Strategic Management Journal
Strat. Mgmt. J., **30**: 221–231 (2009)
Published online 27 November 2008 in Wiley InterScience (www.interscience.wiley.com) DOI: 10.1002/smj.738
Received 8 April 2005; Final revision received 12 September 2008

RESEARCH NOTES AND COMMENTARIES

EXPLORATION, EXPLOITATION, AND FINANCIAL PERFORMANCE: ANALYSIS OF S&P 500 CORPORATIONS

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The literature suggests that established firms need to balance their exploration and exploitation activities in order to achieve superior performance. Yet, previous empirical research has modeled this balance as the interaction of orthogonal activities. In this study, we show that there is a trade-off between exploration and exploitation and that the optimal balance between exploration and exploitation depends upon environmental conditions. Using a novel methodology to measure the relative exploration versus exploitation orientation, we find an inverted U-shaped relationship between the relative share of explorative orientation and financial performance. This relationship is positively moderated by the R&D intensity of the industry in which the firm operates.

INTRODUCTION

The argument that organizations need to balance their exploration and exploitation activities to achieve optimal performance is widely accepted in the literature (Benner and Tushman, 2002, 2003; Ghemawat and Ricart i Costa, 1993; Gupta, Smith, and Shalley, 2006; McGrath, 2001). As March (1991) proposes, firms that overemphasize exploration, risk spending scarce resources with very little payback. Conversely, firms that overemphasize exploitation reduce learning of new skills and might become captive of outdated practices, knowledge and resources, possibly depressing their long-term performance.

March's (1991) argument hinges on the assumption that in an environment of limited resources, firms face a trade-off in allocating these resources either to exploration or exploitation activities. Yet, empirical tests of how exploration and exploitation activities relate to performance have frequently taken a somewhat different approach and modeled exploration and exploitation as orthogonal activities that positively interact (He and Wong, 2004; Jansen, Van den Bosch, and Volberda, 2006; Katila and Ahuja, 2002; Lubatkin *et al*., 2006; Nerkar, 2003). Thus, March's (1991)

Keywords: exploration; exploitation; organizational learning; behavioral theory of the firm; performance
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original formulation of the relationship between the exploration-exploitation balance and firm performance has remained largely untested. Further, prior research has failed to combine broad firm-level measures of exploration and exploitation with longitudinal research designs that are needed to control for endogeneity and unobserved heterogeneity when testing the link between exploration and exploitation and firm performance.

In this study, we contribute to the literature by developing a new automated content analysis based firm-year level operationalization of the exploration orientation construct, making it possible to directly test the relationship between the relative exploration orientation of a firm and its performance using a large scale longitudinal panel research design. A longitudinal research design is important in studies explaining the effect of strategic choices on firm performance because it facilitates the use of sophisticated econometrical methods that control for endogeneity and unobserved heterogeneity. Using Generalized Method of Moments (GMM) methodology to test our hypotheses and employing longitudinal data covering the years 1989–2004 for 279 manufacturing firms in the 1989 *Standard & Poor's 500* index, we find an inverted-U shaped relationship between a firm's relative exploration orientation and its financial performance, with the majority of companies engaging in less than an optimal amount of exploration.

We further add to the literature on the effects of exploration and exploitation on performance by examining how this balance might be contingent upon the environment an organization faces (Benner and Tushman, 2003; Gupta *et al*., 2006; Jansen *et al*., 2006). For instance, organizational environments differ significantly in their degree of technological dynamism (Zahra, 1996). Frequent technological change might make an organization's resources and competences obsolete in a relatively short period of time, forcing the firm to constantly explore new technologies. In environments with lower technological dynamism, a firm's technology base could be used for a protracted period of time, making it possible to completely focus on exploitation. Thus, for environments characterized by different levels of technological dynamism, a different balance of exploration and exploitation might be optimal to maximize performance. In line with this argument, we find that the relationship between the relative amount of exploration orientation and financial performance is moderated by the research and development (R&D) intensity of the industry in which firms operate.

