CONTENT ANALYSIS AS A METHOD FOR MEASURING EXPLOITATION AND EXPLORATION: DISCUSSION WITH EXAMPLE APPLICATION TO THE WORLDWIDE OPTICAL LIBRARY INDUSTRY

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Gun Jea Yu

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ABSTRACT

This thesis summarizes and reviews the empirical literature on organizational ambidexterity and compares four distinct approaches to measuring exploration and exploitation: patent-based measures, survey-based measures, accounting-based measures, and press-based measures. I argue that press-based measures can be an effective way to measure exploration and exploitation longitudinally. However, such measures must be tailored to specific industries, and therefore I suggest strategies and procedures for constructing valid and reliable press-based measures in a single industry context. I illustrate my arguments through a study of the worldwide optical disk industry.

BIOGRAPHICAL SKETCH

Gun Jea Yu was born in Pusan, South Korea. He graduated from Sogang University and received a Bachelor's of Science in business management, with a minor economics. He received his M.S. in Human Resources Management from the School of Krannert at Purdue University in 2008. His M.S. from the School of Industrial and Labor Relations, Cornell University is in Organizational Behavior, with a minor in Human Resource Studies.

This thesis is dedicated to my loving wife who has supported me throughout my academic career and parents and parents-in-law who have encouraged me to pursue my dream.

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CHAPTER 1

INTRODUCTION

Since March (1991) proposed the concepts of exploitation and exploration, a diverse range of operationalizations have emerged for these two concepts, and there is little agreement on the ideal measurement approach. Research using survey-based measures captures exploration and exploitation through cross-sectional snapshots. As a result, this work does not capture the evolution of exploitation and exploitation over time. This is potentially problematic because organizations adjust their exploratory and exploitative activities over time to cope with environmental change. Some studies have used patent-based measures to capture exploitation and exploration (Audia & Goncalo, 2007; Rosenkopf & Nerkar, 2001; Katila & Ahuja, 2002; Quintana & Benavides, 2008; Wang & Li, 2008). Patent data have considerable variation in terms of representation of a firm's technology because firms in different industries have different strategies to protect their technologies. Such variation results in less generalizability across industries (Gambardella, Harhoff, & Verspagen, 2008). In addition to survey-based and patent-based measures, accounting-based measures (e.g., research and development [R&D] expenditures) can be used as a measure of exploration and exploitation. Measures of exploration and exploitation based on R&D expenditures capture the trade-off between exploration and exploitation because organizations need to allocate their limited resources to either exploration or exploitation. Recent surveys from the U.S. Census Bureau have started to provide R&D expenditure data. However, the U.S. Census Bureau does not provide data on R&D expenditures of individual firms to the public. In addition, surveys will be conducted every four year, and thus it takes time for researchers to use these data longitudinally.

Recently, Uotila, Maula, Keil & Zahra (2009) suggested press-based measures[1] using news documents as an alternative to survey-based and patent-based measures of exploitation and exploration.

[1] Press-based measures are one of the content analytic measures. Press-based measures use news documents or journals to collect data.

This method is designed to broaden the coverage of firm actions aimed at exploitation and exploration, increase generalizability, and measure these activities longitudinally. However, the press-based measures Utotila et al. (2009) used also have limitations such as limited coverage by news sources, the selection of search terms for exploration and exploitation, and sample bias.

In this thesis, I provide an overview of the existing literature with particular attention to the operationalization of exploration and exploitation. I review the empirical strategies, the data sources, and the construction of various measures that have been employed by past scholars. I identify four distinct approaches -- 1) survey-based measures; 2) patent-based measures; 3) accounting-based measures; and 3) press-based measures - and highlight the strengths and weaknesses of each. I then examine press-based measures, the most recently developed approach, in greater depth and apply the technique to a study of innovation in a single industry.

