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Takehiko Isobe

University of Marketing and Distribution Sciences

Shige Makino

The Chinese University of Hong Kong

David B. Montgomery

Singapore Management University, dmontgomery@smu.edu.sg

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**EXPLOITATION, EXPLORATION, AND FIRM PERFORMANCE: THE CASE OF
SMALL MANUFACTURING FIRMS IN JAPAN**

TAKEHIKO ISOBE

Professor

Department of Commerce
University of Marketing and Distribution Sciences
3-1 Gakuen-nishimachi Nishi-ku,
Kobe, 651-2188 Japan
Tel.: (81) 78-796-4308
Fax: (81) 78-794-6149
tisobe@xc4.so-net.ne.jp

SHIGE MAKINO

Professor

Department of Management
The Chinese University of Hong Kong
Shatin, N.T., Hong Kong
Tel.: (852) 2609-7636
Fax: (852) 2603-5104
makino@baf.msmail.cuhk.edu.hk

DAVID B. MONTGOMERY

Dean

School of Business
Singapore Management University
469 Bukit Timah Road
Business Building, #03-29
Singapore 259756
Tel.: (65) 6822-0538
Fax: (65) 6822-0777
dmontgomery@smu.edu.sg

EXPLOITATION, EXPLORATION, AND FIRM PERFORMANCE: THE CASE OF SMALL MANUFACTURING FIRMS IN JAPAN

ABSTRACT

The purpose of this study is to investigate the relationship between technological capabilities and firm performance. We divide technological capabilities into two types – *exploitation*, which refers to refinement, production and execution, and *exploration*, which refers to searching, flexibility, and innovation. Based on a sample of 302 small and medium-sized manufacturing firms in Japan, our analysis reveals that exploitation relates more positively to operational efficiency than exploration, and conversely, exploration relates more positively to strategic performance, such as technological innovation and new product development, than exploitation. Moreover, firms with superior exploitation capabilities tend to possess superior exploration skills. Our findings show that exploitation and exploration have different effects on firm performance, and that neither activity is independent or mutually exclusive, although exploration tends to be enhanced by exploitation.

Key words: dynamic capabilities; technological capabilities; exploitation; exploration; competitive advantage.

INTRODUCTION

There is a growing body of literature on the way in which firms reconfigure their competence base to develop a sustainable competitive advantage in rapidly changing and unpredictable environments (Karim & Mitchell, 2000; Teece, Pisano, & Shuen, 1997; Eisenhardt & Martin, 2000). Scholars of organizational learning argue that firms that wish to reconfigure their competence base have two options – exploitation, which is the improvement of the existing competence base by upgrading the existing resource mix, and exploration, which is the development of a new competence base by the acquisition of new resources from external sources (March, 1991). Scholars of strategic management (Teece et al., 1997; Eisenhardt & Martin, 2000) highlight that a firm’s capability to reconfigure the dynamic processes of exploitation and exploration, also known as “dynamic capability,” is the key source of its sustainable competitive advantage (Teece, et al., 1997). They also suggest that firms that successfully reconfigure their competence base to match emerging market opportunities faster than their rivals are more likely to achieve superior performance.

Although a growing number of studies reveal the importance of exploitation and exploration as key sources of sustainable competitive advantage, there are three areas of research that need further development. First, most studies do not distinguish clearly between the effects of exploitation and the effects of exploration on performance (Zott, 2003). March (1991) argues that exploitation involves the use of the information that is currently available, and thus leads to the improvement of current (short-term) performance, whereas exploration involves the acquisition of new information about alternatives and thus leads to the improvement of future (long-term) performance. A failure to account for the distinct effects of exploitation and exploration on performance may mask the fact that a firm’s choice of strategic

action (exploitation or exploration) is endogenous to its expected outcome in both the short term and the long term, and therefore creates serious endogeneity problems in empirical studies (Hamilton and Nickerson, 2003).

Second, previous studies have provided limited evidence to demonstrate how the balance between exploitation and exploration can be struck and under what conditions this would occur. Both exploitation and exploration involve a trade-off, because firms with limited available resources may not be able to afford to exploit and explore simultaneously. Such a trade-off presents a “key dilemma” for organizations that aim to enhance both their “adaptation to exploit present opportunities” and their “adaptability to exploit future opportunities” at the same time. (Weick, 1982:386). Levinthal and March (1993) argue that overexploitation results in obsolete competences and the under-utilization of new opportunities, and that over-exploration results in small returns from new ideas. Organizations therefore need to strike an appropriate balance between exploitation and exploration, but to date we have a poor understanding of the mechanisms within an organization that are the key to effecting such a balance.

Finally, most previous studies have not explicitly examined the interaction between exploitation and exploration. Recent studies in strategic management have suggested that exploitation and exploration are linked by dynamic capability in a sequential and path-dependent process. Given that dynamic capability is defined as a process rather than a rent-generating asset (Eisenhardt & Martin, 2000), the management of the interaction between exploitation and exploration is critical for the development of sustainable competitive advantage. Although firms usually grow through the period of exploitation and exploration (Holmqvist, 2004), we have a poor understanding of how exploitation and exploration co-evolve and interact in the development of a sustainable competitive advantage.