THEORY AND HYPOTHESES

Originally developed in the context of organizational learning, March (1991) defines exploration activities as including 'things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation' (March, 1991: 71). In contrast, exploitation activities include 'such things as refinement, choice, production, efficiency, selection, implementation, execution' (March, 1991 : 71). The broad conceptual distinction has since been expanded into a wide range of managerial contexts including strategic management (e.g., He and Wong, 2004), organization theory (e.g., Holmqvist, 2004; Siggelkow and Levinthal, 2003), technology and innovation management (e.g., Benner and Tushman, 2002, 2003; McGrath, 2001) and managerial economics (e.g., Ghemawat and Ricart i Costa, 1993).

Researchers have consistently argued that exploration and exploitation draw on different structures, processes, and resources (He and Wong, 2004), generating significantly different performance outcomes over time. By reducing variety, increasing efficiency, and improving adaptation to current environments, exploitation activities can lead to positive short-term performance effects. However, these short-term performance improvements might come at the expense of long-term performance, because the reduced variety and the adaptation to the external environment become liabilities as environments change over time. Firms that emphasize exploitation activities might lack the capability to adapt to significant environmental changes, and thus the recipe that makes these firms successful in the short term might endanger their success in the long run.

To improve a firm's ability to adapt to environmental change and reduce the risk of obsolescence, exploitation needs to be balanced with variance increasing activities. Such exploration-oriented activities help the firm to develop new knowledge and create those capabilities necessary for survival and long-term prosperity. However, exploration activities are uncertain in their payoffs

DOI: 10.1002/smj

and performance effects usually occur in the long run. Therefore, focusing solely on exploration can be similarly detrimental for the firm locking it into a cycle in which 'failure leads to search and change which leads to failure which leads to more search, and so on' (Levinthal and March, 1993: 105–106).

Following March (1991), a balance between exploration and exploitation is optimal for firm performance. This balance becomes evident in the extent to which the firm emphasizes exploration activities over exploitation activities (hereafter 'relative exploration orientation'). A firm with a low relative exploration orientation conducts primarily exploitation activities, while a high relative exploration orientation suggests that the firm focuses mainly on exploration activities. Therefore:

Hypothesis 1: The relative exploration orientation of the firm exhibits a curvilinear (inverted U-shaped) relationship to the future financial performance of the firm.

Environmental dynamism, and in particular industry technological dynamism, increases the importance of innovation and relative activities. Zahra (1996) suggests that in technologically dynamic environments, which are characterized by high levels of R&D spending and patenting, technological opportunities are more common than in environments with lower R&D spending. The abundance of these opportunities increases the potential benefits from successful exploration (Baysinger and Hoskisson, 1989).

A high level of technological dynamism also increases the risks associated with an overemphasis on exploitation. In industries with high technology dynamism, firms not only have more opportunities, but they also face a greater risk that their core technologies become rapidly obsolete (Sørensen and Stuart, 2000). This constrains a firm's capacity to exploit promising opportunities. Thus, in environments with a high level of technological dynamism, the combination of increased risk of obsolescence and increased upside potential from successful exploration efforts makes sufficient exploration more important and profitable. Therefore:

Hypothesis 2: Industry technological dynamism positively moderates the relationship between relative exploration orientation and the future financial performance of the firm.

METHOD

Sample

To test our hypotheses, we collected data covering the years 1989–2004 for 279 manufacturing firms in the 1989 *Standard & Poor's 500* index. Our sample included all the companies with four-digit Standard Industrial Classification (SIC) codes 2000–3999 and 7370–7379. These SIC codes represent both traditional manufacturing industries and information technology industries for which our measures of exploration and exploitation and technological dynamism are particularly relevant. We collected the financial data from *Compustat*.

