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A CRITICAL REVIEW OF THE ENVIRONMENTAL UNCERTAINTY LITERATURE SINCE 1987

DERRICK MCIVER

KATSUHIKO SHIMIZU

&

BONGJIN KIM

Department of Management
University of Texas at San Antonio
6900 North Loop 1604 West
San Antonio, TX 78249-0634
(210) 458-5380
(210) 458-5783 (FAX)

Department of Management,
University of Texas at San Antonio,
San Antonio, TX 78249, U.S.A

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ABSTRACT

Environmental uncertainty has been a central construct of organizational theorists and strategic management researchers for many decades. The number of empirical studies using the uncertainty construct also continues to be significant. However, the confusion surrounding the conceptualization and measurement of the uncertainty construct remains a subject of scholarly debate. Through our comprehensive review of 77 empirical studies over the last 20 years and related theoretical and methodological work, we intend to (1) review the conceptualization trends and persisting issues that are apparent in uncertainty research, (2) review empirical issues particularly important to uncertainty work and illustrate how researches have or have not overcome some of these challenges, and (3) suggest directions for future research using the uncertainty construct.

Environmental uncertainty has been a central construct of organizational theorists and strategic management researchers for many decades (Duncan, 1972; Knight, 1921; March & Simon, 1958; Pfeffer & Salancik, 1978; Thompson, 1967). In 1987, Milliken published a review of the literature on environmental uncertainty, summarizing the inconsistencies and problems in conceptualizing and measuring the construct and provided direction for future research by organization scholars. The environmental uncertainty construct continues to be a fundamental component in organization research as scholars proceed to develop intricate taxonomies (Miller, 1992; Priem, Love, & Shaffer, 2002) and validate alternate measures (Buchko, 1994; Gerloff, Muir, & Bodensteiner, 1991; Werner, Brouthers, & Brouthers, 1996a). The number of empirical studies using the uncertainty construct also continues to be significant. For example, when "uncertainty" is used as a key word, an average of more than 21 articles per year appeared in the eight top journals we reviewed. However, the confusion surrounding the conceptualization and measurement of the uncertainty construct remains a subject of scholarly debate. Boyd and Fulk (1996) argue that "upon review of the literature one is less sure how to define the construct [uncertainty], let alone measure it" (Boyd & Fulk, 1996: 3). We wonder if Downey and Slocum's observation more than three decades ago is still valid today; "Uncertainty is a term which is used daily in a variety of ways. This everyday acquaintance with uncertainty can be seductive in that it is all too easy to assume that one knows what he is talking about" (1975: 562).

It has now been 20 years since Milliken's (1987) seminal paper on the environmental uncertainty construct was published. We believe that the vast amount of research that has been published using the environmental uncertainty construct provides a valuable opportunity to review the state of the empirical research and to explore directions for future empirical work. Through our comprehensive review of 77 empirical studies over the last 20 years and related

theoretical and methodological work, we intend to (1) review the conceptualization trends and persisting issues that are apparent in uncertainty research, (2) review empirical issues particularly important to uncertainty work and illustrate how researches have or have not overcome some of these challenges, and (3) suggest directions for future research using the uncertainty construct.

Scope of the Review

We reviewed empirical studies published in the *Academy of Management Journal*, *Administrative Science Quarterly*, *Journal of International Business Studies*, *Journal of Management*, *Journal of Management Studies*, *Management Science*, *Organization Science*, and *Strategic Management Journal*. We identified studies that included the phrase "uncertainty" in its title, abstract, or listing of key words. Using this approach, we identified 425 studies that have appeared in the organization research literature during the 1988 –2007 period. Among these, we selected only studies that presented and tested hypotheses upon sample populations by operationalizing uncertainty in an empirical study. Thus, our review and comments focus on 77 empirical studies that expressly test hypothesized associations using the uncertainty construct. We plan to discuss that there are many studies that use uncertainty as a key term but never identify or measure it. We argue that the casual use of "uncertainty" without specifying exactly what it means can be a source of confusion (Downey & Slocum, 1975). Another possible source of confusion is the propensity of authors to use ambiguity, risk, volatility and uncertainty interchangeably. As noted by Bromiley, Miller and Devaki Rau (2001), there should be a distinction between constructs and a greater emphasis on the classification system is required. To be practical and conservative, we limited our examination and review specifically to the uncertainty construct. We believe that our comprehensive review of uncertainty studies provides

a good starting point toward further understanding the current issues related to environmental uncertainty and other related constructs.