This paper advances the literature by filling the gap in these three research areas. Two distinct performance variables are examined – operational efficiency and strategic performance. Operational efficiency represents short-term performance, which is reflected in productive efficiency and financial profitability. Strategic performance represents long-term performance, which is reflected in new technology and product development. A variety of contextual factors is included that systematically influence the choice between exploitation and exploration within a firm, including the internal, external, and inter-organizational characteristics of the firm. Finally, the relationship between exploitation and exploration is directly examined, and both the direct and indirect effects of exploitation and exploration on two performance measures are investigated.

This paper is organized as follows. First, we review the literature and provide discussions on the development of the hypotheses. Second, we discuss the sample, the methodology, and the measures that are employed. Finally, we report the empirical results and conclude the paper.

THEORY

Building on a model of organizational learning and adaptation, March proposes that to create and maintain competitive advantage, firms need to engage in the strategic processes of “exploring new possibilities and exploiting old certainties” (1991:71). Exploitation involves the efficient utilization of existing resources, and exploration implies the invention of new resources. The concepts of exploitation and exploration are akin to those of asset deepening and asset extension (Karim & Mitchell, 2000), and of component capability and architectural capability (Henderson & Cockburn, 1994) in the literature of strategic management. We review the related articles and develop hypotheses on the effects of exploitation and exploration on firm

performance.

Relationship between Exploitation and Performance

The resource-based view of firms assumes that a firm achieves a competitive advantage not only because it owns proprietary assets, but also because it possesses a superior ability to make good use of those assets (Penrose, 1959; Wernerfelt, 1984; Peteraf, 1993; Conner, 1991; Barney, 1991). Dierickx and Cool (1989) suggest that resources should be differentiated as either asset flows or asset stocks, and that “strategic asset stocks are accumulated by choosing appropriate time paths of flows over a periods of time” (Dierickx & Cool, 1989:1506). Feedback effects, which amplify the heterogeneity among organizations (Levinthal & Myatt, 1994), have similar implications. The notion underlying the concept of feedback effects is that in a stable market, the more resources a firm possesses, the more likely it is to be able to acquire and accumulate greater knowledge than its rivals, and at a faster rate. Feedback effects have naturally self-reinforcing characteristics, in that a firm can acquire more resources if it has a large pool of resources to begin with. Some scholars define a firm’s ability to utilize its assets and resources as capabilities (Amit & Shoemaker, 1993; Grant, 1996; Penrose, 1959), which they claim can give the firm a competitive advantage.

Teece et al. (1997) have suggested that a firm’s technological assets will evolve in a path-dependent manner. Path dependence describes the situation in which a firm builds on what it already knows, and what it chooses to do or know in the future depends on what it chose to do or know in the past (Langlois, 1995). A firm accumulates its resources as the result of path-dependent processes of investment, learning, and decision-making that it adopts over time (Dierickx & Cool, 1989). For example, a firm’s research and development (R&D) activity is

closely related to its previous R&D activity (Nelson & Winter, 1982; Helfat, 1997). As a result, firms tend to confine themselves to a limited set of technological domains and lose flexibility in their response to environmental change (Levitt & March, 1988; Tushman & Anderson, 1986). In a similar vein, Cohen and Levinthal (1990) suggest that a firm's existing knowledge base (or previous related knowledge) plays a key role in its innovative activities. Such a knowledge base is referred to as *absorptive capacity*, which is defined as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990:128). Absorptive capacity means that a firm's competence in the future depends on its existing level of technological assets and knowledge, and that therefore a firm's capabilities simultaneously enhance and inhibit technological innovation (Leonard-Barton, 1992). Studying market entry strategies in the medical equipment industry in the U.S., Mitchell (1989) observes that the level of a firm's industry-specific capabilities is significantly associated with the likelihood that the firm will be able to effectively utilize its existing resources and exploit new technology within that industry. Similarly, Henderson and Cockburn (1994) find that a firm's previous or cumulative success increases the likelihood of its future success, and explains a substantial portion of the variance in heterogeneity across firms.

Exploitation tends to enhance operational efficiency. As March points out, "the certainty, speed, proximity, and clarity of feedback ties exploitation to its consequences more quickly and more precisely than is the case with exploration" (1991:73), as firms know and can predict their technological domains and existing products. In empirical studies on diversification strategy, related diversification is found to lead to higher profitability (Bettis, 1981; Bettis & Hall, 1982; Christensen & Montgomery, 1981; Lubatkin, 1987; Montgomery, 1985; Rumelt, 1974), because this type of diversification strategy enables firms to utilize and share their existing

resources more effectively rather than unrelated diversification. In sum, as the exploitation of existing resources and capabilities seems to be appropriate, particularly in situations of incremental change, we hypothesize that this activity positively relates to profitability or productivity.

Hypothesis 1: The greater the capacity for exploitation, the greater the ability of a firm to enhance its operational efficiency.

