ASSESSMENT AND REDIRECTION OF LONGITUDINAL ANALYSIS: DEMONSTRATION WITH A STUDY OF THE DIVERSIFICATION AND DIVESTITURE RELATIONSHIP

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The authors review the application of longitudinal analysis in strategic management research and show that how such analysis is conducted has implications for empirical results and theory development. A content analysis of 203 longitudinal strategic management studies reveals that most researchers have not (1) tested and controlled for violations in the data assumptions underlying longitudinal analysis or (2) tested the stability and form of the empirical relationships over time. Implications of these findings are demonstrated with analyses of the diversification and divestiture relationships of 180 Fortune *500 companies over the period 1985–88. The results show that empirical results, theoretical development, and practical applications can vary on the basis of how longitudinal analysis is performed. Suggestions for the use of longitudinal analysis in strategic management research are offered. © 1997 by John Wiley & Sons, Ltd.*

INTRODUCTION

Longitudinal studies have become popular in strategic management research (Bergh, 1993a). Their increase in popularity is not surprising as most definitions and theories of strategic management are longitudinal (Ginsberg, 1988; Mintzberg and Waters, 1985; Porter, 1991). For example, Miller and Friesen (1982: 1020) noted that 'strategy can best be understood by tracking it over time; by looking at behavior rather than condition; by studying "what happens in response to what".'

However, for longitudinal relationships to be interpreted correctly, researchers must recognize strict analytical assumptions and employ specific analytical procedures (Bergh, 1993b; Isaac and Griffin, 1989; Rogosa, 1980a, 1980b). Failure to meet those special requirements can render studies with longitudinal data vulnerable to statistical errors and can lead to incorrect conclusions for theory development (Bergh, 1995; LaTour and Miniard, 1983). Consequently, strategy researchers need to understand what can go wrong in longitudinal analysis, what remedies are possible, and how theory development can be enhanced by more rigorous evaluation of longitudinal data. Such knowledge is important because longitudinal studies are expected to assume a larger role in the future testing, development, and application of strategic management research (Barnett and Burgelman, 1996; Porter, 1991; Schendel, 1996).

To assist strategy researchers in their testing of longitudinal data, a study was conducted to identify problems in longitudinal analysis in strategic management research and demonstrate how alternative approaches for conducting longitudinal analysis can affect empirical results and theory development. The study consisted of a content analysis of longitudinal studies and an analysis of the longitudinal relationship between diversification and divestiture of 180 *Fortune* 500 companies.

LONGITUDINAL ANALYSIS AND STRATEGIC MANAGEMENT RESEARCH

The practices (and potential problems) of longitudinal analysis in strategic management research were identified by reviewing the fundamental requirements of longitudinal analysis and then evaluating how those requirements have been applied in strategic management studies.

Fundamentals of longitudinal analysis

Longitudinal research has been defined as 'those techniques, methodologies and activities which permit the observation, description and/or classification of organizational phenomena in such a way that process can be identified and empirically documented' (Kimberly, 1976: 329). It generally involves collection of data at two or more points in time by use of consistent measures of comparable (or identical) subjects (Menard, 1991). The analysis of such data is accurate and complete when researchers (1) satisfy strict analytical assumptions and (2) test the stability and form of empirical relationships over time (Bergh, 1993a, 1995; LaTour and Miniard, 1983; Rogosa, 1980b).[1]

Analytical assumptions of longitudinal analysis

Longitudinal analyses are valid only when specific assumptions about the variances and covariances of observation error terms are met. In general, the error terms of the observations must

have uniform variance (be homoscedastic) and not be correlated with one another (be free of autocorrelation).[2] Those assumptions are represented in the variance–covariance matrix of the error terms of the observations of each variable. The diagonal of the matrix shows the variance of the errors associated with each observation (i.e., the first term on the diagonal is the variance of the error associated with the first observation, and the last term is the variance of the error associated with the *n*th observation). All the diagonal terms must be equal (homoscedastic). When the terms are not equal, a condition known as heteroscedasticity is present. The off-diagonal terms are the covariances between the errors associated with any two observations (i.e., the term in the second column and the fifth row is the covariance between the error associated with the second observation and the error associated with the fifth observation). All off-diagonal terms must be zero. If the off-diagonal terms are not equal to zero, the errors are 'autocorrelated', meaning the error terms of the observations for a variable are correlated.[3]

Analyzing longitudinal data that are heteroscedastic and/or autocorrelated can introduce bias into the empirical results. The bias generally results in inflated F-statistics (Box, 1953; Hunyh and Feldt, 1980; McCall and Appelbaum, 1973); in fact, Boik (1981) demonstrated that a deviation of 0.05 from a level of uniform variance can inflate an F-statistic to more than 200 times its unbiased size. Unless the bias is recognized and remedied, analytical results are vulnerable to type I statistical errors.

Strategy researchers have two remedies to over-

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[1] Note that those issues may not apply to all forms of event history analysis or ordinal time series methods (cf. Ruefli and Wilson, 1987).

[2] There is no possibility of violating the conditions in studies with just two measurement episodes. However, the results of those types of studies are vulnerable to other problems, including bias created by regression toward the mean effects and by correlations of the change score with the initial measurement episode (Bergh and Fairbank, 1996; cf. Cohen and Cohen, 1975; Cronbach and Furby, 1970; Linn and Slinde, 1977; Lord, 1956; O'Conner, 1972).

