SOCRATES, STRATEGY, AND STRUCTURAL MODELING

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ABSTRACT

Strategic management research has been characterized as placing less emphasis on construct measurement than other management subfields. In this study, we document the state of the art of measurement in strategic management research, and discuss the implications for interpreting the results of this research. We begin with a content analysis of empirical strategic management articles published in leading journals in the period of 1998-2000. We find that many studies do not discuss reliability and validity issues, and typically rely on single-indicator measures. Additionally, studies rarely address the problems of attenuation due to measurement error. To illustrate the consequences of measurement error, we revisit the debate on the causes of diversification (Amihud & Lev, 1982). Our research suggests that the divergent findings between studies on this topic are largely the result of measurement error, and that prior work has underestimated the true effect size between variables. Implications for future research, and for interpreting prior work are then discussed.

Key Words: Measurement, research design, agency theory, diversification, corporate governance

Book 7 of *The Republic* presents what is probably the most widely known parable of Socrates – the shadows on the cave wall. As he said to Glaucon:

> Behold! human beings living in an underground den, which has a mouth open toward the light and reaching all along the den; here they have been since childhood, and have their legs and necks chained so that they cannot move, and can only see before them, being prevented by the chains from turning round their heads. Above and behind them is a fire blazing at a distance, and between the fire and the prisoners there is a raised way; and you will see, if you look, a low wall built along the way, like the screen which marionette-players have in front of them, over which they show the puppets
>
> I see.
>
> And do you see, I said, men passing along the wall carrying all sorts of vessels, and statues and figures of animals made of wood and stone and various materials, which appear over the wall? Some of them are talking, others silent.
>
> You have shown me a strange image, and they are strange prisoners.
>
> Like ourselves, I replied; and they see only their own shadows, or the shadows of one another, which the fire throws on the opposite wall of the cave. (Jowett, 1999: 209).

As the prisoners converse, and without any other vantage point, they naturally perceive the shadows to be reality – they assign names and try to explain the various flickering shapes which appear on the wall. Echoes of sound are attributed to the shadows. Consider what happens if a prisoner were to become unchained, and look into the light. Once his eyes adjusted, he would realize that "what he saw before was an illusion (Jowett, 1999: 210)." However, any efforts to explain the true nature of reality would be immediately ridiculed by his peers.

What relevance does Socrates' allegory have for strategic management researchers? We propose that the cave is a metaphor for one of the most serious threats to strategic management research: poor construct measurement. While the implications of measurement error are well known, they are typically ignored in the majority of studies on strategic management topics. So, as with the freed prisoner, many academic researchers ignore or are unaware that their measures often may not fully or accurately capture the constructs of interest. Our purpose is to highlight both the extent and consequences of measurement error in strategy research.

We begin with a brief overview of research design and methodology issues in strategy. Next, we explore several topics in more detail, including statistical power, sample size, and measurement. Then, we assess the “state of the art”, with a review and critique of 183 empirical strategic management articles published in a recent three-year period.

To further illustrate the consequences of measurement issues, we replicate a prominent debate among strategy researchers: whether diversification is a consequence of agency costs (Amihud & Lev, 1981). Using data from 640 *Fortune* firms, we created multiple indicator models of both agency costs and diversification. Then, we developed multiple LISREL models representing all possible single- and multiple-indicator combinations of these variables. Our results provide strong evidence that the debate between authors (i.e., Amihud & Lev, 1999; Denis, Denis & Sarin, 1997; 1999; Lane Cannella & Lubatkin, 1998; 1999) is largely an artifact of measurement error.

RESEARCH DESIGN ISSUES IN STRATEGIC MANAGEMENT

Background

Strategic management is generally acknowledged to be one of the younger subdisciplines within the broader management discipline. Such emergent areas are typically characterized by debate, and challenges to existing paradigms (Kuhn, 1996). While the latter are often couched as theoretical discussions, empirical work plays a critical role in confirming, or disconfirming, a particular perspective. Contributing to this advancement of the field, there has been a small research stream that critiques empirical research in strategic management. This stream includes both narrative (Hitt, Gimeno & Hoskisson, 1998; Venkatraman & Grant, 1986) and quantitative reviews. Examples of the latter are summarized in Table 1. Regardless of the topic, these reviews have been consistently critical of the rigor of strategic management research. However, one central aspect of research design – construct measurement – is not covered by this pool of studies.

Construct measurement is particularly relevant to strategic management research, as the variables of interest tend to be complex or unobservable (Godfrey & Hill, 1995). Paradoxically, measurement has historically been a low priority topic for strategic management scholars (Hitt, et al., 1998). As a result, complex constructs have often been represented with simple measures, and with limited testing for reliability or validity (Venkatraman & Grant, 1986). Our intent is to contribute to this research stream with a critique of measurement issues in strategic management. We begin with a brief discussion of two related topics – statistical power and sample size, and the compounding effects of measurement error.

Statistical power and sample size

Power is the potential of a statistical test to yield a significant result. Issues relevant to power are a researcher's willingness to consider Type I and Type II errors, sample size, the magnitude of the effect being studied, the test being used, and the quality of the data (Cohen, 1988, 1992). **Type I** error is the risk of mistakenly rejecting the null hypothesis – i.e., a false positive finding. This type of error is routinely addressed in empirical studies, with the $p \leq .05$ level (alternately stated, a 95 percent likelihood that a relationship is not a false-positive) widely accepted as the threshold. **Type II** error is the risk of failing to reject the null, even though a meaningful relationship does exist. Statistical power is an estimate of the probability that a null hypothesis will be rejected for a given effect size. Cohen (1988) recommends using 0.80 as the threshold for power assessment – i.e., an 8 in 10 chance that an existing relationship will be successfully detected.

Everything else constant, a more stringent p-level for a Type I error leads to a greater risk of Type II error, and vice versa. Additionally, sample size affects the risks of Type I and Type II error. For example, consider a population correlation between two constructs of 0.30. Using a significance criterion of a=.05, a sample of N=30 has only a 50-50 chance of successfully detecting this relationship. The probability improves to 70 percent with the addition of 20 subjects, though, and over 90 percent when the sample is increased to 100 subjects.

While the Type I error is considered by authors and reviewers alike, Type II error frequently is not; surveys of management authors reveal that power analyses are unusual, and that the perceived need for such analysis is low (Mone, Mueller & Mauland, 1996). In stark contrast to these surveys, the power of most studies is weak; strategic management studies have been characterized as having only *half* the recommended power levels – they have only a 4 in 10 chance of rejecting the null hypothesis (Mazen, Magid, Hemmasi, & Lewis, 1997).