CHAPTER 2

Literature Review

March (1991) developed the original concepts of exploitation and exploration. Exploration is associated with "search, variation, risk-taking, experimentation, play, flexibility, discovery, and innovation," whereas exploitation refers to activities such as "refinement, choice, production, efficiency, selection, implementation, and execution" (p.71). These definitions of exploration and exploitation can be interpreted in various ways due to their quite broad scope. In a subsequent study, Levinthal and March (1993) narrowed down the scope of the two activities to the knowledge domain, noting that exploitation refers to "the use and development of things already known," whereas exploration is related to "a pursuit of new knowledge" (p. 105). Subsequent research on exploration and exploitation used this refined definition based on knowledge concepts. For example, Katila and Ahuja (2002) defined exploitation as search depth, which represents how deeply a firm reuses its existing knowledge, whereas exploration is search scope, which means how broad knowledge a firm searches. More recently, scholars have expanded the notions of exploration and exploitation beyond knowledge-related concepts. The notions of exploration and exploitation have been defined in terms of radical versus incremental innovation (Beckman, 2006; Cao, Gedajlovic, & Zhang, 2009; He & Wang, 2004), and variation-reducing or variation-increasing (Burgelman, 1991; 2002).

The effects of exploitation and exploration on organizational performance have been the primary concerns in the exploration and exploitation literature. Researchers have argued that the impacts of exploration and exploitation on organizational performance differ in terms of long-term and short-term outcomes. Exploration activities help the firm search for new capabilities and enhance long-term performance, such as survival. However, the chance of a payoff is uncertain and distant compared with that of exploitation. Thus, the uncertain long-term performance from exploration can lead to vicious cycles (i.e., failure of exploration results in more exploration) (Levinthal & March, 1993). On the other hand, exploitation enhances short-term performance by increasing efficiency, decreasing performance variance, and improving adaptation to the current environment. However, high efficiency and reduced variation might become an organizational liability that prevents firms from adapting to changing environments.

Few empirical studies have shown the differential effects of exploration and exploitation on organizational performance. For example, Auh and Menguc (2005) found that exploration is associated with organizational effectiveness, measured by market-share growth and sales growth. On the other hand, exploitation is related to organizational efficiency, captured by return on assets and return on sales. However, the relationship between exploitation, exploration, and organizational performance is contingent on environments or managerial preferences (Lavie et al., 2010). For instance, environmental dynamism and competitiveness moderate the relationship between exploitation and exploration and financial performance (Jansen, Van den Bosch, & Volberda, 2006). While competitive pressures intensify the contribution of exploitation to performance, environmental dynamics increase the positive effect of exploration on performance. Furthermore, the contingent effect of environments on performance may differ according to the organization’s orientation. Organizations that focus on exploitation strategies may face decreasing short-term performance under competitive market conditions, whereas organizations with exploratory tendencies can improve their short-term performance under the same conditions (Auh & Menguc, 2005).

CHAPTER 3

Four Approaches to Measuring Exploration and Exploitation

In the fall of 2011, I conducted an extensive review of the empirical literature in management, strategy, organizational behavior, and marketing. Based on a few previous reviews of the exploration and exploitation literature as well as my own search, I identified and reviewed 35 empirical articles published in *Academy of Management Journal, Organization Science, Strategic Management Journal*, *Journal of Organizational Behavior*, *Journal of Management Studies,* and others between 2002 and 2010. These 35 studies were conducted in a diverse range of fields (e.g., organizational design, organizational learning, technological innovation, strategy, leadership [top management team], and contingency theory). In terms of research methodology, studies using survey-based measures account for 67% (24) of the total, studies using patent-based measures account for 14% (5), and studies using press-based measures account for 19% (7). With regard to the level of analysis, 22 studies (63%) were conducted at the organizational level. The rest of the studies were conducted at the unit, team, individual and inter-firm level (See Table 1). In addition, a short review of 35 empirical studies on exploration and exploitation are provided (See Appendix A).

Table 1
Summary of the Level of Analysis and Data Type of 35 Empirical Articles

Data type

patent	5	14%
content analysis	7	19%
survey	24	67%
Sum	36	100%

The level of analysis

Inter-firm	3	9%
Organization	22	63%
Unit	2	6%
Branch	4	11%
Team	1	3%
Individual	3	9%
Sum	35	100%

Researchers addressed the need for a longitudinal approach to capture exploration and exploitation because a balance between the two is not a static, but rather a dynamic alignment (Raich & Birkinshaw, 2008; Raich, Birkinshaw, Probst, & Tushman, 2010). However, a majority of empirical studies investigated the effect of exploration or exploitation and ways to enable organizations to be ambidextrous with a static perspective. In my review, 34 of the 35 empirical articles took a static approach, using cross-sectional exploration and exploitation data.