[3] In addition to the variance–covariance matrix for determining homoscedasticity, a popular statistical test is Box's M test of variance homogeneity. It compares the distributions of the error terms by using a chi-square approximation, with levels below $p < 0.05$ indicating that homogeneity is violated. Autocorrelation can be tested with the Durbin–Watson test. It produces the d-statistic, which ranges from zero to four (the general equation is $2(1-p)$, where p is the degree of correlation among the error terms). A value of approximately 2.0 indicates no autocorrelation. Other tests and procedures are available. See Kennedy (1992) for additional information.

come those problems. One is to adjust the critical values of the analytical model to compensate for the bias. That is typically done by use of the Cochrane–Orcutt iterative least-squares technique, Durbin's two-stage method, or a parameter adjustment process (cf. Bergh, 1995; Kennedy, 1992). The other remedy is to use an analytical technique that is not reliant on the variance–covariance assumptions. Two popular procedures are generalized least-squares analyses (GLS) and multivariate models. Those alternatives are highly recommended because they (1) provide reliable parameter estimates without dependence on the assumptions (neither approach requires satisfaction of the variance assumptions because they are derived from different distribution properties than ordinary least-squares (OLS) models) and (2) eliminate the need to recompute model parameters and statistical critical levels (O'Brien and Kaiser, 1985). Either alternative enables strategy researchers to compensate for the potential bias brought on by heteroscedasticity and/or autocorrelation.[4]

The stability and form of empirical relationships over time

Longitudinal designs and data provide the basis for observing changes in relationships over time (Bergh, 1993b, 1995). How such changes are tested depends on the number of observations being compared. If the number is just two (e.g., a firm's diversification is to be compared at two different points in time), a *t*-test of differences in means may be most appropriate (if the respective *t*-test assumptions are met). If the number of observations is greater than two, contrast tests may be the single best alternative for evaluating the form of an empirical relationship over time.[5]

Contrast tests have several features that alternative techniques do not offer, in that they (1) provide overall and individual tests of differences in three or more observations, (2) are computed to be free of the bias of heteroscedasticity and autocorrelation, (3) provide a coefficient for the direction and strength of a relationship over time, and (4) require a minimum of only two observations, which makes them appropriate for longitudinal studies that do not have enough ($n > 25$) observations for time-series econometric models (e.g., the Box–Jenkins autoregressive integrated moving average or ARIMA model and the structural econometric time-series approach or SEMTSA model). Contrasts can be performed in numerous ways, from testing absolute differences in observations to examining nonlinear relationships over a set of observations.

Strategy researchers can use contrasts for detecting both detailed and general relationships among longitudinal data. That capability further distinguishes contrast tests from other analytical methods. For example, techniques such as pooled cross-sectional analyses tend to aggregate shifts and changes in relationships over a set of longitudinal observations (Bergh, 1993a, 1993b). However, contrast tests can be used for evaluating the form of an empirical relationship at any point within a longitudinal data set. Contrast tests enable researchers to tease out relationships among constructs, thereby allowing the characteristics of relationships to be tested more fully than is possible with most other techniques.

Content analysis of longitudinal studies in strategic management research

To determine how strategic management researchers are addressing the foregoing issues, a content analysis of longitudinal studies appearing in the *Strategic Management Journal* from 1980 through 1993 was performed.[6] The journal published 568 articles during that period, of which 203 were classified as reporting longitudinal studies.[7] The studies covered a variety of content

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[4] Neither approach is universally superior for testing data with assumption violations. However, they should not be used for analyzing data that do not violate the assumptions. In those cases, the procedures are susceptible to power problems and type II errors.

[5] Other analytical alternatives can be used to test dynamic relationships. For example, researchers can employ forecasting models, spectral analysis, state–space models, and estimation techniques that can account for linear, nonlinear, and multivariate variations. Consideration of those approaches exceeds the domain of the present study, especially as very few have been used by strategy researchers. Chatfield's (1996) introduction on time series analysis is recommended for readers interested in those alternatives.

[6] This journal was used because it contains articles on only strategic management topics, thus minimizing guesswork in defining what should and should not be considered a strategic management study.

[7] To be classified as longitudinal, a study had to meet three criteria: (1) for each case in the study, data were collected for each variable for at least two points in time, (2) the cases were comparable for each time point in the study, and (3) the analysis involved a comparison of the data between or

areas, ranging from diversification (34 studies, 16.1% overall), to mergers and acquisitions (21 studies, 9.9% overall), to business cycles (3 studies, 1.4% overall). In addition, both the number and proportion of longitudinal studies increased over the 14-year period. Table 1 shows that whereas 21 percent of the studies reported in 1980 were longitudinal, the proportion had risen to 57 percent in 1993. Apparently, longitudinal studies are becoming popular in strategic management research.