More recently, Ferguson and Ketchen (1999) reviewed the research stream on organizational configurations, and concluded that only 8 percent of published studies had sufficient statistical power. Finally, Mone and colleagues (1996) reported that the statistical power of many strategic management studies was significantly lower than in many other management subdisciplines.

Thus, there is strong evidence to conclude that statistical power is a critical issue in the design of academic research, and that the power of studies in strategic management has been weaker than others. In the next section, we explore the status of construct measurement in strategic management, another potential problem, and the implications of measurement error for statistical power.

Measurement error and attenuation

Blalock (1979) describes models of social processes as having three elements: (1) a theoretical language that describes causal relations between constructs; (2) an operational language that links certain indicators to their respective constructs; and (3) an integrative theory that links the causal ties between constructs and indicators. The second component is of particular relevance to strategy research.

Most strategic management research is framed using Blalock's first component – a hypothesis that relates two unobserved concepts. So, for example, research may posit that the presence of an agency problem can lead to opportunistic actions by executives. However, this hypothesis is not tested directly. Instead, a researcher may study the relationship between two variables (or indicators) which serve as proxies for the respective constructs: For instance, CEO equity or the ratio of insiders on the board may be used to predict levels of executive pay; CEO equity serving as the proxy for agency problems, and pay serving as the proxy for opportunistic behavior.

If the indicators fully represent the latent concepts, power is unchanged. In practical terms, this requires that all variables are valid, and measured without error. However, even moderate amounts of measurement error can have substantial negative implications for power (Schmidt, Hunter & Urry, 1976; Zimmerman & Williams, 1986). Power analyses do not consider measurement error – instead, the calculations to determine a minimum *N* assume exact measurement of predictor and outcome variables. Consequently, even researchers who conduct power analyses "will take samples that are too small and will be too unlikely to reject the null hypothesis, even when a reasonable hypothesis is actually true" (Maxwell, 1980: 253).

As an example, consider a researcher who is designing a study and the population effect size is believed to be moderate to small (r=0.30). Setting p=.05, a sample size of 150 is needed to have a power level of 0.80 (Cohen, 1988). However, Cronbach's alpha for predictor and outcome variables are each 0.60. Because of the measurement error associated with each term, the observed correlation will be much smaller – approximately r = 0.10. The sample of 150 now has only a 1 in 3 chance of detecting the observed relationship.

As we have described previously, statistical power levels are often unacceptably low, in both the broader management field, and in strategic management research in particular. (Mone et al., 1996; Ferguson & Ketchen, 1999). More importantly, the presence of measurement error indicates that prior reviews may actually *underestimate* the magnitude of this problem: "The bottom line is that unreliability shrinks observed effect sizes and therefore reduces power, and increases in reliability enhance observed effect sizes and therefore increase power" (Cohen, 1988: 537). In the following section, we present two analyses that further describe the potential severity of this problem. In the first, we assess the extent of measurement error problems in strategic management research. The second analysis describes how measurement errors can mistakenly fuel divergent findings and perspectives.

Study 1: Content Analysis of Empirical Studies

What is the extent of measurement error in strategic management research? To explore this question, we completed a content analysis of a sample of strategy-related articles published in leading scholarly journals that publish strategic management research.

Sample

To determine the optimal characteristics of the sample, we reviewed the design characteristics of prior methodological critiques of strategic management research, as shown in Table 1. This review suggests that the sample should have three attributes: First, a range of journals should be sampled. Second, the sample should have a multi-year time frame. Third, prior critiques have used two different approaches for selecting specific articles for analysis – some have included all articles that met the relevant criteria (e.g., Ketchen & Shook, 1996; Mone, et al., 1996), while others included a subset of relevant articles (e.g., Hubbard, et al., 1998). We chose to include all relevant studies in the interests of generalizability.

Our sample comprised the universe of empirical strategic management articles that were published in the discipline's leading outlets. We began with MacMillan's (1989) set of

14 primary outlets for strategy research wherein a half dozen of these journals were ranked by an expert panel to be of ‘outstanding quality’: *ASQ*, *AMJ*, *AMR*, *HBR*, *MS*, and *SMJ*. We excluded *AMR* and *HBR* from our list as they generally do not publish empirical work. We then drew upon three recent reviews (i.e., Franke, Edlund, & Oster, 1990; MacMillan, 1991; Tahai & Meyer, 1999) of management publication outlets and narrowed the pool to the three leading journals based on article impact and relevance to strategic management. Therefore, strategic management articles published in the *Academy of Management Journal*, *Administrative Science Quarterly,* and *Strategic Management Journal* were included in the final sample. We selected a time period of 1998-2000, as the more recent studies are presumably most likely to have the highest level of methodological sophistication. Collectively, our combination of leading journals and recent timeframe should provide a “best case” assessment of the state of construct measurement in strategy.

We reviewed each volume of the journals selecting articles for inclusion using a two-stage approach. First, we identified articles reporting research on strategic management topics. We included all papers published in *SMJ*, as it is a discipline-specific outlet. From *AMJ* and *ASQ*, we selected all articles in the strategic management domain. The coders who made these assignments have served as reviewers on manuscripts for each of these journals, and have held repeat editorial board assignments on a subset of these journals. The pool was narrowed by selecting only articles reporting empirical tests of hypotheses. We specifically excluded those relying solely on case analysis and descriptive statistics, those which developed scales without testing hypotheses, and meta-analyses as they are restricted in their selection of measures. This screen yielded a final sample of 183 articles – a sample comparable to the prior methodological critiques listed in Table 1. A list of the sample articles is available from the authors.

A substantial number of the articles included multiple statistical tests with different independent and dependent variables, samples, sample sizes, and analyses. Therefore, each *statistical test* was used as the unit of analysis. We selected the most complete models presented as multiple, hierarchical-like models were common (e.g., a regression with control variables, indicators, and interaction terms tested in three separate models). We counted all tests that utilized different dependent variables and samples as unique. To avoid allocating extra weight to articles that present multiple sub-sample analyses, we counted sub-samples only if a new dependent variable was utilized. This yielded a final sample of 602 statistical tests from the 183 articles – a sample considerably larger and more comprehensive than prior methodological critiques in the field.

Analysis

A content analysis of each article and test was completed by an expert rater. The articles were examined to evaluate the construct operationalizations employed with the intent of developing a categorization scheme. We elected to treat all variables as potential constructs. This was based on two findings from the review: differences between articles regarding what constitutes a construct and the prevalence of "hidden" constructs masked as single variables within the studies.

