



The role of an entrepreneurially alert information system in promoting corporate entrepreneurship

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ABSTRACT

The literature has suggested that an entrepreneurially alert information system may be a salient driver of corporate entrepreneurship, even though this role has been neither theoretically articulated nor empirically substantiated. Building upon the organizational learning, information orientation, and entrepreneurial awareness literatures we identify three key elements of a firm's entrepreneurially alert information system, and then develop a parsimonious model that examines the impact of these elements on corporate entrepreneurship. Using both single- and multi-source survey data from 495 small- to medium-sized firms, we test our model and find that each element individually and collectively imparts significant positive influence on corporate entrepreneurship.

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Entrepreneurial alertness, a concept originating in the theories of Kirzner (1973) and the “Austrian School” of economics, has for decades been viewed as playing a key role in the discovery and evaluation of economic opportunities by individuals (Busenitz, 1996), groups (Mosakowski, 1998), and firms (Kirzner, 1997; Zaheer and Zaheer, 1997). Indeed, such alertness might help explain why some firms are more apt than others to engage in corporate entrepreneurship, i.e. the sum of a firm's innovation, venturing, and strategic renewal efforts directed at advancing new opportunities for the firm to use or expand its resources (Zahra, 1996). Because advantageous information-seeking behaviors are at the very core of alertness, firms that are alert should be better able to recognize and exploit information asymmetries, what Kirzner (1997) refers to as “entrepreneurial arbitrage,” and parlay it into greater corporate entrepreneurship. In particular, those firms with entrepreneurially alert information systems are in possession of advantageous knowledge about the expected value of their resources, as well as how those resources might be innovatively transformed into new products and services and, therefore, are better prepared to capture nascent opportunities in the marketplace. Consequently, our thesis is that the alertness of a firm's information system, i.e. its ability to proactively acquire, process, and exploit valuable market information, is an essential precursor of corporate entrepreneurship.

However, while this view may be intuitively compelling, research on the role of an entrepreneurially alert information system has been limited, largely because there is much about the entrepreneurial alertness construct, in terms of conceptual development, measurement, and testing that remains vague. Despite some early attempts at conceptualizing this construct at the individual level of analysis, notably by Busenitz (1996) and Gaglio and Katz (2001), there have been no attempts at doing so at the firm level. In fact, Gaglio and Katz (2001) characterized this line of inquiry as a scattering of descriptive studies that were individually interesting but did not encourage the accumulation of findings or development of theory. As an aside, while Zaheer and Zaheer invoked the term “entrepreneurial alertness” as a way to describe a firm's information-seeking behaviors which are in “a state of proactive attentiveness to environmental signals” (1997: 73), they did not directly measure or test this construct.

In order to identify key elements of an entrepreneurially alert information system, we integrated the literatures on organizational learning, information orientation, and entrepreneurial awareness. These literatures broadly view a firm's information processing system as being a function of three subsystems, technology, a system of managerial authority, and a social community with values and norms. However, given the abundance of inexpensive information technology, we primarily focus on the latter two subsystems by emphasizing the management of the system as well as the organizational values and norms of those who utilize the system because, at the margin, they are more likely to impact alertness. Indeed, as Huber (1991) suggests, a firm's information system is critical to the firm's functioning, precisely because it can be utilized to monitor and scan the

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organizations internal and external environments, transmit the resulting observations and interpretations to strategic decision-makers, and relay the progress and results of implementing new decisions to all organizational members.

Consequently, we conceptualized an entrepreneurially alert information system as a latent firm-level construct, which emanates from and is enhanced by three key elements: (1) *strategic utilization*, or the frequency that a firm uses its information system in making strategic decisions; (2) *market sensing orientation*, or the type of marketplace information that the firm's information system is focused on gathering; and (3) *user proactiveness*, or the extent to which organizational members recognize, value, and understand the importance of proactively contributing new marketplace information to the system. With this more encompassing and multidimensional conceptualization of an entrepreneurially alert information system, we propose and then test a rationale for why each element is a salient driver of corporate entrepreneurship. Using both single- and multi-source survey data from 495 small- to medium-sized firms (SMEs), our findings demonstrate that all three elements are positively associated with corporate entrepreneurship, and that the second-order modeling of these three elements explains additional variance in the firm's pursuit of corporate entrepreneurship.

