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TESTING A CAUSAL MODEL OF CORPORATE RISK TAKING AND PERFORMANCE

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The determinants of organizational risk taking and its impact on economic performance are critical issues in strategic management. Using a model that included risk, performance, performance expectations and aspirations, slack, and industry performance, this research addressed how past performance and other factors influence risk taking and how risk taking and other factors influence future performance. Not only did poor performance appear to increase risk taking—risk taking appeared to result in further poor performance, even when past performance, industry performance, and organizational slack were controlled. Overall, the results favor a model in which low performance and lack of slack drive risk taking, but the risks taken have poor returns.

Although risk has long been considered an important aspect of strategic choice, it is only in recent years that researchers in strategic management have become directly concerned with research on risk. Sparked by Bowman (1980, 1982, 1984), many recent studies of strategy have included risk measures. Part of the attention has focused on what Bowman described as a paradox. Using a capital markets analogy, he predicted that risky projects and investments would need to offer higher earnings than other projects to be attractive and that by extension, variable income flows would be associated with high average income. Instead, he found negative associations between variance in returns and the level of returns in some industries.

Since Bowman (1980), numerous studies have investigated risk-return connections. Fiegenbaum and Thomas (1985, 1988) found some industries with positive associations between returns and variance in returns and some with negative associations. They also found that the associations varied over time. Fiegenbaum and Thomas (1988) reported a positive association be-

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tween returns and variance in returns for above-average performers and a negative association for below-average performers. This pattern is consistent with Bowman's concept of "risk seeking by troubled firms" (Bowman, 1982: 33), which he associated with the prospect theory of Kahneman and Tversky (1979). Related studies have focused on risk and return relative to diversification (Amit & Livnat, 1988; Bettis & Mahajan, 1985; Chang & Thomas, 1987); business unit risk assessed in terms of both accounting-based measures of systematic risk (Aaker & Jacobson, 1987) and a variety of accounting and operational risk measures (Woo, 1987); and corporate risk and return relative to structural and operational variables (Jemison, 1987; Singh, 1986). Fiegenbaum and Thomas (1988) provide an excellent survey of the risk-return literature.

An underlying difficulty in much of this literature is that researchers wish to make causal statements but are dealing with strictly cross-sectional data.¹ Researchers want to say that a given set of circumstances leads to risk taking or that risk taking has a certain effect on performance, but their analyses usually associate variance in returns with average returns calculated using data from the same time period, making it impossible to differentiate between risk influencing performance and performance influencing risk. Bowman (1984) attempted to disentangle this effect by looking at content analysis measures of risk in one time period and performance in another. His analysis suggested that low performance led to risk taking but that risk taking did not influence future performance.

Previous researchers have clearly recognized this problem of unclear causality. Both Singh (1986) and Woo (1987) noted that their models imposed stringent and untested assumptions concerning the direction of causal relations between risk and performance. They argued that time series models incorporating lags were needed to test such relations more clearly (Singh, 1986: 581; Woo, 1987: 152). Following their suggestions, I attempted to model the impact of past performance on risk taking and the impact of risk taking on subsequent performance.

Specifically, this research addressed two questions: (1) What determines the amount of risk a corporation undertakes? and (2) What effect does that risk taking have on future economic performance? Following Bowman (1980, 1982, 1984) and Fiegenbaum and Thomas (1985, 1986, 1988), I defined risk as the uncertainty of a company's income stream. I addressed the two questions by specifying and estimating a statistical model that includes both the determinants of risk taking and its influence on economic performance. The model estimated is based on the process theory of organizational decision making (cf. Cyert & March, 1963; Simon, 1976).

The answers to the questions addressed in this research may contribute to knowledge in two areas. First, by specifying and testing a model of cor-

¹ Bowman (1982, 1984) and Aaker and Jacobson (1987) are exceptions

porate risk taking, this work attempts to advance understanding of the determinants of corporate risk taking and performance. It advances the research on risk by (1) presenting and estimating a dynamic model based on a specific theory of organizations, (2) testing for possible ties between risk taking and future economic performance, and (3) using an ex ante measure of risk taking. Second, because Cyert and March's (1963) behavioral theory of the firm underlies the model tested, the research can be seen as a large-sample test of that theory

MODEL DEVELOPMENT

The model used herein was based on Cyert and March's (1963) behavioral theory of the firm. A very brief summary of some of the basic concepts of that theory follows; a more detailed summary appears in chapter 6 of Cyert and March's book. Cyert and March viewed firms as large systems of standard operating procedures, or routines. Managers in firms have both levels of performance they aspire to (aspirations) and levels of performance they expect (expectations). If expectations fall below aspirations, managers search for solutions that can raise expected performance to the aspiration level, and if they cannot find such solutions, they lower aspirations. The system is buffered by slack—excess resources that a company can use to loosen the ties between environmental changes and the need for organizational responses.

Following the behavioral theory of the firm, the current model includes five basic variables: performance, slack, aspirations, expectations, and risk.

