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RESEARCH NOTES AND COMMENTARIES

CONSEQUENCES OF MEASUREMENT PROBLEMS IN STRATEGIC MANAGEMENT RESEARCH: THE CASE OF AMIHUD AND LEV

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Strategic management research has been characterized as placing less emphasis on construct measurement than other management subfields. To illustrate the consequences of measurement error, we revisit the debate on the causes of diversification. 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 of size in the relationships between variables.

Strategic management is generally acknowledged to be one of the younger subdisciplines within the broader management domain. 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 challenging, a particular perspective. Contributing to the advancement of the field, there has been a small research stream that critiques empirical research in strategic management. Regardless of the topic, these reviews have been consistently critical of the rigor of strategic management research.

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Construct measurement is a key area of concern for strategic management research, as the variables of interest tend to be complex or unobservable (Godfrey and Hill, 1995). Paradoxically, measurement has been a low-priority topic for strategic management scholars (Hitt, Boyd, and Li, 2004). As a result, complex constructs have often been represented with simple measures, and with limited testing for reliability or validity (Boyd, Gove, and Hitt, 2005). To illustrate the consequences of measurement issues, we replicate a prominent debate among strategy researchers regarding whether or not diversification is a consequence of agency costs (Amihud and Lev, 1981). Using data from 640 *Fortune* firms, we created multiple indicator models of both agency costs and diversification. Our results provide strong evidence that the debate between authors is largely an artifact of measurement error.

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LITERATURE REVIEW AND HYPOTHESES

A common explanation for diversification is the continued search for growth. A mature firm might consider expanding the scope of its offerings in pursuit of new growth opportunities. An alternative explanation is based in agency theory. Much as investors strive to balance their personal portfolios and thus their risk, agency theorists contend that top managers expand the firm's business portfolio to mitigate their individual risk—even if doing so ultimately results in a reduction of shareholder wealth.

Evidence suggests that the unique interests of managers, including natural inclinations toward risk aversion (Berle and Means, 1932; Jensen and Meckling, 1976), help to explain many organizational phenomena including executive perquisites (e.g., Boyd, 1994), governance innovations (e.g., Hoskisson and Hitt, 1994), and strategic initiatives (e.g., Baysinger, Kosnik, and Turk, 1991; Sirower, 1997), among others.

The agency rationale has achieved the status of conventional wisdom in the two decades since Amihud and Lev's (1981) seminal article. Their study revealed that management-controlled firms engaged 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 (Berger and Ofek, 1995; Denis, Denis, and Sarin, 1997), Amihud and Lev (1981) concluded that managerial self-interest is a primary motivator behind diversification.

Relevance of Amihud and Lev to measurement issues

Three factors guided our selection of Amihud and Lev's work to illustrate the consequences of measurement error. First, while their results have been largely accepted in the field, their work was recently challenged. Second, there are issues surrounding the measurement of both predictor and dependent variables. Third, statistical power and attenuation play a role in interpreting the results to date. Next, we discuss each of these issues in more detail.

Challenges to conventional wisdom

Debate and challenges to conventional wisdom are central to a field's advancement (Kuhn, 1996). Recently, Lane, Cannella, and Lubatkin (1998) reanalyzed the Amihud and Lev data, and concluded that owner monitoring had little effect on corporate diversification strategies. The debate between these researchers was highlighted in a recent issue of *SMJ*. Denis and colleagues summarized the matter, noting that:

> 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.' (Denis, Denis, and Sarin, 1999: 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 methodologies of both studies 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 refined measures of diversification—more substantial results were generated (Denis *et al*., 1997, 1999).

We believe that the confusion surrounding the agency–diversification link is largely an artifact of the methodologies used in studies, specifically the measurement approaches. Empirical analysis confirms that measurement error is more prevalent for abstract vs. concrete concepts (Cote and Buckley, 1987). Since the publication of Amihud and Lev's (1981) work, the field's understanding of the key variables has advanced considerably—so, too, has our ability to measure the specific variables of interest. In the context of control alone, it is now well recognized that the construct has several nuances (Fama and Jensen, 1983), leading 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 been reported to have superior reliability and validity (Chatterjee and Blocher, 1992; Hoskisson *et al*., 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 and Sankaran, 1999; Palepu, 1985).