The increasing attention to exploration and exploitation has contributed to conceptual refinement (Raisch & Birkinshaw, 2007). In addition, many empirical studies have provided evidence of conceptual work. However, less attention has been given to methodology, and the understanding of methodology in the exploration and exploitation literature has remained under-explored. In this thesis, I intend to clarify what methods are applicable to exploration and exploitation studies and to review the strengths and weaknesses of different methods. Before reviewing the methods, criteria to evaluate them will be addressed.

Four criteria to evaluate measures of exploration and exploitation

Three different approaches to measuring exploration and exploitation have been used in the exploration and exploitation literature: survey-based measures, patent-based measures, and press-based measures. In addition to these three measures, accounting-based measures (R&D expenditures) can be used to measure exploration and exploitation. These four approaches are compared using four criteria: longitudinal data, content validity, generalizability, and accessibility. In this section, I will define the four criteria and explain why these four criteria were adopted.

One of the important criteria is whether or not a measure of exploration and exploitation can provide longitudinal data. A static perspective on exploitation and exploration has been prevalent (Alexander, Jansen, van den Bosch, & Volberda, 2010; Auh & Menguc, 2005; Cao, Gedajlovic, & Zhang, 2009; Cao, Simsek & Zhang, 2010; Gibson & Birkinshaw, 2004; He & Wong, 2004; Jansen, George, Van den Bosch & Volberda, 2008; Jansen, Vera, & Crossan, 2009; Jansen, Tempelaar, Bosch, and Volberda, 2009; Jansen, van den Bosch, & Volberda, 2005; Rothaermel & Alexandre, 2009; Sidhu, Jatinder, Volberda, Henk & Harry, 2004). This perspective assumes that organizations pursue exploration and exploitation activities to cope with demands of internal and external environments and that these two activities are constant over time (Raisch & Birkinshaw, 2008). However, organizations need to adjust their exploration and exploitation activities to satisfy changing demands in their internal and external environments (Siggelkow, 2003; Tushman & Anderson, 1986). In line with this argument, modern contingency theory suggested that alignment is a dynamic process rather than a static status (Zajac, Kraatz, & Bresser, 2000). The static perspective has limitations in that it cannot capture the evolution of exploration and exploitation. Methodologies using longitudinal data can provide the historical pattern of exploitation and exploration and help to clarify their evolution.

Content validity is one of two validity tests based on the subjective evaluation of an operational definition. Content validity is defined as "the extent to which a measure adequately represents all facets of a concept" (Singleton & Straits, 2010, p. 139). In this paper, content validity is defined as the extent to which a measure of exploration and exploitation represents the concepts of exploration and exploitation that March (1991) proposed, because most researchers have conceptualized exploration and exploitation based on his definitions. With regard to archival data (i.e., patent-based measures, accounting-based measures, and press-based measures), judgments of content validity can be made by comparing March's (1991) conceptualizations of exploration and exploitation and the operationalizations of exploration and exploitation made using the three approaches that rely on archival data. The content validity of survey-based measures can be made by analyzing content validity of previous studies that used surveys. Validity testing is frequently used as a criterion to judge the quality of various measures (Singleton & Straits, 2010).

Generalizability is defined as the extent to which inferences can be made from a sample and extended to the population as a whole and is often referred to as one criterion for the quality of measures

(Singleton & Straits, 2010). Lack of generalizability derives from various sources such as the research sample, the time of study, and the operational definitions (Singleton & Straits, 2010). In this thesis, I evaluated generalizability across industries in terms of operational definitions because the three measures using archival data are limited in terms of operationalization and generalizability across firms within industry by examining whether a measure can be applicable to diverse types of firms within industry[2]. I also evaluated accessibility of data from three archival-based measures as one of the criteria to judge the quality of a measure.

Reviews of the four measures of exploitation and exploration

I reviewed the four approaches to measuring exploration and exploitation using four criteria: longitudinal data, content validity, generalizability, and accessibility. Table 2 summarizes the strengths and weaknesses of the four approaches based on these four criteria.

Table 2: Comparison of Four Approaches for Measuring Exploration and Exploitation

Criteria	Survey	Patent	R&D expenditure data (US Census)	Content analysis
Longitudinal data	M*	H	M**	H
Content Validity	H	M	H	H
Generalizability across industries	H	L*	M	M
Generalizability across firms within industry	H	M	H	M
Accessibility	N/A	H	M	H

H (High): Fully support M (Medium): Support, but not fully L(Low): Do not support

* These are not inherent weaknesses of measures, but a weakness with the design choices in the exploration and exploitation literature
** Longitudinal data will be available 2012 or 2013.