Each of the 203 longitudinal studies was reviewed to determine whether the researchers tested and/or controlled for violations of the assumptions underlying longitudinal analysis. That examination raised several issues about the status of longitudinal analysis in strategic management research. First, few of the researchers acknowledged the statistical requirements (56 of 203, 28%) of longitudinal analysis. Even fewer did anything about the assumptions: 38 of the 56 *mentioned* that longitudinal analysis requires the

Table 1. Frequency of longitudinal studies reported in the *Strategic Management Journal*, 1980–93

Year	Total articles	Number longitudinal	Percent longitudinal
1980	24	5	21
1981	28	4	14
1982	27	5	19
1983	27	5	19
1984	26	2	8
1985	23	4	17
1986	35	11	31
1987	44	14	32
1988	57	29	51
1989	51	20	39
1990	53	18	34
1991	64	28	44
1992	60	30	50
1993	49	28	57
Total	568	203	36

among the periods represented (Menard, 1991: 4). The 203 articles were identified by three researchers working independently. Each researcher made a list of the articles that met the three criteria. The lists were then compared. Agreement on the lists exceeded 96 per cent. Articles that were not on all three lists were dropped from further consideration. Articles that were common to all three lists were used for the content analysis. Each of the 203 studies was reviewed in terms of whether the analyses accounted for the analytical assumptions and how forms of longitudinal relationships were tested.

satisfaction of strict statistical standards, but they did not test the assumptions or apply techniques that were safe from violations of the assumptions. Only 18 of the 56 who acknowledged the assumptions (9% overall) used analytical techniques whose results were not contingent upon the bias of autocorrelation and heteroscedasticity. Of those 18, most used generalized least-squares regression (13 of 18) and the rest used a multivariate model (5 of 18). Not one study tested for the assumptions, adjusted model parameters to account for autocorrelation or heteroscedasticity, accounted for regression toward the mean effects, or adjusted for the high correlation between change scores and their initial measurements.

Second, few researchers (8 of 203, 4%) tested shifts and changes in relationships over time. Of those, half used repeated-measures ANOVA designs (multiple comparisons were done to isolate changes in measurement means) whereas the other half used trend analyses. In the remaining 96 percent of the longitudinal studies the researchers either pooled, averaged, tested percentage changes, or performed cross-sectional analyses for each measurement period.

Finally, the content analysis provided evidence that researchers are not changing their approaches to analyzing longitudinal data. The ones who recognized assumptions or tested shifts and changes in relationships appeared randomly distributed over the time period of the study. That finding indicates there is no trend toward improving how longitudinal analysis is conducted.

To demonstrate how empirical results and theory development would be affected by current practices in analyzing longitudinal data, a study on the diversification–divestiture relationship was conducted. That topic was chosen because (1) it has been researched with longitudinal designs and is representative of other topics for which longitudinal designs have been used in strategic management research, (2) the studies are clear in how longitudinal analyses were performed, and (3) data can be obtained with a high degree of validity and reliability.[8]

[8] Note that the studies on diversification and divestiture are used for illustration only and that other literatures could have been used for this example (cf. Bergh, 1993b, 1995; Isaac and Griffin, 1989; LaTour and Miniard, 1983). The relationship discussed serves only as an example of what can happen when theoretical development tends to be based on contemporaneous results and when violations in analytical asssumptions are not

LONGITUDINAL STUDIES OF DIVERSIFICATION AND DIVESTITURE

Companies have recently been undergoing a massive wave of divestitures (Bowman and Singh, 1993; Lichtenberg, 1992; Ravenscraft and Scherer, 1987). One prevalent explanation for those actions is that firms overdiversified in the 1960s and 1970s and expanded beyond the point where they could be managed efficiently (Bhide, 1993; Comment and Jarrell, 1995; Shleifer and Vishny, 1991). The emergence of active takeover markets accentuated those inefficiencies (Jarrell, Brickley, and Netter, 1988; Jensen, 1986, 1988), and firms that did not reduce the inefficiencies became targets of takeover attempts (Davis and Stout, 1992; Hoskisson and Turk, 1990; Shleifer and Vishny, 1991). Divestitures arose as instruments for returning firms to 'optimal levels of diversification' (Markides, 1992, 1995; Williams, Paez, and Sanders, 1988).[9] By using divestitures to reduce diversification, firms could lower their costs of managing business units, reconfigure internal governance structures to raise efficiency, transfer assets to more highly valued uses, have a clearer and more tightly bound group of business units, and better protect managerial employment risks over time (see Hoskisson, Johnson, and Moesel, 1994, for review).

The overdiversification perspective has received empirical support (e.g., Bhide, 1993; Comment and Jarrell, 1995; Donaldson, 1990; Gibbs, 1993; Hoskisson *et al.*, 1994; Kose and Ofek, 1995; Lang, Poulsen, and Stulz, 1995; Markides, 1992, 1995). Nonetheless, several questions can be raised about the theoretical logic and analytical practices of studies on the diversification–divestiture linkage.

