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RESEARCH NOTES AND COMMENTARIES

DISRUPTIVENESS OF INNOVATIONS: MEASUREMENT AND AN ASSESSMENT OF RELIABILITY AND VALIDITY

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Strategic management scholars have long explored the broad topic of innovation, a cornerstone in creating competitive advantage. Any attempt at theory construction in this area must encompass reliable and valid measures for key innovation characteristics. Yet, with respect to an important construct, i.e., disruptiveness of innovations, there has been relatively little academic research. Without formalizing the disruptiveness concept with a reliable and valid measure, it is difficult to conduct rigorous research to uncover the causes of the innovator's dilemma and identify mechanisms to help incumbents develop such innovations. In this paper, we develop a scale for the disruptiveness of innovations. We collected data from senior executives (vice president or general manager level) at 199 strategic business units (SBUs) in 38 Fortune *500 corporations and performed a series of analyses to establish the reliability and validity of the disruptiveness scale. The reliability measures, exploratory factor analysis, confirmatory factor analysis, and subsequent statistical tests strongly support our measure. Further, we also present nomological validity of the disruptiveness construct, thus establishing its predictive validity. Thus, this paper distinguishes the disruptiveness concept from other established innovation constructs, such as radicalness and competency destroying. Finally, we discuss the significance of our results and how this study might be useful to other researchers.* Copyright © 2006 John Wiley & Sons, Ltd.

INTRODUCTION

In the current environment, business leaders are constantly struggling to develop and introduce new product, process, and service[1] innovations (Bayus, Griffin, and Lehmann, 1998). Researchers have examined important issues in this area, such as the new product development process (Bajaj, Kekre, and Srinivasan, 2004; Mahajan and Wind, 1992; Rao, 1997; Urban and Hauser, 1993), product design and customer feedback (Griffin and Hauser, 1993; Srinivasan, Lovejoy, and Beach, 1997; Wittink and Cattin, 1989), diffusion of innovations (Bayus, 1993; Gatignon, Eliashberg, and Robertson, 1989; Golder and Tellis, 1997, 2004; Mahajan, Muller, and Bass, 1990); Sultan, Farley, and Lehmann,

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[1] In the remainder of the paper, for brevity, we refer to 'product, process, and service' as 'product.'

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1990), consumer innovativeness (Steenkamp, ter Hofstede, and Wedel, 1999), and the impact of firm capabilities on innovation (Chandy and Tellis, 1998; Dutta, Narasimhan, and Rajiv, 1999; Gatignon and Xuereb, 1997; Moorman and Slotegraaf, 1999; Souza, Bayus, and Wagner, 2004; Srinivasan, Lilien, and Rangaswamy, 2002). Although the concept of 'disruptiveness' of innovations (Christensen, 1997) has been emerging as strategically important, it has received less attention from researchers.

Disruptive innovations are a powerful means for broadening and developing new markets and providing new functionality, which, in turn, disrupt existing market linkages (Abernathy and Clark, 1985; Adner, 2002; Charitou and Markides, 2003; Christensen and Bower, 1996; Christensen and Raynor, 2003; Danneels, 2004; Gilbert, 2003). Using six generations of technology in the disk drive industry, Christensen and Bower (1996) advance the notion of the 'innovator's dilemma': how and why incumbents tend to ignore disruptive innovations. However, despite the importance of disruptive innovations, there has been relatively little academic research on this characteristic (Danneels, 2004). The dearth of such research may be because there is neither an appropriate measure for the disruptiveness of innovations (Danneels, 2004) nor has prior research assessed the discriminant and convergent validity of the disruptiveness characteristic relative to two other well-known innovation characteristics. One of these is radicalness, which is technology based—that is, the extent to which an innovation advances the performance frontier faster than the existing technological trajectory (Gatignon *et al*., 2002). The other characteristic is competency based—that is, the extent to which innovations build upon and reinforce, rather than destroy, existing competencies (Tushman and Anderson, 1986). Prior research has established the convergent and discriminant validity of the radicalness and competency-destroying characteristics (Gatignon *et al*., 2002).