Measures

Dependent variable

Market value. Exploration and exploitation activities have been argued to influence company performance in different ways and over different time periods. This makes studying the effect of the balance between the two on company performance using accounting-based performance measures problematic, as the ultimate effects of exploration on company financials are often more distant, while exploitation has a more immediate effect. Consequently, instead of using accounting-based measures of performance, we use the market-based measure of Tobin's Q as our dependent performance variable. Market value based measures such as Tobin's Q have the advantage of capturing short-term performance and long-term prospects (Lubatkin and Shrieves, 1986; Allen, 1993), allowing us to operationalize both short- and long-term performance effects using a single performance variable. Market value based measures have been frequently used in empirical research examining performance effects over varying time horizons (e.g., Richard, Murthi, and Ismail, 2007; Huselid, 1995). We use the widely used operationalization of Tobin's Q as the market value of assets divided by the book value of assets (Brown and Caylor, 2006; Bebchuk and Cohen, 2005; Gompers, Ishii, and Metrick, 2003; Kaplan and Zingales, 1997). We also ran additional regression analyses (not

DOI: 10.1002/smj

reported here) with accounting-based measures. These robustness tests produced consistent results.

Independent and moderating variables

Exploration versus exploitation orientation. The study's main independent variable is the *relative* amount of exploration versus exploitation in the company's business activities, measured annually at the firm level. A diverse range of operationalizations has emerged for the exploration and exploitation concepts. Some studies have employed objective proxies such as the degree to which search activity is technologically and organizationally boundary spanning (Rosenkopf and Nerkar, 2001), or as the depth and breadth of technological search activity (Katila and Ahuja, 2002). Others have used questionnaires of key personnel to evaluate the company's explorative focus (McGrath, 2001; Sidhu, Commandeur, and Volberda, 2003; Jansen *et al*., 2006), the exploration and exploitation focus of innovation activities (He and Wong, 2004), or the radicalness of innovations introduced (Bierly and Chakrabarti, 1996). These operationalizations frequently lack generalizability and applicability outside their respective contexts. Furthermore, it is often unclear whether such operationalizations are consistent with the conceptual definitions of exploration and exploitation (Gupta *et al*., 2006).

To address these concerns, we sought to quantify the annual relative amount of explorative orientation of the company through content analysis. The goal was to develop a measure that would (1) cover a broad scope of corporate actions, (2) be available for a large number of companies over an extended period of time, and (3) be applicable across a range of industries. Therefore, we examined a very large set of published news articles and newswires classifying those business activities described as exploratory and/or exploitative. In practice, we base our operational definition of exploration and exploitation on March's (1991) previously quoted conceptual definition of exploration as 'things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation' (March 1991: 71) and exploitation as 'such things as refinement, choice, production, efficiency, selection, implementation, execution' (March, 1991: 71), and use these lists of words directly to operationalize exploration versus exploitation orientation of firms' activities.

Traditionally, event coding of texts such as news documents, has been done manually by trained coders. In recent years, the use of computer-assisted coding has begun to replace manual coding. King and Lowe (2003) have shown in their study that automated event coding employing computer software with a parser and a sufficient vocabulary is equally accurate to human coding. Further, several studies (Laver, Benoit, and Garry, 2003; Porac, Wade, and Pollock, 1999: 123–125) have shown that the content analysis method of counting and scoring words and word frequencies without examining the textual context can accurately reproduce results similar to those obtained from the more laborious context-dependent manual or computer-assisted coding. Recent research (Tetlock, Saar-Tsechansky, and Macskassy, 2008) also suggests that simple word count analysis of company news stories can capture firm attributes that are difficult to quantify otherwise.

For the content analysis, we collected textual data in the form of published news articles and newswires from the Factiva database. The search was limited to the Reuters News archive. We included only those documents that contained a name of a company belonging to the sample in their headline. When the name or abbreviation of the company caused ambiguity, Factiva's 'intelligent indexing' tags were used to screen out irrelevant documents. The collection process resulted in a total of 258,513 news documents, containing a total of 428 megabytes of textual data. The news documents collected from Factiva are analyzed using a computer program specifically written for this purpose. The numbers of exploratory and exploitative words appearing in the documents with the name of the company in the headline are calculated for each company-year. The variable for the relative amount of exploratory activities of a company is calculated by dividing the number of exploratory words by the sum of exploratory and exploitative words per company-year.

