and low-performance firms. Contrary to previous cross-sectional work, performance reduced subsequent income stream uncertainty for high performers and increased income stream risk for low performers.

Just as numerous researchers in strategic management have begun to incorporate risk in their research designs,[1] the same authors have begun to call for research on the definition and measurement of risk (Baird & Thomas, 1985). The potential shortcomings of current measures are substantial, but with a few exceptions (e.g., Baird & Thomas, 1985; Beaver, Kettler, & Scholes, 1970; Bildersee, 1975), neither theoretical nor empirical comparisons of risk measures are available. This article reports an initial investigation of the measurement properties of some of the most common measures of risk used in strategic management research.

In addition to examining the measurement properties of risk measures, we sought to demonstrate that differences in measurement influence substantive findings. Previous research on the association between risk and performance has questioned the measurement of risk (Bromiley, in press; Fiegenbaum & Thomas, 1986; Ruefli, 1990). Consequently, although risk has been used in numerous areas of strategic management research, we focused on studies that have considered the direct influences of risk on corporate performance and corporate performance on risk. The results of this compar-

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[1] Fiegenbaum and Thomas (1988) summarized such studies.

ison of risk measures is, however, germane to many empirical areas in strategic management. We restricted our view to risk-performance studies to demonstrate the implications of our measurement study for substantive research without being overwhelmed by the many relevant but very different topic areas in which measures of strategic risk have figured.

Studies of the influence of risk on performance have yielded conflicting results. Using variance in returns and content analysis measures, Bowman (1980, 1982, 1984) found a negative association between risk and returns, particularly for below-average performers. Fiegenbaum and Thomas (1985, 1986) found that variance in returns and average returns had associations that varied over time. In their 1986 research, they found no association between the systematic risk of a firm's stock returns—commonly known as beta—and returns measured using accounting data. Fiegenbaum and Thomas (1988), Fiegenbaum (in press), and Jegers (1991) found positive associations between variance in returns and average returns for firms whose returns were above the median in their industry and negative associations for below-median performers. Aaker and Jacobson (1987), using the PIMS data base, found a positive association between performance and both systematic and unsystematic risk when they defined those risk measures using accounting data. The risk-return relation has not had a consistent sign in previous studies.

The use of different risk measures in the cited studies may explain some of their contradictory results. Different measures may, in fact, capture different dimensions of risk. Furthermore, the relations among risk measures and between risk and performance may vary over time.

This study sought to clarify the relations among a variety of risk measures that are relevant to strategic management research and to examine the stability of those relations over time. In this report, we first identify the risk measures that we used and explain their construction.

RISK MEASURES AND DATA

Nine measures of risk that have been used in research relevant to the field of strategic management were identified: systematic risk (beta); unsystematic risk; the debt-to-equity ratio; capital intensity; R&D intensity; the standard deviations of return on assets (ROA), return on equity (ROE), and stock analysts' earnings forecasts; and the coefficient of variation of stock analysts' earnings forecasts.[2] We grouped these variables into three categories: stock returns, financial ratios, and income stream uncertainty.

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[2] Accounting betas, which Aaker and Jacobson (1987) employed, were investigated but not used because the estimates of accounting beta we obtained using quarterly data over the chosen five-year period were extremely unstable and often beyond reasonable values. We would expect betas to cluster in the vicinity of one and range generally from zero to two, but we obtained many estimates over three and substantially below zero.

Measures Based on Stock Returns

Systematic risk and unsystematic risk are standard measures of risk for stock market returns data. In the capital asset pricing model (CAPM) (Lintner, 1965; Sharpe, 1964), systematic risk reflects the sensitivity of the return on a firm's stock to general market movements. Unsystematic risk refers to the extent to which general market movements cannot explain a firm's stock return. Unsystematic risk stems from unique firm or industry characteristics not shared by the market in general.

Aaker and Jacobson (1987) found that both systematic and unsystematic risk, defined with accounting data, influenced performance. Fiegenbaum and Thomas (1986) found that Bowman's (1980, 1982) risk-return paradox, which Bowman demonstrated with accounting data, did not hold if they used beta to measure risk. Numerous studies of stock returns have used beta to control for risk (e.g., Davidson & Worrell, 1988; McGuire, Schneeweis, & Naroff, 1988). Amit and Livnat (1988) included systematic and unsystematic risk among their market measures of risk in an examination of risk-return clusters and corporate diversification.

The regression estimates of beta used here were based on about 1,250 daily observations for each of two approximately five-year periods. The unsystematic risk measure was the standard deviation of the error terms from the equations estimating the betas.

Measures Based on Financial Ratios

Selecting an appropriate set of financial ratios to indicate corporate risk was problematic. As Ben-Zion and Shalit observed,

> The empirical literature in finance often makes little distinction between variables which are *measures* of risk and those which constitute *determinants* of risk. Ideally, one would have liked to possess one set of variables which are theoretically presumed to influence "risk," and another set of variables which are direct measures of "risk," while attempting to explain empirically the latter by the former. Unfortunately, this is not entirely possible at the present state of the arts (1975: 1017).

Since this was an exploratory study of the risk measures encountered in the existing empirical work, it seemed best to err on the side of inclusion rather than exclusion of risk proxies. Consequently, we chose a set of variables that other researchers have argued are related to risk and appeared to us to have the potential to measure risk.