1. Theory and hypotheses

1.1. Strategic utilization

A firm's information system is comprised of technical hardware, like computer systems and telecommunications networks, and technical software. These technologies can be used to support a firm's operations, business processes, innovation efforts, as well as strategic decision-making. They do so by not only improving the speed at which relevant internal (enterprise-specific) and external (market-specific) information is gathered, analyzed, and forecasted, but also by facilitating the codification of large and disparate amounts of information rendering it more intelligible and more readily accessible to senior management (Tippins and Sohi, 2003). Consequently, "many firms are employing the latest information technology as a set of knowledge-management tools" (Nonaka et al., 2001).

But, can a firm's information system promote entrepreneurial alertness, and in turn, corporate entrepreneurship? The evidence to date is both indirect and ambiguous. Some researchers have suggested a link between a firm's investment in information technologies and its business-level strategies (e.g., Sambamurthy et al., 2003). Others, however, question whether the amount invested alone improves the likelihood that managers will choose performance enhancing strategies, for the amount invested in the information system does not guarantee that it will be correctly deployed and effectively leveraged (Devaraj and Kohli, 2003). Moreover, because relatively low cost information technology is ubiquitous today, the amount invested *per se* is more likely to play a diminished explanatory role.

Consequently, a few researchers have begun to focus on the frequency that information provided by the system is utilized by senior management to support strategic choices. They argue that for firms to be able to improve their strategic understanding by analyzing environmental information, that information must first be available to managers, for "it is information about the organization's environment, as contrasted with the environment itself, which constitutes the raw material of organizational communications and actions" (Huber and Daft, 1987:30). Thus, while a firm's information system represents the latent capacity of firms to codify, capture, and store entrepreneurially relevant information, it is the strategic utilization of that system, or the frequency that managers use the system in making strategic decisions, that captures the firm's capability for sharing, synthesizing, and applying that information to entrepreneurial ends.

Essentially, a firm's information system, if strategically utilized, can promote entrepreneurial alertness and actions by efficiently filtering, sorting, routing, and, even contextualizing relevant information for senior managers. Leonard-Barton offers a complementary view point by noting that through years of actively accumulating, codifying, and structuring individuals' knowledge and skills into the technical aspects of an information system, "the whole technical system is greater than the sum of its parts" (1992: 113). And, from an information processing perspective, strategic IT utilization facilitates firm-level absorptive capacity (Zahra and George, 2002); that is, the routines and systems that allow firms to analyze, process, interpret, and understand the information obtained from external sources.

Conversely, we infer from Janis (1989) work on executive level decision-making that when this information source is underutilized or the information from it made hard to access, senior managers will show a greater tendency to engage in selective bias in utilizing whatever information that is immediately at hand. As such, these managers will be prone to perceive higher levels of uncertainty and risk (Fischer et al., 2000), and, in turn, become more risk averse and less inclined to encourage corporate entrepreneurship. Indeed, without relevant, rich, and timely supporting information, senior managers are likely to experience an increase of anticipatory regret (Fischer et al., 2000), which has the effect of deterring them, from "seizing upon a seemingly attractive opportunity" (Janis and Mann, 1977: 219). Therefore, it follows that,

Hypothesis 1. The frequency that senior managers utilize information developed by the firm's information system to make strategic decisions will be positively associated with the firm's pursuit of corporate entrepreneurship.

1.2. Market sensing orientation

Market sensing orientation represents a second element of a firm's entrepreneurially alert information system. Whereas strategic utilization deals with the frequency that senior managers use its information system in making strategic decisions, market sensing orientation deals with the system's focus; specifically, the type of market information that is gathered by the system, how that information is interpreted, and the knowledge derived from those interpretations (Marchand et al., 2000). Choo (1998) defines sensing as the firm's active seeking, absorbing, and interpreting of information, events, and trends in the competitive environment. Hence, contrary to "scanning," which involves a search for both internal and external sources of information focused on the narrow needs of a particular problem, market sensing is more about actively listening, detecting, and identifying, with broader and deeper noticing capabilities for new questions and new answers. As Day (1994) argues, market sensing involves open-minded inquiry, rather than simply looking for information to confirm pre-existing beliefs about the market.

Viewed accordingly, the knowledge-based concept of market sensing is analogous to the concept of intrusiveness, which Daft and Weick (1984) consider to be the driving force in the organizational adaptation process. Thus, a central mechanism through a marketing sensing orientation is likely to confer upon the firm an adaptive advantage via strategy makers' knowledge of environmental conditions. The logic is that higher levels of this orientation result in more accurate appraisals of the environment, which, in turn, enable timely and appropriate action. Organizations that actively intrude into their environments perform trials in order to learn what an error is, and discover what is feasible by testing presumed constraints (Daft and Weick, 1984: 288). Consequently, they develop more insightful interpretations and more informed decisions than do organizations that passively base their actions on whatever environmental information that happens to come their way. Said differently, firms with a market sensing oriented information system should be better at

discovering and assembling information about emerging opportunities, which should result in increased entrepreneurial alertness. It follows that a market sensing orientation is important to the firm's pursuit of corporate entrepreneurship because it is one of the first links in the chain of perceptions and actions that permit the firm to adapt to its environment. Thus:

Hypothesis 2. The market sensing orientation of the firm's information system will be positively associated with the firm's pursuit of corporate entrepreneurship.