We found that the definition of what constituted a construct within the strategic management literature, was largely at the discretion of the researcher. Constructs are “theoretical creations based on observations but which cannot be observed directly or indirectly” (Babbie, 1989: 109) and the basis for most strategy theories (Godfrey & Hill, 1995). In practice, we found many constructs in the sample were not identified as such. Organizational size, for example, appeared in our sample as a widely utilized variable and is arguably one of the most commonly used in the strategic management literature. Size was repeatedly found in the samples as an independent and a control variable. We drew on a sub-sample of articles and found “size” as a proxy of available organizational resources, propensity/ability to initiate competitive action, core rigidity, and public profile among a wide range of other constructs. These varied constructs were, however, generally operationalized using a single indicator. No attempts to examine (establish) convergent validity were reported for the association between size and other measures of the intended construct. As single indicators were the norm, reports of reliabilities and measurement error were not common.

When examined across the volume of studies, the measures of size also appeared to vary far less than the constructs size is purported to represent. Three indicators in particular – total assets, sales, and employees – were found to constitute over 80 percent of the size variables employed despite the range of constructs size presumably represents.

Together, the lack of specific criteria for identifying constructs in the studies and the potential for commonly used variables to represent complex constructs led us to treat all variables as potential constructs. The primary benefit of this is a lack of positive bias in the use of multiple indicators in the field for constructs. However, our analysis should be considered as a comprehensive yet conservative estimation of the use of construct measurement.

The measures employed in the tests were coded into one of five categories that progressively provide increased ability to assess validity, reliability, and measurement error. These categories are: single indicators, single ratios, discrete items, indexes, and scales / multiple measures. S*ingle indicators*, at the nadir of methodological sophistication, provide the researcher with the least assurance that a measure is a valid and reliable proxy of a construct and no estimates of reliability, and thus error, are possible. In the context of a regression model, we coded the use of a sole variable with an accompanying beta as a single variable. For example, a regression estimate for “sales outside of home country” would be coded as a single indicator if no other variables for internationalization were included.

Single ratios, like single indicators, serve as sole indicators of a construct but they are comprised of two parts in the form of a ratio. These variables have an advantage over single indicators as they provide a multi-faceted perspective (i.e., condition *Y* in relation to *Z*) but do not allow for the overall association between the variables to be examined in terms of reliability. For example, a single ratio of the internationalization construct is “ratio of foreign sales to total sales”. Other common single ratios include debt-to-equity, return-on-assets, and book-to-market measures (e.g., Tobin’s *Q*).

Discrete indicators are collections of single indicators that collectively serve to indicate a construct. They are conceptually linked, but have their own beta estimates in a regression model. For example, the internationalization construct may be assessed using three separate, discrete variables (e.g., “sales outside of home country”, “employees outside of home country”, and “count of products sold outside of home country”). The correlation between discrete items can be analyzed and serve as a limited assessment of reliability.

Indexes incorporate measures of one or more dimensions of a construct into a single item, commonly using a summative approach. For example, a firm's level of internationalization can be operationalized using an index calculated by summing "foreign sales", "foreign employees", and "expatriate managers". In a regression model, a single beta is calculated for the index. Indexes commonly utilize scale-dependent weights of each indicator that comprise the index or category weights assigned from a distribution of sampled subjects. The reliability between index components may be calculated prior to index creation to provide statistical support for the collective measure.

The final category, s*cales and multiple measures,* utilize data reduction approaches (i.e., factor analysis, principal component modeling, structural equation modeling, etc.) to explicitly assess the degree to which multiple items represent a construct and the error associated with the measure. In a regression model, a single beta is calculated for the scale, not for the individual items. For the internationalization construct, a single "internationalization" value may be comprised using multiple items (e.g., "foreign sales", "foreign employees", and "expatriate managers") and assessing fit onto a common dimension. Assessing reliability, and thus measurement error, is an inherent aspect of such an approach.

Results

The results of our content analysis are organized along three areas: sample size, measurement schemes, and reliability. Highlights of these results are shown in Tables 2 and 3.

Sample size. Other studies (Mazen, et al., 1997; Mone, et al., 1996) have documented the scope of power issues in strategy research. Consequently, a power analysis of our sample would add significant length to the paper, yet little new knowledge**.** Two aspects relating to statistical power, sample size and the ratio of sample size to indicators, are germane to our analysis.

We begin with an examination of sample size statistics. In aggregate, the mean sample size of our pool was 2,596 (*s.d.* = 13,125), and ranged from 20 to 158,782. This mean alone is misleading given a high positive skew (S = 8.282, Z = 82.82) and large kurtosis (K = 80.635, Z = 20.08). A more accurate picture of the average sample size is garnered from an examination of the percentiles. Studies at the 50th percentile utilized a sample of N = 197 with studies at the 75th, 90th, and 95th percentiles having samples of 422, 1,135 and 12,248 respectively.

The number of indicators used in a study relative to the sample size also provides an indication of statistical power. The distributions for the number of independent variables and control variables along with the ratio of sample size to independent, control, and the sum of independent and control variables are significantly skewed and non-normal. A statistical test at the 50th percentile was comprised of 4 independent variables and 3 control variables having a sample size to independent variable ratio of 57 to 1, a sample size to control variable ratio of 39 to 1, and an overall ratio of 23 observations to independent and dependent variables. Two conclusions may be drawn from this analysis. First, while ultimately dependent on the statistical power of the measures used, ratios of subjects to indicators in the studies examined appear consistent with generally accepted norms. Second, and directly related to our emphasis on measurement, sample size insufficiencies do not appear to be a hindrance for the use of measurement schemes incorporating multiple measures. The sample sizes, on average, would appear to allow multiple measurement approaches to be incorporated into research designs without the burden for additional subjects.

Measurement schemes. At the nadir, the use of variables which cannot be assessed for reliability (i.e., single indicators, single ratios, and discrete items) provide the researcher and reader with the least assurance that a measure is a valid and error-less proxy of a construct. Our review of the published tests suggests that the use of such variables is a common approach in strategy research.

Of the 3,276 independent variables, 1,569 (47.9 percent) were single indicators. Of the 653 dependent variables, 240 (36.8 percent) were measured using single indicators. For control variables, 80.1 percent (4,221 of 5,272 variables) were single indicators. Across the 602 tests reviewed, 320 used at least one single indicator for an independent variable, 220 for a dependent variable, and 413 for a control variable. Thirty-four (5.65 percent of the sample) relied on single-item indicators exclusively for independent, dependent, and control variables. Single ratios also appear prevalently in the studies examined comprising 9.1 percent, 15.0 percent, and 7.8 percent of the independent, dependent, and control variables. Discrete items comprise 13.7 percent, 4.9 percent, and 4.7 percent of the respective variables.

