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MEASUREMENT OF PERCEIVED ENVIRONMENTAL UNCERTAINTIES:

RESPONSE AND EXTENSION

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MEASUREMENT OF PERCEIVED ENVIRONMENTAL UNCERTAINTIES: RESPONSE AND EXTENSION

Miller (1993) presented an instrument for measuring managers' perceptions of the environmental uncertainties relevant to international business. Application of this instrument by Werner, Brouthers, and Brouthers (1996), led them to suggest an alternative measurement instrument. This study applies confirmatory factor analysis to examine the reliability and discriminant validity of these alternative PEU scales. Recommendations regarding PEU measurement and directions for future research on international environmental uncertainties follow the empirical analysis.

Miller (1992) developed a typology for classifying the environmental uncertainties relevant in international business. A follow-up article (Miller, 1993) developed and applied an instrument for measuring managers' perceptions of environmental uncertainties. While that study did examine interrater reliability among multiple respondents within firms, the thirty-five perceived environmental uncertainty (PEU) items were examined individually rather than analyzed to determine general PEU factors. This approach was consistent with the assertion that while there may be some intercorrelation among uncertainty variables, pooling uncertainty categories may result in a loss of information relevant to managers.

Seeing assessment of scale dimensionality and reliability as the logical next step in refining a measure of perceived environmental uncertainty (PEU), Werner, Brouthers, and Brouthers (henceforth, WBB, 1996) used exploratory factor analysis to examine the Miller (1993) scale. While their findings generally supported the categories developed by Miller (1992; 1993), they suggested some scale modifications.

Two general issues raised by WBB (1996) were whether subsets of perceived environmental uncertainties are sufficiently intercorrelated to be represented by common factors, and the extent to which these common factors correspond with the categories asserted by Miller (1992; 1993). The present study will examine these issues using confirmatory factor analysis on the Miller (1993) data consisting of responses from nearly five hundred managers in 211 firms in six Latin American countries. This study has four primary objectives: (1) examine the goodness-of-fit and reliability of the Miller (1993) scale and the alternative recommended by WBB (1996); (2) examine the discriminant validity of the PEU scales; (3) make recommendations regarding PEU measurement; and (4) suggest theoretical perspectives and directions for future research on strategic responses to environmental uncertainties in international business.

BACKGROUND

Drawing from international business, strategy, and related research, Miller (1992) developed a typology for decomposing the international business environment into distinct elements when measuring managers' uncertainty perceptions. In keeping with the uncertainty categories presented in that article, a

follow-up study (Miller, 1993) developed a questionnaire to measure managers' environmental uncertainty perceptions at the general country environmental and industry levels. The two broad general environmental uncertainty categories included political and government policy, and macroeconomic. Corresponding to the industry level, the survey included items related to input, product market, competitive, and technological uncertainties. Managers were asked to indicate their evaluations of the predictability of each of these environmental components. Rankings were recorded on Likert-type scales ranging from 1 (easy to predict) to 7 (not predictable). Table 1 contains the specific items included in the PEU instrument.¹

In the 1993 study, data from managers in six Latin American countries provided a basis for assessing interrater reliability. Since data from multiple respondents were available for many of the sample firms, item reliability was evaluated using a simple ANOVA model for firm effects. Of the thirty-five uncertainty indicators, twenty-one had F test ratios significant at the .05 level. While managers within firms generally agreed on the uncertainty of political, government policy, macroeconomic, input, and competitive items, there was much less agreement on the product market and technology uncertainty items. No assessment of scale dimensionality or reliability was presented.

Recently, Werner, Brouthers, and Brouthers (1996) published an article examining the scale reliability of the Miller (1993) instrument using data from Dutch multinational companies. The results were generally consistent with the earlier study. Their exploratory factor analysis did, however, lead them to suggest some modifications in the PEU scale items, which they presented as the modified measure labeled PEU2. Their recommended PEU2 scale does not follow directly from their factor analysis but is a compromise between the a priori categories of Miller (1993) and their empirical results.