1.3. User proactiveness

A firm's social system of informational norms and values represents the firm's tacit normative beliefs as to why information is gathered, analyzed, and interpreted the way that it is. Such beliefs are part of a firm's taken-for-granted reality, a feature of the employees' cognitive framing, which guides the mental pathways by which they decide what is, and what is not, important. According to Leonard-Barton (1992), these norms and values represent the accretion of decisions made over time in response to the interpretation of organizational roles. She also notes that although this characteristic of a firm's information system is often overlooked in the literature, "understanding it is crucial to managing both new product/process development and core capabilities" (Leonard-Barton, 1992: 113). Accordingly, we view user proactiveness as a third key element of a firm's entrepreneurially alert information system.

Various aspects of informational norms and values have been proposed as important. For example, Davenport (1994) introduced the notion of human-centered information culture to describe how organizations actually go about acquiring, sharing, and making use of information. Information culture broadly represents specific organizational norms and practices guiding the patterns of information sharing, dissemination, and usage. Similarly, Marchand et al. (2000) define it as the capability of the firm to instill and promote behaviors and values in its people for effective use of information. And by integrating these definitions, Zheng (2005) defines it as an understood set of rules of behavior, with regard to accessing, understanding, and using information in a social collectivity.

Clearly then, a proactive set of norms and values as evidenced by the efforts of the system users to actively seek out new information about changes in their competitive environment, and to think about how such information could enhance existing products and services as well as create new products and services, is critical to an entrepreneurially alert information system. When such behavior is embedded in an organizational context, system users become bottom-up contributors to the relevant information needed to enhance existing products and services, as well as key informants with regard to new products and services and the relevant actions and decisions required to capture entrepreneurial opportunities. As such, their proactive behaviors become a third important source of entrepreneurially alert knowledge in a firm's information system. Moreover, when system users recognize and value the importance of proactively contributing externally oriented marketplace information to the system, without being prompted or required by formal governance mechanisms, they can endow the firm with a "capacity to act" (Marchand et al., 2000) and with a timely "responsiveness" (Kohli et al., 1993) that enhance and leverage entrepreneurial actions. In contrast, firms without such user proactiveness are more inclined to focus on a limited internal information set that is relatively routine, familiar, and past-oriented. Thus,

Hypothesis 3. The extent to which the firm's information system users proactively contribute new information to the system will be positively associated with the firm's pursuit of corporate entrepreneurship.

2. Methodology

2.1. Sample and data collection

To test our model, we chose SMEs (i.e., firms employing 20 to 500 individuals) as our sampling frame, partly because they represent a vital component of most nations' economies. In the U.S. alone, SMEs are, by far, the most common form of business organization. Yet, despite their ubiquity, SMEs tend to be more difficult to research, primarily due to the fact that objective data about them are not readily available in the public domain. More importantly, we chose SMEs because firms of this size generally have fewer hierarchical levels. Their top managers are, therefore, more likely to play both strategic and operational roles, making them well informed about "strategic issues that explicitly entail organization-wide or external focus" (Sharfman, 1998: 6), like their firm's information system and entrepreneurial activities.

Because our tested model entails a complex array of multiple latent constructs and numerous structural relationships, testing them requires a large sample of firms for statistical validity. To that end, following Huber and Power's (1985) guidelines for improving the accuracy of reports gathered from key respondents, and Simsek and Veiga's (2000) guidelines for web-based surveys, we collected data from member firms of the National Federation of Independent Business (NFIB). NFIB is the nation's largest SME advocacy organization. We sent a link to our web-based survey in an e-mailed cover letter, from the NFIB president, to the CEOs of all 5957 manufacturing and service firms with 20 to 500 employees.

After three follow-up reminder emails conducted over two months, we received responses from 632 CEOs, for a response rate of 11%, which is consistent with the 10–12% response rate typical for mailed surveys to top executives. In the final data set, we excluded 6 firms with incomplete data and 84 firms where the CEOs indicated current employment numbers that differed from that listed in the NFIB data files, specifically when the firm no longer fit the size criterion of an SME. This yielded a final sample of 495 firms – 47.5% in the service industry and the remainder in the manufacturing sector. Our sample's mean firm size is 70 employees, with a mean firm age of 44 years. The average CEO was 52 years of age, with 14 years tenure in the position, having been employed by their firm for 20 years, and having had 25 years of industry experience.