On theoretical grounds, the central premise of the overdiversification perspective may be problematic. The argument that high levels of diversification cannot be managed efficiently or economically is contradicted by the argument behind

Williamson's (1975) m-form (multidivisional form) hypothesis. The m-form hypothesis suggests that highly diversified firms can be managed efficiently and that divestiture is used only when a business unit fails to achieve its own performance objectives (Dundas and Richardson, 1982; Hill and Hoskisson, 1987; see Hill, Hitt, and Hoskisson, 1992). According to the m-form hypothesis, there is no *a priori* relationship between high levels of diversification and the occurrence of divestiture (Williamson, 1985). To date, advocates of the overdiversification perspective have neglected Williamson's (1975) hypothesis that highly diversified firms can be efficient organizational forms. Accordingly, for the overdiversification perspective to hold, it is necessary to demonstrate that the m-form logic is flawed or that m-forms have failed (e.g., *all* highly diversified firms have used divestitures to reduce diversification). No such evidence has been provided. The overdiversification explanation of divestiture is difficult to support unless the m-form can be shown to be inefficient.

On methodological grounds, the concern is how the longitudinal studies on the over-diversification–divestiture relationship have been conducted. First, few researchers have acknowledged the assumptions underlying longitudinal analysis (Hoskisson and Johnson, 1992, controlled for autocorrelation). The common approach is to test pooled longitudinal data with OLS regression analysis, which is problematic because the data are unlikely to meet the critical assumptions of OLS regression and the findings are therefore highly vulnerable to statistical errors (type I). Second, tests of longitudinal relationships have focused on changes in observations between two points in time. However, the results of those tests may be vulnerable to bias because they did not control for regression toward the mean effects or the correlation between the change score and the initial measurement (cf. Cohen and Cohen, 1975; Cronbach and Furby, 1970; O'Conner, 1972). Third, researchers have not included time-related change in their empirical models, either as a structural component or as a factor. As a result, the stability of the relationship between diversification and divestiture has not been tested.

Considered collectively, the theoretical and methodological practices raise questions about whether divestitures are remedial actions for

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recognized empirically. Our arguments are illustrative only, and absolutely no attribution of incorrect conclusions is made to any prior study.

[9] Previous research has focused on the incidence and not the characteristics of divestiture. Future theory development should consider how the theorized relationships would differ on the basis of the characteristics of the divestiture. An anonymous reviewer is thanked for this observation.

regaining optimal levels of diversification, and how diversification and divestiture are related over time. Perhaps diversification and divestiture are related for some firms. However, for that argument to be supported generally, the longitudinal relationship between diversification and divestiture must be shown to meet three conditions: (1) divestitures reduce diversification to a level beyond which the divestitures are no longer employed, (2) the sequential ordering of divestitures is related only to reductions in diversification, and (3) the size of divestitures is related to an optimal level of diversification. Only when those conditions are satisfied can the argument that overdiversification drives divestiture be supported. To date, no longitudinal study has considered those issues by applying an analytical technique that accounts for the special requirements and conditions of longitudinal analysis.

METHODS

A study was designed to examine the longitudinal relationship between diversification and divestiture, with three main research objectives: (1) to compare the conventional approaches for longitudinal analysis in the strategy literature with techniques that accommodate assumption violations, (2) to explore the relationship between diversification and divestiture and to identify meaningful patterns, and (3) to use a large, representative sample of firms as a basis for drawing valid conclusions.

Panel and measures

The question of how diversification and divestiture are related over time was tested with data collected on 180 *Fortune* 500 companies over the period 1985–88. The time period and sampling frame were selected to maintain consistency with previous longitudinal studies on diversification and divestiture. The panel of firms was identified through a random sample of 250 firms from the *Fortune* 500 of 1985. The 250 firms were subjected to three screens to eliminate firms that (1) were a subsidiary of another diversified organization, (2) had filed for bankruptcy, or (3) had engaged in involuntary divestiture only. Such firms are unlikely to have voluntary influence over their divestiture actions. The final sample consisted of 180 publicly held firms, among which 112 4-digit SIC primary industries (manufacturing and service) were represented.

The dependent variable, divestitures, was operationalized by using each firm's yearly percentage of assets divested, either through spin-offs, sell-offs, or carve-outs (Hoskisson *et al.*, 1994). Data for determining the yearly percentage of assets divested were found in the journal *Mergers and Acquisitions* and the COMPUSTAT *Business Segment Tapes*. Data were collected for 1985–88.

The independent variable, diversification, was operationalized by using the entropy measure of total diversification (Palepu, 1985). It was computed as $\Sigma\, P_j * \ln(1/P_j)$, where P_j is the percentage of firm sales in segment j and $\ln(1/P_j)$ is the weight for each segment j. That measure accounts for the number of 4-digit SIC business segments in which the company resides and the relative weighting of each segment for the parent company. The computation of entropy results in three variables: (1) related diversification (DR), the amount of company sales resulting from 4-digit SIC segments within the same 2-digit groups, (2) unrelated diversification (DU), the amount of company sales resulting from different 2-digit industry groups, and (3) total diversification (DT), the sum of DR and DU. The DT measure ranges from zero (no diversification) to about three (highly diversified), and has been shown to have high construct validity in comparison with other diversification measures (Hoskisson *et al.*, 1993). To avoid the possible effects of industry bias, each company's entropy measure was subtracted from the entropy average of the company's dominant 2-digit industry (Hoskisson *et al.*, 1994).[10] The entropy measures were computed by using the COMPUSTAT *Business Segment Tapes*. Data were collected for 1985–88.