Relationship between Exploration and Performance

In a rapidly changing environment, a firm should develop new technologies and change its resource structure to adapt to new environmental opportunities (Karim & Mitchell, 2000), because existing organizational practices and routines may reduce a firm's flexibility to adapt to new changes (Levitt & March, 1988). The term "dynamic capability" is defined as "the firm's processes that use resources – especially the processes to integrate, reconfigure, gain and release resources – to match and even create market change" (Eisenhardt & Martin, 2000:1107). This perspective emphasizes the importance of the reconfiguration of firm competence in the creation of competitive advantage (Teece et al., 1997; Eisenhardt & Martin, 2000; Henderson & Cockburn, 1994).

Dynamic capability is the natural process with which a firm creates a preferable circular system or routine, not only through the deployment of capabilities in attractive product markets in which such resources would be most effectively utilized, but also through the integration of various types of resources within or between organizations (Teece et al., 1997). The concept of dynamic capability is akin to the concept of combinative capability, which is defined as the

ability to synthesize and apply current and acquired knowledge (Kogut & Zander, 1992), and the concept of architectural competence, which is defined as the ability to access new knowledge from outside the boundaries of an organization and to integrate knowledge flexibly across disciplinary and therapeutic class boundaries within an organization (Henderson & Cockburn, 1994).

In an innovative firm, procurement, production, marketing, and organizational structures and control systems are built to support and complement R&D activities (Nelson, 1991; Teece, 1986). The resource-based view of firms typically recognizes resources and capabilities as independent sources of competitive advantage, and tends to ignore the way in which resources are reconfigured with one another and how the nature of the relationships between them influence a firm's sustainable competitive advantage (Black & Boal, 1994). Henderson and Cockburn (1994) study the sources of competitive advantage in the pharmaceutical industry. They differentiate component competence, which involves local activities and the knowledge that is required to solve day-to-day problems, from architectural competence, which involves a firm's ability to use component competencies, integrate them effectively, and develop new competencies. They find that architectural competencies appear to explain a significant portion of the variance in research productivity across firms.

The commonality of combinative capability, architectural competence, and dynamic capability is that a firm's sustainable advantage comes from its ability to redeploy or recombine its resource structure through the integration of internal and external sources of technology to capture new market opportunities in changing environments. Unlike exploitation activities, which utilize existing resources, it takes some years to achieve positive outcomes from exploitation activities (Teece, et al., 1997), as the returns that are associated with exploration are

often distant in time and highly variable (March, 1991). Isobe (2000) reports that small and medium-sized manufacturing firms take on average more than four years to successfully develop new products and technologies, and over five years to earn profit from them. Thus, exploration activities relate to future performance in such areas as new product development and technological innovation (Floyd & Lane, 2000), which we term “strategic performance.”

Hypothesis 2: The greater the capacity for exploration, the greater a firm’s ability to enhance its strategic performance.

Relationship between Exploitation and Exploration

Dynamic capabilities are the natural processes through which a firm creates a preferable circular system or routine with which it can identify valuable resources, deploy them to attractive product markets in which such resources would be most effectively utilized, and create new distinctive competencies or integrate internal and external resources (Teece et al., 1997; Winter, 1995). New distinctive resources and capabilities are repeatedly accumulated within firms through identification, exploitation, and exploration activities. Firms usually accumulate and upgrade their distinctive resources and capabilities through the exploitation process, which in turn enhances its innovative activities and investments. Dierickx and Cool (1989) stress that the amount and level of a firm’s resources and exploitation capabilities are the primary determinants of exploration capacity.

In prevailing theories of organizational learning, exploitation and exploration are assumed to be very distinct activities, and thus it is not possible for a firm to enhance both at the same time (March, 1991; Crossan, Lane, & White, 1999). However, recent research has suggested that

exploitation and exploration are not separate, mutually independent activities, and that organizations sequentially go through the periods of exploitation and exploration (Weick & Westley 1996). Studying the product development process in a leading Scandinavian software producer, Holmqvist (2004) reports that exploitation can be caused by exploration, and vice versa. Holmqvist stresses that exploitation and exploration occur both within and between organizations, and that they are interdependent because of intra- and inter-organizational learning processes.

The concept of absorptive capacity (Cohen & Levinthal, 1990) states that a firm with a high absorptive capacity has a greater capacity to learn, and hence tends to promote both internal and external R&D collaborations that lead to organizational innovation. Kogut and Zander (1992) argue that firms need to develop combinative capabilities as an explorative mechanism through which they can transform their resources and competences to further develop new products and technologies. Although exploration primarily involves the acquisition of new knowledge from external sources, it can also involve the novel combination of existing technologies and know-how. In recent in-depth cases studies, for example, researchers have found that the growth path of a firm typically follows the sequential process of exploration *and* exploitation, and suggest that firms accumulate and utilize their existing technologies and search for next-generation technology at the same time (Burgelman, 1994; Rosenbloom, 2000). In essence, these arguments suggest that firms that are committed to a greater level of exploitation tend to engage in a greater level of exploration, and vice versa.

Hypothesis 3a: The exploitation and exploration activities of firms are positively associated with each other.