Given the nature of our data collection method, respondents were asked to assess all firm-level variables using the previous three years, on average, as a reference point. We framed responses in this way in order to avoid respondents assuming some limited, unspecified timeframe, and to more completely capture the more generalized trends that their firms were experiencing. Of course, reliance on single respondents may introduce common method bias in our study. Therefore, we took several recommended steps (described in a later section and presented in Appendix A) to mitigate, detect, and control for this bias, and found no traces of it. We also ran a series of robustness tests, presented in Appendix B, which suggested the robustness of our core findings.

Following Armstrong and Overton (1977), we assessed the likelihood of non-response bias using the extrapolation technique, wherein early respondents were compared to late respondents, with late respondents being assumed to be similar to non-respondents. We then compared these groups in terms of the mean responses on each variable and found no significant differences, leading us to conclude that non-response bias was not a likely threat.

2.2. Measures

While firm-level entrepreneurial activities have been conceptualized in different ways, we focus on corporate entrepreneurship because it has been used to comprehensively capture a firm's actual entrepreneurial

behaviors. Based on Zahra (1996), we measured a firm's level of corporate entrepreneurship over the last three years as a three dimensional, latent meta-construct represented by 16 items rated on a five-point scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). The first, the *innovation dimension*, was a 5-item measure, and included, for example, initiatives such as introducing a large number of new products to the market and pioneering the development of breakthrough innovations in the industry. Results from confirmatory factor analysis (CFA) indicated that, with the exception of one item which we dropped from the subsequent analyses, the relationship between each indicator variable and the latent construct was statistically significant ($p < .001$), verifying the posited relationships among indicators and the construct. Cronbach's alpha was .85. The second, the *venturing dimension*, was also a 5-item measure and included, for example, activities such as entering new markets and finding new niches in current markets. Results from CFA indicated that, with the exception of one item which, again, we dropped from subsequent analyses, the relationship between each indicator variable and the latent construct was statistically significant ($p < .001$). Cronbach's alpha was .77. Finally, the third, the *renewal dimension* measured (via 6 items) the extent to which a firm, during the last three years, refocused its capabilities, strategy, structure, etc., and included, for example, redefining the industries in which it competes and introducing innovative human resource programs. Results from CFA indicated that, again, with the exception of one item, which we then dropped, the relationship between each indicator variable and the latent construct was statistically significant ($p < .001$). Cronbach's alpha was .78. Although the validity of the *corporate entrepreneurship* measure has been established in prior research, we nevertheless took two additional steps to ensure its measurement validity including correlating it with the entrepreneurial orientation scale ($r = .63$, $p < .001$) and interrater reliability in our multi-source sample (.80 $p < .001$).

Guided by the works of Huber (1991), Leonard-Barton (1992), and Marchand et al. (2000), we developed measures to capture each of the three key elements of an entrepreneurially alert information system. Specifically, *strategic utilization* was measured by asking CEOs to assess how frequently, over the previous three years, had senior management based strategic decisions on information developed by their information system involving: (1) proactive marketplace responses; (2) analyses of uncertain business situations; (3) defending market position; (4) difficult decisions; (5) forecasting trends and anticipating changes in business conditions; and (6) assessing business risks. Respondents used a five-point frequency scale from 1 ("to a little extent") to 5 ("to a great extent"). Results from CFA indicated that the relationship between each indicator variable and the latent construct was statistically significant ($p < .001$). Cronbach's alpha was .91.

Next, market sensing orientation was measured by asking CEOs to assess the extent to which their information system, over the past three years, was focused on gathering information that: (1) anticipated market shifts and changes in customer demands; (2) anticipated changes in competitive strategies and methods; (3) assembled pieces

of information from the business environment into a coherent picture; and (4) predicted external and internal forces that may impact the future effectiveness and efficiency of the organization. Respondents used a five-point scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Results from CFA indicated that the relationship between each indicator variable and the latent construct was statistically significant ($p < .001$). Cronbach's alpha was .87.

Finally, user proactiveness was assessed by asking CEOs to assess the extent to which organizational members, during the past three years, contributed new information to the system by: (1) seeking out new information about changes and trends in the company's business environment; (2) thinking about how to use new information to create or enhance products and services; (3) wanting to use new information to make better decisions and do their jobs better; (4) helping others to use new information so others will make better decisions and do their jobs better; and (5) using new information to respond quickly to changes in the competitive environment. Respondents used a five-point scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Results from CFA indicated that the relationship between each indicator variable and the latent construct was significant ($p < .001$). Cronbach's alpha was .93.