Given that the effect of potential inaccuracies in the classification of individual items is low in large-scale statistical analyses, the most important threat to validity arises from the accuracy of the vocabularies employed to identify exploration and exploitation. We derived the vocabularies for exploration and exploitation directly from the definition of the two concepts in March (1991). The words and word roots we employed to identify exploratory action and exploitative action from

DOI: 10.1002/smj

the news documents are presented in Appendix 1. Even though the vocabularies were taken directly from the original definitions proposed by March (1991) and therefore should capture these concepts, the ability of the words to identify actual cases of exploration and exploitation has not been tested in prior research. Therefore, we performed several additional analyses to ensure their validity.

To establish the validity of the automated word count method, we conducted a concurrent operationalization of exploration versus exploitation orientation using the established method of manually classifying company actions. Manual classification was performed on a different set of news articles. These articles were taken randomly from articles collected from the *Lexis-Nexis* company news database for the year 1999. The sample for manual analysis consisted of 14 companies and 1,055 articles total, 328 of which reported unique business development actions. In this analysis, we operationalized exploration versus exploitation orientation as the number of exploration actions divided by the sum of exploration and exploitation actions, similar to the procedure used by Volberda *et al.* (2001).

To avoid simply manually replicating the automatic analysis procedure, the coding instructions for manual analysis were developed independently from the word list used in the automated method. The coding instructions were based on the definitions of exploration and exploitation in several studies on business development (e.g., March, 1991; Koza and Lewin, 1998; Rothaermel and Deeds, 2004; Volberda *et al*., 2001), and relied on the personal judgment of the human coders to identify exploration and exploitation actions. Using Cohen's kappa (Cohen, 1960), the interrater reliability of the classification process with two coders was 0.68. All *Lexis-Nexis* company news articles for the 14 company-years used in manual classification were also analyzed using the automated analysis program. In the sample of 14 companies, the correlation between this manual classification operationalization and the automated word count operationalization was 0.52 ($p = 0.06$). The observed high correlation with an established operationalization technique supported the validity of our automated method.

The manual classification of articles into exploration and exploitation was also used to investigate the semantical validity of the method (Krippendorff, 1980: 159–162). Lists of word frequencies were created separately from the manually classified exploration articles and exploitation articles using *Intext*, a computer program for content analysis. The words that measured exploration in this study were found with a frequency of 4.5 per 1,000 words in articles describing exploration actions and a frequency of 1.5 per 1,000 words in articles describing exploitation actions. Conversely, exploitation words were found with frequencies of 3.0 per 1,000 words in exploitation articles and 1.6 per 1,000 words in exploration articles. This led us to conclude that the dictionary we used seemed to statistically and accurately differentiate exploration and exploitation.

To further validate the measure of exploration, a key word in context (KWIC) analysis (Krippendorff, 1980: 122) was conducted to evaluate the relevance of different words and their usefulness in measuring exploration and exploitation in the text corpus under study. All occurrences of the exploration and exploitation words presented in Appendix 1 were recorded using a computer program, along with their textual context, which in this case consisted of the 100 surrounding characters. For each word, 100 occurrences were selected at random and analyzed manually. Word forms and word combinations that were clearly irrelevant to the analysis were identified. These included such expressions as e.g., 'Internet Explorer' for the word root 'explor,' 'PlayStation' for 'play,' and 'executive' for 'execut.' The automatic analysis program was then revised to exclude these word occurrences from the calculation of the relative exploration variable.

Some examples of the usage of different words in the text are presented in Appendix 2. To ensure that our results are not spurious effects caused by a single influential word (e.g., 'production'), we excluded each of the individual word roots from the analysis. The exclusion of the individual exploration or exploitation words did not materially alter the results.