Finally, several factors have been shown to influence the relationship between diversification and divestiture and can serve as alternative explanations of divestiture (Bethel and Liebeskind, 1993; Gibbs, 1993; Hoskisson *et al.*, 1994; Markides, 1995). The effects of those factors were included as controls. The controls were also used because the objective was to show how the choice of analytical technique, not only the variables in

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[10] The dominant 2-digit SIC industry represents the segment producing most of the firm sales. It is reported in the company financial statements.

the model, could affect empirical results. As in previous research, controls were used to represent governance structure and organizational characteristics. Governance structure was operationalized as the ratio of outsiders to total directors on directory boards, the percentage of outstanding common stockholdings held by 5 percent holders, by institutional owners, and by managers. Organizational characteristics were operationalized along several dimensions, including firm size (log of employees), performance (return on assets), and debt (debt to equity). Performance and debt were both adjusted for industry effects by the same process as described for the entropy measure. Data on corporate governance were available from COMPACT DISCLOSURE, and data on ROA and debt ratio were found in COMPUSTAT. Data were collected for each of the measures for 1985–88.

Analysis

Three sets of analyses were conducted. First, analyses of the variance assumptions were performed by inspection of covariance matrices and empirical tests (Box's *M*). Second, the results of the 'conventional' ways of analyzing longitudinal data (pooled data tested with OLS regression) were compared with the results of a procedure whose results were not biased by violations of the assumptions (pooled data tested with GLS regression). Third, the results of 'conventional' approaches to testing the longitudinal relationship between diversification and divestiture (percentage changes, absolute differences) were compared with the results of a procedure that tests shifts and changes (a repeated-measures analysis). The latter approach was conducted by using a within-subjects design whereby yearly changes in diversification were related to yearly changes in divestitures over time. Use of a multivariate model ensured that assumption violations would not affect the results. All results were derived from a fully saturated multivariate model (Wilks lambda, *F*, critical value) and parameters for each variable are provided (unstandardized coefficients and *t*-statistics). Contrast tests were used for testing the overall change in observation means as well as shifts and changes on a year-to-year basis.[11]

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[11] Contrasts provide tests of the differences between the measures. Because the total number of measures in this study is

RESULTS

Table 2 reports means, standard deviations, and correlations among the variables. Those descriptive statistics are based on a pooled sample (180 firms observed for each of the 5 years, providing a pooled sample of 900 observations). The table shows that divestitures are correlated positively with size (log of employees) and diversification, and correlated negatively with return on assets.

Table 3 is the covariance matrix of the error terms of the contrasts. The contrasts are computed as the differences between the variable measurements. The first contrast reflects the changes in the measures for particular variables between 1985 and 1986, the second reflects the changes for 1986 and 1987, and so on. For each of those contrasts, the matrix shows that the variances are not equal (diagonal terms, i.e., nonhomoscedastic) and that the covariances are not equal to zero (off-diagonal terms; i.e., autocorrelation is present). In addition, a statistical test for the form of the error terms, the Box's *M* statistic, is significant at a level below $p < 0.05$, providing evidence that the assumption of homogeneous variances is not supported (Box $M = 970.70$, $F = 1.84$, $p < 0.000$). The observed significance of this statistic is based on a chi-square approximation, with levels below $p < 0.05$ indicating that variance homogeneity is violated.

Table 4 reports the results of two alternatives for testing the relationship between diversification and divestiture. The results of the first alternative (pooled data tested with OLS regression) indicate that diversification *is* related positively to divestiture. However, the results of the other alternative (pooled data tested with GLS regression) indicate that diversification *is not* related significantly to divestiture. Also, Table 4 shows that blockholders and employees are related positively and ROA is related negatively to divestiture.

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four (each variable measured for the years 1985, 1986, 1987, 1988), a total of three contrasts was computed. The first contrast (C1) is the difference between the second (1986) and first (1985) measures for each variable. The second contrast (C2) is the difference between the third (1987) and second measures (1986), relative to the first contrast. The third contrast (C3) is the difference between the fourth (1988) and third measures (1987), relative to the second contrast. Those contrasts are known as 'difference contrasts'. Several other types could have been used, depending on the nature of the theorized relationships (see Girden, 1992, or O'Brien and Kaiser, 1985).

Table 2. Mean standard deviations, and correlations[a, b]

Variable	Mean	S.D.	1	2	3	4	5	6	7
1. Outsiders on board	0.27	0.12							
2. Blockholdings (%)	18.23	20.93	−0.14*						
3. Insitutional holdings (%)	51.81	13.36	0.05	−0.31*					
4. Employees (log)	4.30	0.46	0.47**	−0.35**	0.13*				
5. ROA	5.89	3.86	0.11*	−0.10*	0.12*	0.14**			
6. Debt to equity	0.45	0.62	−0.00	−0.03	−0.40**	0.02	−0.13*		
7. Diversification	1.41	0.55	0.27**	−0.23**	−0.00	0.33**	0.02	0.03	
8. Divestitures	0.60	0.80	0.06	0.09	0.09	0.16**	−0.14*	−0.04	0.35**

$N = 900$; * $p < 0.05$; ** $p < 0.01$
[a] All variables are pooled for descriptive purposes.
[b] Values are reported in raw form (non-industry adjustments).