Collectively this provides an indication of a lack of attention to measurement error in strategy research. Fully 70.7 percent of independent, 56.7 percent of dependent, and 92.6 percent of control variables are based on a methodology that forgoes the assessment of reliability. Furthermore, the approach appears widespread; approximately one third of the articles rely exclusively on single-indicator, single-ratio, or discrete items for independent or control variables (31.1 percent for independent variables; 35.6 percent for control variables). More disturbing, over half (56.7 percent) rely on a dependent variable for which reliability and error cannot be estimated.

Techniques allowing reliability and measurement error to be assessed are used in some of the strategic management studies. Indexes and scales / multiple measures comprise 14.7 percent and 11.9 percent of the independent variables used respectively, 17.6 percent and 19.9 percent of the dependent variables, and 1.9 percent and 0.7 percent of the control variables used. Additionally, 17.6 percent of the studies rely exclusively on these types for independent variables and 25.6 percent for dependent variables. However, only .5 percent of the studies rely on control variables which allow reliability and measurement error to be assessed. Control variables serve the purpose of ensuring that the predictions provided by independent variables under examination are not overly inflated due to covariance with other explanations. If control variables do not reliably measure their intended constructs, and our analysis suggests little evidence supporting reliable measurement, the true value of the explanatory variables is likely inflated.

Reliability. While measures that allow reliability to be addressed are desirable, the reporting of reliability information is necessary to obtain the full value from this effort. Such information can be provided explicitly or implicitly in the manuscript. We find that this vital information is lacking in many cases.

Reported reliabilities in general appear to be acceptable (average α = .80, .82, and .76 for scales / multiple measures used as independent, dependent, and control variables respectively). These outcomes may, however, be an artifact of the reporting as the majority of studies do not report reliabilities. Reliability assessments were made for less than 0.5 percent of the independent and dependent variables based on indexes. Control variables based on indexes receive far more attention - nearly half (44.1 percent) of the studies using indicators as control variables report reliabilities. This result indicates that the validity of the indexes is generally assumed and not subjected to statistical confirmation.

It may be argued that reporting reliabilities for indexes is not a requirement or standard approach. However, studies using scales did little better. Of the 390 independent variables based on scales, reliability scores are reported for only 129 (33.1 percent). The reporting rate for the reliability of dependent variables increases to 62.3 percent while the rate for control variables is approximately 41 percent.

While less informative than reliabilities, correlations between indicators provide an indication of reliability. Correlation matrices were presented in 140 of the articles 183 articles (76.5 percent). Approximately one third of these (46 articles; 32.9 percent) included all variables in the correlation matrix. We regularly found independent variables, dependent variables, interaction terms, squared terms, and control variables missing from the correlation matrixes. More disturbing, fully 43 of the 183 articles in the overall sample (23.5 percent) present no correlation matrix at all.

As a follow-up to Mone et al.'s (1996) call for greater attention on statistical power in strategy research, we examined the studies for evidence of attention to statistical power. Of the few studies that present a power analysis, none incorporated the reliability of their measures into their calculation. An understanding and appreciation of the influence of poor construct measurement on both the *a priori* planning of research approaches and the *post hoc* diagnostics of results appear to be absent

Study 2: Illustrating the Consequences of Measurement

Thus far we have applied a macro-level lens, examining the overall state of construct measurement in strategy research. Our initial review of research design issues suggests that current measurement practices may negatively affect the rigor and generalizability of strategy research. Unfortunately, this macro focus also prohibits assessment of whether measurement issues represent a small or large threat to the validity of the research base. To address this issue, we apply a micro-level lens for the second study. Specifically, we examine how varying levels of measurement affect the outcome of a prominent hypothesis: Amihud and Lev's (1981) agency model of diversification. We begin with a review of relevant research, followed by a discussion of the relevance of this stream to the concern for construct measurement.

Background

A common explanation for why a firm diversifies its line of business is the continued search for growth. After reaching maturity, a firm might consider expanding the scope of its offerings or markets, whether product or geographic, in pursuit of alternative growth opportunities. A second explanation is rooted in agency theory and its precepts surrounding managerial risk aversion. Much as investors strive to balance their personal portfolios, agency theorists contend that top managers often seek to mitigate their individual employment risk by expanding the firm's business portfolio -- even if doing so ultimately results in a reduction of shareholder wealth. The frequent divergence between agent interests and those of the owners they serve is a cornerstone of agency theory (Berle & Means, 1932; Jensen & Meckling, 1976). Evidence suggests that the unique interests of managers, including natural inclinations toward risk aversion, help to explain many organizational phenomena including executive perquisites (e.g., Jensen and Murphy, 1990; Lambert, Larcker, and Weigelt, 1993), governance innovations (e.g., Singh and Harianto, 1989), and strategic initiatives (e.g., Baysinger, Kosnik, and Turk, 1991; Sirower, 1994), among others.

The latter explanation has achieved the status of conventional wisdom in the two decades since the publication of Amihud and Lev's (1981) findings. Drawing on an agency perspective, they examined the relationship between corporate ownership structure and diversification strategies in 309 large U.S. firms. Their study revealed that management-controlled firms engage in conglomerate mergers at a far greater rate than owner-controlled organizations. Because conglomerates are typically valued at a discount – much to the disadvantage of shareholders -- (e.g., Berger & Ofek, 1995; Denis, Denis, & Sarin, 1997), Amihud and Lev (1981) concluded that managerial self-interest is a key motivator behind diversification.

Relevance

Why choose Amihud and Lev to illustrate the consequences of measurement error? Three factors guided our selection: First, while their results have been largely accepted in the field, their work has recently been challenged. Second, there are issues surrounding the measurement of both predictor and dependent variables. Third, statistical power and attenuation play a role in interpreting results to date. We will now discuss each item in more detail.