Debt-to-equity ratio. The ratio between debt and equity is a standard measure of corporate financial leverage reflecting a company's risk of bankruptcy (e.g., Hurdle, 1974; Shapiro & Titman, 1986). It is closely related to the ratio of debt to total assets, the leverage measure Amit and Livnat (1988)

employed. In this study, we calculated debt to equity as the ratio of total debt to the sum of common equity and preferred equity.[3]

Capital intensity. Capital intensity, the ratio of capital to sales, increases risk in two ways (cf. Brealey & Myers, 1984; Shapiro & Titman, 1986). If capital inputs are less variable than labor inputs in the short run, a firm choosing to produce a given output with large amounts of capital and low amounts of labor increases its fixed costs and lowers its variable costs. The firm consequently will experience larger variations in profits if demand fluctuates.[4] In addition, a firm using large amounts of capital runs a high risk of capital obsolescence—the possibility that technological change will make its capital investment worth little or nothing.

Empirical studies using capital intensity or a similar measure include Lev (1974) and Hurdle (1974). Hurdle used a heterogeneous sample of large firms studied from 1960 to 1969 and found a positive association between capital intensity, measured as the ratio of capital to sales, and the debt-to-equity ratio. Contrary to industrial economics theory, she found a negative association between capital intensity and variability in returns. Lev examined electric utilities, steel manufacturers, and oil producers from 1957 to 1968. His within-industry analysis indicated that operating leverage (the ratio of fixed costs to variable costs) was positively associated with both systematic and unsystematic risk. In this study, we calculated capital intensity as the ratio of total assets to sales.

R&D intensity. R&D intensity reflects the extent to which a company chooses to develop new processes or products. Investments in R&D face both technological and market uncertainty (Kamien & Schwartz, 1971; Loury, 1979; Scherer, 1967). Technological uncertainty results from decision makers' inability to perfectly foresee the connections between R&D expenditures and the actual introduction of a new product or process. Market uncertainty results from not knowing when actual or potential rivals will introduce innovations that will affect the value of an R&D project at its completion.

Amit and Livnat (1988) clustered firms on the basis of profits and variability of profits and then explained cluster membership by R&D intensity, leverage, and advertising intensity. They found that both leverage and R&D intensity varied significantly across risk-return clusters. Baird (1986) used R&D intensity as a measure of innovation risk, finding that R&D intensity varied significantly across five risk groups in the telecommunications industry. Miller and Friesen (1982) equated subjective measures of risk taking and innovation—but not R&D intensity—and used the two together in defining conservative and entrepreneurial firms. Their subjective measures of

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[3] Common equity is calculated as the closing common share price at the end of the year multiplied by the number of outstanding common shares. Preferred equity is the value of outstanding preferred shares.

[4] For detailed derivations of this point, see Lev (1974) or Percival (1974).

risk taking and innovation correlated at 0.51 ($p < .001$). Here, we calculated R&D intensity as the ratio of R&D expenditures to sales.

Measures Based on Income Stream Uncertainty

Historical returns variability. Along with capital market measures of risk, measures of historical fluctuations in an income stream are among the most common risk measures employed in strategic management research. In addition to the studies by Bowman (1980, 1982) and Fiegenbaum and Thomas (1985, 1986, 1988) mentioned previously, numerous other studies have used variance in returns to measure risk (Armour & Teece, 1978; Bettis, 1981; Bettis & Hall, 1982; Christensen & Montgomery, 1981; Fisher & Hall, 1969; Rumelt, 1974; Woo, 1987). This study included both the standard deviation of ROE and the standard deviation of ROA as proxies for instability of returns.

Measures derived from analysts' forecasts. If a number of individuals forecast the earnings per share for a given corporation, the extent to which they disagree is a reasonable proxy for the uncertainty associated with the firm's future income stream. The Institutional Brokers Estimate System (IBES) reports data that include means and standard deviations of stock analysts' forecasts of earnings per share for companies for a one-year horizon. The number of analysts varies across firms; we dropped observations based on fewer than three analysts' forecasts from the data.

Two risk measures were derived from these data. The first one is the standard deviation of the earnings-per-share forecasts. Applications of this measure appear in Bromiley (1991), Conroy and Harris (1987), and Imhoff and Lobo (1987, 1988). We used the average of the standard deviations reported for January, February, March, and April of a given year. The second measure is the standard deviation normalized by the mean estimate, or coefficient of variation, which several investigators have also used as a measure of uncertainty (e.g., Brown, Richardson, & Schwager, 1987; Pari & Chen, 1985).

Data

All companies in COMPUSTAT's primary, secondary, and tertiary files for which matching data could be found in IBES were included in the analysis. Consequently, the firms studied were generally large and included companies from the single-digit Standard Industrial Classification (SIC) code industries zero through eight. We used daily stock price data from the Center for Research on Stock Prices (CRSP) for calculating beta and unsystematic risk. The data set was divided into two five-year time periods (1978–82 and 1983–87) to test the stability of the risk factors over time. This partitioning also facilitated assessment of the influence of risk on subsequent performance and the effect of performance on subsequent firm risk.

An analysis of the distributions of the risk and performance measures indicated that these data included some extreme outlier values. We elimi-

nated outliers in the annual data by deleting the observations with values in the bottom or top 2 percent of each variable's distribution. In the case of the unsystematic risk variable, however, we deleted only observations in the top two percentiles.

For the first period, data on the nine risk variables were from 526 firms. For the second period, data were from 746 firms. A total of 493 firms appeared in both time periods. We calculated the standard deviations of annual ROE and ROA for each company in each period. As noted above, we estimated beta and unsystematic risk from a conventional market model regression equation using daily data. All other variable values were calculated as the means for each time period.