In contrast to Hypothesis 3a, a growing body of research has suggested that a firm's existing competencies often inhibit, rather than promote, the exploration activities that lead to new product development and technological innovation, and that core competence has both a lock-in and lock-out effect. Once a firm makes a commitment to a certain technology path, it becomes increasingly difficult for it to change its course of action. For example, Leonard-Barton (1992) proposes that current core capabilities often become core rigidities, and prevent a firm from responding appropriately to changes in the environment. The terms "competency trap" and "success trap" (Levinthal & March, 1993) are used to describe the phenomena of exploitation driving out exploration. In support of these observations, Dougherty (1995) finds that a firm's existing knowledge pool negatively influences internal venturing activities and impedes future innovation. Similarly, Benner and Tushman (2002) find that the increased utilization of certain process management activities affects the balance between exploratory and exploitative innovation. In sum, these arguments suggest that exploitation and exploration are often traded-off in reality, and thus firms that are committed to a greater level of exploitation tend to engage in a lower level of exploration, and vice versa.

Hypothesis 3b: The exploitation and exploration activities of firms are negatively associated with each other.

DATA AND METHOD

The data that are used in this study were collected by a mail survey that was sent to the

member firms of the Osaka Industrial Association. A questionnaire was separately mailed to each of the presidents of 917 small to medium-sized manufacturing firms in the association. Three hundred and seventeen questionnaires were returned, of which 302 were suitable for analysis, which gave a response rate of 32.5 percent. Small to medium-sized firms tend to have a relatively limited number of core products or technologies, and thus managers are likely to have a good understanding of the key technologies of the firm and their impact on the firm's core competencies, which thus enhances the accuracy of the responses.

Following the non-response bias detection method (Armstrong & Overton, 1977), comparisons between several key variables for the earlier and later respondents in our sample were made. We considered those respondents who responded within two weeks of being sent the questionnaire to be "early respondents" (183) and the rest to be "late respondents" (119). The t-tests showed no significant differences for any of the variables between the early and late respondent groups. In addition, we examined the potential response bias that could stem from differences in firm size in terms of number of employees and industrial sector. As the Spearman's correlation and variance analysis showed that there was no significant association between primary activities and firm performance, we concluded that neither industry difference nor firm size effects would bias the findings of the study.

We sent the same questionnaire to the technology or manufacturing managers of the responding firms, and seventy-one questionnaires were returned. They were compared with those that were initially returned by the presidents of the firms in terms of the variables that represented exploitation, exploration, and firm performance. All of the variables were positively and significantly correlated, and the data that were collected from the first respondents were used in the analysis.

In addition, to test for a possible self-reporting bias in the measurement of performance, we examined whether the profitability of the selected firms in our sample (67 in total) as reported by the managers was significantly correlated with the profitability as reported in the *Nikkei Mijoujou Kigyo Soran 2000* (Directory of Non-listed Companies). There was a significant correlation (profitability $r = .402, p < 0.01$) between the profitability measures that were obtained from the two different sources of information, which indicates a reasonable validity for the performance measures.

Because we could not use external subjective measures, we had to rely on the self-reported assessments of the presidents of the firms that were surveyed. Thus, we examined the possibility of common method variance using Harman's single factor test (Podsakoff & Organ, 1986). The assumption that underlies this test is that if a significant amount of common method variance exists, then a single factor that explains a significant amount of the variance will emerge from the factor analysis. Unrotated factor analysis using the criterion of an eigenvalue that is greater than one revealed six factors, with the first ranked factor explaining only 19.5 percent of the variance in the data. We thus conclude that the data were not subject to common method bias to any substantial extent.

The overall measurement model employed 18 items to measure the four exogenous and the four endogenous constructs. The exogenous constructs are included as control variables, and are firm size, age, inter-firm collaboration, and technological volatility. The endogenous constructs represent two types of capabilities, exploitation and exploration activities, and two performance constructs, operational efficiency and strategic performance. Details of the individual items that were used to measure each construct are presented in the Appendix.

We use four exogenous constructs of firm size, age, inter-firm collaboration, and

technological change. Firm size and age are involved in the model because we assume that both are related to exploitation. Hannan and Freeman suggest that well-established firms have two advantages – *reliability*, or the capacity to “produce collective products of a given quality repeatedly” and *accountability*, or the capacity to “account rationally for their actions” (1989: 72-73).

Inter-firm collaboration, which is embedded in a firm’s relationships with its suppliers, customers, and particular institutions, often brings new resources and opportunities to a firm, and thus means that such collaboration is a significant source of competitive advantage (McEvily & Zaheer, 1999; Gulati, 1999; Powell, Koput, & Smith-Doerr, 1996). Many empirical studies have found positive relationships between inter-firm links, technological development, and firm performance (Powell et al., 1996; Henderson & Cockburn, 1994; Baum, Calabrese, & Silverman, 2000). Powell et al. suggest that “inter-firm collaborations are not simply a means to compensate for the lack of internal skills, nor should they be viewed as a series of discrete transactions” (1996:119), and that a firm can further develop and strengthen internal competence through collaboration. They find that a knowledge creation process of external linkage in the form of inter-firm collaboration leads to superior technological performance. In addition, as collaboration makes firms more aware of outside opportunities, it is expected that it will also make them more flexible and innovative in dynamic environments (Tushman, 1977).