Industry technological dynamism. The moderating effects of environmental conditions on the relative exploration orientation-performance relationship are studied focusing on industry technological dynamism. We operationalize industry technological dynamism as industry R&D intensity (e.g., Audretsch and Feldmann, 1996; Ito and Pucik, 1993; Baysinger and Hoskisson, 1989). Industry R&D intensity is calculated as the logarithm of

DOI: 10.1002/smj

the industry's total R&D expense divided by total industry sales. Industry R&D intensity is centered in the analysis to provide for the estimation in the model testing the average effects of the relative exploration variable.

Control variables

Our analysis also included the following control variables: company size and company R&D intensity, and a dummy variable to account for R&D data limitations. Year dummies are also included in the models to control for unobserved time effects. Company size is measured as a logarithm of the company's number of employees. Company R&D intensity is calculated as the logarithm of the company's R&D expense divided by sales. If the company has not reported its R&D expense, it is treated as being zero and the R&D missing dummy is coded as one.

Model

Testing our hypotheses using a dynamic longitudinal panel data research design required us to control for endogeneity and unobserved heterogeneity. We did so by using a GMM estimator (Arellano and Bond, 1991). We used a System GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998) instead of a Difference GMM estimator, because the persistence of the dependent performance variable could cause severe weak instrument problems in Difference GMM models. System GMM was estimated using the xtabond2 Stata module (Roodman, 2005). Industry and year controls were treated as exogenous variables. All other independent variables were treated as predetermined. As our data had a large number of variables observed over several years, the number of available moment conditions was large, potentially causing overfitting bias (Baltagi, 2005: 153). Therefore, the models were also tested while limiting the number of instruments to the first available lagged levels, with similar results. As a robustness test, we also tested treating the independent variables as endogenous rather than predetermined, obtaining qualitatively similar results.

RESULTS

After inspecting descriptive statistics, which are available upon request from the authors, we set out to run the system GMM regression models. The results from the system GMM regression models appear in Table 1. Model 1 reports the regression

Table 1. GMM estimation of relative exploration, R&D intensity and firm performance

Dependent variable: Tobin's Q	Model 1		Model 2	
	Coeff.	S.E.	Coeff.	S.E.
Explanatory variables				
Relative exploration			0.321	$(0.130)^{*}$
(Relative exploration)^2			−0.221	$(0.132)^{+}$
(Relative exploration) × (Industry R&D intensity[ab])			0.601	$(0.204)^{**}$
(Relative exploration)^2 × (Industry R&D intensity[ab])			−0.411	$(0.216)^{+}$
Control variables				
Tobin's Q_{t-1}[a]	0.837	$(0.031)^{***}$	0.843	$(0.026)^{***}$
Number of employees, log[a]	−0.039	(0.035)	−0.016	(0.027)
R&D intensity[a]	−0.009	(0.084)	−0.013	(0.057)
R&D missing dummy	0.106	(0.099)	0.042	(0.079)
Industry R&D intensity[ab]	0.087	(0.074)	−0.068	(0.058)
Constant	0.211	(0.155)	0.318	$(0.119)^{**}$
N	2754		2754	
Wald χ^{2c}	3434.53(19)		4621.49(23)	
Hansen	1.00		1.00	
z_1[d]	−5.67		−5.46	
z_2[d]	−1.00		−1.34	

Robust standard errors in parentheses. Year dummies included but not reported. $^{+}$ $p < 0.1$ level; * $p < 0.05$ level; ** $p < 0.01$ level; *** $p < 0.001$ level, [a] Winsorized fraction. 01. [b] Centered. [c] Degrees of freedom in parentheses [d] z_1 and z_2 are z values for Arellano-Bond tests of AR(1) and AR(2) in first differences, respectively.

with only the control variables. Model 2 reports the full model. Hypothesis 1 predicted a curvilinear relationship between the relative amount of exploration and financial performance. Hypothesis 2 predicted a positive interaction effect between the relative amount of exploration and industry R&D intensity to financial performance. The results support both Hypotheses 1 and 2.