Review of Conceptual Definitions

Highlighting the confusing sate of conceptual definitions in the literature Milliken (1987) indicated a requirement to reexamine the nature of the uncertainty and suggested a need to be much more precise in defining, using, and measuring the construct. In her manuscript she defined environmental uncertainty as "an individual's perceived inability to predict something accurately" (1987:136). In addition, Milliken (1987) suggested that the uncertainty construct should be disaggregated and identified three types of perceived uncertainty about the environment: (1) state uncertainty – the inability to predict the future state of the environment; (2) effect uncertainty – the inability of decision makers to predict how environmental changes will impact their organizations; and (3) response uncertainty – the inability of managers to identify potential organizational actions and their outcomes.

In our section on *review of conceptual definitions,* we review the remaining and/or persisting issues associated with the uncertainty construct. We plan to stress three issues: (1) objective and subjective nature of uncertainty, (2) definition or key components of uncertainty, and (3) aggregation and disaggregation associated with uncertainty.

The primary source of the confusion surrounding the construct is that "authors have used environmental uncertainty to describe both an environmental and individual state" (Buchko, 1994: 411). In other words, corresponding to their research questions and theoretical lenses (Rajagopalan & Spreitzer, 1996), authors need to distinguish between objective measures of the environment and perceived uncertainty both conceptually and operationally. We agree with the argument that objective measures are more appropriate for studying external phenomena, while

perceptual measures are more appropriate for examining managerial behavior and decision making (Boyd & Fulk, 1996). Behavioral decision research suggests that management perception is subject to a variety of biases and distortions (Kahneman & Tversky, 2000). Perceptual measures of environmental uncertainty reflect an administrators' ability or perceived ability to predict an organization's environment (Milliken, 1987). Thus, as a perceptual phenomena, perceived environmental uncertainty becomes valuable for studying potential antecedents to such items as decision making (Atuahene-Gima & Li, 2004), leadership effectiveness (Waldman, Ramirez, House, & Puranam, 2001), or similar managerial behavior such as environmental scanning (Daft, Sormunen, & Parks, 1988; May, Stewart, & Sweo, 2000). Contrastingly, objective environmental conditions are valuable for understanding primary strategy issues such as domain selection or expansion (Leiblein & Miller, 2003), level of competition and government influence (Delios & Henisz, 2003; Henisz & Delios, 2001), or scale of entry (Luo, 2004) and mode of entry (Folta & O'Brien, 2004; Luo, 2001).

Besides the objective versus subjective distinction, the environmental uncertainty construct has recently been conceptualized using a range of definitions such as unpredictable variation (Priem et al., 2002), lack of information needed to assess cause-effect relations in order to make decisions (Carpenter & Fredrickson, 2001), or changes in economic conditions faced by an organization that are outside of its control and hard to anticipate (Krishnan, Martin, & Noorderhaven, 2006). Moreover, Buchko (1994) argued that such a broad span of definitions to define uncertainty ranging from predictability through dynamism to controllability made interpretations of results and generalizations difficult. We believe that the central concept of environmental uncertainty is *unpredictability* (we plan to enrich our arguments), and thus that environmental uncertainty should be defined as such. Given that unpredictability is intangible,

whether to use inputs (e.g., information availability) or outputs (e.g., variance) as a proxy of uncertainty is an empirical question. However, in selecting a proxy, researchers should provide theoretical rationale.

Third, several studies have suggested numerous methods of disaggregating environmental uncertainty into its component parts (e.g.,(Beckman, Haunschild, & Phillips, 2004; Carson, Madhok, & Wu, 2006; Daft et al., 1988; Miller & Shamsie, 1999; Robertson & Gatignon, 1998; Santoro & Mcgill, 2005; Steensma & Corley, 2000; Sutcliffe & Zaheer, 1998) . These disaggregation's have followed such categorizations as demand, technological and behavioral; primary, competitive and supplier; state, effect and response; firm specific and market; and partner, task and technological. One plausible explanation for the inconsistency in aggregations across studies is the complex and differentiated nature of the uncertainty construct. Specifically, as Sutcliffe and Zaheer (1998) argue, it is possible that uncertainty may be generated from a number of different sources or characterized along a number of different dimensions that result in different implications.

By assessing the current state of the conceptual definitions in the literature we hope to emphasize some of the progression made and investigate some of the remaining issues in defining the uncertainty construct and how they have been or might be overcome.