FACTOR ANALYSIS METHODS AND RESULTS

The factor analysis consisted of three stages. We first conducted an exploratory analysis of the period one data and then used the same procedures on the period two data. Next, we examined the congruence between the factor structures for the two periods. Table 1 provides the correlation matrix for the two sets of risk measures.

Estimation of the orthogonal factor model on the period one data indicated three eigenvalues greater than one. For estimation, we used the SAS factor analysis procedure (SAS, 1985). The top half of Table 2 shows the principal component factor solution with varimax rotation for period one. Factors with eigenvalues greater than one were retained for rotation, and the reported variance explained is for the rotated factor pattern. Following Johnson and Wichern (1988), we also estimated the factor structure using a maximum likelihood procedure. Those results, as well as those using an oblique rotation, were very similar to the pattern of factor loadings presented here.

TABLE 1
Correlations Among Variables[a]

Variables	1	2	3	4	5	6	7	8	9
1. s.d., ROA		.80	.36	.37	.40	.32	−.04	−.17	.20
2. s.d., ROE	.83		.45	.34	.33	.26	.18	.03	.10
3. s.d., forecasts	.47	.48		.55	.20	.05	.18	.02	.01
4. Coefficient of variation, forecasts	.55	.57	.69		.33	.26	.11	.03	−.01
5. Beta	.24	.31	.09	.23		.60	.07	−.14	.21
6. Unsystematic risk	.23	.33	−.01	.23	.66		.11	−.08	.02
7. Debt-to-equity ratio	−.11	.18	.13	.16	.05	.19		.29	−.29
8. Capital intensity	−.29	−.00	−.01	−.05	−.14	−.14	.35		−.22
9. R&D intensity	.13	.03	−.07	−.03	.23	.06	−.32	−.24	

[a] Correlations for period one (1978–82) appear below the diagonal, and those for period two (1983–87) appear above it. Correlations with absolute values over .09 are statistically significant ($p < .05$) for period one ($N = 526$). For period two ($N = 746$), the critical value ($p < .05$) is .07.

TABLE 2
Rotated Factor Patterns[a]

Variables	Factor One: Income Stream Risk	Factor Two: Stock Returns Risk	Factor Three: Strategic Risk	Communalities
Period one, 1978–82				
s.d., ROA	**0.824**	0.169	−0.309	0.803
s.d., ROE	**0.819**	0.301	0.029	0.762
s.d., forecasts	**0.823**	−0.130	0.112	0.707
Coefficient of variation, forecasts	**0.838**	0.127	0.087	0.726
Beta	0.137	**0.862**	−0.140	0.781
Unsystematic risk	0.110	**0.905**	0.025	0.832
Debt-to-equity ratio	0.099	0.257	**0.791**	0.702
Capital intensity	−0.101	−0.108	**0.719**	0.539
R&D intensity	−0.039	0.195	**−0.664**	0.480
Variance explained	2.782	1.830	1.720	
Proportion	0.309	0.203	0.191	
Cumulative	0.309	0.512	0.703	
Period two, 1983–87				
s.d., ROA	**0.754**	0.299	−0.287	0.741
s.d., ROE	**0.811**	0.219	−0.023	0.707
s.d., forecasts	**0.807**	−0.095	0.123	0.676
Coefficient of variation, forecasts	**0.673**	0.192	0.120	0.504
Beta	0.267	**0.819**	−0.124	0.758
Unsystematic risk	0.095	**0.904**	0.040	0.828
Debt-to-equity ratio	0.156	0.167	**0.749**	0.613
Capital intensity	0.025	−0.141	**0.672**	0.472
R&D intensity	0.111	0.067	**−0.696**	0.501
Variance explained	2.450	1.724	1.626	
Proportion	0.272	0.192	0.181	
Cumulative	0.272	0.464	0.645	

[a] Bold print highlights the factor loadings with absolute values greater than .40.

The standard deviations of ROA and ROE and the two measures based on variation in stock analysts' forecasts of earnings per share have large positive loadings on the first factor. We termed this factor *income stream risk*.

The second factor, consisting of systematic and unsystematic risk, we termed *stock returns risk*.

The third factor, which loads positively on the debt-to-equity ratio and capital intensity and negatively on R&D intensity, captures some key corporate strategy variables affecting firm risk and was labeled *strategic risk* or *industry risk*. This factor reflects the finding, evident in the correlation matrix in Table 1, that high debt-to-equity ratios and capital intensity are associated with levels of R&D expenditures that are low relative to sales. Since leverage, capital intensity, and R&D intensity vary substantially and system-

atically across industries, it is possible that part of what this factor is picking up is industry-specific risk.

The bottom half of Table 2 reports the results from the principal components factor analysis with varimax rotation for the period two data. As with the period one data, we used both maximum likelihood factor analysis and an oblique rotation factor solution to check the consistency of the factor-loading pattern across alternative methods. The results from the various techniques agree with the varimax-rotated principal components results presented here.

Direct examination of the factor loadings indicates substantial agreement between the factor structures for the two periods. The coefficients of congruence between the two structures are quite high for all three factors;[5] the congruences between periods one and two for factors one to three are 0.985, 0.984, and 0.997. Thus, we concluded that the factors identified were stable over the two time periods.

INTERPRETING THE RISK FACTORS

Several authors (Fiegenbaum & Thomas, 1988; Jemison, 1987; Oxelheim & Wihlborg, 1987) have suggested that different stakeholders may be interested in different measures of corporate risk. The labels attached to the three risk factors we identified are consistent with the notion that the relevance of a risk measure differs across stakeholder groups (Freeman, 1984).