While WBB (1996) raised some interesting issues regarding PEU measurement, their approach deserves further review. They interpreted subsets of Miller's (1993) items as multiple indicators of factors which could be empirically distinguished from one another. Such an interpretation was not explicit in Miller (1993) and contradicts his (1992) contention that complex intercorrelations may exist among environmental uncertainties. Hence, the reliability and discriminant validity of the PEU and PEU2 scales deserve further examination before they are applied in future research.

Beyond these conceptual issues, several aspects of WBB's methodology should be noted. Single respondents did not allow for testing interrater reliability. Their sample consisted of respondents from a single country (the Netherlands) and registered this home-country perspective on seventeen country environments, rather than an international sample drawn from managers in the various countries. Whether home or host country perspectives are most appropriate is, of course, a function of the research question of interest.

The dimensionality of the WBB scale was determined using an exploratory factor analysis procedure. Exploratory approaches are susceptible to overfitting the data. That is, exploratory results may reflect idiosyncratic patterns in the data which do not generalize to other samples. While exploratory factor analysis may be appropriate in the early stages of scale development, confirmatory analysis offers advantages for scale assessment as an area of empirical research matures (Jöreskog & Sörbom, 1989: 96).

This study examines the issues raised by WBB using an alternative data set and methodology to examine the robustness of their findings.

METHODOLOGY

Data

Managers from six Latin American countries--Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama--provided data. This was a particularly interesting region in which to conduct research on managerial uncertainty because of the economic and political reforms characterizing Central America and Panama during the data collection period (July, 1990 through February, 1991). The sample included a broad cross-section of industries within each country.²

All of the managers were selected from the top management team in each firm. Their backgrounds included work in a wide variety of functional areas. Questionnaire responses were solicited from three managers per firm. For each firm in the sample, responses to the questionnaire items were solicited in an interview with one of the members of the top management team at their place of work. When possible, an additional one or two managers from each firm completed a questionnaire containing the same PEU items. No interview was conducted with the second and third questionnaire respondents. Since not all firms agreed to have additional managers participate in the study, the number of respondents

per firm varied from one to three. A total of 497 managers from 211 firms provided usable responses. After assessing interrater reliability (see Miller, 1993), this study used the means of the responses across managers within each firm.

Analysis

WBB (1996) interpreted Miller's (1993) PEU items as multiple indicators of six factors: political/government policies, macroeconomic, resources and services used by the company, product market and demand, competition, and technology in your industry. WBB's (1996) exploratory factor analyses yielded loading patterns for six-factor and eight-factor solutions. WBB offered the distinct PEU2 scale, consisting of a subset of Miller's PEU items, as a suggested scale for future research.

In contrast to exploratory factor analysis, confirmatory factor analysis imposes theoretically meaningful constraints in order to estimate model parameters (see Long, 1983). The present study uses a confirmatory factor analytic approach to fit the original model implicit in Miller (1993) and WBB's (1996) PEU2 loading patterns. Comparison of the overall chi-square goodness-of-fit measures across the alternative models indicates whether the WBB (1996) findings are merely artifacts of their particular data or if they are a valid basis for reforming the PEU scale. Examination of factor loadings can be used to assess individual items. Low factor correlations (i.e., significantly different from 1.0) among factors provide evidence of discriminant validity (Bagozzi, Yi, & Phillips, 1991).

Following the notation of Jöreskog and Sörbom (1989: 96-97), the confirmatory factor analysis model is of the form:

(1)
$$\mathbf{x} = \Lambda \boldsymbol{\xi} + \boldsymbol{\delta}$$

where x is a (q x 1) vector of observed PEU items, ξ is a (n x 1) vector of common factors, Λ is a (q x n)matrix of factor loadings, and δ is a (q x 1) vector of unique residuals. Under the standard assumptions that $E(\xi) = 0$, $E(\delta) = 0$, and ξ is uncorrelated with δ , the (q x q) covariance matrix for x is:

(2)
$$\Sigma = \Lambda \Phi \Lambda' + \Theta$$

where Φ is the (n x n) covariance matrix of the latent variables, and Θ the (q x q) diagonal matrix of covariances among the unique residuals.