Challenges to conventional wisdom. As noted in our introduction, debate and challenges to conventional wisdom are central to a field's advancement (Kuhn, 1996). Recently, Lane, Cannella, and Lubatkin (1998) challenged the validity of the agency model of diversification. They not only questioned the methodology employed by Amihud and Lev (1981), but more broadly, disputed the applicability of the agency model to strategy research on diversification. Lane et al. (1998) attempted to replicate Amihud and Lev's (1981) research and also update the examination of diversification activity to a 1980s timeframe. They interpret their findings as suggesting owner monitoring – or control – has little effect on corporate diversification strategies; thus, they conclude that an agency explanation is not supported. The debate between these researchers was highlighted in a recent issue of *SMJ*. In the same volume, Denis, Denis, and Sarin (1999) summarized the matter, noting:

> "Though both sets of authors conduct similar empirical tests on virtually identical data, they arrive at completely different conclusions. Lane et al. (1999: 1077) conclude that '…there is little theoretical or empirical basis for believing that monitoring by a firm's principals influences its diversification strategy and investment decisions.' In contrast, Amihud and Lev (1999: 1064) conclude that 'The evidence shows that there exists a relationship between corporate diversification and corporate ownership structure.'" (page 1071)

Measurement issues. Denis and colleagues (1999) argued that resolution of this debate hinges, in part, on a careful evaluation of the empirical evidence. Their own review suggested that the methodology of both studies – Amihud and Lev (1981) and Lane, et al. (1998) – were flawed, with an important shortfall noted in the studies' measurement approaches. For example, each used broad ownership categories constituting coarse-grained indicators of agency conditions (e.g., McEachern, 1975; Palmer, 1973). When improved constructs were substituted in the analyses – namely, ratio-level indicators of equity ownership, as well as more refined measures of diversification – more substantial results are generated (Denis, et al., 1997; 1999). .

Echoing Denis, et al. (1999), we believe that the confusion surrounding the agency – diversification link is, to a significant extent, an artifact of methodology, and most especially, measurement. Empirical analysis confirms that measurement error is more prevalent for abstract versus concrete concepts (Cote & Buckley, 1987). Since the publication of Amihud and Lev (1981), the field's understanding of the key issues underlying that work – most notably, board control and diversification strategies – has advanced considerably. So, too, has our ability to measure these variables. In the context of control alone, it is now well recognized that the construct has several nuances (Fama & Jensen, 1983), leading prominent researchers to recommend use of multiple measures when studying control issues (Eisenhardt, 1989). Recognizing the complexity of measuring board oversight, one study developed a multi-indicator factor model to tap control (Boyd, 1994).

There are similar opportunities to refine the measurement of firm diversification. While there are multiple measurement schemes available – including Rumelt's categories and SIC counts – the entropy measure (Palepu, 1985) has reported superior reliability and validity (Chatterjee & Blocher, 1992; Hoskisson, Hitt, Johnson & Moesel, 1993). The entropy measure is particularly germane to our analysis, as it can be decomposed into unique elements – indicators of both related and unrelated diversification (Acar & Sankaran, 1999; Palepu, 1985).

Power. Of the core studies in this research stream, only Lane and colleagues (1998) have explicitly addressed statistical power. They argued (1998: 563) that their sample size of 309 had ample power, as "Cohen (1992: 13) observed that economic research usually reports large effect sizes." Additionally, they also noted that their sample had ample power to detect moderate effect sizes as well. However, Cohen (1988) stated that the expectation of large effect sizes may hold only when using "potent" variables, and/or in the presence of strong experimental controls. As discussed in Study 1, there are significant questions as to the robustness of single-item and categorical measures. Separately, Cohen (1988: 413) also commented that "what may be a moderate theoretical effect size may easily, in a "noisy" research, be no larger than what is defined here as small."

Sample size requirements change dramatically, depending on expected magnitude of the effect being studied. Cohen (1992: 158) offered a simple comparison: Consider a regression model with three predictors; the researcher desires a significance level of p =.05, and an 80 percent likelihood of successfully detecting the relationship. Minimum sample size is 34 for a large effect, 76 for a moderate one, and 547 for a small effect. Lane et al. (1998) sampled 309 firms, and Denis et al. (1999) sampled 933 firms. Therefore, if there is a moderate theoretical effect size between agency factors and diversification, and measurement error exists, only Denis et al. likely had sufficient power to capture an attenuated effect.

The purpose of our study is to refine the debate surrounding the control-diversification relationship. We build on the methodological refinements recommended by Denis, et al. (1997; 1999) and other scholars (e.g., Boyd, 1994; Eisenhardt, 1989) to test a series of models which use progressively finer measures of both variables – corporate control and extent of diversification. These measures are not only consistent with recent advances in strategy research, but should provide a more robust test of the agency relationship. Stated formally:

H1: Board control will be negatively related to the level of diversification.

H2: The relationship between board control and diversification will be stronger when both variables are measured with multiple indicators.

Methodology

Sample. Data were collected from a random sample of 640 *Fortune* firms as part of a larger research project. The sample included a broad range of industries, and included all of the SIC broad industrial classes; including over 50 2-digit SICs, and nearly 200 4-digit SICs. Governance data were collected from proxy statements, and we excluded *Fortune* firms that either (a) were not required to file proxies with the SEC, or (b) filed only limited reports (e.g., subsidiaries of foreign-owned firms, farmer's co-operatives, mutual associations). Company names were selected randomly, and proxy statements were collected from a variety of sources, including the firms themselves, Q-File, and document retrieval services. Because of this approach, non-respondent bias was not an issue in our sample. Our design is cross-sectional, with all data from the year 1987.

Analysis. In order to test for the effects of measurement error and attenuation, we tested our hypotheses in a structural model, using LISREL VII. Consistent with the approach of Denis et al. (1997), we used the extent of diversification as the dependent variable, versus merger activity. The model is shown in Figure 1.

Measurement. **Board control** was measured using Boyd's (1994) multi-indicator factor model. The indicators for this measure are duality, ratio of insiders, director stock ownership, representation by owner groups, and director pay. Proxy statements were used to code these variables. Duality and director pay load negatively on this construct, while the other indicators load positively. Boyd (1994) reported that a single factor solution explained 80 percent of the variation of these five indicators; additionally, other LISREL-based fit indicators also offered strong support for this model. **Total diversification** (Palepu, 1985) was broken into its components *du* (unrelated) and *dr* (related), using data from the Compustat Business Segment database. Company 10-K filings were used as a supplement when Compustat records were incomplete. Finally, we included **firm size** as a control variable, as it has been previously linked to levels of diversification (Denis et al., 1997). We measured size with three indicators: net sales, total assets, and total stockholder equity also from Compustat. Log transforms were used to normalize all size indicators.

Results

Descriptive statistics for all variables are reported in Table 4.