Table 5 reports the results of three alternatives for testing the longitudinal relationship between diversification and divestiture. The first two alternatives (percentage change and absolute difference) indicate that the longitudinal changes in diversification are related positively to those in divestiture. The third alternative (within-subject repeated-measures analysis) indicates that longitudinal changes in diversification and divestiture variables are not related. However, it does show that blockholdings and employees are related positively and ROA is related negatively to divestiture.

Table 6 reports the results of testing the stability and form of the relationships. It shows that blockholdings were related positively and significantly during the early years of the study (between 1985 and 1986), but were not related thereafter. The variable for organization size (log of employees) is related positively and the variable for performance (ROA) is related negatively to divestiture. The latter variables were related consistently over the entire study period.

DISCUSSION

Many of the definitions, theories, and concepts in strategic management are dynamic (cf. Chandler, 1962; Ginsberg, 1988; Miller and Friesen, 1982). Not surprisingly, longitudinal research designs are becoming popular in the strategic management literature. With their increased application, however, questions arise about how such studies have been—and should be—conducted (Bergh, 1993a, 1995; Ruefli and Wilson, 1987). Our study au-

dited longitudinal analysis in strategic management research and then examined whether current practices might influence empirical results and potential conclusions for theory development. The results indicate that few researchers using longitudinal studies analyzed their data with respect to the critical assumptions of uniform variance and zero covariances, fewer yet examined the stability of the empirical relationships over time, and failure to control for assumption violations can lead to problematic findings. In addition, strategy researchers are not recognizing problems that are unique to longitudinal relationships, such as regression toward the mean effects and correlations between change scores and measurement bases. Moreover, the practices found have not been reversed, nor do they appear to have improved over the last few years. Several issues emerge from the findings.

Problems in strategic management research

First, the finding that more than 90 percent of the longitudinal analyses were not conducted with recognition of the variance–covariance assumptions raises grave concerns about the potential for biased empirical results in strategic management research examining longitudinal data. The bias would be present in the form of type I statistical errors and would occur because the measurements of the subjects of strategy research (companies, managers) over time are not likely to have nonzero covariances and because researchers have not controlled for those assumption violations. Although its magnitude, applicability, and prevalence are impossible to ascertain, bias is probable

Table 3. Error variance – covariance matrix[a]

Variable	Contrast[b]		
	C1	C2	C3
1. Outsiders on board (%)			
C1 = (1985–86)	0.001		
C2 = (1987–86) – (C1)	0.001	0.005	
C3 = (1988–87) – (C2)	0.000	0.002	0.003
2. Blockholders (%)			
C1	21.561		
C2	−0.747	56.762	
C3	2.214	29.389	52.587
3. Institutional holdings (%)			
C1	21.827		
C2	5.134	37.493	
C3	0.796	13.640	25.262
4. Employees (log)			
C1	0.004		
C2	0.002	0.006	
C3	0.001	0.004	0.007
5. Return on assets			
C1	9.560		
C2	2.235	12.590	
C3	1.668	4.176	15.620
6. Debt to equity ratio			
C1	0.241		
C2	0.114	0.190	
C3	0.100	0.156	0.276
7. Diversification			
C1	0.019		
C2	0.011	0.032	
C3	0.006	0.230	0.046
8. Divestiture			
C1	0.005		
C2	0.001	0.008	
C3	0.001	0.001	0.010

[a] The variances of the error terms are reported on the diagonals (should be equal). The covariances of the error terms are reported on the off-diagonal (should be zero).
[b] The first contrast (C1) is the difference between 1985 and 1986, the second (C2) is the difference between 1987 and 1986, relative to the difference between 1986 and 1985, and so on.

and the attendant adverse effects cannot be ignored. It is therefore critical that strategy researchers recognize the strict assumption requirements of longitudinal analysis. Failure to incorporate those specifications will most certainly lead to statistical errors, incorrect conclusions for theory development, and inappropri-

ate recommendations for practitioners and policy-makers.

Second, researchers have not examined how empirical relationships hold over time. The most popular methods of testing longitudinal data (e.g., cross-sectional analyses for each measurement period, percentage changes, pooling of data) ignore the dynamic aspects of those data (cf. Bergh, 1993a, 1993b). Such practices are analogous to cutting a movie film into pieces and then trying to make a story from all the separate strips. The resulting pieces do not allow the dynamic relationships to be understood fully. For strategy researchers, such practices prevent the observation of theoretical relationships, including the stability and form of associations, the sequential ordering of strategic actions, the magnitude and duration of changes, and the stability of conditions over time. Hence, the failure by strategy researchers to hypothesize and test for longitudinal relationships has left several important research questions undertheorized and underanalyzed. Finding answers to those questions is important because it would extend prior theory development that was based on contemporaneous arguments and data and would allow strategic management phenomena to be represented more accurately.