Power

Of the core studies in this research stream, only Lane and colleagues have explicitly addressed statistical power. They argued (Lane *et al*., 1998: 563) that their sample size of 309 had ample power, as 'Cohen (1988: 13) observed that economic research usually reports large effect sizes.' Additionally, they also suggested that their sample had ample power to detect moderate effect sizes as well. However, Cohen (1987) stated that the expectation of large effect sizes may hold only when using 'potent' variables, and/or in the presence of strong experimental controls. Separately, Cohen (1987) also suggested that in 'noisy research' a moderate theoretical effect size may really end up to be a small observed effect. Thus, differences in expected effect sizes can dramatically change the required sample size. Cohen (1992: 158) provided an example of a regression model with three predictors, a significance level of $p = 0.05$, and an 80 percent likelihood of identifying the relationship. The minimum sample size is 34 for a large effect, 76 for a moderate effect, and 547 for a small effect. Lane *et al*. (1998) sampled 309 firms, and Denis *et al*. (1997) 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 that use progressively more fine-grained measures of both variables—corporate control and extent of diversification. Based on the prior theoretical arguments offered in the previous studies of these phenomena, we offer the following formal hypotheses for testing:

Hypothesis 1: Board control is negatively related to the level of diversification.

Hypothesis 2: The relationship between board control and diversification is stronger when both variables are measured with multiple indicators.

METHODS

Sample

Data were collected from a random sample of 640 *Fortune* firms as part of a larger research project. The sample included over 50 2-digit SICs, and nearly 200 4-digit SICs. Company names were selected randomly, and proxy statements were used to collect governance data. Our design is cross-sectional, with all data from the year 1987.

Analysis

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

Measurement

Board control was measured using Boyd's (1994) multi-indicator factor model.[1] The indicators for this measure are CEO duality, ratio of insiders to total board members, director stock ownership, representation on the board by ownership groups,

[1] Boyd's model is not an exhaustive set of agency indicators. Thus, we conducted additional analyses to evaluate the robustness of our results. We developed new models that introduced a sixth indicator, CEO tenure, as an additional measure of board oversight. While tenure loaded on the board control factor model, its magnitude and level of statistical significance, while acceptable, were substantially less than the other extant indicators. Therefore, inclusion of a sixth indicator yielded only minor changes in path coefficients, and tests of Hypotheses 1 and 2 were unaffected.