In this paper, we (a) develop a scale to measure the disruptiveness of innovations, (b) establish the construct's reliability and discriminant and convergent validity, (c) provide nomological validity of the disruptiveness characteristic, hence establishing its predictive validity, and (d) discuss the significance of our results for other researchers. While this paper primarily makes a methodological and measurement contribution, the results of this study have important theoretical and empirical implications because a coherent body of knowledge on innovations needs to include psychometrically valid and reliable scales for measuring key constructs, which, in turn, will stimulate further research (DeVellis, 2003).

BACKGROUND

Disruptiveness of innovations is distinct from the radicalness or the competency-destroying dimensions of innovations. As Adner (2002: 668) states, 'Disruptive technologies ... introduce a different performance package from mainstream technologies and are inferior to mainstream technologies along the dimensions of performance that are most important to mainstream customers. As such, in their early development they only serve niche segments that value their non-standard performance attributes. Subsequently, further development raises the disruptive technology's performance on the focal mainstream attributes to a level sufficient to satisfy mainstream customers.' Further, Adner (2002) concludes that disruptive innovations are offered at a lower price and states (Adner, 2002: 669), 'disruptive technologies ... with their lower performance, appeal to the low-end, low-profit portion of the mainstream market.' The above characterization of disruptive innovations is consistent with (i) Christensen (1997), who states that disruptive technologies typically are simpler and cheaper and (ii) Charitou and Markides' (2003) and Gilbert's (2003) three phases of disruptive innovations, where they consider disruptive innovations starting out as low-margin businesses. Thus, following Abernathy and Clark (1985), Adner (2002), Christensen (1997), Christensen and Bower (1996), Christensen and Raynor (2003), Charitou and Markides (2003), and Gilbert (2003), disruptiveness of innovations may be considered a continuous variable and described as follows: a disruptive innovation introduces a different set of features and performance attributes relative to the existing products and is offered at a lower price, a combination that is unattractive to mainstream customers at the time of product introduction due to inferior performance on the attributes that mainstream customers value. However, a new customer segment (or the more price-sensitive mainstream market) sees value in the innovation's new attributes and lower price.

Over time, subsequent developments raise the new product's attributes to a level that is sufficient to satisfy mainstream customers, thus potentially attracting more of the mainstream market.[2]

Given that disruptive innovations attract a different customer segment at the time of their introduction, it is relevant to distinguish such a different (or niche) segment from that of the 'early adopter segment,' discussed in the diffusion of innovation literature, which is based on the timing of adoption and is defined as those who buy the product first (Rogers, 2003). Such early adopters have several characteristics (Rogers, 2003). They are (a) respected by peers, (b) a more integrated part of the social system, (c) opinion leaders, (d) role models for other members of the social system, and (e) less price sensitive than the rest of the market. Rogers (2003) identifies this segment in the context of radical innovations, where such innovations have a relative advantage compared to extant products but are more complex and less compatible with current practices. Hence, the notion of 'early adopters' is useful when firms introduce radical innovations targeted at the mainstream market. The opinions of early adopters in such a market may then influence the rest of the mainstream market. The 'niche' customer segment that initially finds a disruptive innovation attractive differs from the 'early adopter' segment in two respects: (a) the niche customer segment has not been described as one that could influence the rest of the mainstream market, either via their opinion leadership or by being role models, and (b) the niche segment, unlike early adopters, is typically more price sensitive than the rest of the market.

More importantly, introducing radical innovations (which first attract the early adopters in a mainstream market) does not pose a dilemma for incumbents because such firms know the early adopters eventually will spread the word to the rest of the market. On the other hand, there are five reasons why disruptive innovations create a dilemma for incumbents:[3] (i) the mainstream market does not value the innovation's particular package of performance attributes at the time of product introduction; (ii) the innovation performs poorly on the attributes mainstream customers value; (iii) the innovation is first introduced in an emerging or insignificant niche market; (iv) there is not necessarily a word-of-mouth effect, or opinion leadership, or respect among peers at play for the niche customer segment that finds disruptive innovations attractive; and (v) the disruptive product offers a lower margin and may therefore be ignored by incumbents who are serving larger and more attractive segments. The above notion of disruption is consistent with Christensen and Raynor (2003), who identify two types of disruptions: 'new-market disruptions' and 'low-end disruptions,' where, respectively, either a new customer segment or the more price-sensitive mainstream market may see value in the innovation when the product is introduced.