Finally, we added the construct of the technological volatility in which a firm operates. Scholars of the dynamic capability perspective stress that exploration activities are needed in uncertain and unpredictable environments (Teece et al., 1997). As our sample includes a variety of industries and technologies, this construct can also help to control for environmental factors. Firms that perceive that their environments are entering a phase of high-velocity turbulence

(Brown & Eisenhardt, 1997) can be expected to intensify and diversify their activities in prospecting for new opportunities (exploration strategies).

The respondents were asked to report their responses to all of the items, except firm size and age, on a five-point Likert scale. To assess internal reliability, we calculated the Cronbach's alpha for each construct, and found that all of them exceeded the 0.7 level that is recommended by Nunnally (1978). Table 1 shows the descriptive statistics and internal reliability.

Insert Table 1 about here

The hypotheses were tested using a complementary factor analysis known as structural equation modeling. This method allowed us to identify the effects of both exploitation and exploration on firm performance. The model that was used in the analysis is described in Figure 1, and LISREL was used to estimate the proposed model.

Insert Figure 1 about here

RESULTS

The overall fit of the model is excellent, as is indicated in Table 2. The p value of the chi-square that indicates the deviation of the variance-covariance matrix of the model is insignificant at $p = 0.24$, and the other indicators of fit (AGFI = 0.93, CFI = 1.00, RFI = 0.95, RMR = 0.041, and RMSEA = 0.018) are all in the range that is considered to be indicative of an excellent overall fit of the model to the data.

Insert Table 2 about here

The fit for the structural equations of the endogenous variables ranges from adequate to excellent for cross-sectional data. The new construct of exploration fits particularly well, with $R^2 = 0.67$, thus demonstrating that the model captures this proposed phenomenon very well. R^2

= 0.36 for exploitation and $R^2 = 0.56$ for strategic performance, which are also very good results for cross-sectional data. Given that short-term performance is likely to be influenced by many factors outside of the scope of our model, $R^2 = 0.11$ is adequate, if unspectacular, for operational efficiency.

The maximum likelihood estimates of these coefficients and their degree of significance are presented in Table 2. All of the regression coefficients in the structural equations are positive, and significant, except for β_{12} (exploration on exploitation), β_{32} (exploration on operational efficiency), and γ_{13} (inter-firm collaboration on exploitation). These results strongly support Hypotheses 1 and 2, which predict positive associations between exploitation and operational efficiency (Hypothesis 1) and between exploration and strategic performance (Hypothesis 2). Consistent with Hypothesis 3a, we find a positive and significant effect of exploitation on exploration at well above the 0.01 level. However, the effect of exploration on exploitation is not statistically significant, although the effect is in the predicted direction.

The total standardized coefficients are presented in Table 3. The standardized coefficients reflect a measure of the relative importance of each predictor variable on the endogenous variables (Goldberger, 1964), that is, the standardized coefficients indicate the “typical” variation in an endogenous variable that is associated with the “typical” variation in an independent variable, where “typical” is calibrated according to the sample standard deviations of all of the variables in turn.

Insert Table 3 about here

Exploitation is the most important construct (0.33) for operational efficiency, whereas exploration (0.72) is the most important construct for strategic performance, followed by inter-firm collaboration (0.43), exploitation (0.38), and technological volatility (0.21). Firm size

and age are substantially less important for both performance variables. However, their effects are not trivial, and are statistically supported.

The most important link for exploitation is with firm age (0.36) and size (0.33). Inter-firm collaboration (0.59) is by far the most important determinant for exploration, followed by exploitation (0.40) and technological volatility (0.29). These results suggest that inter-firm collaboration plays a vital role in the enhancement of exploration, which in turn improves strategic performance.

With regard to the relationship between exploitation and exploration, our results show that exploitation strongly enhances exploration (0.40), although the effect of exploration on exploitation (0.06) is not significant. These findings suggest that neither activity is mutually exclusive or independent, and that although exploitation tends to enhance exploration, exploration has little effect on exploitation.

DISCUSSION AND CONCLUSIONS

This study investigates the way in which exploitation and exploration independently and jointly influence the operational efficiency and strategic performance of a firm, and how they interact in improving both types of performance. The results of the analyses suggest that both exploitation and exploration are strongly associated with different levels of firm performance. Specifically, our findings suggest that exploitation has a greater positive impact on operational efficiency than exploration, and that exploration has a greater positive impact on strategic performance than exploitation. These findings suggest that exploitation contributes to short-term improvement and better operational performance, and that exploration contributes to long-term improvement and better strategic performance.

With regard to the relationship between exploitation and exploration, the results suggest that exploitation is positively related to exploration, and that exploration is also positively related to exploitation. However, the latter relationship is not statistically significant. This finding suggests that although exploitation can be a building block for exploration, exploration does not necessarily prompt exploitation. One possible reason for this non-significant result is that exploitation and exploration have different implications for a firm's resource configuration. Exploration may limit the availability of resources for exploitation, whereas exploitation leverages resources for exploration.