Determinants of Risk Taking

A company's performance, the performance of its industry, and its expectations, aspirations, and slack will influence the amount of risk it takes. The model of risk taking used in this research is

$$\begin{aligned} \text{Risk}_{t+1} = & b_0 + b_1 \text{ performance}_t + b_2 \text{ industry performance}_t \\ & + b_3 \text{ expectations}_t + b_4 \text{ aspirations}_t + b_5 \text{ slack}_t \\ & + b_6 \text{ slack}_t^2 + b_7 \text{ risk}_t + e, \end{aligned} \quad (1)$$

where

$$\begin{aligned} b_i &= \text{parameters to be estimated,} \\ t &= \text{year,} \end{aligned}$$

and

$$e = \text{error term.}$$

Performance. The direct impact of performance on risk taking is central to work by Bowman (1980, 1982, 1984) and by Fiegenbaum and Thomas

(1985, 1986, 1988) and was significant in Singh's (1986) research. Fisher and Hall (1969) presented an economic argument for the impact of performance on risk taking: If the utility to a firm of each additional dollar in profits is slightly less than the utility of a previously gained profit dollar (declining marginal utility of income), the expected utility of an investment will decline with increases in the variance of returns for that investment. For a high-variance investment to have equivalent utility to a low-variance investment, the high-variance investment would need to show higher mean performance. Fisher and Hall concluded that "this implies that earnings should be larger, on the average, for firms with greater variation in their earnings than for firms with little earnings variability" (1969: 82).²

Hypothesis 1 Performance has a negative influence on risk ($b_1 < 0$ in Equation 1)

Industry performance. It is hypothesized that industry performance will have a negative influence on risk. The argument parallels that for individual companies. If low performance results in firms taking risky actions, an industry that on the average has low performance will be populated with firms taking risky actions. If competitors are taking risky actions, such as introducing new technologies and new products, a firm of interest will be forced to take such actions to keep up, even if its performance level is high.

Consider, for example, a high-profit firm in a low-profit industry, in which the introduction of new products is the main area of competition. Most firms in the industry are making low profits and consequently take risks by introducing new products. The high-profit firm will be under pressure to match the competitive moves of the other firms in the industry and so will also take risks by introducing new products. Thus, low industry performance should increase risk taking by the firms in an industry over and above the influence of a firm's own performance level.

Hypothesis 2: Average industry performance has a negative influence on risk ($b_2 < 0$ in Equation 1)

Aspirations and expectations. Cyert and March (1963), March and Shapira (1987), and Manns and March (1978) suggested that if a firm aspires to a higher level of performance than it expects to attain under the status quo, it looks for ways to raise its performance. Given the role of routines in increasing predictability (March & Simon, 1958), it is likely that some of the changes to routines occasioned by attempts to increase performance will reduce organizational predictability. Such reductions should increase uncertainty with respect to the outcomes the organization may incur and may in particular increase income stream uncertainty. In an examination of players' responses to a strategic marketing game, Lant and Montgomery (1987) found that performance below aspirations resulted in riskier choices and more innovative search than performance that met or exceeded aspirations.

² For an alternative derivation of this proposition, see Singh (1986)

Although Lant and Montgomery used actual performance to predict risk, I followed the behavioral theory of the firm and used expected performance. Doing so allowed differentiation between the direct effects of performance on risk taking and the effects of the aspirations-expectations process. The income stream of a firm that makes few changes should be more predictable—less risky—than the income stream of a firm that makes many changes. Thus, the level of aspirations should have a positive influence on risk taking, and expectations should have a negative influence.

Similar hypotheses can be based on prospect theory (Kahneman & Tversky, 1979). According to that theory, the level of a firm's aspirations serves as a target or reference level; firms that anticipate returns below that level will be risk seeking, and those that anticipate returns above it will be risk avoiding. Thus, increases in aspirations (the target) will be associated with increases in risk taking, and increases in expectations (anticipated returns) will be associated with decreases in risk taking.

Because the sources of the data on aspirations and expectations used here differed, the scales on which they were measured may not be identical. Consequently, in this research the difference between aspirations and expectations could not be usefully calculated. But if risk is a function of aspirations minus expectations, aspirations should have a positive influence on risk and expectations a negative influence.

Hypothesis 3: Expectations have a negative influence on risk ($b_3 < 0$ in Equation 1).

Hypothesis 4: Aspirations have a positive influence on risk ($b_4 > 0$ in Equation 1).

Slack. The influence of slack on risk taking depends on the relation of slack to a target level of slack (March & Shapira, 1987).³ If slack falls substantially below its target level, managers take risks in order to create additional slack (Cyert & March, 1963; MacCrimmon & Wehrung, 1986; March, 1981). Alternatively, if slack is around the target level, managers take few risks; they see their organization as operating in a satisfactory manner and continue with conventional routines (Cyert & March, 1963). At slack levels well above the target level, managers engage in "slack search" (March, 1981: 214), trying out new ideas.

As MacCrimmon and Wehrung (1986) noted, managers are far more willing to take risks that are very small relative to their organization's current wealth than to take large risks. High levels of available wealth (slack) should therefore result in risk taking. Researchers have associated high levels of

³ Comments by James March on an earlier draft of this article indicated that the paper misinterpreted March and Shapira (1987). Consequently, I changed two hypotheses based on March and Shapira. Although revising hypotheses after data analysis presents serious methodological problems, presenting an erroneous theoretical derivation seemed a more substantial error. The previous hypotheses predicted that slack would have a positive influence on risk taking and squared slack a negative influence in Equation 1.

slack with high levels of innovation, a form of risk taking (e.g., Mansfield, 1961); Greenhalgh (1983) hypothesized that slack would have a positive influence on innovation in declining industries. Slack levels well above or below a company's reference level should increase risk taking, and slack levels near the reference level should reduce it.⁴ Thus, slack should have a nonlinear influence on risk taking, with both high and low levels of slack associated with high levels of risk and moderate levels of slack associated with low levels of risk. The model represents this U-shaped relation by including variables measuring kinds of slack and the squares of these variables. For the U-shape, the coefficient on slack should be negative, and the coefficient on slack squared should be positive.