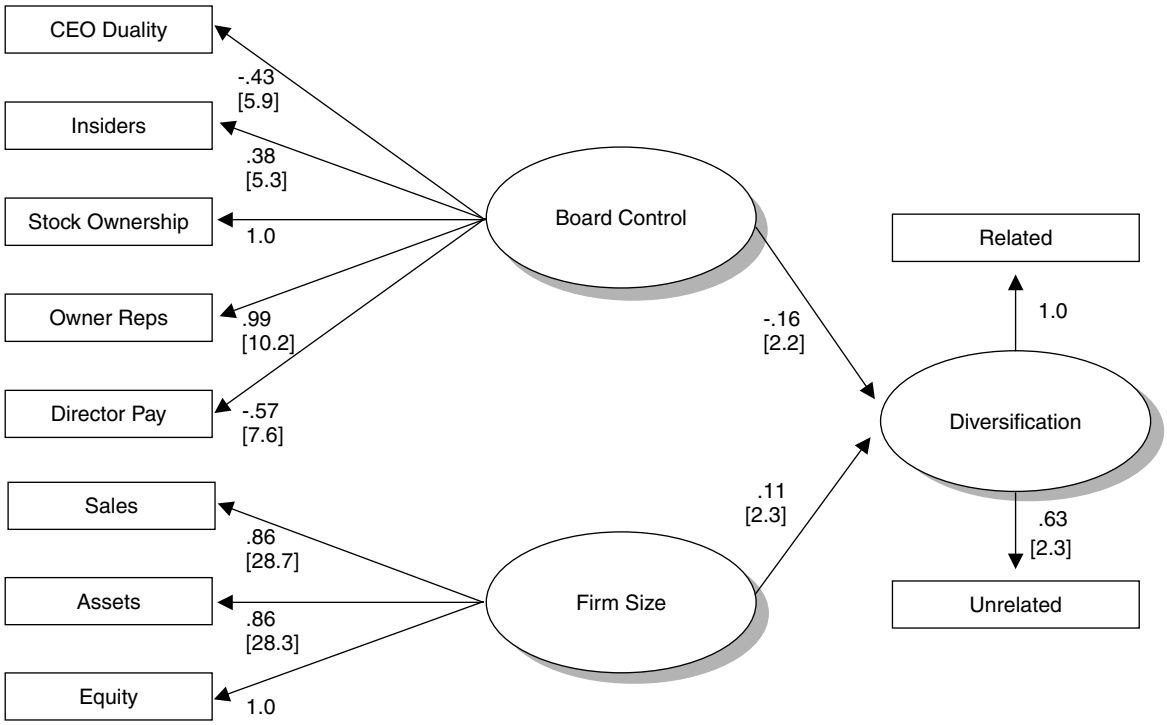

Figure 1. Results of structural model. *Note:* Certain terms (e.g., theta and phi matrices) are omitted for ease of representation. t-values of parameters are noted in brackets; significance levels as follows: $t = 2.0$, $p < 0.05$; $t = 2.7$, $p < 0.01$; $t = 3.5$, $p < 0.001$

and director pay. Proxy statements were used to code these variables. CEO duality and director pay loaded negatively on this construct, while the other indicators loaded positively. *Total diversification* (Palepu, 1985) was separated into its components *du* (unrelated) and *dr* (related), using data from the Compustat Business Segment database and company 10-K filings. Finally, we included *firm size* as a control variable, because 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 transformations were used to normalize all size indicators.

RESULTS

Descriptive statistics for all variables are reported in Table 1.

Tests of dimensionality

Prior to testing the hypotheses, we conducted a series of analyses to confirm the factor loadings and dimensionality of our predictor and control variables. The first model represented a confirmatory factor analysis for the board control construct. The results of this analysis are consistent with Boyd's (1994) results. All factor loadings were in the expected direction, and statistically significant at the $p < 0.001$ level. Overall fit measures reported that a unidimensional model provided the best fit to the data.

Second, we examined whether or not it is appropriate to treat *dr* and *du* as indicators of a common dimension. The full model (Figure 1) provides strong support for this assumption: *dr* was used as the referent indicator, and the loading for *du* was 0.63 ($p < 0.01$).[2] However, an alternative argument could be made that the related and unrelated diversification strategies are different phenomena and, as such, likely have differing relationships with agency variables. For instance, managers might consider related and unrelated portfolios to have different types and levels of risk. If

[2] Because there are only two indicators for this dimension, it is not feasible to conduct a separate confirmatory factor analysis for diversification.

Table 1. 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	−0.09	−0.09	−0.20	−0.24	−0.25	−0.26	−0.21	1.00		
9. Owner reps	−0.07	−0.05	−0.15	−0.20	−0.23	−0.19	−0.23	0.52	1.00	
10. Insiders	0.04	−0.03	−0.05	−0.20	−0.16	−0.11	−0.15	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

Correlations greater than 0.08 significant at $p < 0.05$; values greater than 0.10 at $p < 0.01$.

true, *dr* and *du* would have unique associations with ownership or monitoring variables. 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 alternative model had a significantly *worse* fit than the Figure 1 model. Our results provide strong support for a multi-indicator approach to measuring diversification (as opposed to separate measures of diversification types). Finally, factor loadings for the three size indicators were highly statistically 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 (GFI) was 0.94; the root mean square residual was 0.08; other measures reported comparable fit. The coefficient of determination, or R^2, was 0.248 for the dependent variables. In comparison, we explain 50 percent more variation of this variable 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 $= -0.28$, $p < 0.001$); in other words, governance oversight tended to be weaker in larger firms. Firm size has a positive effect (0.11, $p < 0.01$) on diversification as well.