[2] Firms are categorized by various factors such as size, public status, and age. However, the different characteristics of organizations resulting from such factors are explained by two mechanisms. Larger (public and older) firms are likely to have more structural inertia and more resource endowment (for review Carroll & Hannan, 2000; Helfat & Lieberman, 2002; Carroll & Khessina, 2005; Khessina, 2006). Therefore, in this thesis, generalizability across firms within industry was evaluated by investigating whether measures of exploration and exploitation can apply to both large and small firms.

Survey-based measures of exploration & exploitation

A large number of studies have used surveys of key personnel to capture firms' exploitation and exploration activities (Alexander, Jansen, van den Bosch, & Volberda, 2010; Auh & Menguc, 2005; Cao, Gedajlovic, & Zhang, 2009; Cao, Simsek & Zhang, 2010; Gibson & Birkinshaw, 2004; He & Wong, 2004; Jansen, George, Van den Bosch & Volberda, 2008; Jansen, Vera, & Crossan, 2009; Jansen, Tempelaar, Bosch, and Volberda, 2009; Jansen, van den Bosch, & Volberda, 2005; Rothaermel & Alexandre, 2009; Sidhu, Jatinder, Volberda, Henk & Harry, 2004). These studies evaluated a company's explorative focus (McGrath, 2001; Jansen et al., 2006), the exploration and exploitation focus of innovation activities (He & Wong, 2004), or the radicalness of innovations (Bierly & Chakrabarti, 1996). Most studies (16 of 22 empirical articles using surveys) operationalized exploration and exploitation using market and product concepts. For example, He and Wong (2004) measured exploitation by asking whether organizations focused on cost reduction and existing products and measured exploration by inquiring whether their products or services were targeted at new markets or customers or they entered into new technology fields. Subsequent studies which adopted a survey methodology have utilized similar operationalizations. 4 of 22 empirical studies using surveys used only either technology or market concepts to operationalize exploration and exploitation. The other two studies operationalized exploration and exploitation based on knowledge sharing (Im & Rao, 2008) and team members' efforts to explore and exploit (Nemanich & Vera, 2010). With regard to the level of analysis, 20 of the 22 studies were conducted at the level of the organization and unit. The other two were conducted at the level of team and individual. In sum, operationalization using technology and market concepts has been dominant in survey-based measures of exploration and exploitation and studies using surveys focused on the organizational level to reveal the consequences or antecedents of exploration and exploitation.

Studies using survey-based measures enhanced content validity by asking managers for items of exploration and exploitation and by conducting factor analysis of exploration and exploitation items (Cao et al., 2009, 2010; Gibson & Birkinshaw, 2004; He & Wong, 2004; Jansen et al., 2005, 2008, 2009; Mom et al., 2009). For example, He and Wong (2004) developed items for exploration and exploitation at the organization level and asked key personnel to inspect the items for exploration and exploitation in terms of appropriateness, redundancy, and ambiguity. Next, they ran factor analysis to determine whether items captured exploration and exploitation distinctly. Many subsequent studies provided evidence of the content validity of survey-based measures of exploration and exploitation. This implies that survey-based measures have a high content validity. Some studies using surveys were conducted in multiple industries (Alexander et al., 2010; Auh & Menguc, 2005; Jansen, et al., 2009; Sidhu et al., 2007). This implies that studies using survey-based measures can develop survey items to cover multiple industries and these items can be generalizable across industries. In addition, the samples in several studies included both large and small firms (Jansen et el., 2009; Rothaermel & Alexandre, 2009; Sidhu et al., 2007). Thus, survey-based measures are also generalizable across firms within industry. However, surveys are less applicable for obtaining longitudinal data than for patent data because it is difficult for informants to retrospectively recall exploitation and exploration activities[3] (Raisch & Birkinshaw, 2007).