Factor one, income stream risk, is generally believed to be the measure of risk most relevant to general managements (Fiegenbaum & Thomas, 1988; Libby & Fishburn, 1977). Profits make it easier for general managers to satisfy the costly needs of diverse stakeholder groups. Reductions in profits result in numerous, usually unpleasant, managerial actions, such as layoffs, reductions in capital investment, and increases in cost control (Bromiley, 1986). In addition, stable, adequate profits facilitate implementation of corporate strategies. Alternatively, if managers are likely to be fired when profits fall rapidly, income stream stability should increase the stability of employment for a company's managers and other employees.

Factor two, stock returns risk, captures risk from the perspective of stockholders. As implemented in this study, stock returns risk measures variability in historical stock returns. According to the assumptions of the CAPM, investors can eliminate unsystematic risk through portfolio diversification. Nevertheless, stockholders with poorly diversified portfolios may value reductions in both systematic and unsystematic risk. In addition, if managers tend to be fired following substantial reductions in stock returns, risk-averse managers will demand a premium to work for firms with high

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[5] As with a correlation coefficient, coefficients of congruence for comparing factor structures can take values from minus one to plus one, corresponding to perfect inverse agreement and perfect agreement, respectively (Harman, 1976: 344). A value of zero indicates there is no similarity between two factors.

unsystematic risk, and in general, firms with high unsystematic risk will have lower-quality managers than other firms (Aaker & Jacobson, 1987). If that is true, stockholders may value reductions in unsystematic risk because they allow a firm to attract better managers and thus improve performance.

Factor three, strategic risk, has risk implications for multiple external stakeholder groups. Its high loadings with opposite signs on R&D intensity and capital intensity indicate contrasting strategic postures in the choice of a firm's technology. A capital-intensive firm may have lower average costs than a more labor-intensive competitor, but a company investing heavily in R&D may exhibit greater dynamic efficiency, or more flexibility than its competitors in adapting to changes in input prices and technology. Such risk trade-offs seem to be central considerations in determining a firm's strategy. The high loading on the debt-to-equity ratio in the strategic risk factor implies that it may also be relevant to creditors.

Chakravarthy (1986) argued that considering diverse stakeholder perspectives is critical to developing valid measures of strategic performance. Our factor analysis results suggest that implicit stakeholder perspectives may underlie investigators' choices of risk measures as well.

A stakeholder interpretation of our risk factors should, however, be tempered by recognizing that we can at least partially explain the factor structure as an artifact of the construction of our risk measures. For example, the standard deviation of analysts' forecasts and the coefficient of variation are likely to be positively correlated since the latter is simply equal to the standard deviation of analysts' forecasts normalized by the mean forecast. Similarly, ROA and ROE share a common numerator. The possibility that the factor structure found is an artifact of variable construction is not, however, incompatible with the stakeholder perspective. For example, even though the standard deviations of ROA and ROE fall into the same factor at least partially because they are both constructed using income, income stability is still important to certain stakeholders. To say that the data source and manner of the variables' construction influence the associations among them is not to say that the variables and their associations do not relate in important ways to other frameworks and modes of interpretation.

RELATIONS BETWEEN RISK AND PERFORMANCE

Given the risk factors identified above, we next examined how performance influenced the three types of risk and how the latter influenced performance. In examining those relations, we used measures taken in period one to explain risk and performance in period two, a procedure that gave us greater confidence that we could assign causality than we would have had with a cross-sectional analysis. Using the risk measures developed above, we estimated (1) the influence of risk on subsequent performance and the stability of that influence across industries and performance levels and (2) the influence of performance on subsequent risk and the stability of that influence across performance levels.

The Influence of Risk on Performance

The different components of risk were measured by the factor scores obtained from the period one (1978–82) principal components factor analysis. The dependent variables, ROE and ROA, measured performance in 1983–87. Each observation consisted of factor scores for a given firm in period one and the firm's performance measures in both periods. Using data from the 493 firms that figured in both time periods, we estimated the following model:

$$Performance_t = b_0 + b_1 \, Income \, stream \, risk_{t-1} + b_2 \, Stock \, returns \, risk_{t-1}$$
$$+ b_3 \, Strategic \, risk_{t-1} + b_4 \, Performance_{t-1} + e_t. \qquad (1)$$

The role of the lagged dependent variable in Equation 1 deserves some comment. If there are relatively stable factors that influence a firm's returns, such as size or degree of diversification, such factors should influence returns in both periods studied. Including period one performance controlled for any such omitted firm-specific factors.

The following sections present hypotheses predicting the signs of the parameters in Equation 1. Since no previous research has employed multidimensional risk constructs in this fashion, the interaction among the independent propositions is unclear.

Income stream uncertainty. Our analysis of the influence of income stream uncertainty on performance drew on three different approaches. Advocates of *prospect theory* view changes in risk as directly reflecting managers' choices about risk and return. Proponents of the *default risk perspective* have argued that performance variability increases the likelihood a firm will default on either implicit or explicit commitments, which results in increased costs, decreased revenues, or both. According to the *adjustment costs position*, changes in output and performance per se impose costs on a firm through operational inefficiencies. Each of these three perspectives leads to specific hypotheses about the influence of income stream risk on firm performance.

Previous research on risk and return has frequently used prospect theory (Kahneman & Tversky, 1979) to explain risk-return relations (Bowman, 1980, 1982, 1984; Fiegenbaum, in press; Fiegenbaum & Thomas, 1985, 1986, 1988). Let us assume a company has a target performance level that corresponds to the mean performance for its industry[6] and that a pool of projects exists from which managers choose the projects they will undertake. The managers evaluate the projects on the basis of the expected risk and return

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[6] Fiegenbaum and Thomas (1988) and Fiegenbaum (in press) used median industry performance as a target level. Both the median and the mean appear to be reasonable proxies for the target performance level within an industry.

each would add to the company's overall position.[7] Managers examine the risk-return position of their corporation under the assumption that the company will take on one of the projects and thus make a choice with respect to overall corporate risk and return.