Hypothesis 5: High and low levels of slack should result in higher levels of risk taking than moderate levels of slack ($b_5 < 0$, $b_6 > 0$ in Equation 1).

Finally, the model includes past risk to control for firm-specific historical influences on risk.

Determinants of Performance

Risk taking, aspirations, expectations, slack, future average industry performance, and past company performance were hypothesized to influence future company performance.

The performance equation is

$$\begin{aligned} \text{Performance}_{t+2} = & c_0 + c_1 \text{performance}_{t+1} + c_2 \text{industry performance}_{t+2} \\ & + c_3 \text{expectations}_{t-1} + c_4 \text{aspirations}_{t+1} \\ & + c_5 \text{slack}_{t+1} + c_6 \text{slack}^2_{t-1} + c_7 \text{risk}_{t+1} + e, \end{aligned} \quad (2)$$

where

c_i = parameters to be estimated,
 t = year,

and

e = error term

Risk. The authors of much of the literature on innovation, organizational change, and general management have assumed that change and risk taking have a positive influence on future performance (cf. Kanter, 1983; Schon, 1971). Aaker and Jacobson (1987) argued that risk had a positive influence on performance and found support for that view using business unit data. In general, economic analyses have argued that corporations need to be compensated for taking risks with high returns. Capital budgeting

⁴ Staw, Sandelands, and Dutton (1981) presented a "threat rigidity" hypothesis, suggesting that as organizations near bankruptcy they will take fewer risks. Within the population of large industrial firms examined in this research, bankruptcy is extremely rare, so the model does not represent this possibility.

theory uses the measure of systematic risk (beta) to discount future returns; to have the same net present value as a low-risk project, a high-risk project must promise higher future net cash flows.

Hypothesis 6: Risk has a positive influence on future performance ($c_7 > 0$ in Equation 2)

Expectations and aspirations. As has been noted, if expectations fall below aspirations, organizations seek to raise expected performance. Although the discussion concerning Equation 1 focused on the likelihood that such solutions will increase uncertainty, some solutions may raise organizational performance without attendant changes in risk. Companies seeking to improve performance might take steps that raise the uncertainty of their income streams, such as introducing new products or trying new, unproven production technologies, or they might take steps without appreciable risk, such as reducing expenses, tightening controls on production waste, or modestly increasing advertising. A firm might take either approach or both of them depending on the exact circumstances it faces. To construct a model allowing for both strategies, I incorporated the aspirations-expectations process into both the performance and risk equations. Given that a difference between aspirations and expectations should intensify a search for improvements, both equations present the same hypotheses.

Hypothesis 7: Expectations have a negative influence on future performance ($c_3 < 0$ in Equation 2).

Hypothesis 8: Aspirations have a positive influence on future performance ($c_4 > 0$ in Equation 2).

Slack. The direct influence of slack on future performance is unclear (Cyert & March, 1963: 279). Although there are numerous works on slack and risk, little has been written about the causal influence of slack on performance. Within a microeconomic analysis, slack would be seen as wasted resources, so that firms with high levels of slack should result in low performance. But such a slack-performance association is static; it says nothing about the influence of slack on future performance when current performance is controlled. Cyert and March (1963) and Thompson (1967) argued that slack may be useful to organizations because it provides an essential buffer to their activities. Without slack, any reductions in cash flow will result in immediate shortages of funds. Such shortages will result in dysfunctional organizational changes such as layoffs and cancellation of capital investments. Firms use slack to smooth investment, staffing, and so forth and to buffer their technological cores from short term random fluctuations in the environment.

Slack also allows firms the ability "to take advantage of opportunities afforded by that environment" (Thompson, 1967: 150) Firms with additional resources have more strategic options available than firms without resources. Thus, available resources in the form of slack provide a strategic advantage, but only if the resources are large relative to those of the compe-

tition. Alternatively, a lack of slack may force a company to manage very carefully. There are many examples of companies that, in the face of shortages of slack, found ways to reduce costs and improve performance. Firms with levels of slack substantially below the normal for their industry may be expected to take such actions. Thus, firms with much slack obtain a competitive advantage and firms with little slack must manage carefully. Either action should increase performance.

Hypothesis 9: High and low levels of slack result in high levels of performance, and moderate levels of slack result in low levels of performance ($c_5 < 0$, $c_6 > 0$ in Equation 2).

Two variables were included in the performance equation as controls. Average industry performance controls for industry-wide factors that may influence performance. Previous performance controls for firm-specific historical effects. Both should have positive influences on future performance.

MEASUREMENT AND ESTIMATION

The model requires measures for risk, performance, aspirations, expectations, and slack.