Patent-based measures of exploration & exploitation

Some studies have relied on patent data as objective proxies for exploration and exploitation (Audia & Goncalo, 2007; Rosenkopf & Nerkar, 2001; Katila & Ahuja, 2002; Quintana & Benavides, 2008; Wang & Li, 2008). All studies except Audio and Goncalo (2007)'s study focused on the firm or inter-firm level as the level of analysis. These studies operationalized exploration and exploitation mainly using citations in patents. For example, Katila and Ahuja (2002) measured exploitation as "the average number of times a firm repeatedly used the citations in the patents it applied for" (p. 1187) and measured exploration as "the proportion of previously unused citations (new citations) in a firm's focal year's list" (p. 1187). Quintana and Benavides (2008) operationalized exploration as the number of granted patents in

[3] Although it is possible to use surveys to collect longitudinal data prospectively, it is easier to do so using patent and content analysis. However this limitation is not an inherent problem with survey research methods, but a problem with research design choices.

a year that had no citations and operationalized exploitation as the number of granted patents in a year that had one or more citations. Wang and Li (2008) constructed exploration as the number of citations in a firm's patent that came from outside of the firm's main class of patented technology and constructed exploitation as the number of citations in the patent that originated within the main class of the firm's patented technology.

Patent data have several strengths as a measure of exploration and exploitation. Patents provide rich and detailed information about technologies such as the people, places, times, and technological characteristics involved in new product development. In addition, patent data are not static, providing longitudinal data. When a patent is submitted for approval, the patent should show the citations that the applicant referred to. Citations in patents provide antecedents and descendants of patented technologies (Gittelman, 2008). In addition, all patent data are filed in the United States Patent and Trademark Office (USPTO). Thus, exploration and exploitation can be measured longitudinally if patent data are used. In addition, patent data are highly accessible and flexible. The National Bureau of Economic Research (NBER) provides a patent database that has citation information. NBER patent data can be merged with Compustat data, which include firms' financial data and cover the years from 1976 to 2006.

Patent-based measures also have limitations in that patent data do not fully represent firms' innovative activities. First, although patent data can provide technological information about firms' innovation, firms' innovative activities have been conceptualized very broadly, including search behavior (Rosenkopf & Nerkar, 2001) and entrance into new markets (He & Wong, 2004) as well as technological advancement. Thus, operationalization using patent-based measures may be too narrow to measure innovation. Such narrow operationalization implies that patents may not represent all facets of exploration and exploitation. In addition, diverse operationalizations of exploitation and exploration using patent data mean that there has been little consensus on how to measure both of these activities. Therefore, I argue that patent-based measures for exploration and exploitation have a low content validity. Second, not all innovative activities are patented. Each firm has a different strategy and motivation to manage its technological assets (Gittelman, 2008). Some firms do not patent their technologies or inventions if they can protect them in other ways such as know-how (Cohen, Nelson, & Walsh, 2000). Such differences result in considerable variation across industries in terms of the number of patents and the value of patents. For example, in the pharmaceutical and chemical industries, inventions are protected by a small number of patents, whereas in the electronics industry, a large number of patents protect inventions. This also implies that researchers should control for unobserved heterogeneity in patent data if multiple industries are studied. Thus, patent-based measures for exploration and exploitation are not generalizable across industries. In addition, firms need resources and personnel to manage their patents. Large firms may have more resources and personnel than small ones. Thus, there is some variation across firms within industry in terms of the number of patents. This implies that researchers also need to control unobserved heterogeneity in patent data if they used the patent-based measures within industry.

Accounting-based measures of exploration & exploitation

Accounting-based measures (R&D expenditures) are one alternative measure of exploration and exploitation, although they have not been used as such. March (1991) clearly distinguishes exploration and exploitation activities, arguing that these two are fundamentally incompatible. He argued that exploration and exploitation contend for scarce resources. The assignment of more resources to exploration results in fewer resources devoted to exploitation. Therefore, the operationalization of exploration and exploitation using R&D expenditures (resource allocation) can capture the trade-off between exploration and exploitation. Such an operationalization fits the original concepts of exploration and exploitation that March (1991) suggested. This implies that accounting-based measures may have a high content validity.