The results are illustrated graphically in Figure 1. The figure shows the observed relationships between relative exploration and firm performance, all other things equal, with three values of industry R&D intensity: medium, high, and low, represented by the mean value of industry R&D intensity and one standard deviation above and below the mean, respectively, as well as the median value of relative exploration in the total sample. In industries with low R&D intensity, relative exploration has little effect on company performance. In industries with average R&D intensity, there is a slight curvilinear effect of exploration on performance, but the effect is relatively small in magnitude. As the R&D intensity of the industry increases, so does the strength of the curvilinear exploration-performance effect, and in industries with high R&D intensity, the effect is significant both statistically and economically. Figure 1 also indicates that the majority of the companies in the sample tend to engage in below optimum amounts of exploration.

DISCUSSION AND CONCLUSIONS

This study set out to empirically test the relationship between a firm's exploration and exploitation activities and its market-based performance. Consistent with Hypothesis 1, we found a curvilinear relationship between the relative amount of exploration and financial performance. Also, in support of Hypothesis 2, we found this relationship to be more pronounced in R&D intensive industries.

Implications for research

This study contributes to the ongoing discussion of the exploration exploitation conceptualization in the strategic management literature. Even though many researchers have invoked March's (1991) exploration and exploitation concepts, most prior measurement efforts have actually conceptualized exploration and exploitation as orthogonal rather than as ends of a continuum as March posited in his original work. By applying a direct measurement

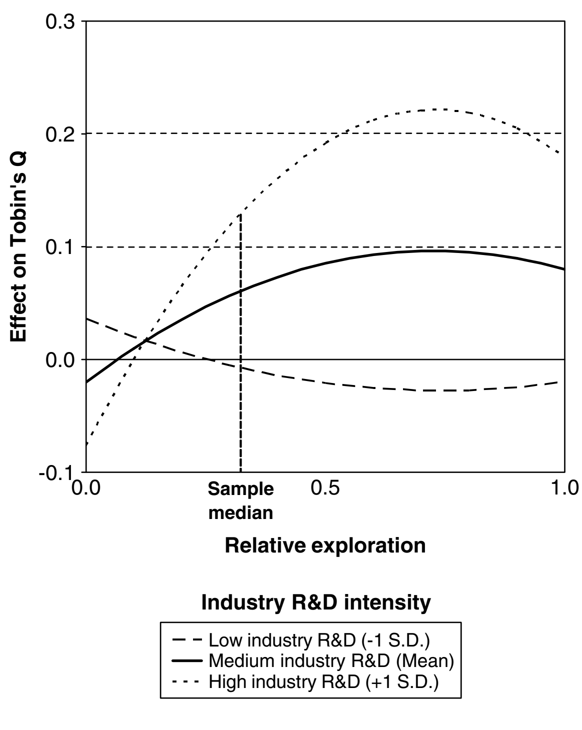

Figure 1. Relationship between relative exploration, industry R&D intensity and firm performance

DOI: 10.1002/smj

approach based on publicly available news documents, we are able to directly test March's predictions in a longitudinal setting while controlling for unobserved heterogeneity and endogeneity. Our finding of a curvilinear relationship between the relative amount of exploration and financial performance supports March's (1991) argument that a balance between exploration and exploitation should provide optimal performance levels, and that such a balance involves trade-offs between exploration and exploitation. Viewing exploration and exploitation as a continuum, and regarding achieving a balance among the two essentially as a trade-off among conflicting goals, would seem particularly relevant when studying situations in which firms are pressured to make trade-offs in resource allocations at the firm level.

Our findings also contribute to understanding the interaction between industry technological dynamism and a firm's orientation toward exploration and exploitation. Researchers have speculated about the situations in which a balance between exploration and exploitation might not be necessary (Gupta *et al.*, 2006). Our results show that in environments characterized by low technological dynamism, this balance might be less important.