Measuring Risk

Previous studies of risk-return relations have defined risk as the unpredictability of a firm's income stream (Bowman, 1980; Conrad & Plotkin, 1968; Fiegenbaum & Thomas, 1985; Fisher & Hall, 1969). These studies have measured risk by the ex post, or actual, variance of a firm's return on investment or equity

In this research, risk was measured as the ex ante uncertainty of a firm's earnings stream. Conventional measures of income stream risk, such as the variance in a firm's return on assets (ROA) and the variance of ROA around a time trend, measure ex post uncertainty, which may differ substantially from the uncertainty occurring before the time period. In 1970, an oil company might have expected the 1970s to be a stable period and would have based its actions on that expectation rather than on the uncertainty that the Organization of Petroleum Exporting Countries (OPEC) introduced. Thus, ex ante measures of risk may be preferable to ex post measures (Bowman, 1982; Silhan & Thomas, 1986). In addition, it is desirable to use a risk measure that differentiates between predictable changes in outcomes, which are not risky, and risky unpredictable changes in outcomes. Measures like variance in returns classify businesses with predictable but rapidly growing returns as highly risky and those with stable or slowly declining returns as not risky (Cardozo & Smith, 1983).

If a number of analysts forecast the earnings of a given corporation, the variance in their forecasts should be strongly associated with the ex ante uncertainty of that earnings stream. Consequently, I measured the risk of a company's income stream for a given year by the variance in security ana-

lysts' forecasts of that income. Extensive research on capital markets has used the divergence of analysts' forecasts as a measure of uncertainty (Brown, Richardson, & Schwager, 1987; Carvell & Strebel, 1984; Givoly & Lakonishok, 1988; Imhoff & Lobo, 1984, 1987; Malkiel, 1982); further, Conroy and Harris (1987) provided results supporting use of this measure. I assumed that the greater the variance in such forecasts, the less predictable and consequently the more risky the income stream. Means and standard deviations of analysts' forecasts are available from the Institutional Brokers Estimate System (IBES). The risk for a company in a given year is measured by the standard deviation of the securities analysts' forecasts of earnings per share for the year. This research used the forecasts from the January IBES report.

Other Measures

All the analyses presented below were executed using return on total assets (ROA), return on equity (ROE), and return on sales (ROS) as performance measures. Since the results agreed across the three measures, only the ROA results are discussed here in order to conserve space and simplify presentation.⁵ Industry performance was the average ROA for firms with a given two-digit Standard Industrial Classification (SIC) code

Expectations were measured by the mean of the earnings forecasts produced by securities analysts. A substantial body of literature indicates that such forecasts not only predict earnings reasonably well, but also contain new information that the stock market has not previously considered (Barefield & Comiskey, 1975; Brown & Rozeff, 1978; Collins & Hopwood, 1980; Fried & Givoly, 1982; Imhoff & Lobo, 1984; Hassell & Jennings, 1986; O'Brien, 1988). Management and analysts' forecasts correlated .90 in the data described in McNichols (1989) and .97 in the data described in Hassell and Jennings (1986).⁶ Thus, analysts' forecasts correlate sufficiently highly with those of management to be considered a reasonable proxy. The original forecasts used here, which are in terms of earnings per share, were converted to ROA by multiplying by shares divided by total assets from the previous year.

March and Simon (1958) argued that past performance and comparison to the performance of others will strongly influence aspiration levels. Other researchers (e.g., Cyert & March, 1963; Lant & Montgomery, 1987; Levinthal & March, 1981; March, 1988) have modeled aspirations as a function of the difference between previous aspiration levels and previous performance. These models often result in aspirations being a function of past performance levels. Eliasson (1976) noted that corporations raise targets to slightly above their previous performance level.

The performance of other companies should also influence aspiration

⁵ Complete results using all three performance measures are available from the author

⁶ Professor Maureen McNichols kindly estimated the correlation coefficient and Professor John Hassell kindly provided the data used to estimate the second correlation

levels. Fiegenbaum and Thomas (1988) and Lev (1974) argued that average performance forms a target level for firms in an industry. Herriott, Levinthal, and March (1985) modeled aspirations as a function of both past performance and the average performance of comparable firms. A firm that performs well below industry norms is hardly likely to aspire to continued below-average performance. A firm that performs above industry norms will not aspire to average performance.

The measure of aspirations used here combines past performance and average industry performance. For firms with performance above the mean for their industry, I represented aspirations by multiplying past performance (ROA) by 1.05.⁷ For firms performing below their industry's mean, I set aspirations equal to that level of performance. Thus, I assumed that firms performing below their industry's average aspire to the average and firms performing above it aspire to improve their current position. This measure, which conforms to the theoretical propositions justifying it and is related to previously used measures, appears to be reasonable but has not been empirically validated.

Bourgeois and Singh (1983) divided slack into three categories—available, recoverable, and potential slack—that differentiate the extent to which resources are available (cf. Bourgeois, 1981; Hambrick & D'Aveni, 1988). Following Bourgeois and Singh, I employed indicators of each kind of slack. A company's current ratio, or current assets divided by current liabilities, represented available slack, and selling, general, and administrative expenses divided by sales (SG&A/sales) represented recoverable slack. Potential slack had two measures: the debt-to-equity ratio, which reflects a lack of potential slack, and the interest coverage ratio, calculated as the ratio of income before taxes and interest charges to interest charges, which indicates the presence of potential slack. A corporation with a high debt-to-equity ratio has a relatively low ability to obtain additional funds through incurring debt and thus has little potential slack. A corporation with a larger income relative to interest charges is better able to take on additional debt than a corporation with low income relative to interest charges and thus has potential slack.