Recently, the U.S. Census Bureau started to collect data on R&D expenditures from 40,000 companies which have 5 or more employees. The Survey of Industrial Research and Development (SIRD) was jointly conducted by the National Science Foundation and the U.S. Census Bureau from 1957 to

2007, when it was replaced by the new Business R&D and innovation survey (BRDIS). The goal of the BRDIS is to collect a variety of data on the R&D activities of companies operating in the United States which will be useful to decision-makers in both the public and private sectors. In this newly developed survey, many new items have been added. Among them, in section 4, the management and strategy of R&D part, the survey asks about the portion of R&D expenditures that were directed toward business areas or product lines that are new to the company (Item 4-3: "What percentage of the amount reported in question 4-1 was directed toward business areas or product lines that are new to your company?"). This question captures the concept of exploration in terms of resource allocation. Therefore, I suggest that exploration could be operationalized as the portion of R&D expenditures related to product or business areas that are new to the company. Exploitation could be operationalized as the remaining portion of R&D expenditures. R&D expenditures data can be collected longitudinally in the future because they will be collected every five years. In addition, R&D expenditures data are generalizable both across firms within industry and across industries which have R&D activities because the concept of R&D expenditures is applicable to both large and small firms.

Operationalization using R&D expenditures has several benefits (e.g., fit with the March's concepts of exploration and exploitation and longitudinal data). However, only aggregate forms of R&D expenditures data such as total R&D expenditures by sectors (NAICS classification) are available to the public. In order to assess micro level data (R&D expenditures of each firm), researchers need to submit a proposal and this proposal must be accepted by the U.S. Census Bureau. This implies that R&D expenditures data are less accessible than data obtained through other approaches.

Press-based measures of exploration & exploitation

The use of content analysis in management studies has been growing (Duriau, Reger, & Pfarrer, 2007). Content analysis enables researchers to explore a wide range of strategy topics such as downsizing (Plamer, Kabanoff, & Dunford, 1997), corporate reputation (Fombrun & Shanley, 1994), and strategy reformulation (Huff, 1982). Recent research suggests that a simple quantitative count of words in news documents that capture a negative evaluation of firms can be used to predict individual firms' financial performance (Tetlock, Saar-Tsechansky, & Macskassy, 2008). In addition, simple word counting using computers minimizes reliability problems in text classification because computerized simple word counting is highly reproducible (Duriau, Reger, & Pfarrer, 2007).

Seven studies adopted the content analytic method to measure exploration and exploitation (Groysberg & Lee. 2009; Lavie & Rosenkopf, 2006; Lavie et al., 2010; Ming, 2010; Rothaermel, Frank & David, 2004; Uotila et al., 2009; Venkatraman, Lee, & Bala, 2006). Most studies utilized content analysis to measure exploration and exploitation which fit into a specific context (e.g., firm alliance - Lavie & Rosenkopf, 2006; Lavie et al., 2010; Rothaermel, Frank & David, 2004) or a specific industry (e.g., professional service - Groysberg & Lee. 2009, hard disk industry – Ming, 2010, Software industry - Venkatraman, Lee, & Bala, 2006). In addition, four studies adopted press-based measures for exploration and exploitation (Groysberg & Lee. 2009; Rothaermel, Frank & David, 2004; Uotila et al., 2009; Venkatraman, Lee, & Bala, 2006). Three of the four used industry-specific journals or news (Groysberg & Lee. 2009; Rothaermel, Frank & David, 2004; Venkatraman, Lee, & Bala, 2006). Uotila and colleagues (2009) were the first to use press-based measures for exploitation and exploration in order to make their operationalization applicable to multiple industries. They developed measures that "(1) cover a broad scope of corporate actions, (2) are available for a large number of companies over an extended period of time, and (3) are applicable across a range of industries" (p.224). The operational definition of exploration and exploitation that Uotila and colleagues (2009) adopted stems from March's notion of exploitation and exploration. This suggests that press-based measures of exploration and exploitation can capture exploration and exploitation accurately. In addition, the collection of longitudinal data is relatively easy because news articles are highly accessible. However, the press-based measures of exploration and exploitation that Uotila and colleagues (2009) employed are not generalizable across industries, although they argue otherwise. On the other hand, the press-based measures that Uotila and colleagues (2009) used are generalizable across firms within industry if visibility of a firm is controlled because large firms are more likely to appear in news documents. I will delineate why their measures of exploration and exploitation are not generalizable across industries in the following section.