Implications for managers

Our results also have implications for managerial action. Earlier conceptual research (Benner and Tushman, 2002, 2003; Lewin, Long, and Carroll, 1999) has suggested that large companies tend to systematically overemphasize exploitation. Our results provide support for this contention. Specifically, around 80 percent of companies we studied engaged in exploration at levels below the optimum in our sample. Clearly, a majority of firms would benefit from increasing their emphasis on exploration, an important activity in entrepreneurial opportunity recognition (Zahra, 2008). Our findings also suggest that aspiring to achieve an optimal balance between exploration and exploitation is most important in high R&D intensive industries. Further, in these industries, firms in our sample engaged in suboptimal levels of exploration. As a result, managers would need to pay more attention to ensuring a sufficient exploratory orientation in the face of the natural overemphasis on exploitation.

Future research

Our results highlight several promising avenues for future research. For example, we have concentrated on the exploration-exploitation dilemma in the context of general, published business activities of a corporation. Future researchers could examine specific areas where there is potential for trade-offs between exploration and exploitation. Also, as the sample used in this study consisted of large companies, future research could study whether our results extend to small and medium enterprises. The use of automated content analysis to operationalize March's (1991) exploration and exploitation concepts appears to have great promise for empirical research. March's definitions of exploration and exploitation have had great impact on theoretical research, but have received little empirical validation because of the difficulty of their measurement. Given that our operationalization employs the exact terms and words used in March's (1991) original definition and derives the measures from thousands of publicly available news documents describing these activities, the methodology offers a relatively easy way to replicate operationalization of these concepts. We hope that our research inspires future empirical research examining the implications of exploration and exploitation for the financial performance of companies.

ACKNOWLEDGEMENTS

We would like to acknowledge the financial support from The Research Programme for Advanced Technology Policy (ProACT) of the Ministry of Trade, Industry, and Tekes, the Finnish Funding Agency for Technology and Innovation; the Academy of Finland (grant 112129); and the Galvin Center for Global Management at Babson College. Juha Uotila would also like to acknowledge financial support from the Finnish Cultural Foundation. We thank Myles Shaver and Aks Zaheer for their useful suggestions.

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Appendix 1. Words and Word Roots in Content Analysis

The wildcard '*' can represent any characters.	
Exploratory action:	explor*, search*, variation*, risk*, experiment*, play*, flexib*, discover*, innovat*
Exploitative action:	exploit*, refine*, choice*, production*, efficien*, select*, implement*, execut*

Appendix 2. Examples of Keyword Occurrences in Content Analysis

Word root	Example
search*	*The long **search** for a synthetic human blood substitute suffered another setback Tuesday when Baxter International Inc. said it halted a European clinical trial of its HemAssist blood product.*
risk*	*Singapore's loss making contract chip maker Chartered Semiconductor Manufacturing Ltd (CSMF.SI) and International Business Machines Corp (IBM.N) said on Wednesday they planned to pool microchip design resources. (...) 'The programme is expected to reduce the **risks** and costs customers typically encounter when designing chips targeted for manufacturing with advanced nanometre-scale technologies,' the statement said.*
innovat*	*'We are looking at all forms of next-generation infrastructure,' said Jonathan Swartz, vice president of venture and strategic investments at Sun. 'We invest to accelerate **innovation** on the Internet.'*
exploit*	*Analysts said a manufacturing deal with Sony would be the first step toward making the Macintosh system an industry standard versus keeping the technology proprietary. 'It looks to me like they are moving in that direction,' said one analyst who requested anonymity. 'It's a big positive that they are going in the direction of **exploiting** their own strengths and building relationships that will **exploit** their strengths using others' strengths.'*
efficien*	*'These contracts have a positive influence on Van Leer's sales volume and market share,' Van Leer said. It said that while the deals were competitively priced, they would boost **efficiency** through higher factory loading, product standardization and longer manufacturing runs.*

DOI: 10.1002/smj