METHOD AND MEASURES

Studies in the innovation area focus at the strategic business unit (SBU) level within a diversified firm (e.g., Gatignon *et al.*, 2002; Srinivasan *et al.*, 2002). Accordingly, we follow a similar approach in this paper. We contacted 38 *Fortune* 500 corporations that were part of a corporate sponsorship and recruiting program at a leading U.S. business school. Based on an explanation of our study, we were given the names of 330 relevant senior executives of SBUs from the 38 companies. Since all our respondents were either vice presidents or general managers, they were knowledgeable about the nature of innovations introduced by their respective SBUs. We received 199 completed surveys, yielding a response rate of about 60.3 percent, a relatively high rate considering our respondents were senior-level executives. Further, we found no significant difference between the respondents and the nonrespondents with respect to such corporate characteristics as sales and employees. Our sample covered seven industry sectors: technology (13% of sample), pharmaceuticals (10.5%), light manufacturing (25%), heavy manufacturing (15%), consumer goods and retailing (14.5%), energy (13%), and financial services (9%). Average annual corporate sales ranged from $8.8 billion to $112.9 billion;

[2] We thank an anonymous reviewer for crystallizing the description of disruptive innovations and for suggesting the use of Canon's inexpensive tabletop copiers as an example of disruptive innovations in our survey instrument.

[3] We thank an anonymous reviewer for helping us clarify and distinguish 'niche' segments in the disruptiveness discussion from the 'early adopters' in the innovation diffusion literature.

average number of corporate employees, 32,964 to 119,035; and average number of SBU employees, 659 to 2627.

Following Churchill (1979), we used a multistage process to build the scale for measuring disruptiveness of innovations (see Appendix). First, we constructed the five-item scale based on the descriptions of disruptiveness provided by Abernathy and Clark (1985), Adner (2002), Christensen (1997), and Christensen and Raynor (2003). Next, to assess content/face validity, we discussed the scale with five scholars in the innovation field, and, based on their comments, we reworded the scale items. The scale was then pilot tested in two stages. In the first stage, the scale was tested with a sample of 35 senior executives for clarity, relevance, and the description of disruptiveness. The scale items were then reworded based on their feedback. Next, we pilot tested the scale with another set of 128 senior executives. In both pilot tests, the respondents read the description of a disruptive innovation, which was illustrated with an example, and then responded to the corresponding scale items. While the coefficient alphas for the proposed five-item scale in both pilot tests were above the cut-off level of 0.70, we further refined the instrument based on professional feedback from other scholars in the innovation area. The responses from both pilot tests were not included in our final analyses of reliability and validity (see Appendix for the disruptiveness measure). For measuring the radicalness of innovations and the competency-destroying characteristics, we chose four items each from Gatignon *et al*. (2002).

Assessing reliability and validity

Following the procedure used by Gatignon *et al*. (2002), we assessed the reliability, convergent, discriminant, and nomological validity of the disruptiveness characteristic as follows: (1) We determined the coefficient alphas and the average inter- and intra-construct correlations, a first-level diagnostic procedure for reliability. (2) We performed exploratory factor analysis, a multivariate approach to understand the factor structure and the corresponding measurement quality, i.e., establishing unidimensionality of the various constructs and discriminant validity. (3) We conducted confirmatory factor analysis, which tested the proposed measurement model. (4) To establish the discriminant validity of the constructs, we estimated multiple confirmatory factor analyses and conducted three additional statistical tests described later in the paper. (5) To assess nomological validity, we examined the relationship of the different innovation types with (a) an SBU's future market focus, (b) the per unit gross margin of innovations relative to extant products, and (c) the number of disruptive innovations.

Reliability measures

The respective coefficient alphas for radicalness, disruptiveness, and competency-destroying characteristics of innovations are 0.89, 0.82, and 0.82, all of which are greater than 0.70 (Nunnally, 1978). Further, we computed the average inter- and intra-construct correlations based on all the corresponding item-to-item correlations and found the average intra-construct correlations (ranging from 0.31 to 0.57) to be noticeably much higher than the average inter-construct correlations (ranging from 0.13 to 0.20). Note that all correlations used to compute the average intra-construct correlations were significantly different from zero ($p < 0.001$), while many of the correlations used to compute the average inter-construct correlations were not significantly different from zero (for example, 36 of the 56 correlations were not significant at the 1% level). As a first cut, this establishes the internal consistency and reliability of the three scales used, as well as the corresponding discriminant validity of the constructs.