In sum, the four approaches for measuring of exploration and exploitation have strengths and limitations. A comparison of the four approaches indicates that press-based measures of exploration and exploitation are the most reliable measures of exploration and exploitation for studies conducted in a single industry (See Table 2). Press-based measures can provide longitudinal data based on accurate operationalization of exploration and exploitation. In addition, data for press-based measures are highly accessible. The narrow operational definitions of exploration and exploitation are a weakness of patent-based measures. Accounting-based measures (R&D expenditure) have a limitation in that R&D expenditures data are not as accessible as other data. Although surveys can provide longitudinal data, it is difficult to collect longitudinal data using surveys. In the following section, I will explain how press-based measures of exploration and exploitation can be used in a single industry by improving on the press-based measures used by Uotila et al. (2009).

CHAPTER 4

The Use of Press-based Measures for Exploration and Exploitation

A broad range of methods and analytical techniques have been categorized as content analysis (Denzin & Lincoln, 1994). Shapiro and Markoff (1997) proposed a concise and complete definition of content analysis: "any methodological measurement applied to text (or other symbolic materials) for social science purposes" (p.14). According to Deffner (1986), content analysis is classified into three types: (1) human scored schema; (2) individual-word-counting systems; and (3) computerized systems using artificial intelligence. Uotila and colleagues (2009) adopted the computerized individual-word-counting method to measure exploration and exploitation. Words in a text are assigned to pre-specified, semantically similar categories in individual-word-counting systems (Weber, 1990). Although human coders can conduct this type of analysis, computerized coding systems are superior because they ensure higher reliability and better cost effectiveness (Rosenberg, Schurrr, & Oxman, 1990).

Uotila and colleagues (2009) collected news documents from the Reuters News archive in the Factiva database. Exploitative activities were captured by counting the number of times March's eight words appeared in news documents for each company-year and exploratory activities were measured by counting the number of times March's nine words appeared in news documents for each company-year. Uotila and colleagues (2009) performed several validity and reliability tests to determine whether the seventeen words identified actual activities of exploration and exploration because previous studies did not use content analysis for the operationalization of these activities.

The strengths of the approach that Uotila and colleagues (2008) suggested are twofold. First, operationalizations using press-based measures of exploration and exploitation are highly generalizable compared with those of survey or patent data methodologies. The search terms for content analysis cover a broader range of firms' exploration and exploitation activities, including strategic action as well as technological aspects, while patent-based measures capture only technological activities. Second, researchers can implement a longitudinal research design because news documents for content analysis are available over a long period of time.

While the press-based measures of exploration and exploitation that Uotila and colleagues (2009) used have several strengths, they also have weaknesses. First, Uotila and colleagues (2009) argued that their press-based measures of exploration and exploitation are highly generalizable across industries. However, the search terms they used may not be generalizable because not all search terms may represent exploration and exploitation in every industry. For example, ‘play’, which is one of the search terms for exploration, can have various meanings such as to make something operate (as in to play a CD), a performance of a role or character, a form of amusement, and to engage in competitive sports (as in to play against another team or player). In the video game industry (e.g., PlayStation and Xbox), ‘play’ usually means a form of amusement or making something operate. Another example is ‘search’. ‘Search’, which is one of the search terms for exploration, is widely used in the Internet industry, including the term ‘search engine’. This usage suggests that ‘search’ is not relevant to explain exploration in the Internet industry. Therefore, the appropriate search terms for measuring exploration and exploitation are likely to vary by industry. This implies that press-based measures of exploration and exploitation are not as generalizable as Uotila et al. (2009) suggested. Second, the selection of news sources may need to be altered in order to capture exploration and exploitation in small firms. Uotila et al. (2009) collected data from 279 manufacturing firms in the *Standard & Poor* 500 index. The firms that they chose are relatively large. Large firms may have higher visibility than small ones in major news sources such as Reuters News, and some small firms may not be covered by one particular news source. They suggested that it would be worthwhile to expand their results to small and medium size firms.

Enhancement of a content analytic measure for exploration and exploitation

I used the same search terms for exploration and exploitation used by Uotila and colleagues (2009) to add empirical evidence from a different sample and to find a way to tailor the operationalization of exploitation and exploration using content analysis in a particular industry or sector. I collected data for exploration and exploitation in the worldwide optical library industry. The optical library industry is an appropriate setting for investigating the effects of exploration and exploitation for several reasons. First, this industry has experienced high rates of innovation change (e.g., changes in optical disk technology and network technology). Second, the data on this industry cover every firm during the period 1990 to 1998, making it possible to avoid sample selection bias. Third, firms in the optical library industry have been diverse in terms of size, providing an appropriate setting for extending the results of Uotila and colleagues (2008) to small firms.