According to prospect theory, a firm with performance above the average for its industry should be risk-averse and only willing to accept an increase in income stream risk if an investment opportunity offers high expected returns. The better the performance of a firm, the less willing it is to take on additional risk in order to increase its expected returns. Thus, when a high-performing firm does assume risk, it is a risk that promises high returns. Consequently, for firms with above-average performance, increases in risk will increase subsequent performance.

Under prospect theory's assumptions, low-performing firms will forego expected returns to increase variance in returns, and the rate at which they make that trade-off increases as performance declines. The choice of high-variance projects increases the probability of obtaining a target level of performance for below-target firms (Singh, 1986). Thus, the lower a firm's performance, the more likely it is to choose a risky project with low expected returns over a less risky project with higher expected returns. Consequently, for low-performing firms, risk should be associated with having given up returns to obtain increased risk, which implies that for firms with below-average performance, increases in risk will decrease subsequent performance.

Shapiro and Titman (1986) and Cornell and Shapiro (1987) argued that variability in performance increases a firm's default risk. High variability in performance increases the likelihood that a firm will default on either its explicit commitments, such as contractual arrangements with suppliers, buyers, and the like, or its implicit commitments—such as mutual understandings with or promises to buyers, employees, and customers. For example, if a buyer perceives that a firm may have to default on its explicit warranty commitments or its implicit commitment to maintain the availability of parts and service, the buyer will tend not to buy from the firm. Similar arguments can be made concerning suppliers and employees. Highly variable returns may both lower a company's sales and raise its direct costs because the parties dealing with it may require a monetary advantage to induce them into a transaction. Income variability influences implicit contracts even if bankruptcy is unlikely since firms under financial pressure may take moves (e.g., selling a division) that negate implicit contracts well before bankruptcy occurs.

Even if suppliers, buyers, and employees are not concerned about a firm's defaulting on explicit or implicit claims, problems with adjustment costs suggest that performance variability is costly. Changes in production

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[7] If we assumed that managers evaluate projects strictly on the basis of the projects' own risk-return characteristics, it would not be clear how to factor a company's current position into the choice.

levels present direct costs incurred in hiring, training, and laying off workers. High variability in sales makes efficient utilization of capital difficult and may force a firm to maintain high levels of inventory. Workers and suppliers will both demand premiums to compensate for the problems of varying employment or purchasing levels. Thus, the frictions associated with adjusting a company's activity levels provide another basis for arguing that performance variability negatively affects performance.

Although the three arguments presented lead to substantially similar predictions, they do differ. According to the default risk argument, risk should have a larger negative influence on performance for low-performance corporations than for high-performance corporations since the likelihood that returns variability will result in the abrogation of contracts should be higher for the former. According to the adjustment costs argument, the negative influence of income stream variability on performance should be constant across performance levels since performance should not influence the direct costs imposed by adjusting production and output. Finally, according to the prospect theory argument, income stream variability will reduce performance for poor performers but increase it for high performers. In another study, Bromiley (1991) found that income stream risk negatively influenced subsequent performance irrespective of a corporation's performance level.

Stock returns risk. If firms use the CAPM to select investment projects, we would expect a positive association between beta and performance. Under value-based planning, or CAPM investment rules, the value of a given investment is the net present value of the income streams associated with it, which can be expressed by the following model:

$$Net\ present\ value = \sum_{t=0}^{t=T} (R_t - C_t)/(1+ r)^t,$$

where R_t and C_t are the levels of revenue and costs in period t, T is the relevant time horizon for a project, and r is the project-specific discount factor, a positive function of the market's risk premium and the project's beta. Cash inflows include both assets and operating subsidies, and cash outflows are net funds from operations. Almost all investments start with one or more years of negative net cash flows, while capital investment occurs and sales have not started, and end with a series of positive net cash flows.

If a corporation uses its corporate beta for capital budgeting, an increase in that beta will make short-term cash flows more important than later cash flows in calculating the expected net present value of a project. Since immediate cash flows tend to be negative, the increased beta reduces the net present value of the investment. Thus, a firm with a low beta—which implies a low cost of capital—can better afford to invest in projects with low returns than a firm with a high beta.[8]

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[8] This relationship underlies much of the public policy debate about differences in the costs of capital in the United States and Japan (Hatsopoulos, 1983).

This argument implies that firms for which capital is costly can only afford to invest in projects yielding high returns on the assets required. If a company is following shareholder value, or net present value, procedures in making investment decisions, increases in beta will be associated with subsequent positive changes in returns on investment.

On the other hand, stock returns risk includes both beta (systematic risk) and unsystematic risk. In the CAPM, unsystematic risk plays no role in influencing investment decisions and so should have no influence on performance. Consequently, stock returns risk should have either a positive or neutral influence on subsequent performance.

Strategic risk. The dynamic effects of strategic risk on performance are not clear. If firms have optimal capital structures, then capital structure should not explain profitability differences across firms. Finance theory often assumes that existing capital structures are optimal and need therefore to be explained as the result of optimizing behavior. Likewise, if firms are being sensible about capital and R&D intensity, they should invest to the point at which marginal cost is equal to marginal revenue. Therefore, it seemed unlikely that we would find an association between those variables and performance.