Table 1 indicates WBB's (1996) interpretation of the subsets of Miller's (1993) items loading on common factors. The PEU2 loadings are WBB's suggested scale for future research. The PEU2 loadings are consistent with their interpretation of Miller (1993) with the exception that they drop certain indicators which they found to reduce scale reliabilities. For any given factor, loadings were estimated for the subset of items deemed to be indicators of the common factor, while the loadings of all other items were constrained to zero for that factor. The variances of each latent factors was fixed at a value of one.

Confirmatory factor analysis was undertaken using the SAS CALIS procedure (SAS Institute, 1990; 1996). This procedure handles structural equations modeling in much the same way as the popular LISREL package (Jöreskog & Sörbom, 1989). Cronbach (1951) alphas were generated to report the internal reliability of the subscales.

RESULTS

Table 1 reports the results of the two confirmatory factor analyses. Due to missing data on some of the PEU measures, four firms were dropped from the PEU analysis and three from the PEU2 analysis. The PEU factor loadings are all positive and significant at the p < .001 level with the exception of the availability of trained labor (AVLABOR), which is significant at the p < .01 level. All PEU2 loadings are positive and significant at the p < .001 level.

Smaller chi-square values indicate better model fit. Small p-values indicate the hypothesized factor loading patterns are not confirmed by the sample data. The p-values indicate we can reject the tested models. Values of Bentler's (1990) comparative fit index also support this conclusion. Both values fall below Browne and Cudeck's (1992) suggested criterion of .90.

Discriminant validity can be assessed by examining the correlations among the latent factors presented in Table 2. Correlations which are significantly different from 1.0 indicate discriminant validity. The appropriate test statistic is (1.0 - correlation)/standard error which should exceed a cutoff value of 2.0 (Bagozzi, Yi, & Philips, 1991). This criterion is satisfied for all of the correlations.

Table 2 also presents Cronbach alphas for each scale. All of the Cronbach alphas exceed Nunnally's (1967) cutoff of 0.70. Since PEU and PEU2 include the same items for four of six scales, the Cronbach alphas are identical for these four scales. The PEU2 scale for resources and services used by your company contains a reduced set of items. For this sample, using the PEU2 reduced set of items actually decreased the scale reliability slightly (from 0.76 to 0.73). The technology in your industry items which, were dropped entirely in the PEU2 scale, show the highest reliability (alpha = 0.89).

DISCUSSION

The recent dialogue between Sullivan (1994; 1996) and Ramaswamy, Kroeck, and Renforth (1996) regarding measurement of the degree of internationalization, as well as the Werner, Brouthers, and Brouthers (1996) extension of Miller (1993) are indications of an increased awareness of measurement issues in international business research. While interest in construct validity and reliability may be viewed by some as an unnecessary divergence from substantive international business issues, a more constructive view sees measurement and substantive theory testing as complementary pursuits. Indeed, the results of theory testing are confounded if the properties of the measures are unknown (Bagozzi, Yi, & Philips, 1991).

This study sought to clarify the measurement of perceived environmental uncertainties in international business research as raised by Miller (1993) and WBB (1996). The results, however, are mixed--limiting our ability to draw definitive conclusions. In support of the WBB (1996) approach, the results show adequate scale reliabilities when assessed using Cronbach's (1951) alpha. Furthermore, rejecting the hypothesis of perfect correlations among scales indicates discriminant validity.