Tests of dimensionality. Prior to testing hypotheses, we ran a series of analyses to confirm the factor loadings and dimensionality of our predictor and control variables. The first model was a confirmatory factor analysis for the board control construct. This reported results consistent with Boyd (1994). All factor loadings were in the expected direction, and significant at the p=.001 level or greater. Overall fit measures reported that a unidimensional model was an appropriate fit to the data.

Second, we examined whether it is appropriate to treat *dr* and *du* as indicators of a common dimension. The full model in Figure 1 provides strong support for this assumption: *dr* was used as the referent indicator (a loading of 1.0), and the loading for *du* was 0.63, significant at the p=.01 level.[1] Contrary to this model, an alternate argument would be that the pursuit of related and unrelated diversification strategies are very different phenomena, and as such would have differing relationships with agency variables. For instance, managers might consider related and unrelated portfolios to have different types and levels of risk. If true, *dr* and *du* would have unique associations with ownership or monitoring variables. While such differences would be reflected in the Figure 1 factor loadings, we conducted an additional test for purposes of rigor. We tested this competing perspective in a supplementary model that treated *dr* and *du* as independent constructs, and having separate paths from control and firm size – i.e., a seemingly unrelated regression. Using an incremental chi-square test, this alternate model had a significantly worse fit than the Figure 1 model. These results, coupled with the strong factor loading for *du* in the hypothesized model, provide strong support for our multi-indicator approach. Finally, factor loadings for the three size indicators were highly significant and in the expected direction.

Model summary statistics. Coefficients were statistically significant and in the expected direction for all structural and measurement paths in Figure 1. Overall model measures reported a very good fit: Goodness of fit was 0.94; the root mean square residual was 0.08; other measures reported comparable fit. The coefficient of determination, or R^2, was 0.25 for dependent variables. For comparison, we explain 50 percent *more* variation of this variable

[1] Since there are only two indicators for this dimension, it is not feasible to run a separate confirmatory factor analysis for diversification.

than Denis and colleagues (1997) analyses do, despite using five *fewer* control variables. There was a statistically significant, negative covariation between control and firm size (phi = -.28, p=.001); in other words, oversight tended to be weaker in larger firms. Firm size has a positive effect (0.11, p=.01) on diversification as well.

Hypothesis tests. **Hypothesis 1** stated that there would be a significant, negative relationship between board control and diversification. This hypothesis was supported with a path coefficient of -.15 (p=.05). **Hypothesis 2** stated that the relationship between control and diversification would be stronger when using multiple versus single indicators. To test this hypothesis, we constructed twelve additional LISREL models; these are reported as sets 2, 3(a) and 3(b). Summary statistics for these models are reported in Table 5. These models provide very strong support for hypothesis 2.

In set 2, we leave the confirmatory factor model for control unchanged, but treat diversification as a single-indicator construct. This yields two separate models – one with *du* representing the diversification construct, and a second using *dr*. By comparing these models against Figure 1, we can identify the degree of attenuation associated with less precise measures. In this set of models, the magnitude of the path coefficient drops slightly (from -.15 to -.14, on average); however, the explained variance of the overall model (retaining control for firm size), drops from 0.226 to 0.029, on average. Additionally, the path coefficient for control becomes nonsignificant when *dr* is used as the sole indicator. In other words, the use of single indicators for the dependent variable is associated with (a) much greater likelihood of Type II error, and (b) in the case of significant results, substantial underestimation of the magnitude of the relationship. To maintain consistency with the simplified measurement schemes of these sub-models, all of the set 2 and set 3 analyses used net sales as the sole indicator of firm size.

In set 3, both board control and diversification were measured with single indicators – i.e., we introduce measurement error for both sides of the equation. These included five models based on *du* and each of the control measures (subset 3a), and another five models based on *dr* and each of the board control indicators measures (subset 3b). Director pay was linked with both *dr* and *du*, while duality was linked with *du*. The strong finding for director pay is not surprising, since it reported the strongest factor loading in Boyd's (1994) analysis. The positive links for these two predictors are expected, since levels of director pay and the presence of duality are associated with increased likelihood of agency problems – i.e., these variables load *negatively* on the control construct.

The models of set 3 also supported hypothesis 2. When single indicators were used for both the predictor and outcome variables, seven of the ten hypothesis tests were not statistically significant. Additionally, the path coefficient changed directionality in half of the models. The corresponding reduction in explained variance was substantial: In comparison to the full model (CED = .25), the aggregate explained variance was 0.020 for subset 3a, and 0.025 for subset 3b. In other words, there was a 10X magnitude of difference in explained variance between the full model and single indicator models. Additionally, in seven of the ten tests, the single indicator models would lead to a mistaken conclusion that there was no relationship. These results provide strong support for hypothesis 2.

Our results suggest that there is an element of truth in both the Amihud and Lev and Lane et al perspectives – while there is a significant linkage between agency conditions and diversification, it is limited in magnitude. More importantly, however, this debate appears to be entirely an artifact of measurement problems. Previously, Denis and colleagues (1999) argued that resolution of this disagreement hinged on a careful review of methodological issues. As we have demonstrated here, discordant results are highly likely when the relevant variables are measured with single indicators. As we demonstrate with our set of single-indicator models, there is a 70% probability of mistakenly concluding there was no significant relationship between control and diversification. Equally important, such research underestimates the true effect size by a magnitude of almost10.

DISCUSSION AND CONCLUSIONS

As an academic specialty, strategic management is a relatively young discipline: Depending on the metric used, the field is between two and three decades old. While, it plays a critical role in the study of business and management. As the field has matured, there are increasing expectations for the rigor of strategic management research. Our purpose is to extend the ongoing commentary on methodological issues by highlighting the importance of construct measurement. As demonstrated by the content analysis presented herein, little relatively emphasis has been placed on measurement in strategic management research. Our replication study demonstrates the consequences of this inattention – including the underreporting of effects and potential for Type II errors.

Our purpose is not to criticize prior work but to identify and emphasize needs for future research designs and methodologies in strategic management. While the field has developed significantly since Dan Schendel founded the *Strategic Management Journal,* our results emphasize the need for better empirical research in the field. We may have reached another plateau in the development of the field. For the strategic management field to develop further and to mature into a well-respected field accepted by its sister social science disciplines, significant attention should be placed on measurement in strategic management research. Lest we seem overly critical of strategic management research, we would note that similar problems are present in other fields as well. A meta-analytic review of 70 studies from various social sciences concluded: "Measurement error, on average, accounts for most of the variance in a measure. This observation raises questions about the practice of applying statistical techniques based on the assumption that trait variance is large in relation to measurement error variance (Cote & Buckley, 1987: 317)."