Review of Empirical Issues

Our section on empirical issues discusses 1) the lack of correspondence between conceptualization and measurement; 2) level of analysis issues (e.g., firm, industry); and 3) the use of aggregated versus disaggregated measures

We plan to discuss the issues and trends surrounding a lack of correspondence between the conceptual development and subsequent measurement. For example, under some conditions it

is plausible to assume that increased volatility and increased certainty can occur simultaneously (Eisenhardt, 1989), or, to add to the confusion, that it is possible that there is no association between volatility and uncertainty at all (Isabella & Waddock, 1994). Along this line, measuring the unpredictability component of uncertainty using the variance of an output statistic (e.g., industry sales) or other volatility measures has significant limitations. "First, it fails to account for the trends in the data, which will increase the measured variance although they may not constitute an element of uncertainty if they are predictable. Second, this approach does not allow for the possibility that the variance may be heteroskedastic (i.e., not constant over time) a characteristic that is typical of many economic time series" (Folta & O'Brien, 2004: 127).

In relation to our discussion regarding definition of uncertainty, it is not surprising to observe that using objective measures of uncertainty that potentially lack correspondence, results in different effects from that found in studies using perceived measures. For example, using items from Khandwalla's (1976) survey instrument Waldman, Ramirez, House and Puranam (2001) found that environmental uncertainty significantly moderated and was potentially the key variable in the charismatic leadership-performance association. Contrastingly, using an objective volatility measure Agle, Nagarajan, Sonnenfeld, and Srinivasan's (2006) findings suggest that subsequent organizational performance has no association with the interaction between charisma and uncertainty.

Our second section under review of empirical issues examines level of analysis comparisons in uncertainty research. Environmental measures have been constructed on a broad range of analytical levels (Boyd, Dess, & Rasheed, 1993). "Disagreements over the impact of uncertainty have arisen largely because researchers have failed to distinguish among several

different types of uncertainty, each occurring at a different level of analysis" (Miller & Shamsie, 1999: 98). We plan to discuss the level issues here.

Our last section under the empirical issues examines the use of unidimensional and multidimensional measures and the current propensity within the literature to measure a disaggregated or single dimension of uncertainty (e.g., technological). Milliken (1987) argued that perceived environmental uncertainty can be conceptualized as having three separate components and that the three should remain disaggregated. It is argued that the use of multidimensional measures is highly consistent with the perceived environmental uncertainty construct and thus the use of multi-item subscales may be an improvement over the use unidimensional scales (Buchko, 1994; Elenkov, 1997). Further, our review suggests that global perceived environmental uncertainty measures are found to have different associations with criterion variables than its disaggregated components (Gerloff et al., 1991). Perceived environmental scales developed (Miller, 1993) and tested (Werner, Brouthers, & Brouthers, 1996b) echo these statements. Furthermore, Dickson and Weaver's (1997) results supported the above arguments that perceived environmental uncertainty is a multidimensional construct that should be disaggregated and characterized by the source of uncertainty.

Similar to the conflicting findings found using objective and perceived measures of uncertainty, using disaggregated and aggregated measures often results in mixed findings. For example, trying to build on Daft et al.'s (1988) findings that supported an increase in environmental scanning with increased uncertainty, Sawyerr (1993) and Elenkov (1997), using composite measures and non-American samples were unable to find conclusive evidence to support the association between uncertainty and environmental scanning. Yet, May et al (2000), also using a non-American sample and a multi-component measure, found a significant

association between scanning and uncertainty when they incorporated information accessibility into their model. As shown in Table 1, our review indicates that 24 studies used multi-dimensional measures, 34 used unidimensional measures and 19 used subcategory measure of uncertainty.

In our review we elaborate on current trends and issues in defining and operationalizing uncertainty. It is our main goal to facilitate further theoretical and empirical development within the uncertainty literature. Table 1 presents a cataloging of empirical studies along these main issues.

Future Directions

In this section we first summarize our review of the theoretical and empirical issues associated with uncertainty research. Following our review and critical evaluation of uncertainty research we offer three recommendations for future research: (1) define uncertainty more precisely and examine uncertainty using its key component (unpredictability); (2) clarify objective and perceptual nature of environmental uncertainty; (3) incorporate internal uncertainty measures.

Our first suggestion to researchers is making a greater effort to increase correspondence between conceptualization and measurement. Since a key component of the definition of environmental uncertainty is unpredictability, researchers might benefit from scales using risk based measures (Buchko, 1994). As pointed out by Buchko (1994), using survey measures of perceptual uncertainty that ask respondents to assign a probability or degree of certainty (Milliken, 1990) or the predictability of a given environmental sector (Elenkov, 1997) might better capture the concept of environmental uncertainty. Yet, similar efforts to explicitly capture the unpredictability component were a rarity in our review after Milliken's (1990) study.