The results of our analyses also suggest that firm size and age are significantly associated with a firm's exploitation, which in turn enhances both operational efficiency and strategic performance. Our results imply that, consistent with the evidence that has been found by previous studies (Rothaermel, 2001; Lane & Lubatkin, 1998; Lee, Lee, & Pennings, 2001), external learning through inter-firm collaboration has a stronger impact on exploration than it does on exploitation.

To supplement these findings, we conducted in-depth interviews with over thirty executives of the small to medium-sized manufacturing firms in our sample, which are all firms that possess the cutting-edge technologies and dominant market share in their respective fields. These firms had aggressively developed original technologies and products, had collaborated with other firms or universities, had absorbed external technologies and knowledge, and had successfully developed new competence bases in their respective areas of business. Most of the executives that we interviewed believed that the most critical source of competitive advantage is a firm's ability to upgrade its technology, to acquire new technology from external sources, and to integrate newly acquired technology with existing technology to develop even more

advanced technology. This belief is consistent with our finding that both exploitation and exploration are the key sources of sustainable competitive advantage. The executives also emphasized the importance of alliances in the exploration of new technology and product development. One senior manager interestingly remarked that his firm forms alliances not just to gain access to the superior technology of their alliance partners, but also to “force” the original firm to make a significant commitment to the joint development of advanced technology by the integration of the firm’s existing technology with the technology of the partner firm. Similarly, another executive noted that “although our alliance partners continue to support us by giving us a significant number of ideas for further improvement and innovation, they also expect us to develop the most advanced technology and be the leader in a specific area of key technology.” These comments suggest that alliance partners play a vital role not only as an external source of new technology, but also as an impetus for exploration.

Implications for the Literature

This study makes several contributions to the literature of organizational learning and strategic management. First, we simultaneously examine the relationship between exploitation and exploration and their respective impact on performance. Our findings show that exploitation and exploration have different effects on firm performance, and in conducting similar analyses, therefore, researchers should make a clear distinction between the decisions that a firm makes on the deployment of its existing competence base, and those that it makes on the development of new a competence base to achieve superior performance. Our study clearly suggests that the former decisions, which are embodied in our exploitation variable, are related to operational efficiency, and the latter decisions, which are embodied in our exploration variable, are related to long-term strategic performance. The existing literature tends to ignore the effects of

exploitation and exploration on different levels of performance, and thus the concepts of exploitation and exploration should be treated separately in future research and their effects on different levels of performance be further examined.

Second, we examine the systematic relationships between exploitation and exploration. Makadok (2001:391) suggests that understanding the relationship between “resource-picking” and “capability-building” mechanisms is one of the most important issues in research on strategy. Our study partly addresses this issue, and the evidence shows that a firm’s exploitation activity significantly enhances its level of exploration, as does inter-firm collaboration. These findings suggest that inter-firm collaboration, exploitation, and exploration work dynamically and complementarily to develop a firm’s competitive advantage. One interesting and important extension of this study would be to investigate how firms use inter-firm collaboration to manage the dynamic process of co-evolution between exploitation and exploration, and how they resolve the potential problems of expropriation (Hamel, 1991), the competency trap (Levitt & March, 1988), or core rigidities (Leonard-Barton, 1992) that are inherent to this process. This kind of research, however, requires in-depth, longitudinal case studies.

The third contribution that our study makes lies in its use of survey data. Previous studies of exploitation and exploration have been mostly conceptual, and although an increasing number of researchers have identified sources of competitive advantage and have investigated the relationship between resources and firm performance, most of this research uses publicly available data such as R&D expenditure, the number of patents, and the development of new products as proxies for technological competencies (Hitt & Ireland, 1985; Hitt, Hoskisson, & Ireland, 1990). By contrast, our study empirically measures exploitation and exploration with a systematic empirical test, and incorporates the effects of firm age and size, technological

volatility, and inter-firm collaboration into the model, all of which are expected to influence the balance of exploitation and exploration.

Finally, this study is one of the few in the field of dynamic capability research to adopt a causal modeling method. We find that exploitation and exploration are not independent activities, and that exploration is enhanced by exploitation, and thus this method helps us to understand the systematic associations between the antecedents and consequences of exploitation and exploration.

Implications for Practitioners

This study has two implications for practitioners. First, our evidence suggests that the impact of exploitation on operational efficiency is greater than that of exploration, although exploration has a greater impact on strategic performance, such as the development of new technology and product development, than exploitation. Our study suggests that decisions both on the utilization and the development of resources and competencies are critical to the achievement of superior performance in both the short and the long term. Although exploration activities that develop new resources and competences are not easy to carry out because they involve organization-wide commitment, managers should recognize that the mere accumulation or utilization of the existing competence base does not guarantee a sustainable competitive advantage, and that in a rapidly changing environment, firms should continuously search for new competence bases to augment their existing capabilities. Our evidence clearly shows that much of the variation in performance of firms is explained by the variation in their level of exploitation and exploration.