Moreover, the common practices in strategic management seem to imply that longitudinal data are stationary, and all that is needed is recognition of the variance–covariance assumptions (Bergh, 1993b). However, relationships in strategic management are not stable over time (Boeker, 1989; Miller and Friesen, 1982; Porter, 1991). For instance, a recent special issue of the *Strategic Management Journal* (Summer 1996) features several articles that illustrate how relationships vary over time. The guest co-editors (Barnett and Burgelman, 1996) of that issue as well as the editor (Schendel, 1996) encourage researchers to address the dynamic aspects of theory development and testing in strategic management research. Their position suggests that prior theoretical arguments can be extended by introducing a longitudinal element and that new theoretical questions can be raised by considering relationships relative to time. By failing to consider the form of relationships over time, strategy researchers are potentially missing the unique insights and important theoretical contributions that longitudinal data can offer.

Table 4. Alternative approaches of analyzing the diversification–diverstiture relationship[a]

Variables	Pooled ordinary least-squares model		Generalized least-squares model	
	Beta	t	Beta	t
1. Outsiders in board (%)	−0.03	−0.46	−0.05	−0.29
2. Blockholders (%)	−0.04	−0.41	4.03	2.23*
3. Institutional holdings (%)	−0.13	−1.94*	−2.78	−1.28
4. Employees (log)	0.18	2.08*	2.01	2.14*
5. ROA	−0.18	−2.20*	−1.38	−2.07*
6. Debt/equity	−0.08	−0.97	0.04	0.41
7. Diversification	0.38	4.65***	0.05	0.62
R^2	0.20			
F	5.10***			
Buse R^2			0.06	
F			1.15	

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
[a]Standardized beta weightings reported for OLS, unstandardized beta weightings reported for GLS analysis.

Table 5. Alternative approaches of testing longitudinal changes in diversification and divestiture relationship[a]

Variable	Model 1: % change (OLS)	Model 2: Absolute differences (OLS)	Model 3: Repeated measures contrast coefficients
1. Outsiders on board (%)	−0.17+	−0.14*	−0.02
2. Blockholdings (%)	−0.05	−0.09	4.03**
3. Institutional holdings (%)	−0.17+	0.03	0.41
4. Employees (log)	0.08	0.55**	0.01*
5. ROA	−0.18+	−0.15*	−0.12*
6. Debt/equity	−0.16+	−0.13*	0.03
7. Diversification	0.34***	0.26**	0.05
R^2	0.18	0.34	
F	2.95**	11.23**	
Wilks lambda			0.69
F			2.38**

+$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
[a]Standardized beta weights reported for OLS regressions and unstandardized beta weights reported for repeated-measures analysis.

Implications for diversification–divestiture relationship

The study of the diversification and divestiture relationship illustrates the possible effects of the foregoing issues. Tests revealed that the variance–covariance assumptions were violated. When those violations were not accounted for analyti-cally, the results indicated a positive and significant relationship between diversification and divestiture. However, when the violations were incorporated into the analysis, the relationship was no longer significant nor was it significant at any point during the period of the study. That discrepancy illustrates how the recognition of assumption violations can affect empirical results.

Table 6. Contrast tests of stability and form of diversification–divestiture relationship

Variable	Contrast[a]	Unstandardized coefficient	t
1. Outsiders on board (%)	1	−0.002	−0.907
	2	−0.004	−0.818
	3	−0.001	−0.081
2. Blockholdings (%)	1	1.031	2.571*
	2	−0.368	−0.566
	3	−0.578	−0.977
3. Institutional holdings (%)	1	0.378	−0.879
	2	−0.222	−0.420
	3	−0.164	−0.379
4. Employees (log)	1	0.010	2.011**
	2	0.016	2.435*
	3	0.035	4.809**
5. ROA	1	−0.116	−1.836*
	2	−0.049	−1.162
	3	−0.151	−2.442**
6. Debt/equity	1	−0.026	−0.615
	2	−0.022	−0.593
	3	−0.051	−1.141
7. Diversification	1	−0.005	−0.454
	2	−0.024	−0.883
	3	−0.011	−0.634

$*p < 0.05$; $**p < 0.01$

[a] Contrast $1 = X_1 − X_2$
   Contrast $2 = X_3 − (X_1 − X_2)$
   Contrast $3 = X_4 − (X_3 − (X_1 − X_2))$

where X_1 is the mean for variable X at year 1, X_2 is the mean for variable X at year 2, and so on.

Because the assumptions were violated, greater confidence should be placed in the results of the GLS regressions and the repeated-measures models. Those results indicate that diversification was not related to divestiture. The implication is that once the assumptions are recognized empirically, the longitudinal relationship between diversification and divestiture is no longer present. Instead, the findings provide evidence for the 'corporate governance' explanation of divestiture: blockholders and organization size (employees) are each related positively and performance (ROA) is related negatively to divestiture. According to advocates of that explanation, owners are forcing managers to improve profitability by reducing the size of their companies (Bethel and Liebeskind, 1993; Donaldson,

1990)—that is, owners have pressured managers to reconfigure corporations into different forms that maximize their self-interests, namely profitability.

The study results suggest that recognition of the analytical assumptions would have influenced the conclusions about the relationships between diversification and divestiture. The findings provide a basis for a possible revision of the overdiversification explanation of divestiture and the premises on which it is based (e.g., the effects of takeovers on forcing diversified firms to divest). The clearest point from the study is that firms are not universally reducing their diversification. Although many studies have documented a relationship between diversification and divestiture, their results may be limited because most examined samples of restructuring firms only and did not examine the relationships completely with respect to changes over time. Most of the prior studies derived the association between diversification and divestiture from contemporaneous examinations of longitudinal data. Little insight has yet been provided about the longitudinal form of the diversification–divestiture relationship.