Similarly, objective measures should follow the same rigorous methodology. One objective methodology that has seen little use in that management literature that attempts to capture the unpredictability of an environment is the use of analysts' forecasts obtained from the I/B/E/S database (Barron, Kim, Lim, & Stevens, 1998; Bromiley & Miller, 1990; Haunschild, 1994). By using such measures that incorporate variance in security analysts' forecasts researchers are able to measure unpredictability *ex ante*, and use the measure in an annual models (Wiseman & Bromiley, 1996).

It is also suggested that further convergence, reliability and validity studies of perceived and objective measures that adhere to greater correspondence between conceptualization and measurement be pursued. The main contradiction stems from the lack correlation between objective and perceptual measure because scholars are confounding constructs (Boyd et al., 1993; Milliken, 1987). Perceptual scales allow researchers to measure the firm's environment from the perspective of key organizational actors or a dominant coalition (Boyd & Fulk, 1996). Accordingly, one suggestion to spur future research to help clarify the difference between the objective and perceptual nature of environmental uncertainty is using perceived uncertainty as a dependent variable. Rajagopalan and Spreitzer (1996) pointed out that the substance and configuration of individual cognitions is influenced by the organizational environment. In the articles reviewed uncertainty was almost exclusively an independent or moderator variable (see Isabella & Waddock, 1994 for an exception). In a study using perceived uncertainty as the dependent variable, Isabella and Waddock (1994) used 225 bank officers as participants in a bank simulation game and found that as the environment was viewed as predictable an analyzable they also viewed the environment as certain. Contrastingly, they found that there was no association between environmental volatility and uncertainty or top management team consensus and

uncertainty. In addition, identifying the simultaneous effects of the component parts of the uncertainty construct would help clarify some of the confusion. It is our opinion that clarifying what contributes to the degree of perceived uncertainty is an important extension of the literature. Rather than simply debating the definition of uncertainty, exploring the relationship between objective environmental conditions and perceived environmental uncertainty can be a great contribution.

Finally, it is argued that findings surrounding uncertainty would be more useful and have greater explanatory power if they also included measures of internal uncertainties (Priem et al., 2002). Even though both external and internal uncertainties are essential to strategic decision making (Bourgeois, 1985), research in the area has almost exclusively focused on external uncertainties. This is despite the fact that both recent (Miller, 1992; Priem et al., 2002) and traditional (Duncan, 1972) uncertainty taxonomies highlight the importance of internal uncertainty.

Conclusion

Overall we believe our review elucidates important but under-examined issues and presents useful guidance for empirical researchers to further enrich our understanding of the uncertainty construct. Environmental uncertainty remains a pivotal construct in the organization literature and there is no sign that it is becoming less ubiquitous. Thus, the purpose of this study is to conduct a comprehensive review and provide insight into the current state of the uncertainty construct in order to spur additional research. In doing so we review empirical findings for the period of 1988-2007, clarify important issues using the uncertainty construct, and provide potential directions for future research.

Appendix

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TABLE 1: Overview of environmental uncertainty studies from 1988 – 2007

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Hits																				
Uncertainty	15	13	9	16	22	24	17	22	27	12	24	25	21	27	21	18	33	27	27	25
Ambiguity	3	5	6	1	6	6	3	7	10	2	1	9	8	5	5	7	7	5	5	3
Volatility	0	0	2	0	2	1	1	2	4	3	3	4	1	2	3	2	4	8	8	7
Perceptual Operationalization																				
Survey	1		2	1	2	3	2	2	3	3	1	2	3	3	3	2	1	3	2	3
Interview																				1
Other																				1
Operationalization by objective measure																				
Volatility	1		1								4	1		1	3	1	3	1	4	3
Other				1			1			1		1		1	1	1		2	1	
Aggregatoin in Operationalization																				
Multi-Item	1		1	1		2	1	1	1	3	1	2	1			2	1	1	3	2
Unidemensinal	1			1	2	1	2	1	2	1	3	1	1	4	4	1	2	2	2	3
Subcategory			2								1	1	1	1	3	1	1	3	2	3
Level of Analysis																				
Macroeconomic							1							1						
Industry	2		3	2		1	1	1	1	1	5	2	2	1	2	2	6	2	4	1
Firm			1		2	2	1	2	3	3	1	1	1	3	5	2	1	3	3	6
Boudary																				
Internal			1	1				1	1		1			1			1			2
External	2		3	2	1	3	2	2	3	4	6	3	3	4	7	5	5	5	7	6
Sources																				
State			1	1								1								
Effect			1	1								1								
Response			1	1								1								

TABLE 1 (Continued)