Data and Estimation

The data used to estimate the model included all firms classified under Standard Industrial Codes (SIC) 3000 to 3999 and for which both accounting data from Standard and Poor's COMPUSTAT tapes and analyst forecast data

⁷ The 1.05 adjustment factor appeared reasonable in light of previous research (cf. Bromiley, 1986; Lant & Montgomery, 1987). To test the sensitivity of the results to this parameter, I constructed aspiration variables using a 1.25 and a 1.50 adjustment factor. The correlations between the aspiration variable using 1.05 and those using 1.25 and 1.50 are .99 and .97, respectively. I also estimated the risk and performance equations using the 1.50 adjustment rate and obtained estimates that agreed with those based on the 1.05 rate. The results presented are not sensitive to the adjustment rate assumption.

from IBES were available. The study examined only manufacturing companies to mitigate difficulties produced by using accounting data from vastly different kinds of businesses; accounting in banks, for instance, differs substantially from accounting in manufacturing firms. Following initial model estimation, I eliminated observations with leverage over four times the average leverage or studentized residuals over four (see Judge, Hill, Griffiths, Lutkepohl, & Lee, 1988) to ensure that a small number of extreme outliers did not overly influence the results. The IBES data begin in 1976 and the COMPUSTAT data employed end in 1987. After construction and lagging of the instrumental variable (described below), a maximum of nine usable observations per company remained. The final data covered 288 companies.

Since the equations, which include lagged dependent variables, were likely to have autoregressive error terms, I estimated them using an instrumental variable procedure (cf. Johnston, 1984). In creating the instrument for the lagged dependent variable, I included all the other independent variables for a given year and for one year before it in the regression. The SAS Autoreg procedure with instrumental variables (SAS Institute, 1984: 192–193) was employed with missing data points inserted between companies to ensure that serial correlation was not defined across companies. This procedure uses a generalized least-squares approach to correct for serial correlation. Table 1 presents means, standard deviations, and correlations among the variables.

RESULTS

Table 2 presents the results concerning risk taking. All tests were two-sided, a conservative approach given that I was testing directional hypotheses. Consistent with Hypothesis 1 and a variety of earlier studies (Bowman, 1982; Singh, 1986), performance has a strong negative influence on risk taking. Past industry performance also has a significant, negative influence on risk taking. Contrary to Hypothesis 3, expectations have a positive influence on risk taking. Aspirations, in agreement with Hypothesis 4, have a significant, positive influence on risk taking. Previous risk has a positive and significant parameter estimate.

Because the correlations between the linear and squared slack variables are high, the results on slack are somewhat complicated to interpret. Although the estimates remain consistent, the collinearity results in imprecise parameter estimates and large standard errors (Johnston, 1984; Judge, Griffiths, Hill, Lutkepohl, & Lee, 1985; Kennedy, 1985). To assist in interpretation, I estimated the model both with and without the squared slack terms (see Table 2).

Available and recoverable slack have significant negative coefficients in the regression equations both with and without squared terms. Interest coverage has negative coefficients in both equations, but the coefficient estimate is only significant when the squared slack terms are included. The debt-to-equity ratio has a negative and insignificant coefficient when squared

TABLE 1
Descriptive Statistics and Correlations^a

Variables	Means	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Performance _{t+1}	0.060	0.050																	
2. Performance _t	0.063	0.049	70																
3. Industry performance _{t+1}	0.047	0.026	41	31															
4. Industry performance _t	0.051	0.027	30	42	73														
5. Risk _{t+1}	0.191	0.228	-37	47	-24	-29													
6. Risk _t	0.182	0.260	-30	-35	-21	-27	53												
7. Expectations _{t+1}	0.050	0.047	36	57	05	16	-31	-19											
8. Expectations _t	0.052	0.038	16	38	-05	07	-13	-22	66										
9. Aspirations _{t+1}	0.074	0.037	90	69	54	40	-38	-32	34	16									
10. Aspirations _t	0.078	0.037	67	89	39	.56	-42	-36	52	37	75								
11. Current ratio _t	2.359	0.860	17	22	04	06	-26	-23	12	23	21	25							
12. SG&A-to-sales ratio _t	0.208	0.107	06	05	02	05	24	-21	05	10	11	11	33						
13. Interest coverage _t ^b	0.120	0.172	43	53	14	17	-23	-19	31	25	45	53	17	-02					
14. Debt-to-equity ratio _t	0.305	0.275	-30	-40	-10	-16	27	22	-29	-28	-30	-38	-09	-13	-40				
15. Current ratio _t ²	6.302	4.989	14	18	04	05	-21	-20	07	20	19	22	.97	29	17	-08			
16. SG&A-to-sales ratio _t ²	0.055	0.052	03	02	-00	03	-18	-17	03	09	09	09	.27	97	-04	-10	24		
17. Interest coverage _t ^{2b}	0.044	0.185	23	24	06	06	-09	-08	14	11	26	27	11	-02	87	-21	13	-02	
18. Debt-to-equity _t ²	0.169	0.423	-.17	-26	-07	-14	19	15	-20	-19	-18	-24	-08	-.10	-19	85	-06	-08	-09

^a N ≥ 1,540

^b Interest coverage has been multiplied by .01 and interest coverage squared by 0001.