We recommend that significant attention be paid to measurement in future strategic management research. To reduce measurement error, strategic management researchers should increase their concern for the construct validity of their measures. Measurement error can often be reduced by using multiple rather than single indicators for specific constructs as shown by the research presented herein. Strategic management scholars should also display more sensitivity to the statistical power of their samples. The reduction of measurement problems may help to avoid debates as the one between Amihud and Lev and Lane et al. It may also help resolve conflicting findings thereby help the field resolve important research questions. As such, it will enhance the power of strategic management research to contribute more value to the conversation involved in the practice of strategy by firms and top executives. Thus, such changes will enrich the field and its value added contribution to knowledge of managing business enterprises.

In point of fact, the field is unlikely to make substantial progress without such attention. For example, extend the problems of interpreting results of the research on the relationship between governance controls and product diversification to other primary research areas in strategic management. Given that diversification is one of the most researched topics in the field, other areas are likely to be less well developed. In support of this conclusion, Bergh (2001) suggested that future strategic management research is likely to place greater emphasis on research designs, construct validation and newer and more sophisticated analytical strategies. While building strong theoretical bases is highly important, measurement is at least equally important for future advances in the field of strategic management. We hope that this work serves as a catalyst to this end.

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TABLE 1

METHODOLOGICAL CRITIQUES OF STRATEGY RESEARCH

Study	Focus	Sample Size	Journals Reviewed	Time Frame	Journal Pool*	General Findings
Bowen & Wiersma (1999)	Cross-sectional designs	90 studies	1	1993-96	Not reported	Insufficient attention given to common issues associated with cross-sectional designs
Ferguson & Ketchen (1999)	Power in configuration research	24 studies	6	1977-96	Not reported	92% of published papers in this research stream had insufficient power
Hubbard, Vetter & Little (1998)	Replications	37 studies	9	1976-95	Subset	Few replication studies published; replications more common in *SMJ* than *AMJ* or *ASQ*
Bergh & Holbein (1997)	Longitudinal designs	203 studies	1	1980-93	All	More than 90% of studies had Type I bias due to insufficient attention to methodological assumptions.
Ketchen & Shook (1996)	Cluster analysis	45 studies	5	1977-93	All	Implementation of cluster analysis methodology often less than ideal
Mone, Mueller & Mauland (1996)	Statistical power	210 studies	7	1992-94	Subset	Average statistical power of management studies is low, especially for small and medium effect sizes

*Subset indicates that a sample of relevant articles were used; All indicates that all papers meeting the study criteria/focus were included

TABLE 2

NORMALITY OF SAMPLE SIZE AND VARIABLE DISTRIBUTIONS

		Distribution for					
		Sample Size (N)	**Independent Variables**	**Control Variables**	**Ratio of *N* to Independent Variables**	**Ratio of *N* to Control Variables**	**Ratio of *N* to (Independent + Control Variables)**
Mean		2,595	5.70	8.76	639.13	611.83	239.22
s.d.		13,125	5.52	30.76	3,152.26	3,594.18	1,357.40
Minimum		20	1	0	2.8	1	1
Maximum		158,782	36	507	39,695.50	39,695.50	19,847.80
Skewness		8.28***	2.27*	10.32***	8.63***	8.77***	11.54***
Kurtosis		80.64***	7.25***	135.08***	90.68***	83.39***	155.92***
Percentiles:	25th	98	2	0	23	21	12
	50th	197	4	3	57	39	24
	75th	422	7	8	142	80	65
	85th	796	10	10	236	201	112
	90th	1,135	12	15	330	265	164
	95th	12,248	17	18	1,906	1,360	344

Note: Significance of skewness and kurtosis based on Z scores with: * $p < .05$; ** $p < .01$; *** $p < .001$

TABLE 3

RESULTS OF CONTENT ANALYSIS

	Independent Variables			*Dependent Variables*			*Control Variables*		
	Counts	**% of Variables**	**% of Tests**	**Counts**	**% of Variables**	**% of Tests**	**Counts**	**% of Variables**	**% of Tests**
All Variables									
Total number of variables	3,276			653			5,272		
Total number of tests	602			602			602		
Single Indicators									
# of single indicators used	1,569	47.9%		240	36.8%		4,221	80.1%	
# of tests using single indicators	320		53.16%	220		36.54%	413		68.60%
of the tests, # that rely solely on single indicators as IV, DV, or control	120		19.93%	160		26.58%	174		28.90%
of the tests, # that rely exclusively on single indicator for IV, DV and control	34		5.65%	34		5.65%	34		5.65%
Single Ratios									
# of single ratios used	298	9.1%		98	15.0%		413	7.8%	
# of tests using single ratio indicators	114		18.94%	92		15.28%	138		22.92%
of the tests, # that rely solely on single ratios as IV, DV, or control	35		5.81%	61		10.13%	27		4.49%
of the tests, # that rely exclusively on single ratios for IV, DV and control	0		0.00%	0		0.00%	0		0.00%
Discrete items									
# of discrete items used	450	13.7%		32	4.9%		246	4.7%	
# of tests using discrete indicators	92		15.28%	32		5.32%	30		4.98%
of the tests, # that rely solely on discrete variables as IV, DV, or control	32		5.32%	31		5.15%	11		1.83%
of the tests, # that rely exclusively on discrete variables for IV, DV and control	0		0.00%	0		0.00%	0		0.00%
Indexes									
# of Indexes used	480	14.7%		115	17.6%		102	1.9%	
Average reliability	0.85			0.74			0.74		
# of tests using indexes	155		25.75%	113		18.77%	63		10.47%
of tests using indexes, # reporting reliabilities	26		16.77%	3		2.65%	45		71.43%
of the tests, # that rely solely on Index as IV, DV, or control	46		7.64%	78		12.96%	0		0.00%
of the tests, # that rely exclusively on Index for IV, DV and control	0		0.00%	0		0.00%	0		0.00%
Full Scales or Multiple Indicators									
# of scales used	390	11.9%		130	19.9%		39	0.7%	
Average reliability	0.80			0.82			0.76		
Mean # of indicators	5.56			5.10			4.99		
# of tests using scales	167		27.74%	97		16.11%	26		4.32%
of tests using scales, # reporting reliabilities	129		77.25%	81		83.51%	16		61.54%
of the tests, # that rely solely on scales / multiple measures as IV, DV, or control	60		9.97%	76		12.62%	3		0.50%
of the tests, # that rely exclusively on scales / multiple measures for IV, DV and control	2		0.33%	2		0.33%	2		0.33%
None used							175	3.3%	
Not specified/detail missing	89	2.7%		38	5.8%		76	1.4%	
		100.00%			100.00%			100.00%	