On the other hand, Jensen (1989) argued that managers in highly leveraged firms must operate more efficiently than the managers of other firms, which implies that the ratio of debt to equity positively influences performance. Further research on R&D has suggested that R&D intensity positively influences performance (Ravenscraft & Scherer, 1982). Given our strategic risk factor's opposite loadings on debt to equity and R&D intensity and the variety of theoretical arguments available, we formed no overall hypothesis concerning the influence of strategic risk on corporate performance.

Results. We examined three sets of estimates of the influence of risk on performance. First, we analyzed an aggregate set of estimates, since many of the hypotheses were not differentiated by performance level. Second, we estimated the model separately for high- and low-performing companies. Third, to test the robustness of the results, we estimated separate models for different industries.

Using the aggregate data and least-squares procedures, we obtained the results shown in Table 3. Since the substantive results of the ROA and ROE regression equations agree, we discuss those results together. Although the significance of the lagged dependent variable (ROE and ROA in period one) indicates significant serial correlation, the similarity between the R^2s computed with and without the lagged dependent variable indicates that the risk factors explain a significant portion of the variance in returns. Furthermore, the signs and general magnitudes of the parameter estimates on the risk factors did not change when we removed lagged performance from the equation. Although lagged performance has a significant influence on performance, the risk factors also appear to have a substantial influence.

Our finding that income stream risk has a significant negative influence on performance is consistent with Bowman's (1980, 1982) risk-return para-

TABLE 3
Results of Aggregate Regression Analysis[a]

Variables	ROE, Period Two	ROE, Period Two	ROA, Period Two	ROA, Period Two
Intercept	0.068***	0.101***	0.015***	0.047***
	(0.010)	(0.003)	(0.003)	(0.002)
ROE, period one	0.251***			
	(0.070)			
ROA, period one			0.503***	
			(0.048)	
Income stream risk	−0.025***	−0.032***	−0.008***	−0.015***
	(0.004)	(0.004)	(0.002)	(0.002)
Stock returns risk	0.002	0.004	0.000	0.001
	(0.004)	(0.004)	(0.002)	(0.002)
Strategic risk	−0.007†	−0.012***	−0.005**	−0.017***
	(0.004)	(0.004)	(0.002)	(0.002)
R^2	0.167	0.145	0.402	0.269
F	24.403***	27.537***	82.120***	60.015***

[a] Standard errors appear in parentheses. $N = 493$.
  † $p < .10$
  * $p < .05$
  ** $p < .01$
  *** $p < .001$

dox. Although the negative association between risk and performance was not surprising, this analysis did extend Bowman's results in an interesting way. In a study of 26 companies, Bowman (1984) found that low performance increased risk taking but not that risk influenced future performance, a relation that our results strongly indicate.

Although stock returns risk has positive parameter estimates in all the regression equations calculated here, all the estimates are statistically insignificant. That insignificance does not lend strong support to our predictions but is consistent with our theoretical discussion suggesting a positive influence for beta and a zero influence for unsystematic risk.

For unclear reasons, strategic risk has significant, negative parameter estimates in all equations. If the parameters were an artifact of the data construction, the signs would be the opposites of those found. For example, the ratio of debt to equity and ROE both have equity in the denominator, which would suggest a positive association between the two, not the negative association that occurs. Although it makes sense that optimal levels of debt to equity, capital intensity, and R&D intensity exist within an industry, it is difficult to accept that such a level has validity across industries. The simple interpretation that firms use excessive capital and debt and insufficient R&D is troublesome because it suggests general errors in capital structure, capital intensity, and R&D expenditures. Most economic and financial models assume such errors do not exist.

In discussing the regression results, it may be that the relations found

are not causal since industry risk factors might reflect omitted variables that could explain the results. For example, perhaps sectors of the economy with low capital intensity, high equity, and high R&D intensity improved their performance during 1983–87 more than other sectors of the economy. Further research is needed to explore this possibility.

The prospect theory analysis suggests that the influence of income stream risk on performance should vary across performance levels. We divided the corporations studied into those above and those below the mean performance level for their single-digit SIC code industry in 1978–82 and then estimated the performance equation separately for high and low performers. A lack of representative firms required combining industries zero and one into one category and seven and eight into another. Since no firm from SIC code nine appeared in both five-year time periods, the industry classification included seven distinct categories.[9] Table 4 presents the results of this analysis.

In all four regression equations, income stream risk has negative, statistically significant coefficients. In the two equations in which strategic risk has significant coefficients, the coefficients are negative. Stock returns risk has insignificant coefficients in all four regressions. We were able to reject the hypothesis that all the parameters were equal for the high and low performers. Tests for such equality yielded a value for $F_{5,482}$ of 8.67 for the ROE equation and of 12.54 for the ROA equation ($p < .001$). Examination of the coefficients indicated large differences in intercepts and in the effects of past performance.

These findings support the position that by imposing costs or decreasing revenues, risk reduces performance. We did not find support for the prospect theory argument that the signs of the parameters on income stream uncertainty differ for high and low performers. Instead, income stream risk has negative and significant parameters in all four estimates. Likewise, we found no support for the default risk argument. The influence of risk on performance is not greater when performance is low; for ROE, the parameters are almost identical ($-.031$ and $-.033$), and for ROA the parameter for low performers is smaller than that for high performers ($-.009$ and $-.023$).