Exploratory factor analysis

Next, we conducted a principal component analysis with Varimax rotation of the 13 items. The results of the varimax rotation reinforce the expected pattern (see Table 1). Three factors emerged with eigenvalues greater than one and represent radicalness, competency-destroying, and disruptiveness characteristics. All relevant factor loadings are greater than, or equal to, 0.5, a very conservative cut-off level (Hair *et al*., 1995), and the percentage variance explained by the three factors are 21.5, 18.1, and 18.0 respectively. Thus, these results further demonstrate the discriminant validity of the disruptiveness construct from the other two measures.

Table 1. Results of principal component analysis[a]

Items	Varimax rotation loadings ($n = 199$)			Percent variance explained
	Factor 1 (Radicalness)	Factor 2 (Disruptiveness)	Factor 3 (Competency destroying)	
Minor improvement over previous technology*	**0.67**	0.03	0.20	21.5
Breakthrough innovations	**0.87**	0.20	−0.01	
Difficult to replace with older technology	**0.83**	0.17	0.05	
Major technological advance	**0.83**	0.18	−0.01	
How disruptive	0.23	**0.72**	0.06	18.1
Rarely introduces disruptive*	0.19	**0**.77	0.02	
Lags behind in disruptive*	0.11	**0.74**	−0.03	
Attractive to a different customer segment	−0.00	**0.50**	0.19	
Mainstream customers found the innovations attractive	0.10	**0.51**	0.21	
Built on prior technological skills*	−0.04	0.06	**0.79**	18.0
Built on existing experience*	0.06	0.16	**0.82**	
Rendered experience base obsolete	0.30	0.22	**0.51**	
Built on existing technological knowledge*	0.05	0.03	**0.82**	

[a] Items with an asterisk are reverse-scaled and have been recoded accordingly. Loadings on a relevant factor are shown in bold.

Confirmatory factor analysis[4]

Here we test whether the data support the three-factor structure proposed in this paper and examine whether the proposed factor structure is different from alternate structures (see Table 2). We estimated all the error variances as well as the covariances among the three factors. All the factor loadings are high (ranging from 0.38 to 0.87) and quite significant ($p < 0.001$). Further, in all cases, the three-factor solution provided a significantly better fit ($p < 0.01$) relative to either a single-factor solution or the three possible two-factor solutions, suggesting discriminant validity. Moreover, the distribution of standardized residuals was symmetrical around zero and contained no large residuals. While requiring the model chi-square to be non-significant is an excessively stringent test in most applied situations, we find the chi-square value is indeed insignificant at a 1 percent level, indicating the measurement model provides a good fit to the data.

The composite reliability indices, which are analogous to coefficient alpha and reflect the internal consistency of the indicators measuring a given factor (Fornell and Larcker, 1981), ranged from 0.71 to 0.85. Equally important, the various fit indices were all satisfactory (see Table 2), e.g., GFI of 0.94, Bentler's comparative fit index (Bentler, 1989) of 0.96, and root mean square residual of about 0.069 and root mean square error approximation of 0.047 (both of which are quite low). All the above results indicate a reasonable fit of data to the model. Finally, the variance extracted by each factor, which assesses the amount of variance captured by the underlying factor in relation

[4] The number of parameters estimated in our measurement model is 29. Our sample size of 199 well exceeds the minimum recommended ratio of five observations per parameter to be estimated (Bentler and Chou, 1988).