TABLE 4

DESCRIPTIVE STATISTICS

	du	*dr*	Sales	Assets	Equity	Duality	Dir. Pay	Dir. Equity	Owner Reps	Insiders
1. *du*	1.00									
2. *dr*	0.12	1.00								
3. Sales	0.12	0.16	1.00							
4. Assets	0.01	0.06	0.69	1.00						
5. Equity	0.07	0.17	0.80	0.80	1.00					
6. Duality	0.10	0.07	0.06	0.02	0.06	1.00				
7. Director Pay	0.16	0.17	0.45	0.38	0.44	0.06	1.00			
8. Director Equity	-.09	-.09	-.20	-.24	-.25	-.26	-.21	1.00		
9. Owner Reps	-.07	-.05	-.15	-.20	-.23	-.19	-.23	0.52	1.00	
10. Insiders	0.04	-.03	-.05	-.20	-.16	-.11	-.15	0.12	0.22	1.00
X	0.29	0.15	7.47	7.63	6.48	0.79	21847	4.47	0.98	0.28
σ	0.41	0.28	1.09	1.44	1.23	0.42	9163	11.52	1.60	0.14

Note: Correlations greater than 0.08 significant at $p=.05$; values greater than 0.10 at $p=.01$.

TABLE 5

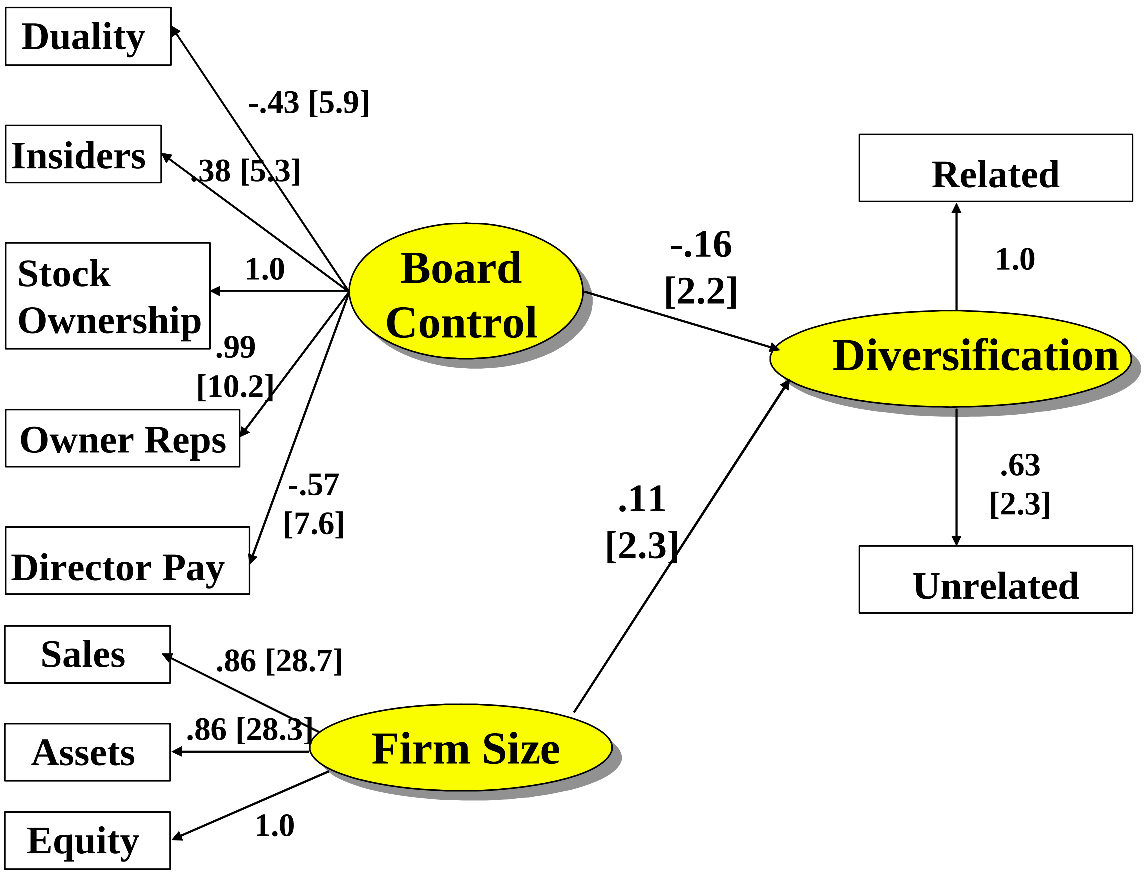
COMPARISON OF ALTERNATE MODELS

Model	Firm Size		Board Control		R^2
	γ	*t*-value	γ	*t*-value	
1. Full model (Figure 1)	.11	2.3	-.16	2.2	.25
2. Single indicator for diversification, multiple indicator for control					
DU	.09	2.0	-.15	2.1	.024
DR	.14	3.1	-.12	1.7	.034
Mean for set 2:			*-.14*		*.029*
3. Single indicator for diversification, single indicator for control					
(a) **DU** and…					
DUAL	.11	2.8	.09	2.2	.022
DIRCOMP	.06	1.3	.13	2.9	.027
PCTDIR	.11	2.5	-.07	1.6	.018
OWNGRP	.11	2.6	-.05	1.3	.017
INSIDER	.12	3.0	.05	1.2	.016
Mean for set 3(a):			*.08*		*.020*
(b) **DR** and…					
DUAL	.16	3.9	.06	1.5	.030
DIRCOMP	.11	2.4	.12	2.7	.038
PCTDIR	.15	3.7	-.06	1.3	.030
OWNGRP	.16	3.9	-.03	0.7	.027
INSIDER	.16	4.0	-.02	0.5	.027
Mean for set 3(b):			*.06*		*.030*
Mean for set 3 overall:			*.07*		*.025*

Note: Highlighted text denotes nonsignificant path estimates.

FIGURE 1

RESULTS OF STRUCTURAL MODEL



Note: Certain terms (e.g., theta and phi matrices) omitted for ease of representation. T-values of parameters noted in brackets; significance levels as follows: $t = 2.0$, $p < .05$; $t = 2.7$, $p < .01$; $t = 3.5$ $p < .001$.