On the other hand, the confirmatory factor analysis results indicated unsatisfactory fit for the two alternative models. The overall fit remained virtually unchanged when moving from the full 35 indicators to the subset suggested by WBB (1996). Whether the poor overall fit is due to random error or substantive measure-specific variance cannot be determined from a single-sample study (Bagozzi, Yi, & Philips, 1991). Poor overall fit suggests patterns of correlations among the PEU indicators may be more complex than can be captured in a simple model with indicators loading on one factor each. Improvements in goodness-of-fit may only be achieved by increasing the complexity of the hypothesized factor loading pattern (McDonald & Marsh, 1990). Evidence from this study, as well as the exploratory analyses presented by WBB (1996), indicate complex intercorrelations across items under distinct categories. The simplifying assumption that the subsets of indicators correlate only with latent uncertainty variables associated with political and government policy, macroeconomic, resources and services used by the company, product market and demand, competition, and technology was rejected. This does not invalidate Miller's (1992) typology, but it does caution against interpreting the broad categories as unidimensional scales.

Attempts to assert PEU or PEU2 as definitive scales for measuring managers' perceptions of environmental uncertainties would be premature. Research in this area should remain open to alternative indicators not used previously. The categories suggested by Miller (1992) may be useful in generating alternative items. Items should be chosen based on both the geographic location of a research project as well as its theoretical orientation. For example, some of the indicators used by Miller (1993) were specific to the Latin American context (e.g., uncertainty regarding the results of economic restructuring) and may not be relevant in more stable environments. The choice between perceptions of managers in different countries versus headquarters managers depends on the level of analysis (i.e., corporate versus foreign subsidiary) relevant to a particular study.

Rather than trying to bring closure to a set of PEU items at this time, a more appropriate approach given the empirical evidence regarding existing scales would be to caution against canonizing the available indicators and encourage flexibility in the choice of indicators. Confirmatory multimethod-multitrait analysis (see Anderson, 1987; Bagozzi, Yi, & Philips, 1991) using multiple respondents as methods and multiple items as traits would be an appropriate direction for scale development in light of concerns regarding interrater reliability raised by Miller (1993). While Miller's (1993) technological uncertainty items evidenced poor interrater reliability, this dimension of uncertainty is of sufficient relevance to international business research to warrant further development of indicators.

It would be useful to bring closure to the measurement of environmental uncertainties in order to move to substantive empirical research linking PEUs to strategic decisions. Absent the basis for such closure at this time, the best advice to researchers would be to sample multiple respondents in each unit of interest, include multiple PEU indicators in their research designs, and provide empirical evidence to justify reducing uncertainty dimensions down to a parsimonious set of scales. This is an awkward conclusion, but to say otherwise would be inconsistent with existing empirical evidence.

ENDNOTES

¹ The study used a Spanish version of the survey instrument prepared by the author and three other bilingual individuals. Table 1 is a back translation written from the Spanish questionnaire. WBB (1996) used five-point rather than a seven-point Likert-type scales.

² Further descriptions of the sample can be found in Miller (1993).

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TABLE 1Results of Confirmatory Factor Analyses^a

	Miller (1993) PEU	WBB (1996) PEU2
1. Government and policies		
a. Ability of the party in power to maintain		
control of the government (CONTROL).	.4959 (.0709)	.4873 (.0711)
b. Threat of armed conflict (THREAT).	.2728 (.0745)	.2724 (.0744)
c. Tax policies (TAXPOL).	.6144 (.0681)	.6118 (.0682)
d. Monetary policy (MONPOL).	.5246 (.0703)	.5266 (.0702)
e. Prices controlled by the government		
(PRICEGOV).	.4253 (.0723)	.4253 (.0722)
f. National laws affecting international		
business (NATLAWS).	.6267 (.0678)	.6212 (.0679)
g. Legal regulations affecting the		
business sector (LEGALREG).	.7811 (.0633)	.7727 (.0636)
h. Tariffs on imported goods (TARIFFS).	.6068 (.0683)	.6072 (.0683)
i. Enforcement of existing laws		
(ENFORLAW).	.4777 (.0713)	.4728 (.0713)
j. Public service provision (PUBLICSE).	.3440 (.0736)	.3442 (.0735)
2. Economy		
a. Inflation rate (INFLATN).	.8122 (.0624)	.8091 (.0624)
b. Exchange rate with dollar		
(EXCHANGE).	.8195 (.0623)	.8233 (.0620)
c. Interest rate (INTEREST).	.7442 (.0641)	.7436 (.0640)
d. Results of economic restructuring		
(RESULTS).	.4374 (.0716)	.4353 (.0715)
3. Resources and services used by your com	ipany.	
a. Availability of trained labor		
(AVLABOR).	.1983 (.0749)	
b. Labor and union problems (LABOR).	.4161 (.0722)	
c. Quality of inputs, raw materials, and		
components (QUALITY).	.6830 (.0663)	.7082 (.0712)
d. Availability of inputs, raw materials,		
and components (AVINPUTS).	.8556 (.0619)	.8249 (.0709)
e. Prices of inputs, raw materials, and		
components (PRICES).	.6954 (.0660)	
f. Transportation system within the		
country (TRANSWI).	.5180 (.0702)	.5199 (.0730)
g. Transportation system to foreign		
countries (TRANSTO).	.4697 (.0712)	.4607 (.0740)