Hypothesis tests

Hypothesis 1 was supported with a statistically significant, negative relationship ($\gamma = -0.16$, $p < 0.05$)[3] between board control and diversification. Hypothesis 2 stated that the relationship between control and diversification is stronger when using multiple vs. single indicators. To test this hypothesis, we constructed 12 additional LISREL models; these are reported as sets 2, 3a, and 3b. Summary statistics for these models are reported in Table 2, and provide 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 diversification, and a second using *dr*. By comparing these models against the model in 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 decreases slightly (from −0.16 to −0.14, on average); however, the explained variance of the overall model (retaining control for firm size) drops from 0.248 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 (a) increases the

[3] We tested for the possibility of reverse causation—i.e., that levels of board control are a *result* of the firm's diversification posture—in a supplemental model that treated diversification as a predictor and control as the dependent variable. The path between these two variables was not statistically significant, and overall levels of explained variance were smaller than our hypothesized Figure 1 model.

Table 2. Comparison of alternate models

Model	Firm size		Board control		R^2
	γ	t-value	γ	t-value	
1. Full model (Figure 1)	0.11	2.3	−0.16	2.2	0.248
2. Single indicator for diversification, multiple indicator for control					
DU	0.09	2.0	−0.15	2.1	0.024
DR	0.14	3.1	−0.12	1.7	0.034
Mean for set 2:			*−0.14*		*0.029*
3. Single indicator for diversification, single indicator for control					
(a) DU and ...					
DUAL	0.11	2.8	0.09	2.2	0.022
DIRCOMP	0.06	1.3	0.13	2.9	0.027
PCTDIR	0.11	2.5	−0.07	1.6	0.018
OWNGRP	0.11	2.6	−0.05	1.3	0.017
INSIDER	0.12	3.0	0.05	1.2	0.016
Mean for set 3a:			*0.08*		*0.020*
(b) DR and ...					
DUAL	0.16	3.9	0.06	1.5	0.030
DIRCOMP	0.11	2.4	0.12	2.7	0.038
PCTDIR	0.15	3.7	−0.06	1.3	0.030
OWNGRP	0.16	3.9	−0.03	0.7	0.027
INSIDER	0.16	4.0	−0.02	0.5	0.027
Mean for set 3b:			*0.06*		*0.030*
Mean for set 3 overall:			*0.07*		*0.025*

Significance of t-values is as follows: $t \geq 2.0$, $p < 0.05$; $t \geq 2.7$, $p < 0.01$; $t \geq 3.5$, $p < 0.001$

likelihood of a Type II error and (b), in the case of statistically significant results, results in substantial underestimation of the magnitude of the relationship. To maintain consistency with the simplified measurement schemes of these submodels, 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 independent and dependent variables). 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 measures (subset 3b). Director pay was linked with both *dr* and *du*, while CEO duality was linked only with *du*. The strong results for director pay are not surprising, as it had the highest factor loading in Boyd's (1994) study. The positive links for these two predictors are expected, because levels of director pay and the presence of CEO 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 provided support for Hypothesis 2. When single indicators were used for both the predictor and outcome variables, seven of the ten 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 ($R^2 = 0.248$), the aggregate explained variance was 0.020 for subset 3a, and 0.025 for subset 3b. In other words, there was approximately a 10× magnitude of difference in explained variance on average 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 the conclusions of both the Amihud and Lev (1981) and Lane *et al*. (1998) studies are partially accurate—while there is a statistically significant relationship between agency conditions and diversification, it is limited in magnitude. More importantly, however, this debate appears to be largely 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. Our results suggest that a 70 percent probability exists for mistakenly concluding there is no relationship between control and diversification when single indicators are used. Equally important, such research underestimates the true effect size by a magnitude of approximately 10×.