TABLE 2
Determinants of Risk Taking^a

Dependent Variables	Risk _{t+1}	Risk _{t+1}
Constant	0.490** (0.052)	0.356** (0.036)
Risk _t	0.163** (0.042)	0.210** (0.042)
Performance _t	-0.3598** (0.216)	-0.3136** (0.199)
Industry performance _t	-0.1259** (0.337)	-0.1257** (0.332)
Expectations _t	0.271† (0.140)	0.183 (0.133)
Aspirations _t	2.919** (0.391)	2.632** (0.356)
Current ratio _t	-0.061* (0.026)	-0.022* (0.010)
SG&A-to-sales ratio _t	-0.891** (0.253)	-0.452** (0.082)
Interest coverage _t ^b	-0.007* (0.001)	-0.056 (0.043)
Debt-to-equity ratio _t	-0.005 (0.025)	0.050** (0.013)
Current ratio _t ²	0.007† (0.004)	
SG&A-to-sales ratio _t ²	0.769† (0.465)	
Interest coverage _t ^{2b}	0.047 (0.030)	
Debt-to-equity ratio _t ²	0.003 (0.003)	
R ²	48	45
ρ ^c	-0.290**	-0.284**
N	1,288	1,286

^a Standard errors appear in parentheses under parameter.

^b Interest coverage has been rescaled by multiplying it by .1. Interest coverage squared has been multiplied by .0001.

^c This statistic is a coefficient of serial correlation.

† $p < .10$

* $p < .05$

** $p < .01$

terms are included but a positive and significant coefficient when they are not. Thus, dependable linear effects consistent with the hypotheses emerge for available and recoverable slack. The results on potential slack were weak, with only two of the four parameter estimates statistically significant, although both significant estimates agree with the hypothesis.

The results for available and recoverable slack squared are both positive as hypothesized but significant at only the 10 percent level. The potential slack variables are both insignificant. The hypothesis that all the squared slack terms have zero coefficients can be rejected, but only at the 6 percent

level ($F_{15,1284} = 2.27, p < .06$). In other words, I found only the weakest support for the presence of a nonlinear influence of slack on risk.

Even if slack has a nonlinear effect on risk, the nonlinearity results in slack having almost no influence on risk for high values of slack rather than the positive influence hypothesized. By taking the derivative of the risk equation with respect to each slack variable and setting it equal to zero, I estimated where the total effect of the linear and nonlinear slack terms switched from negative to positive. For both the current ratio (available slack) and the ratio of selling, general, and administrative expenses to sales (recoverable slack), under 4 percent of the observations have values that would indicate a positive influence of slack on risk. Rather than generating a U-shaped curve, the influence of changes in slack on risk starts negative and declines to zero for high values of slack. The nonlinear parameter estimates cannot be interpreted as support for the proposition that slack allows risk taking.

Table 3 presents the results concerning future performance. As hypothesized, industry performance has significant, positive parameter estimates. Past performance has an insignificant parameter estimate. Contrary to the hypothesis, the risk parameter is negative and significant. Expectations have the hypothesized negative influence on performance, and aspirations have the hypothesized positive influence, both significant.

Collinearity complicates interpretation of the slack coefficients in the performance equation as it did in the risk equation. Although the slack variables clearly influence performance, their influence is not consistent with the hypotheses. The current ratio (available slack) and interest coverage (potential slack) have positive influences on performance. The debt-to-equity ratio (potential slack) has negative coefficients in regression equations both with and without the squared slack terms, but the coefficient is only significant when the squared terms are not included. The SG&A-to-sales ratio (recoverable slack) has negative but insignificant parameter estimates. The estimates indicate that available slack, in the form of current ratio, and potential slack, in the form of interest coverage, both have positive influences on performance and that potential slack, in the form of the debt-to-equity ratio, may have a positive influence.

Of the squared slack terms, only the current ratio squared is significant, and it is negative. The hypothesis that all the squared slack terms have zero coefficients can be rejected, but only at the 10 percent level. Approximately 10 percent of the current ratio values fall in the range in which increases in slack would result in decreases in performance. Overall, the results do not provide strong support for the existence of a nonlinear influence of slack on performance.

Further Investigations

In this section, I examine the stability of the parameter estimates across industry, performance, and size. In addition, the long-run effects of risk on performance are examined.

TABLE 3
Determinants of Performance^a

Dependent Variables	Performance _{t+2}	Performance _{t+2}
Constant	- 0 016† (0 010)	-0.005 (0 006)
Performance _{t+1}	- 0 043 (0 044)	0.026 (0 046)
Industry performance _{t+2}	0 623** (0 051)	0.656** (0 055)
Risk _{t+1}	- 0 019** (0 004)	-0.019** (0 005)
Expectations _{t+1}	- 0 094* (0 038)	-0.018 (0 041)
Aspirations _{t+1}	0 511** (0 050)	0 370** (0.043)
Current ratio _{t+1}	0 015* (0 006)	0 004* (0 002)
SG&A-to-sales ratio _{t+1}	- 0 037 (0 049)	-0 010 (0 014)
Interest coverage _{t+1} ^b	0 060** (0 021)	0 044** (0.011)
Debt-to-equity ratio _{t+1}	- 0 014 (0 009)	-0 012** (0.004)
Current ratio _{t+1} ²	- 0 002* (0 001)	
SG&A-to-sales ratio _{t+1} ²	0 059 (0 095)	
Interest coverage _{t+1} ^{2b}	- 0 023 (0 017)	
Debt-to-equity ratio _{t+1} ²	0 001 (0.004)	
R ²	.45	.42
ρ ^c	- 149**	- 170**
N	1,310	1,299

^a Standard errors appear in parentheses under parameters

^b Interest coverage has been rescaled by multiplying it by .01. Interest coverage squared has been multiplied by .0001

^c This statistic is a coefficient of serial correlation

† $p < .10$

* $p < .05$

** $p < .01$

Interindustry differences. Previous researchers (Bowman, 1980, 1984; Fiegenbaum & Thomas, 1986) have found strong interindustry differences in the risk-performance association. Consequently, I tested whether the parameters of the model differed across industries. First, I grouped the data by two-digit SIC codes and estimated the risk and performance equations for each industry using the same estimation procedure described above. Using a Chow test (Kennedy, 1985), I tested the hypothesis that the parameters were equal across industries and was able to reject it for both the risk and the

performance equation (risk, $F_{1,35,996} = 2.49$; performance, $F_{1,35,1140} = 1.92$, $p < .001$).