2.3. Covariates

Research suggests that a firm's investment decisions, including its willingness to undertake entrepreneurial activity, are influenced by an exogenous set of competitive environmental influences, embodying separate dimensions of *munificence*, *complexity*, and *dynamism*. Using measures drawn from Miller and Friesen (1983), we measured munificence (5 items), complexity (4 items), and dynamism (5 items) with a scale ranging from 1 (strongly disagree) to 5 (strongly agree). CFA results showed that with the exception of one item, which was then dropped, the relationship between each indicator and its respective latent construct was significant ($p < .001$). Cronbach's alpha was .78 for munificence, .72 for complexity, and .75 for dynamism. Following Zahra et al. (1999), we also controlled for three firm-level variables, firm size, firm age and past performance. We measured *firm size* as the number of full-time employees, which we log-transformed for normality, and measured *firm age* by the number of years since the company was established. We measured *past performance* using eight items with a three-year lag; i.e., we asked the CEO to consider firm performance four years ago. Cronbach's alpha was .94.

3. Analyses and results

Table 1 presents the means, standard deviations, and correlations for each of the measures. We used maximum likelihood structural equation modeling (SEM) to test our model. In brief, we deemed SEM appropriate because it allows for the simultaneous estimation of both a measurement model and a structural model. The measurement models address

Table 1
Means, standard deviations, and correlations^a.

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9
1. Market sensing orientation	3.35	.88									
2. User proactiveness	3.10	1.04	.52***								
3. Strategic utilization	2.95	1.05	.61***	.54***							
4. Corporate entrepreneurship	2.51	.77	.53***	.47***	.51***						
5. Munificence	2.88	.72	.34***	.37***	.35***	.51***					
6. Complexity	2.99	.76	.25***	.14***	.25***	.44***	.55***				
7. Dynamism	3.17	.69	.07	.11*	.15***	.26***	.48***	.62***			
8. Past performance	3.39	.77	.19**	.12**	.06	.12**	.12**	.08	.08		
9. Firm age (log)	1.48	.31	-.08	-.07	-.05	-.12**	-.09*	.03	-.00	-.09*	
10. Firm size (log)	1.71	.32	.10*	.18***	.12**	.33**	.10*	.03	-.05	.08	.21***

^aN=495. Correlations are from structural equation modeling estimations. *** $p < .001$; ** $p < .01$; * $p < .05$.

the reliability and validity of the indicators in measuring the latent variables or hypothetical constructs, while the structural model specifies the direct and indirect relations among the latent variables and describes the amount of explained and unexplained variance in the model. We adopted the two-phase approach to SEM as outlined in Anderson and Gerbing (1988).

3.1. Phase I: measurement model

The first SEM phase involves a CFA model to assess the fit of the measurement model. Following convention, we used four alternative and complementary fit indices: the comparative fit index (CFI), the incremental fit index (IFI), the Tucker–Lewis index (TLI), and the normed fit index (NFI). Values for our measurement model were consistently greater than the threshold of .90 (CFI=.96, IFI=.97, TLI=.96, NFI=.93).

Then, following Hair et al. (1995), we evaluated each of the constructs separately and found a relationship between each indicator and its respective construct to be statistically significant, thus suggesting convergent validity. No inter-factor correlation is above .65, suggesting that multicollinearity and, hence, problems created by a lack of discriminant validity are not likely to bias our data. Nevertheless we centered the corresponding values and creating composite scales for all measures that were highly correlated.

We further examined the discriminant validity of the constructs by developing a series of one- two- and three- factor models, each serving as a basis of comparison for our measurement model. The hypothesized model clearly outperformed all of the other configurations in terms of discriminant validity as evidenced by significant chi-square reductions. Taken together, these analyses suggest that our final measurement model fits the data well, and thus, is appropriate for the hypothesis testing phase.

3.2. Phase II: nested structural models results and hypothesis testing

The second phase of Anderson and Gerbing's (1988) approach to SEM involves contrasts (chi-square difference tests) between sequences of nested structural models to identify the model that best accounts for the covariances observed between the latent constructs. The first important contrast is between the measurement model and a null latent model, because a significant chi-square difference between the two indicates that sufficient covariance exists between the latent variables to warrant testing the hypothesized model. The initial comparison between the measurement model ($\chi^2[429, n=495]=794, p<.001, CFI=.96, IFI=.97, TLI=.96, NFI=.93$) and the null latent variable – Model 1 ($\chi^2[466, n=495]=2536, p<.001, CFI=.81, IFI=.81, TLI=.79, NFI=.73$) evidenced a large and significant ($p<.001$) chi-square difference [(37) of 1742].