Second, our evidence suggests that inter-firm collaboration is a very effective means of enhancing exploration. The evidence further highlights that even small firms with limited

resources are able to develop a sustainable competitive advantage that is comparable to that of resource-rich large enterprises through the formation of collaborative relationships with other firms, and can thereby enhance their exploration of new competence bases. Some firms may be reluctant to form alliances or other types of collaboration with other firms because of the risk of expropriation of proprietary know-how, but they should recognize that the key issue in inter-firm collaboration is not about how to avoid these risks, but about how to develop a good partnership within which to explore new competitive opportunities.

Limitations

Despite the aforementioned contributions, this study has some potential limitations. We focus only on exploitation and exploration as key elements of competitive advantage, and other elements that affect performance, such as organizational culture, leadership, marketing competence, and other functional skills, are ignored. As superior performance is often based on a complex mix of interrelated and organizationally embedded resources (Black & Boal, 1994), more in-depth investigation is necessary to gain a true understanding of the links between different sets of resources and their relative impact on performance. The moderate R^2 for operational efficiency in our results suggests that further development of the performance model might be helpful. However, the very high R^2 for strategic performance suggests that the current model is strong in this area.

This study is cross sectional in nature, and says little about the dynamic process of competitive strategy (Porter, 1991; Priem & Butler, 2001; Foss, Knudsen, & Montgomery, 1995). Some scholars have recently proposed a new perspective that emphasizes the dynamic and evolutionary nature of technological competencies (Teece et al., 1997; Eisenhardt & Martin, 2000; Amit & Schoemaker, 1993). From this perspective, a firm's distinctive competence is

viewed as a “process” rather than a fixed element, and the way in which a firm allocates the necessary resources for innovation over time, how it deploys its existing resources, and where it sources new resources is explained. However, because our study is cross sectional, it does not capture the process aspect of competitive strategy.

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TABLE 1
Descriptive Statistics: Correlation Coefficients and Cronbach's Alphas

	Constructs	1	2	3	4	5	6	7	Items	Cronbach's alphas
1	Firm size								1	-
2	Firm age	0.19							1	-
3	Inter-firm collaboration	0.15	0.05						3	0.82
4	Technological volatility	0.21	0.08	0.28					3	0.72
5	Exploitation	0.32	0.32	0.22	0.14				3	0.74
6	Exploration	0.26	0.26	0.71	0.51	0.46			3	0.84
7	Efficiency	0.11	0.11	0.08	0.05	0.16	0.16		2	0.79
8	Strategic performance	0.21	0.15	0.52	0.37	0.40	0.74	0.14	2	0.77

TABLE 2
LISREL Results by Maximum Likelihood Estimators

Constructs	Exploitation	Exploration	Operational efficiency	Strategic performance
	$\eta 1$	$\eta 2$	$\eta 3$	$\eta 4$
Firm size	$\gamma 11$			
$\xi 1$	0.25 (4.59)			
Firm age	$\gamma 12$			
$\xi 2$	0.28 (4.15)			
Inter-firm collaboration	$\gamma 13$	$\gamma 23$		
$\xi 3$	0.063 (0.50)	0.31 (6.72)		
Technological volatility		$\gamma 24$		
$\xi 4$		0.33 (3.34)		
Exploitation		$\beta 21$	$\beta 31$	$\beta 41$
$\eta 1$		0.29 (3.55)	0.30 (3.16)	0.11 (1.58)
Exploration	$\beta 12$		$\beta 32$	$\beta 42$
$\eta 2$	0.083 (0.26)		0.020 (0.20)	1.00 (7.68)
Adjusted R ²	0.36	0.67	0.11	0.56

n = 302; chi-square = 94.18, df = 84 p = .23; adjusted goodness of fit index (AGFI) = .93; comparative fit index (CFI) = 1.00; relative fit index (RFI) = 0.95; root mean square residual (RMR) = .041; root mean square error of approximation (RMSEA) = .018. The values in the upper rows are maximum likelihood estimators, and the t-values are in parentheses.