Performance and size differences. The effects reported here may also depend on the performance or size of an organization. Fiegenbaum and Thomas (1988) and Fiegenbaum (1990) argued that low performers seek risk and high performers avoid it, resulting in a negative risk-return relation for low performers and a positive risk-return relation for high performers. If this is true, past performance should have a positive parameter in the risk equation using data from the top quartile of performers and a negative parameter in the equation using data from the bottom quartile.

Hambrick and D'Aveni (1988) found that firms that went bankrupt had lower levels of slack, particularly as indicated by their debt-to-equity ratio, lower returns on assets, and higher variability in initiating new projects than a matched sample of nonbankrupt firms. They discussed the possibility that there is something particular about the decision-making or management processes in these firms that builds from these conditions and leads to bankruptcy. If this were so, high performers and low performers would differ in their risk taking and in the relation of risk taking to future performance.

Since the process by which a company responds to changes in internal and external factors should depend more on long-run experience than on short-run experience, I grouped companies into quartiles based on their average ROA and average sales over the 11 years of data available on ROA and sales. The risk and performance equations were estimated for each quartile defined by average company ROA and sales and the parameters tested for equality across the quartiles.

For both the ROA- and sales-defined divisions, I could strongly reject the hypothesis that the parameters of the equations are equal across quartiles.⁸ All F s are significant beyond .001.

To summarize the primary features of the quartile-based parameter estimates, I found no sign changes for any of the variables that were significant in the overall equations. Contrary to the findings of Fiegenbaum and Thomas (1988) and of Fiegenbaum (1990), past performance has a negative influence on risk in all eight quartile equations, and it is significant in all but the top ROA-defined group. The estimates of the influence of risk on subsequent performance are negative and significant in all sales-defined quartiles and negative in three of the four performance quartiles. They are significant only in the third performance quartile; the parameter estimate for the top performance group was positive and insignificant. Although I can reject the hypothesis that parameters are equal across quartiles, in no case did the sign of a significant coefficient switch between top and bottom quartiles. The degree

⁸ With the ROA-based quartiles, the results for the risk equation are $F_{45,1086} = 4.00$, and for the performance equation they are $F_{45,1239} = 9.02$. With the sales-based quartiles, the results are $F_{45,1086} = 3.05$ for risk and $F_{45,1239} = 5.30$ for performance.

of association appears to differ, but I cannot demonstrate that the major feature of the influence—its direction—varies across quartiles.

Long-run effects. Finally, the possibility exists that risk in a given year has a negative influence on performance in the next year but a positive influence in subsequent years. I examined this possibility using the same performance model presented earlier (Equation 2) with two changes. First, instead of explaining performance in a given year by variables measured in the previous year, I explained performance by variables measured two to four years previously. Thus, the model estimates the influence of risk in a given year on performance up to four years later (in terms of Equation 2, years $t + 3$ to $t + 5$). Second, I dropped lagged performance since it was insignificant in the one-year estimates and substantially complicated estimation of the model. Constructing the instrument for lagged performance resulted in large reductions in data, which lowered the precision of the estimates. Risk in a given year had significant, negative influences on performance in all these estimates. The magnitude of the influence of risk in a given year on performance four years later was larger than the influence of risk in a given year on performance in the very next year.

Given these results, what general observations can be derived? First, the parameters in the model differ when estimated across industries, across quartiles defined by average ROA, and across quartiles defined by average sales. Second, the data fail to support the argument that performance has a positive influence on risk for high performers. Third, risk in a given year negatively influences performance up to four years later. Fourth, it appears likely that the factors influencing risk taking and performance differ in magnitude across performance and size levels, but the results do not indicate that the signs of the effects differ. In other words, it is not clear that differing behavioral models are justified for firms at differing performance levels.

CONCLUSIONS, DISCUSSION, AND FURTHER DIRECTIONS

Reviewing Bowman's (1980) risk-return paradox and related work (Fiegenbaum & Thomas, 1985, 1986; Jemison, 1987; Singh, 1986), the issue of the causal relations among past performance, risk taking, and future performance became apparent. The results presented here, although more complex than previous results in the area, may shed some light on the problem.

The Risk Model

The estimation results strongly support the risk model. With the exception of expectations' positive influence on risk, all the significant parameters have the hypothesized signs. Several of the results on the determinants of risk taking are worth further discussion. Industry performance has a negative parameter, suggesting that low average industry performance results in less certain income streams for the corporations in an industry. Variables measuring both expectations and aspirations have positive and significant in-

fluences on risk; in an analysis in which past performance was held constant, companies expecting to perform well took on additional risk, and the higher their aspirations, the greater the risks they took. Slack appears to reduce risk taking. The negative influence of firm performance, industry performance, and slack on risk taking support the notion that low performance drives risk taking rather than the argument that slack allows room for it. As noted above, the parameter values indicate that the data do not support the argument that slack allows risk taking even for high levels of slack.