The significance of this difference provides the basis for examining the nested structural models in which the relative fit of the hypothesized model against other nested models is assessed. In particular, to test the direct effects associated with H1–H3, we examined several nested models, the results of which are summarized in Table 2. Model 1 is the base null latent model, which as previously noted, is used for comparison purposes. Model 2 is the environmental

covariates model, which specifies the influences of the three environment-level covariates on the corporate entrepreneurship construct. These covariates accounted for 32% variance in corporate entrepreneurship, and, as expected, both complexity and munificence had a positive association with corporate entrepreneurship (.28, $p<.001$; .43, $p<.001$, respectively) and dynamism (–.13, $p<.05$), a negative association with corporate entrepreneurship. Model 3 specifies the effect of firm-level covariates on corporate entrepreneurship after accounting for the effects of the environmental covariates. These covariates accounted for 10% of the variance in corporate entrepreneurship. As expected, firm age had a negative association with corporate entrepreneurship (–.15, $p<.01$) and firm size had a positive (.32, $p<.01$) association. We found no support for firm performance.

Model 4 specifies the effects of each of the three elements of an entrepreneurially alert information system on corporate entrepreneurship, after controlling for the effects of all covariates. The results show that, when taken together, the three elements explained 14% additional variance in corporate entrepreneurship, and provided support for H1–H3 in that strategic utilization, market sensing orientation, and user proactiveness are all positively and significantly associated with corporate entrepreneurship (Table 2 and Fig. 1).

3.3. A test of complementarities

Consistent with Leonard-Barton's knowledge-based view of the firm, we also explored the possibility that these three elements of an entrepreneurially alert information system are interrelated and mutually reinforcing, such that the impact of each element on corporate entrepreneurship might also be contingent on the relative impact of the other two. Absent theoretical support, however, we did not formally hypothesize such a relationship.

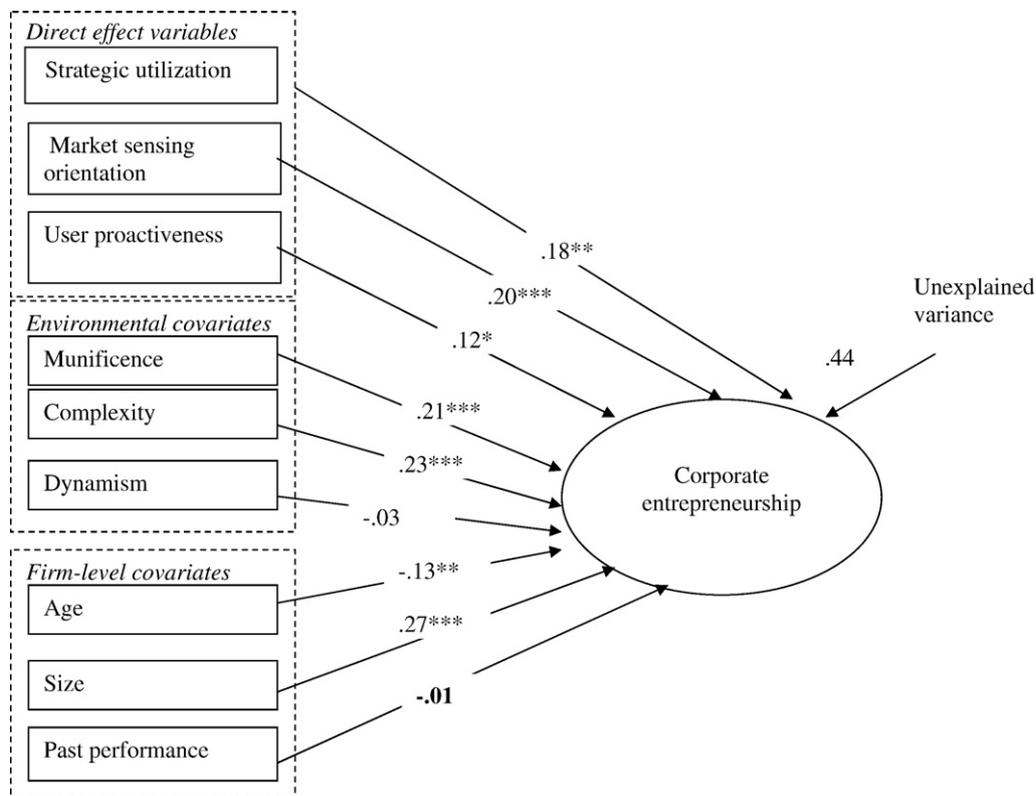
Nevertheless, we reason that the degree to which a firm's information system is market sensing oriented toward identifying new market opportunities, the greater will be its strategic utilization, for each of these two elements of entrepreneurial alertness would seem to reinforce the effectiveness of the other. Similarly, we reason that the system's strategic utilization is also complemented by the degree to which a firm's norms and values are attuned to proactively using marketplace information as a competitive advantage ahead of its competition, as it is by its market sensing orientation. In short, when the three elements of a firm's entrepreneurially alert information system are in sync and directed toward a common opportunistic objective, we expect that synergy is possible. Conversely, an information system that is lacking in any of the three elements will be less able to pursue corporate entrepreneurship. For example, a firm may try to make efficient strategic use of its information system, but the effectiveness of that system will be diminished if its market sensing orientation is not clearly focused on markets and customers or if its employees do not act to proactively seek out new information about changes in their competitive environment.