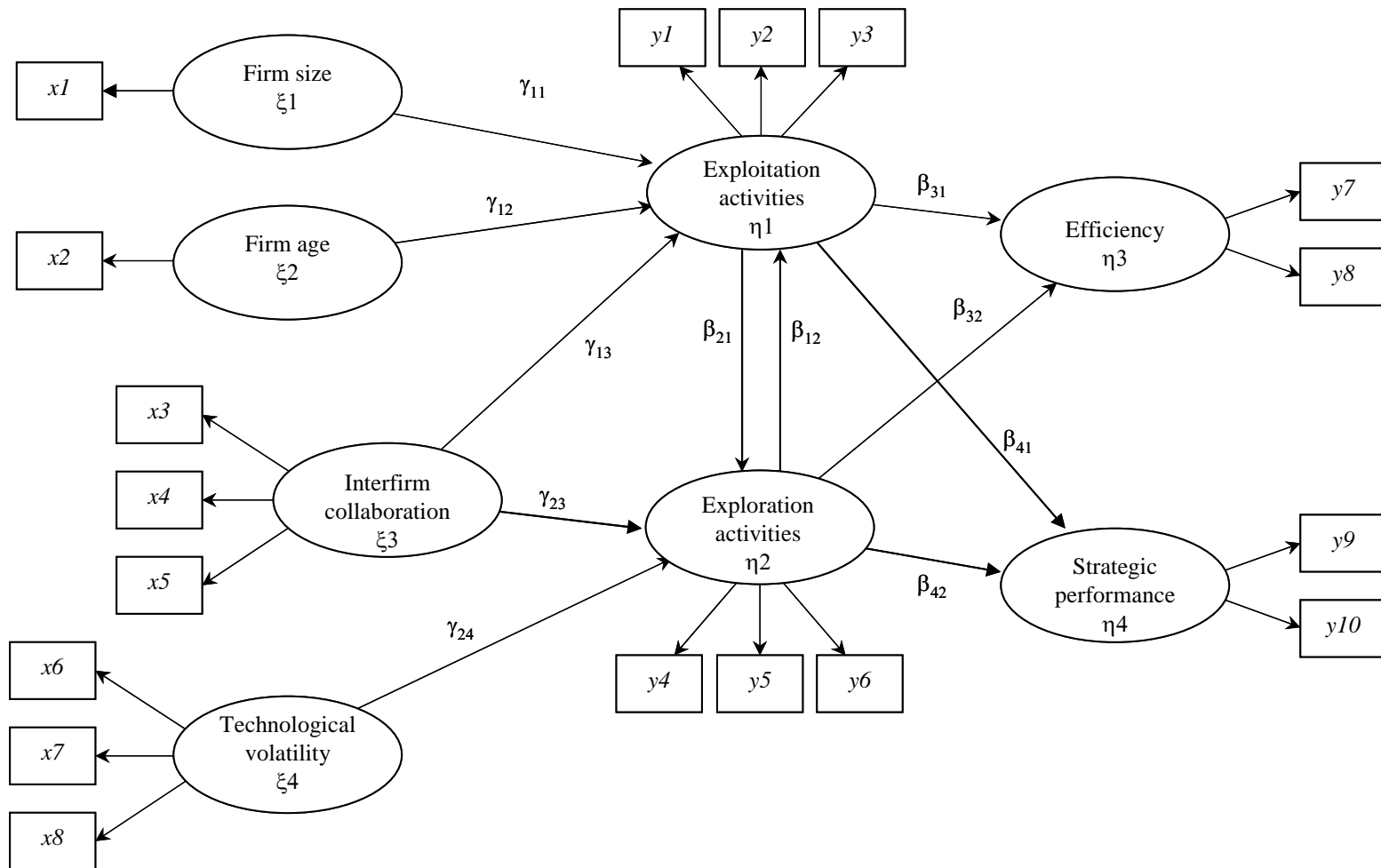
TABLE 3
Standardized Total Effects of Exogenous and Previous Endogenous
Constructs^a

	Exploitation	Exploration	Efficiency	Strategic performance
Firm size	0.33	0.13	0.11	0.12
Firm age	0.36	0.14	0.12	0.13
Inter-firm collaboration	0.12	0.59	0.05	0.43
Technological volatility	0.02	0.29	0.01	0.21
Exploitation	0.02	0.40	0.33	0.38
Exploration	0.06	0.02	0.04	0.72

^a Values greater than 0.11 are significant at the 0.01 level.

FIGURE 1

Paths between Latent Variables



APPENDIX

Measurement items

Control variables

- ξ_1 Firm size
 - x_1 Number of employees
- ξ_2 Firm age
 - x_2 Age (year)
- ξ_3 Inter-firm collaboration
 - x_4 We aggressively participate in technological alliances (very unlikely-very likely).
 - x_5 We obtain important product/market information from external sources (suppliers, customers, and alliance partners) rather than internal sources (internal search) (very unlikely-very likely).
 - x_6 We frequently develop new products or services with customers (very unlikely-very likely).
- ξ_4 Technological volatility
 - x_7 Our technologies/products are substituted for new technologies/products (very unlikely-very likely).
 - x_8 Our technologies become obsolete rapidly (very unlikely-very likely).
 - x_9 Major technological innovations frequently appear in our industry (very unlikely-very likely).

Activity variables

- η_1 Exploitation activities
 - y_1 Our new technologies/products are highly related to existing technologies/products (very unlikely-very likely).
 - y_2 The majority of our customers are in similar industries (very unlikely-very likely).
 - y_3 We improve production process and quality (very unlikely-very likely).
- η_2 Exploration activities
 - y_4 We always search for new and promising technologies (very unlikely-very likely).
 - y_5 We integrate internal and external technologies (very unlikely-very likely).
 - y_6 We take risks to develop new technologies or products (very unlikely-very likely).

Performance variables

- η_3 Operational efficiency
 - y_7 Our profitability is higher than that of our major competitors (very low-very high).
 - y_8 Our production process is more efficient than that of our major competitors (very unlikely-very likely).
- η_4 Strategic performance
 - y_9 We develop more new technologies/products than our major competitors (very unlikely-very likely).
 - y_{10} We enter growing industries (e.g., biotechnology, information, and environmental technology) faster than our major competitors (very late-very early).

* Items with verbal anchors in parentheses had a 1-5 response scale.