Further research is needed to identify when the overdiversification perspective holds and when it may not. Clearly, that research must address when the m-form system of managing high diversification is likely to fail and when it would work effectively. One recent study shows that m-forms are most likely to fail when environmental volatility increases (Bergh and Lawless, 1997). However, more research is needed to test the diversification–divestiture relationship with different samples and different time periods. In addition, research is needed to bridge the alternative explanations of divestiture, as well as integrate the roles of m-form systems, owner expectations, takeover threats, and changes in strategy. Such research could provide a deeper understanding of the relationships between diversification, corporate governance, and divestiture. Finally, future research should address the specific longitudinal questions about the relationships between diversification and divestiture, namely the implicit assumption of a stable, equilibrium level of diversification, the sequential ordering of divestitures, and the magnitude and duration of those divestitures relative to diversification. Only when those relationships are specified fully can the overdiversification position be supported completely.

Redirecting longitudinal analysis

It is important to place the study findings in the context of longitudinal research in the organizational sciences. Previous assessments of longitudinal studies (includes nonstrategy studies) in leading organizational journals showed that most of the researchers did not recognize the longitudinal assumptions of autocorrelation and heteroscedasticity, employ longitudinal analytical techniques, or fully analyze changes over time (Bergh, 1993a, 1995: 1704). In addition, many longitudinal studies in areas outside organizational research (e.g., economics, sociology, marketing) have not been conducted with recognition of the key assumptions (Isaac and Griffin, 1989; Kennedy, 1992; LaTour and Miniard, 1983). Apparently, data analysis in longitudinal studies in strategic management is very similar to that in other research fields. The implication is that the entire field of organizational research needs to be redirected in terms of the basic requirements and utility of longitudinal analysis.

Considered more generally, the study results underscore the importance of analyzing longitudinal data completely and effectively. In testing longitudinal data, strategy researchers (and researchers outside strategic management) should perform several interrelated steps. First, they should test the assumptions of homoscedastic and noncorrelated error terms. Several approaches can be used, including specific statistical tests and/or inspection of the terms within covariance matrices. Second, they should base the choice of analytical technique on the results of the assumption tests. Failure to account for the assumption violations is likely to lead to biased results. Third, researchers should evaluate the form of the empirical relationships over time. Longitudinal data enable researchers to test the direction, magnitude, and overall pattern of changes in relationships over time. By including tests of how relationships change over time, researchers can add new and unique research questions for extending and building theories. Fourth, researchers must acknowledge that even the simplest forms of longitudinal analysis, such as testing simple change scores, have complex problems that cannot be ignored (Bergh and Fairbank, 1966). Strategy researchers have not addressed such problems as regression toward the mean effects in their efforts to test changes in relationships over time. Clearly, longitudinal relationships can be biased if such issues are not incorporated into analytical approaches. Fifth, researchers need to use analytical techniques that fully represent the multidimensional aspects of their theoretical models. In particular, structural equation models should be explored as alternatives for testing longitudinal data (cf. Crano and Mendoza, 1987; Ecob, 1987; Hertzog and Nesselroade, 1987), as they have advantages for modeling complex strategic phenomena that techniques such as pooled GLS regressions simply do not and cannot capture.

The preceding suggestions support the calls to improve research in strategic management. For example, researchers have sought to validate measures of diversification (Chatterjee and Blocher, 1992; Hall and St. John, 1994; Hoskisson *et al.*, 1993; Lubatkin, Merchant, and Srinivasan, 1993), risk–return (Baucus, Golec, and Cooper, 1993), performance (Venkatraman and Ramanujam, 1986), organizational strategy (Venkatraman and Grant, 1986), and locus of control (Hodgkinson, 1992). Other researchers have evaluated data sources (Young, 1989), such as PIMS and the FTC line-of-business data (Marshall and Buzzell, 1990), and COMPUSTAT and TRINET (Davis and Duhaime, 1992). Still others have urged researchers to attend to theory building (Camerer, 1985) and improve the practical usefulness of empirical results (Shrivastava, 1987). Moreover, scholars have debated the philosophies of how strategic management research is conducted (Montgomery, Wernerfelt, and Balakrishnan, 1989, 1991; Seth and Zinkhan, 1991). Hence, our suggestions for improving longitudinal analysis complement those of other researchers who focus on how research in strategic management is conducted.

CONCLUSION

Schendel (1995) stated that if the field of strategic management is to continue to grow and develop important linkages between research and practice, researchers must improve the rigor of their studies by (1) identifying, cataloging, and defining strategy phenomena more carefully, (2) recognizing and developing theories through more appropriate use of data and analysis, and (3) producing results that are replicable and useful to other researchers

and ultimately practitioners. Those recommendations are especially applicable to strategy researchers conducting longitudinal studies because strategic management is an inherently longitudinal subject, longitudinal research is expected to be used more frequently in the future, and failure to account for violations of the strict analytical assumptions of longitudinal analysis can lead to problematic conclusions. Hopefully, our study is a step toward enhancing future longitudinal research in the field of strategic management.

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