Although the aggregate results appear quite strong, they do not provide evidence that the patterns can be applied in any specific industry. That is, a strong pattern in some industries might hide a lack of association in other industries. Results of the test for equality of regression coefficients across industries indicated that significant differences existed ($F_{30,457} = 3.34$ for ROE and 3.67 for ROA, $p < .01$). Examination of the coefficients indicated

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[9] The number of companies in each single-digit SIC industry group was as follows: agricultural production, mining, and construction (SIC 0 and 1): 22; food products, tobacco, textiles and apparel, lumber and wood products, paper, chemicals, and petroleum (SIC 2): 128; rubber, leather, glass, concrete, metals, machinery, and other manufacturing (SIC 3): 139; transportation, communication, and utilities (SIC 4): 105; wholesale and retail trade (SIC 5): 31; financial industries (SIC 6): 42; and services (SIC 7 and 8): 26.

TABLE 4
Results of Regression Analysis by Performance Level[a]

Independent Variables	ROE, Period Two		ROA, Period Two	
	High Performers	Low Performers	High Performers	Low Performers
Intercept	−0.020	0.111***	−0.024**	0.033***
	(0.024)	(0.014)	(0.007)	(0.004)
ROE, period one	0.724***	−0.198		
	(0.132)	(0.129)		
ROA, period one			0.841***	0.175*
			(0.079)	(0.087)
Income stream risk	−0.031***	−0.033***	−0.023***	−0.009***
	(0.007)	(0.005)	(0.004)	(0.002)
Stock returns risk	−0.009	0.007	−0.004	0.001
	(0.006)	(0.004)	(0.003)	(0.002)
Strategic risk	−0.017**	−0.000	0.003	−0.010***
	(0.006)	(0.005)	(0.004)	(0.002)
R^2	0.223	0.174	0.509	0.226
F	17.303***	12.732***	50.693***	20.906***
N	246	247	201	292

[a] Standard errors appear in parentheses.
  † $p < .10$
  * $p < .05$
 ** $p < .01$
*** $p < .001$

that income stream uncertainty generally had a negative influence on subsequent performance. It was statistically significant ($p < .10$) in five of the seven ROE equations and three of the seven ROA equations. The influence of the other factors, which varied substantially, was generally statistically insignificant. Thus, we concluded that the influences of stock returns and strategic risk on performance differ across industries but that income stream uncertainty appears to have a broad negative influence on performance.

The Influence of Performance on Risk

Having examined the influence of risk on performance, we turned to the symmetric question—the influence of performance on risk. In evaluating this question, we used the following model:

$$Risk_t = c_0 + c_1 \, Performance_{t-1} + c_2 \, Risk_{t-1} + e_t. \qquad (2)$$

Income stream uncertainty. According to the prospect theory logic presented above, a firm with performance above its industry average will be risk-averse, and risk aversion will increase as performance increases. Consequently, the higher its past performance, the less risk a firm will assume. For firms with above-average performance, increases in performance reduce subsequent levels of risk.

For firms that are below target, prospect theory suggests that low performance results in seeking projects with higher risk. Thus, the lower the

firm's performance, the higher the subsequent risk. In other words, for firms with below-average performance, increases in performance reduce subsequent levels of risk.

Taken together, the analyses for high and low performers imply that performance reduces risk for all firms.

Stock returns risk. We expected that performance would have a negative, indirect influence on stock returns risk. Stock prices vary with fluctuations in actual performance. Indeed, some authors have argued that variability in stock prices is substantially greater than can be explained by variability in corporate cash flows (e.g., Shiller, 1981, 1986). If variability in stock returns is associated positively with variability in returns, and variability in returns is negatively associated with the level of previous returns, there is likely to be a negative association between the level of returns and subsequent stock returns risk.

Strategic risk. We expected high performance would reduce strategic risk. If a firm does not consciously increase its debt or dividends, increases in profits add to retained earnings and stockholder equity, which reduces the debt-to-equity ratio. Alternatively, losses reduce retained earnings and stockholders' equity and increase debt to equity. Since improvements in performance increase slack resources, performance and subsequent R&D intensity should have a positive relationship. A negative relationship between performance and the strategic risk factor, which loads negatively on R&D intensity, is thus likely. The influence of performance on capital intensity is too complex to capture in a simple hypothesis. The designers of most investment models have assumed that firms attempt to reach a target level of capital intensity. The influence of performance per se on adjustments in capital intensity should depend on the direction of change in output, the liquidity position of a firm, and a number of other factors (Bromiley, 1986).

Results. We estimated regression equations for each of the three risk measures using both ROA and ROE. Each of the six estimations used the entire set of 493 observations. In only one of these models was the coefficient on lagged performance significant at the 0.10 level. Thus, these results do not indicate a significant association between performance and subsequent firm risk in the data combining high- and low-performing firms.

Although we hypothesized that performance would have the same influence on income stream uncertainty for high and low performers, that assumption required testing, since many previous researchers have found that risk-return associations differ across performance levels. We divided the firms into those above and those below the mean performance level for their industry in 1978–82, using ROA in period one to assign firms to performance categories in the equations with ROA as an independent variable and ROE in the ROE equations. The model was estimated for each of the three risk factors. Table 5 reports the coefficient on period one performance (c_1 in Equation 2), its statistical significance, and the values for R^2 and F for each of the 12 regression equations resulting from crossing the three risk factors with the two performance measures and two performance levels.

TABLE 5
The Influence of Performance on Risk[a]

Independent Variables	N	Income Stream Risk			Stock Returns Risk			Strategic Risk		
		c_1	R^2	F	c_1	R^2	F	c_1	R^2	F
ROA										
High performers	201	$-2.846\dagger$	0.305	43.4	0.395	0.516	105.5	0.903	0.823	459.0
Low performers	292	1.786	0.375	86.7	-1.669	0.689	319.7	$-2.782*$	0.852	830.4
ROE										
High performers	246	$-2.469*$	0.264	43.7	1.155	0.586	171.8	-0.258	0.852	699.0
Low performers	247	$4.161**$	0.427	90.7	$-2.728***$	0.691	273.2	$-2.304***$	0.863	770.1

[a] Entries are the coefficient estimates for the performance variable, c_1 in Equation 2. All F statistics reported are statistically significant ($p < .001$).