Table 2. Confirmatory factor analysis results ($n = 199$)[a]

Construct and indicators	Standardized loading	t-value	Composite reliability (variance extracted)	Fit measures
Radicalness				
Minor improvement*	0.567	8.2	0.85 (0.58)	
Breakthrough innovations	0.870	14.4		
Difficult to replace	0.790	12.6		
Major technological advance	0.794	12.7		
Disruptiveness				Goodness of fit index = 0.938
How disruptive	0.686	9.5	0.71 (0.36)	Adj. GFI = 0.908
Rarely introduces disruptive*	0.749	10.5		Root mean squared residual = 0.069
Lags behind in disruptive*	0.605	8.2		Root mean squared error approximation = .047
Attractive to a different segment	0.376	4.8		Chi-square (d.f.) = 88.8 (62)
Mainstream customers found attractive over time	0.418	5.4		p-value = 0.014
Competency destroying				Bentler's comparative index (Bentler, 1989) = 0.965
Built on prior technological skills*	0.666	9.4	0.76 (0.48)	Bentler and Bonnet's non-normed index = 0.955
Built on existing experience*	0.823	11.9		
Rendered experience base obsolete	0.464	6.2		
Built on existing technology*	0.700	10.0		

Chi-square difference tests

Model	Chi-square (d.f.)	p-value	Difference in chi-square from full model (difference in d.f.)	p-value for chi-square difference test
1. Full model with $\phi_{R,D} = 1$	200.5 (63)	<0.0001	111.7 (1)	$p < .001$
2. Full model with $\phi_{R,C} = 1$	260.8 (63)	<0.0001	172.0 (1)	$p < .001$
3. Full model with $\phi_{D,C} = 1$	221.2 (63)	<0.0001	132.4 (1)	$p < .001$

Confidence-interval tests

Correlations among constructs in full model	Standard error	95% confidence interval
Correlation between radical and disruptiveness = 0.483	0.072	[0.340, 0.626]
Correlation between radical and competency destroying = 0.169	0.083	[0.003, 0.334]
Correlation between disruptiveness and competency destroying = 0.130	0.085	[0.130, 0.470]

[a] Items with an asterisk are reverse-scaled and have been recoded accordingly in the analysis.

to the amount of variance due to measurement error, ranged from 0.36 to 0.58.

Discriminant and convergent validity

Following Bagozzi, Yi, and Phillips (1991), we assessed the discriminant and convergent validity of the disruptiveness construct apart from that of the radicalness and competency-destroying constructs by conducting the following three tests: In the first test, we (i) estimated the standard measurement model in which all factors were allowed to covary, (ii) estimated a new measurement model identical to the previous one, except the correlation between any two factors was fixed at one, and (iii) computed the difference in chi-square values between (i) and (ii). The resulting changes in chi-square values were all significantly different from zero ($p < 0.001$, Table 2). Second, we calculated the confidence interval of plus or minus two standard errors around the correlation between the factors and determined whether this interval includes 1.0. If it does not include 1.0, discriminant validity is demonstrated (Anderson and Gerbing, 1988). As seen in Table 2, none of the three confidence intervals include 1.0 in our analysis. Finally, discriminant validity is assessed with a variance-extracted test, where we compared the variance-extracted estimates for the two factors of interest with the square of the correlation between the two factors. Discriminant validity is demonstrated if the variance-extracted estimates are greater than the corresponding squared correlation (Fornell and Larcker, 1981; Netermeyer, Johnston, and Burton, 1990). We find that all the variance-extracted estimates are greater than the corresponding squared correlations. Therefore, the above three tests fully support the discriminant and convergent validity of the three constructs tested in this study.

Nomological validity

The final common criterion for construct validity is nomological validity—i.e., the degree to which the construct, as measured by a set of indicators, predicts other variables or constructs in a way that is consistent with *a priori* expectations about how the new construct should affect the predicted variable or variables (Peter, 1981). We establish the nomological validity of the disruptiveness construct via two ways. First, we examined the correlation of the disruptiveness scale with executives' responses to the question about the percentage of an SBU's current total sales derived from disruptive innovations that the SBU had introduced in the past 5 years. The correlation was positive and significant (0.39, $p < 0.001$). Second, we conduct hypothesis testing in a multivariate setting. Here, we consider the following three variables, which we predict would be positively related to disruptive innovations but not with radical or competency-destroying innovations: future market focus at an SBU (as measured by Srinivasan *et al*., 2002), lower per unit gross margin of innovations relative to existing products, and the number of disruptive innovations by an SBU during the past 5 years. The future market focus at an SBU captures the extent to which that SBU is oriented toward customers of the future. Introduction of disruptive innovations by an SBU would suggest a future market focus at that SBU due to the following. (i) Disruptive innovations target a different customer segment relative to the current (mainstream) customer base. An SBU that targets innovations that appeal to new customers suggests the SBU is oriented toward new or future customers. (ii) While disruptive innovations attract a different customer segment at the time of their introduction, over time, the mainstream customers see the benefit in such innovations. Implicitly, the introduction of such innovations shows that the SBU may indeed be keeping track of mainstream customers' future needs. The link between the disruptiveness measure and the number of disruptive innovations at an SBU is evident. Due to the lower price of disruptive innovations relative to extant products, we expect a positive relationship between the disruptiveness measure and the lower per unit gross margin of such products.