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Type																				
Technological						1			1	1	2	1	2	1	2		1	4		2
Demand						1				1	1		2		1	1	2	1	1	
Market/Product									1		1				1	1	2	1		1
Frim specific																	1			
supplier											1									1
Input															1					
Behavioral										1	1					1		1	1	
Competitive			2								1		1					1	1	
Regulatoy			1			1								1		1				
Transaction																1				
Outcome	1																			
Cognitive																				1
Turbulance								1												
Complexity								1										1		
Decision						1				1										
Resource													1							
Natural														1				1		
Structural															1			1		
Invester											1					1	1			
Strategic										1			1							
Environmental	1		1	1	2	1	2	1	2	2	2	1		2	2	1			5	2
Accosication																				
IV	2		2	2	2	3	2	2	4	4	6	3	1	2	5	4	3	3	4	6
Moderater			1										1	3	2	1	2	2	2	1
DV							1	1					1			1				
Sample Size																				
<100	2		1	2	2	2		1	2	1		1	3	1	2				2	2
100-300			2			1	1	1	2	1	4	1		2	5	2	3	3	4	4
>300							1			1	2	1		2		3	2	2	1	2

TABLE 2: Overview of objective measures of uncertainty

Aggregated Measures		
Author	Type of Uncertainty	Description of Measure
Bergh, 1998; Bergh & Lawless, 1998; Carpenter & Fredrickson, 2001	Environmental	Standard error of regression slope divided by mean sales in quasi time series regression
Agle. Nagarajan, Sonnenfeld, & Srinivasan, 2006	Environmental	Volatility of stock returns estimated as the annualized standard deviation of daily stock returns of a firm adjusted for average industry volatility
Haunschild,1994; Haunschild & Miner, 1997	Environmental	Variance in analysts' estimates about the performance of a company (i.e., coefficient of variation of forecasts)
Disaggregated Measures		
Miller & Shamsie, 1999	State, Effect, Response	State uncertainty – 2 measures robustness of demand and competitive volatility Effect uncertainty – 2 measures creative, functional and technical skills and Control over distribution Response Uncertainty – 2 measures operating costs and tenure of production head
Luo, 2002a,b, 2003, 2004, 2005; Luo & Park 2004	Structural	Geometric average of the standard deviations in output, sales, and profit of the industry
Eisenhardt, 1988	Outcome	Outcome uncertainty - two measures: 1) failure rates reported in the Dun and Bradstreet's Survey of Retail store failures, 2) Census Bureau figures for the number of competitors in an MSA
Westphal, Boivie, & Chang, 2006	Competitive	Competitive uncertainty is the mean-deviated concentration level of the focal firm's primary industry
Santoro & Mcgill, 2005	Task, Partner, Technological	Task Uncertainty- Ordinal measure where alliances were code from high to low uncertainty based on progress of project Partner uncertainty – measured as absence of prior ties in five years prior study through a dummy variable Technological uncertainty – dummy variable for difference in volatility of technological uncertainty of subfield: 1) chemical compound (little uncertainty); 2) diagnostics; and 3) therapeutics(less routine and high uncertainty)

TABLE 2 (Continued)

Disaggregated Measures Cont.		
Goerzen, 2007	Technological	Change in patent activity within an industry. Measured as percent of change between periods t and t-1
Camuffo, Furlan, & Rettore, 2007	Supplier	Variation in suppliers operating costs
Folta, 1998; Folta & Miller, 2002; Miller & Folta, 2002	Exogenous	26 week standard deviation of weekly returns. Then converted to monthly measure by averaging weekly standard deviations within a given month
Leiblein & Miller, 2003	Demand	Demand uncertainty - The sum of squared errors from a regression of relevant product-market's historical unit demand over 5 years
Folta & O'Brien, 2004	Demand	Square root of annul conditional variance generated from a GARCH-M(1-1) model using industry GDP.
Randall, Netessine, & Rudi, 2006)	Demand	Demand uncertainty - coefficient of variation of demand calculated using annual inflation adjusted data for 10 year period
Beckman et. al., 2004	Firm Specific, Market	Firm-specific: standardized monthly volatility of a focal firm's stock in the year prior to the network change (i.e., coefficient of variation for firms annual monthly stock closing price) (265) Market uncertainty – mean monthly stock price volatility (monthly price coefficient of variation) of all sampled firms in the focal firm's industry
Miller & Chen, 1996	Market	Uncertainty index for airline industry comprised of three components: the annual number of route entries by new carriers, route exits, and bankruptcies
Delios & Henisz, 2003; Henisz, 2000; Henisz & Delios, 2001	Political	Policy uncertainty – A political hazards index.