$\dagger\ p < .10$
$*\ p < .05$
$**\ p < .01$
$***\ p < .001$

The results reported in Table 5 indicate that the influence of performance on income stream risk differs substantially across performance levels. Rather than the consistently negative parameters hypothesized, we obtained negative parameters for high performers and positive parameters for low performers.

Performance had a statistically significant influence on stock returns risk only for firms with a low ROE, and that influence was negative. Rather than the consistently negative parameters hypothesized, we obtained statistically significant negative parameter estimates for the influence of performance on strategic risk for low performers and insignificant parameter estimates for high performers.

Although the aggregate regression equations indicated that performance had no influence on risk, dividing the data by performance level substantially changed the results. The most interesting result from the split data analysis is that performance appears to reduce subsequent income stream uncertainty for high performers but increase it for low performers, at least when ROE is the measure. This finding is not consistent with previous cross-sectional research (Fiegenbaum, in press; Fiegenbaum & Thomas, 1988), nor with our interpretation of prospect theory.

CONCLUSIONS

This study yielded a number of findings regarding the existence of differing risk factors, their influence on performance, and the influence of performance on risk.

Risk Factors

The factor analysis results suggest that several distinct empirical risk factors exist and are stable over time. The factors identified were income stream uncertainty, stock returns risk, and strategic, or industry, risk. Although other sets of candidate variables may give slightly different factors, the analysis strongly supported our contention that risk measures differ substantially.

The three risk factors have substantial face validity. Factor one clearly fits the income stream uncertainty concept, with high loadings on the standard deviations of ROA, ROE, analysts' forecasts, and the coefficient of variation of analysts' forecasts. The two measures based on analysts' forecasts are ex ante proxies for income stream uncertainty. Factor two includes both stock market variables measured. Factor three includes all three accounting ratios used: debt to equity, capital intensity, and (with a contrasting sign) R&D intensity. Reasonable explanations are readily available for these groupings.

In addition to demonstrating the existence of different dimensions of risk, the factor analysis results indicate that several of the original variables are reasonable indicators of the underlying risk factors. In the orthogonal factor model, factor loadings can be interpreted as the correlations between the observed measures and the common factors (Johnson & Wichern, 1988).

The factor loadings (Table 2) indicate that all four variables measuring income stream uncertainty correlate highly ($r > .67$) with the underlying factor, and the standard deviations of ROE and of analysts' forecasts have correlations over .80 with the factor in both time periods. Similarly, the correlations of beta and unsystematic risk with the stock returns factor are over .81. The three strategic or industry risk variables have correlations with the third factor over .66. The ratio of debt to equity appears to have the highest correlation with the third factor (r's = .791 and .749). These high correlations suggest that some of the original variables can serve as reasonable proxies for the underlying risk factors.

The Influence of Risk on Performance

The results demonstrate that income stream risk reduces subsequent performance and that this influence exists across industries and performance levels. On the other hand, the influence of strategic risk on performance varies across industries and performance levels. Additional work on strategic risk, particularly the connections among financial strategies, operational strategies, and performance, appears to be needed. We found no evidence that stock returns risk influenced performance. Rather than supporting a prospect theory view that the influence of risk on performance varies across performance classes, these results are consistent with the view that income stream variability creates costs or reduces revenues for a company. The results of the regression equations calculated for performance here demonstrate that studies using different measures of risk will get different results.

The Influence of Performance on Risk

Contrary to our interpretation of prospect theory, the influence of performance on income stream risk varies across performance levels. For high performers, performance reduces subsequent income stream risk, but for low performers, it increases income stream risk. Little evidence that performance influences stock market risk emerged. Performance appears to reduce strategic risk for low-performing companies.

Our estimates suggest a peaked relation between performance and subsequent income stream risk: high and low levels of performance result in low levels of income stream risk, and moderate performance levels result in high levels of risk. These results, which certainly do not fit our interpretation of prospect theory, pose a puzzle for further theory development. Applications of prospect theory to time series models depend critically on assumptions about firms' pools of available projects and whether projects are evaluated in isolation or in terms of their contribution to overall corporate risk and return. The present results may be explicable with prospect theory if different assumptions were used.

In addition to developing multidimensional risk measures, this study made another methodological contribution. Although the cross-sectional work of previous authors makes sense within the theories they have tested,

longitudinal studies allow tests of the direction of causality, a dimension absent in cross-sectional work. Bowman's (1982) statement about "risk-seeking by troubled firms" clearly implied that performance drives risk. The multiple time periods approach used here allowed us to test such models, and the results demonstrated that such testing can yield significant results. It is impressive to us that models based on five-year averages can have significant results when one five-year period explains a subsequent five-year period.

In summary, this study evaluated the measurement properties of some of the most common risk proxies used in strategic management research. We applied the three underlying risk factors derived from this analysis to the study of risk-return relations in corporate data, demonstrating that differing risk factors provide different substantive results. The results indicate that income stream risk has a negative influence on subsequent performance. Other findings from the application were not readily explicable with the theory developed here and merit further study. These results can be seen as a prelude to more detailed and sophisticated tests of the causal mechanisms and logics presented for risk-return relations.

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