We do not expect radicalness and competency-destroying innovations to be significantly related to future market focus, lower per unit margin, and the number of disruptive innovations because such innovations (i) may be built either for current or future customers, (ii) may have either a lower or higher per unit gross margin, and (iii) could be either disruptive or non-disruptive. These hypotheses were tested using three multiple regressions, where 'future market focus,' 'lower per unit gross margin relative to existing products,' and 'number of disruptive innovations' were the three dependent variables, and radicalness, disruptiveness, competency-destroying characteristics, and the corresponding three interactions

were the independent variables in each regression. The respective R^2 ranged from 0.06 to 0.16. In the analysis, for each multi-item construct, the averages were computed across the items after recoding the reverse-scaled items, if any. We found that only the disruptiveness of innovations exhibits a significant ($p < 0.05$, two-tailed) positive impact on all three variables of interest, while the other two innovation characteristics do not exhibit a significant ($p > 0.10$) effect.

DISCUSSION

Any attempt at theory construction in the field of innovation, in areas such as marketing, strategy, and operations, must encompass reliable and valid measures for key innovation characteristics. Yet, with respect to an important construct, i.e., disruptiveness of innovations, there is neither a psychometrically valid measure nor an assessment of the convergent and discriminant validity of the disruptiveness characteristic from those of other characteristics, such as radicalness or competency destroying. In this paper, we develop a scale for the disruptiveness of innovations. In order to test its reliability and discriminant, convergent, and nomological validity, we collected data from senior executives at 199 SBUs in 38 *Fortune* 500 corporations and performed a series of analyses. The reliability measures, exploratory and confirmatory factor analyses, and the subsequent tests strongly support our scale.

According to Hatcher (1994), the reliability and discriminant and convergent validity of a construct is established when the measurement model conforms to the following: (i) the p-value for the chi-square test should be non-significant, say, greater than 0.01; (ii) the ratio of chi-square to degrees of freedom should be less than two; the comparative fit index (CFI) and the non-normed fit index (NNFI) should both exceed 0.90; (iii) the absolute value of the t-statistics for each factor loading should exceed 1.96; (iv) the distribution of normalized residuals should be symmetrical and centered on zero, and relatively few normalized residuals should exceed 2.0 in absolute value; (v) composite reliabilities for the latent factors should exceed 0.6; (vi) covariance-extracted estimates for the latent factors should exceed 0.50; and (vii) discriminant validity for pairs of factors should be demonstrated. While fulfilling all seven above characteristics is a stringent test, our confirmatory factor analysis and the corresponding tests indicate almost all of the characteristics of an 'ideal fit' for the measurement model are indeed met.

Implications for research

Using our measure of disruptiveness, it would be possible to conduct a large-scale study to examine a central question: What determines whether incumbents fail or succeed in the face of disruptive technology? Given the added precision of measuring the disruptiveness of innovations, future research can also examine the antecedents and consequences of different types of innovations. First, researchers would be equipped to examine the relationships between organizational capabilities and innovation characteristics. Literature on the resource-based view of the firm recognizes the importance of building unique capabilities to drive innovations (Teece, Pisano, and Shuen, 1997). For instance, consider an SBU's ability to gather information on its mainstream customer needs and examine solutions that meet those needs. One could argue such a capability is critical to the successful introduction of radical innovations, detrimental to disruptive innovations, and neutral in the case of competency-destroying innovations. Future research could uncover how customer orientation capability, as described above, and other capabilities, such as technology sensing and responding, differ across innovation characteristics.