These overall results are important for two reasons. First, they constitute one of the very few quantitative, large-scale tests of the behavioral theory of the firm. Almost all previous relevant work has been qualitative research or quantitative work using very small samples. Second, the present results support a theoretically justified model of risk taking that is substantially more complex than previous models. Although some previous work has employed more variables than this study, theoretical justification for many of these models was absent; for instance, work using the PIMS data base has usually included numerous variables because they were significant in previous studies (cf. Aaker & Jacobson, 1987; Woo, 1987).

The Performance Model

The performance model supported the following conclusions: (1) risk reduces subsequent performance, (2) aspirations have the hypothesized positive influence on performance and expectations a negative influence, and (3) slack, particularly available and potential slack, increases performance. Overall, these results support the utility of financial resources in increasing performance.

The Interaction of Risk and Performance

If just the interaction of performance and risk is reviewed, the results suggest that performance has a negative influence on risk taking and that risk taking has a negative influence on future performance. Thus, not only does low performance result in a company's income stream becoming more risky—such riskiness lowers future performance even when factors such as past and industry performance are controlled.

If risk and performance constituted the entire model tested here, these findings would be extremely worrisome. If performance has a negative influence on risk, which in turn has a negative influence on future performance, the potential exists for a vicious circle: once a firm starts to perform poorly, matters will keep getting worse and worse. Alternatively, a high performer, once started, can keep earning higher and higher returns with less and less risk. The parameter values presented indicate that although such negative feedback does exist, it is small relative to other effects. For example, a .05 reduction in ROA (approximately one standard deviation) would result in a .003 reduction in ROA two years later. Thus, the relations of performance and risk do create a negative feedback loop, but it is of such small magnitude that other factors overwhelm it.

Comparisons with Other Studies

Bowman suggested that poorly performing firms may seek risky investments in a manner similar to the risk seeking of individuals found in research on behavioral decision theory. An important issue in risk seeking by individuals that had not been addressed using corporate data is whether such risk taking is sensible or not. The interesting part of risk seeking by individuals is not simply that poor performers take more risks, but rather that they take bad gambles—risks with low expected values. The results presented here suggest a similar phenomenon: low business performance results in taking more risk, and that risk has a negative influence on future performance, over and above what would be expected from past performance and an industry's performance. Thus, it appears that firms performing poorly do indeed make risky and low-payoff strategic choices.

These results agree to some extent with the results of Bowman's (1984) content analysis of risk taking but do not agree with his finding that risk taking has no impact on future performance (Bowman, 1984). Although the exact reasons for this difference cannot be determined, it should not be cause for great concern. The multivariate techniques and much larger data set used here (over 1,000 observations compared to Bowman's 26) may have simply facilitated picking up effects that were too small to emerge with Bowman's bivariate techniques and small sample.

The same cannot be said of discrepancies with Aaker and Jacobson's (1987) work using the PIMS data base. They found that two measures of variability in return on investment (accounting-based measures of systematic and unsystematic variance) both had positive influences on performance. Some substantial methodological differences exist between this study and Aaker and Jacobson's: their data were from business units, mine from corporations; their model was cross-sectional with a lagged dependent variable, mine a pooled cross-sectional time series model; and the risk measures used differed. Exactly why such differences would give these results is not clear, but the varying definitions of risk offer a particularly likely explanation. Aaker and Jacobson used accounting data on ROI from a given time period to estimate beta and unsystematic risk and then apparently used these estimates in regression equations that explain ROI over the same time period. I join Fiegenbaum and Thomas (1988) in emphasizing the need for further work on the meaning and measurement of strategic risk (see also Miller & Bromiley, 1990).

The factors influencing risk taking appear to vary at least in magnitude across industries, performance levels, and sales levels. The present results contrast with those of Fiegenbaum and Thomas (1988), who found that risk-return associations differed in sign for high- and low-performing industries and that no association between risk and return was visible for firms near an average industry performance level. Although the aggregate findings of the two studies agree in that low performance is associated with high risk and vice versa in both, specific findings differ. This study found negative influ-

ences of performance on risk in all quartiles and positive influences of risk on performance. It may be that adding additional control variables to the bivariate approach used by Fiegenbaum and Thomas will explain the differences in findings.

Only two of Singh's (1986) findings on the determinants of risk are comparable to the results presented here. The studies agree in finding that performance reduces risk taking. On the other hand, Singh found that absorbed slack, which he measured by the ratios of selling, general, and administrative expenses and of working capital to sales, had a positive influence on risk but that the quick ratio (cash and marketable securities divided by current liabilities) had no significant influence on risk. I found that both expenses divided by sales and the current ratio had negative effects on risk. Although the numerous methodological differences between the two studies may explain the differences in results, a particularly interesting possibility is that substantial differences exist between Singh's measure of managerial perceptions of risk and measures of income stream uncertainty.

This article has presented a dynamic model of risk taking and performance and estimations of the model using ex ante measures of risk rather than the more conventional ex post measures. A number of factors limit the generality of the findings: studying large manufacturing companies, measuring risk with income stream uncertainty, potential measurement errors, and the omission of substantive measures of risky actions. However, the results are interesting in their own right and also suggest a number of additional studies. The effect of using alternative functional forms to measure expectations, aspirations, and slack warrants further exploration (Duhaime & Davis, 1986). The differences among quartiles of companies defined by performance strongly suggest a more complex theory may be needed so that these parameter differences can be explained rather than simply estimated. Finally, researchers might use other data bases to test the generality of these results.

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