Following Tanriverdi and Venkatraman's (2005) test of complementarities, we assessed the possibility that the three elements of a firm's entrepreneurially alert information system are interdependent, by examining the impact of the three collectively as a second-order

Table 2
Results of tests of hypotheses based on comparisons of nested models.

Model	df	χ^2	CFI	IFI	TLI	NFI	R ² corporate entrepreneurship	Comparison	$\Delta\chi^2$	Δdf
Model 4: SU, MSO, UP+environmental+firm covariates	421	1283***	.92	.92	.91	.89	.56	Model 4 vs. Model 3	74***	3
Model 3: environmental+firm covariates	424	1357***	.91	.91	.90	.88	.42	Model 3 vs. Model 2	53***	3
Model 2: environmental covariates	427	1410***	.91	.91	.89	.87	.32	Model 2 vs. Model 1	1126***	39
Model 1: null latent	466	2536***	.81	.81	.79	.73	—	—	—	—

Strategic Utilization (SU), Market Sensing Orientation (MSO), User Proactiveness (UP).
N=495. *** $p<.001$; ** $p<.01$; * $p<.05$; † $p<.10$.



^a This is a simplified version of the actual model. It does not show indicators, error terms, exogenous factor variances, and correlations between exogenous factors. Note. Standardized parameter estimates. $N = 495$. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; † $p < 0.10$

Fig. 1. Results from structural equation modeling^a.

interdependent construct on corporate entrepreneurship, and then comparing that collective impact to the total of their separate, individual, direct effects. Specifically, we examined the same number of nested models and undertook the same steps as above, but modeled the three elements as a latent second-order construct. Our results indicated that there exists a collective, interdependent effect of these characteristics that explains an additional 18% variance, over and above the 42% variance explained by the environmental and firm-level covariates ($p < .001$). Indeed, the single second-order effect explained significantly more incremental variance than did the sum of the three individual effects. More telling, a comparison of the results for the full second-order model ($\chi^2[433, n=495]=817, p < .001, CFI = .96, IFI = .97, TLI = .96, NFI = .93$) with that of the direct (first-order) effects model (Model 4 in Table 2): ($\chi^2[421, n=495]=1283, p < .001, CFI = .92, IFI = .92, TLI = .91, NFI = .89$) indicated that, in addition to being more parsimonious, the second-order model better fits the data. This was evidenced by a large and significant ($p < .001$) chi-square difference [(12) of 466] between the two models.

4. Conclusion

Building upon the organizational learning, information orientation, and entrepreneurial awareness literatures, we conceptualized the three key elements of an entrepreneurially alert information system and then developed a reliable measure of each. Our findings support the long-held belief that firms with entrepreneurially alert information systems are more likely to engage in entrepreneurial acts.

Moreover, while still speculative, we reason that by treating the three key elements collectively as an interdependent, second-order construct, we provide a proxy for a core capability that is otherwise unobservable. This construct also more closely approximates the firm's entrepreneurial capacity to derive and utilize superior informa-

tion about market opportunities, essential to its entrepreneurial endeavors. We conclude from this logic and our findings that to the extent the complementarities of these three key information system elements co-evolve and build upon each other, the overall information system will be causally ambiguous, path dependent, and socially complex.