Second, akin to Sorescu, Chandy, and Prabhu (2003), future research will be able to examine the performance implications of the three innovation characteristics. Gatignon *et al.* (2002) found innovations that build on existing competencies are more rapidly introduced and are positively associated with commercial success, particularly when they are incremental. Christensen (1997) and others suggest that disruptive innovations are much more difficult for incumbents to introduce. This study will help future research address key questions, such as whether disruptive innovations are more profitable than, say, radical or competency-destroying innovations, and whether there are performance differences across disruptive innovations developed internally versus those developed through alliances, joint ventures, or acquisitions.

Another avenue for fruitful research is to apply the considerable knowledge gained from prior research, in areas such as the new product development process (Mahajan and Wind, 1992), product design and customer feedback (Griffin and Hauser, 1993), and new product concept techniques (Dahan and Srinivasan, 2000), to the context of developing and introducing disruptive innovations. For example, considering the high failure rate of new products (Goldenberg, Lehmann, and Mazursky, 2001), particularly in the consumer packaged goods industry, future research might examine how to identify future customers and use the feedback from them in developing new product concepts that are disruptive in nature.

Finally, an analysis of the data from the pilot test and the final sample suggests that there are wide and interesting industry-level differences in innovation characteristics. For example, heavy manufacturing and consumer non-durables really stand out with respect to a lack of radicalness, disruptiveness, and competency-destroying innovations. On the other hand, there are significantly more disruptive and radical innovations in technology and telecommunication industries relative to consumer non-durables. Interestingly, the innovations in the pharmaceutical industry are quite radical in nature relative to the consumer non-durables industry but not more disruptive. Thus, future research can examine the fundamental sources of variation in innovation characteristics across different industry sectors.

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APPENDIX: MEASURING DISRUPTIVENESS OF INNOVATIONS

(All items use 7-point, strongly disagree/strongly agree scales, unless otherwise specified. Items with an asterisk are reverse-scaled and have been recoded accordingly in the analysis.)

In this survey, for brevity, we refer to 'product, process, and service' innovations as 'product' innovations. In your responses, please consider only those innovations that have already been commercially introduced by your strategic business unit (SBU) during the past five years.

Disruptive product innovations (mean = 3.84, S.D. = 1.07, coefficient alpha = 0.82)

Description: A *disruptive* innovation *introduces a different set of features* and *performance attributes relative to the existing products* and is offered at a *lower price*, a combination that is *unattractive to mainstream customers* at the time of product introduction due to inferior performance on the attributes that mainstream customers value. *However, a new customer segment (or the more price-sensitive mainstream market) sees value in the innovation's new attributes and the lower price. But, over time, subsequent developments raise the new product's attributes to a level that is sufficient to satisfy mainstream customers*, thus potentially attracting more of the mainstream market.

Canon's introduction of slower but inexpensive tabletop photocopiers in the late 1970s relative to Xerox's high-speed big copiers is an example of disruptive innovation. The tabletop copiers were rapidly accepted by small businesses and individuals who appreciated the convenience and price despite poor resolution. At the time of their introduction, the mainstream market (larger companies) still preferred the large copiers because of speed, resolution, collation, etc. However, over time, further developments in small copiers have allowed Canon to improve quality, speed, and features and offer them at a price point that is sufficient to satisfy the needs of mainstream market.

1. In your opinion, how disruptive were your SBU's new product introductions during the past 5 years? Not Very Disruptive/Very Disruptive. (Mean = 3.28, S.D. = 1.62)
2. This SBU rarely introduces products that are disruptive in nature.* (Mean = 3.50, S.D. = 1.65)
3. This SBU lags behind in introducing disruptive product innovations.* (Mean = 3.85, S.D. = 1.63)
4. During the past 5 years, the new products that were introduced by this SBU were very attractive to a different customer segment at the time of product introduction. (Mean = 3.99, S.D. = 1.59)
5. During the past 5 years, the new products that were introduced by this SBU were those where the mainstream customers found the innovations attractive over time as they were able to satisfy the requirements of the mainstream market. (Mean = 4.57, S.D. = 1.42)