^a Standard errors are in parentheses.

Product market and demand.		
a. Client preferences (CLIENT).	.4022 (.0708)	.4005 (.0706)
b. Product demand (PRODUCT).	.4761 (.0695)	.4750 (.0693)
c. Availability of substitute products		× ,
(AVSUBPRO).	.8562 (.0622)	.8577 (.0620)
d. Availability of complementary		. ,
products (AVCOMPRO).	.9015 (.0613)	.9013 (.0611)
5. Competition.		
a. Changes in competitors' prices		
(CHPRICES).	.5077 (.0724)	.5211 (.0726)
b. Changes in the markets served by		
competitors (CHMARKET).	.5902 (.0706)	.5873 (.0712)
c. Changes in competitors' strategies		
(CHSTRAT).	.6458 (.0692)	.6501 (.0697)
d. Entry of new firms into the market		
(ENTRY).	.5935 (.0705)	.6092 (.0707)
e. Domestic competitors (DOMCOMP).	.6196 (.0699)	.6078 (.0707)
f. Foreign competitors (FORCOMP).	.6309 (.0696)	.6236 (.0703)
6. Technology in your industry.		
a. Product changes (PRODCHNG).	.8091 (.0599)	
b. Changes in product quality (CHQUAL).	.8593 (.0581)	
c. New product introductions		•
(NEWPRODS).	.7965 (.0603)	
d. Changes in the production process		
(CHPROCES).	.7861 (.0607)	
Chi-square	1236.5238	837.6534
df	545	340
Prob > chi-square	0.0001	0.0001
Bentler's Comparative Fit Index	0.7472	0.7398
N	207	208

 TABLE 2

 Factor Correlations and Cronbach Alphas^b

(a) FEU	(a)	PEU
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	1.	2.	3.	4.	5.	6.
1. Government and policies						
2. Economy	.466***	:				
3. Resources and services used by your company.	(.069)	.166*				
4. Product market and demand.	(.080)	.021	.288***			
5. Competition.	(.078)	(.081) 5.021	(.075)	.430***		
6. Technology in your industry.	(.077) .169* (.079)	(.086) 027 (.080)	(.082) .172* (.078)	(.072) .282*** (.073)	.531*** (.065)	
Cronbach Alpha	0.77	0.79	0.76	0.77	0.76	0.89
(b) PEU2	1.	2.	3.	4.	5.	
1. Government and policies						
2. Economy	.470***	:				
3. Resources and services used by your company.	(.008) .193* (.084)	.131				
4. Product market and demand.	.232**	.024	.306***			
5. Competition.	(.078) .383*** (.077)	(.080) 5 .022 (.086)	(.077) .182* (.087)	.434*** (.071)		
Cronbach Alpha	0.77	0.79	0.73	0.77	0.76	

^b Standard errors are in parentheses.

† p < .10, * p < .05, ** p < .01, *** p < .001

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