We are mindful, of course, that like most examinations of firm-level effects, facets of our research design puts limits on the extent to which we can place full confidence on the interpretation of the results. For example, while we used the structural equation modeling method, our research design is, nevertheless, cross-sectional, which limits our ability to ultimately infer cause-effect relationships. Also, our information systems measures are based on the memories of the executives and might suffer from common method variance. The issue is magnified by the *perceptual* nature of our independent and dependent variables, because managers who report higher information systems capabilities may also report greater CE. We believe that the extent of this problem was reduced by the careful way that our data were collected and analyzed. Given that our tests revealed no bias (Appendixes A and B), and the fact that we could replicate our findings using multi-source data, as well as using a second dependent variable, entrepreneurial orientation, we view these aforementioned limitations as acceptable particularly since our hypotheses dealt with complex, firm-level effects that required a large sample of firms to fully test them. In sum, we conclude that an entrepreneurially alert information system is a salient driver of corporate entrepreneurship.

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Appendix A. Addressing common method bias

We took several steps to mitigate, detect, and control for a common method bias. To *mitigate* the biasing effects, we carefully constructed all survey items, and wherever possible, used pre-tested, valid, multidimensional constructs (Huber and Power, 1985). Thus, because all of our constructs were of a higher order nature and assessed by established multiple-item measures, the likelihood of respondents artificially inflating relationships among them is reduced. Also, by surveying the CEO, as a key informant, we sought to minimize the likelihood of bias. Indeed, CEOs of SMEs have been shown to be particularly knowledgeable about the constructs within our study, including corporate entrepreneurship (Zahra, 1996).

To *detect* this bias, we performed several tests – namely, bivariate correlations and confirmatory factor analysis (CFA) (Podsakoff et al., 2003). We used CFA as a more sophisticated test of the hypothesis that a single factor can account for all of the variance in our data by developing a series of one- two- and three- factor models, each serving as a basis of comparison for our measurement model. The goodness-of-fit indices indicate a poor fit for the single factor model, which suggests that biasing from common method variance is unlikely. The hypothesized model clearly outperformed other configurations in terms of discriminant validity, as evidenced by significant chi-square reductions. Additionally, we statistically controlled for the effect of common method bias by using the “single-method-factor approach” discussed in Podsakoff et al. (2003), and found consistent results.

To more directly control for common method bias, we used the multi-respondent data drawn from our sub-sample of 47 firms that provided two responses, to assess responses at the item and scale levels, including *t*-tests of items, intra-class correlations, mean differences of scales, and correlations of scales. The correlations of constructs – strategic utilization (.84), market sensing orientation (.65), user proactiveness (.85), corporate entrepreneurship (.80), past performance (.61), munificence (.60), complexity (.65), and dynamism (.64) – are all high and significant. These correlations suggest a high level of agreement between CEOs and their highest-ranked executive, corroborating our key informant responses.

As an aside, we used regression analysis to rerun our tests using data from the sub-sample of 47 firms where we had multi-source data. First, to establish comparability across samples, we ran our tests on this sub-sample using only the responses from the CEO, and found results for the three single-order effects and for the second-order effect that were fully consistent in direction and significance with that which we found from the larger sample of CEO-single source response data. We then conducted these same tests using multiple source data from the sub-sample; that is, we used exogenous constructs from the CEO and the endogenous construct from the second executive who responded to our survey, and arrived at the same pattern of significant results for both the single-order and second-order effects. And, again, using our multiple source data sub-sample, we ran these two sets of tests a third way, using exogenous constructs from the second executive and the endogenous construct from the CEO – and, again, produced the same pattern of significant results (available on request).

Appendix B. Robustness tests

We undertook three additional tests to determine the robustness of our findings: replicating our results using a second measure of entrepreneurial behavior; using structural equation modeling with correlated error terms; and using two-stage least squares regression. First, since entrepreneurial orientation has been empirically linked to corporate entrepreneurship (Zahra, 1996), we replicated our findings with respect to our hypotheses using entrepreneurial orientation ($\alpha=.71$) as our dependent variable. Once again, we found that the

interdependent, second-order model fits the data significantly better (the chi-square difference of the two models being [$p<.001$] (12) of 466]). Moreover, and again, consistent with our primary results based on corporate entrepreneurship as the dependent variable, we found that the second-order model explained significantly more incremental variance (6%) in entrepreneurial orientation than did the sum of the three direct effects (55% vs. 49%, respectively). Moreover, the overall entrepreneurial orientation measure was significantly associated with corporate entrepreneurship ($r=.63$ $p<.001$), and consistent with previous findings (Zahra, 1996), thus providing further evidence of the validity of the corporate entrepreneurship measure used.

Second, to determine whether or not our findings are influenced by correlated measurement error and endogeneity, we ran additional SEM tests that explicitly modeled the error (disturbance) terms between our independent variable (second-order construct) and the corporate entrepreneurship, and found that our results were not influenced by the inclusion of correlated error terms. Available upon request.

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