Additionally, by decomposing the elements of diversification, we find that there is a differential effect for the type of diversification: high levels of board control have a stronger effect on unrelated vs. related diversification. In other words, while firms with strong board oversight are less likely to have any type of diversification activity, the effect is more pronounced for unrelated as opposed to related diversification. These results are demonstrated in the factor loadings for our full model, as well as the varying results for set 2 and set 3 submodels. This differential may reflect an assessment by the board that related diversification has greater potential value to the firm.[4]

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. However, even with this youth, 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 by Boyd *et al*. (2005), there has been little emphasis placed on measurement concerns in strategic management research. Our replication study demonstrates the consequences of such inattention—including the underreporting of effects and potential for Type II errors.

To date, the primary focus has been on avoiding Type I errors, yet Type II errors also deserve attention. Important relationships may exist but remain undetected. These relationships can be particularly important in the test of theory and interpretation of results for practice. In fact, Type II errors are definitely as critical as Type I errors to the development of our field and the practice of strategic management. Additionally, Type II errors are likely to be underreported in the published research because it is more difficult to publish research that reports few statistically significant results. Thus, the results of this study exemplify a problem that is of particular concern for the strategic management field.

The conclusions of our study have important implications for future research on corporate governance and corporate strategy and for managerial practice. First, the results support Amihud and Lev's original conclusion that governance affects strategy. In fact, in contrast to the Lane *et al*. (1998) conclusions, our more fine-grained results show that strong governance constrains diversification in general but especially unrelated diversification. The effects on related diversification are lower, suggesting that boards may see more potential in related diversification activities. In other words, they likely perceive the potential synergies are greater and have a higher probability of being realized.

Since the publication of the Lane *et al*. (1998) research through June 2004, the Amihud and Lev (1981) article received 88 citations (it had 265 citations since its publication). The Lane *et al*. (1998) article received 27 citations (three of which related to responses to their original article). There were only four overlapping citations. Of the 88 publications citing the Amihud and Lev (1981) research, 32 were in management and related subdisciplines. The rest were in economics, finance, and law. All but two of the works citing the Lane *et al*. (1998) article were in management or a closely related subdiscipline. Thus, while the Amihud and Lev (1981) work continues to be cited, the Lane *et al*. (1998) work appears to have its strongest effect on management research. It is troubling that in the 5 $\frac{1}{2}$ years since its publication 20 scholarly research pieces used the results of their work without reference to the Amihud and Lev (1981) work. Even the citation of both does not prevent the compounding of a Type II error.

It is equally troubling that, given the prominence of the debate over the effect of ownership and diversification, few researchers have acknowledged that measurement effects may

[4] We thank a reviewer for highlighting this point.

explain divergent findings. Only one published study, Eisenmann (2002), cited and considered the perspectives of Amihud and Lev (1981, 1999), Lane *et al*. (1998), as well as measurement explanations (Denis *et al*., 1999) for differences in findings.

Research with errors can lead future research in the wrong direction, making it less valuable. Worse, if managers base strategic or even operational decisions on the results of erroneous research, they are unlikely to be successful. These conclusions are highly important. Research results published in journals with strong academic reputations must be as error free as is reasonable because we use the journal quality as a proxy for the quality of the research published in it. Future research, managerial actions, tenure and promotion decisions, and other rewards are based on the published research. Therefore, when published research contains errors, these errors are compounded because of the other decisions and actions based on it. The conclusions of the Boyd *et al*. (2005) work on errors in strategic management research and the consequences of poor measurement, as demonstrated herein, suggest that strategic management needs to place more emphasis on research design and methodologies to improve the quality of the research and the impact of the field.

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