The population I studied (optical library industry) included 100 firms from 1984 to 1998, which generated a total of 461 firm-year observations. Among these 100 firms, 15 firms were de novo (start-up firms), 85 firms were de alio (diversified firms); 24 firms were public, and 72 firms were private (three firms went public during this period and one firm was separated from the parent firm, resulting in its going private). Companies were located in many different countries (Canada, France, Germany, Israel, Japan, the Netherlands, Singapore, South Korea, Spain, Sweden, Taiwan, the United Kingdom, and the United States), among which the U.S. and Japan hosted 74% of all producers over time. The average sales of public firms were 2.3 times those of private firms.

Content analysis was done using "*Concordance,"* which is a software package widely used in many disciplines including accountancy, history, marketing, musicology, politics, geography, and media studies. The individual firm data were collected by year. I used the same word roots that Uotila and colleagues (2009) used. Exploration was captured by the word roots explor∗, search∗, variation∗, risk∗, experiment∗, play∗, flexib∗, discover∗, and innovat∗ (The wildcard '∗' can represent any character). Exploitation was captured by the word roots exploit∗, refine∗, choice∗, production∗, efficien∗, select∗, implement*, and execut*. All words that have the word roots included in the search were identified from collected news documents by firm-year using content analysis software. However, inappropriate forms of words were identified after checking all of the words that appeared in the software: executive(s) for ‘execut*’, player(s), playstation and playback for ‘play*’, and explorer(s) for ‘explor*’. Because these words do not represent exploration or exploration activities, they were excluded from the calculation of the number of exploitation and exploration words. The total number of exploitation words (60,618) surpassed the total number of exploration words (33,419) from 1984 to 1998. Over this time period, the total number of firms in the optical library industry increased from 2 firms to 67 firms.

I pointed out that the press-based measures of exploration and exploitation that Uotila and colleagues (2009) used have two weaknesses: the selection of journals and the selection of word roots used to search news documents. I will explain the process I used to overcome these two weaknesses.

The selection of word roots. One weakness of content analysis for the operationalization of exploitation and exploration is that not all word roots may represent exploration and exploitation in every industry. To determine the appropriate word roots that capture exploration and exploitation of firms for the optical library industry, an understanding of the industry is needed. The key product of the optical library industry is an optical library, also called an optical jukebox or an optical tower, designated for storage and retrieval of massive amounts of data. An optical library is designed to automatically pick, load, unload, and re-file media units for an optical disk drive to write or read. It is used in high-capacity archive storage environments such as imaging, medical, and video. Optical libraries are useful for record retention, backup systems, desktop publishing and many more applications. The three major technological components are optical disk drives, disk technologies that handle the tower that contains multiple slots for disks, and software to control and link multiple optical libraries. The term ‘play’ is frequently used in the optical disk industry as a synonym for reading an optical disk. The term ‘search’ also often appeared with the meaning of finding an optical disk in an optical tower that contains multiple optical disks. Therefore, these two terms needed to be examined to determine whether they represent exploration activities of firms in the optical disk industry.

In the optical disk industry, ‘play’ is the dominant word root among the word roots that capture exploration activities, accounting for 27%. However, the meaning of play in most of the news documents that were searched is making something operate. I found that relatively few of the mentions of ‘play’ were related to exploration activities. Therefore, it is appropriate to exclude ‘play’ from the exploration word roots as a search term.

Examples:

*“The bus supports hot-swapping, and its recognition support allows plug-and-**play** operation. This type of peripheral is worth examining this year, but don't expect a flood of products immediately. SCSI will remain the best choice for at least a few more years. Maxopix 1998”*

*“NEC has a 4x speed CD-ROM with 7 disc changer that allows you to **play** music CDs while running software applications. NEC 1995”*

An optical library is used to write or read information. To read information, optical libraries must have a searching function. In addition, ‘search’ refers to a search engine in many news articles. Only a small portion of news items identified using the term ‘search’ were in fact related to exploration activities. The following examples show when the term ‘search’ does not mean exploration:

*“It comes bundled with Alchemy Personal, text-based file retrieval software that lets you build databases of images and documents that can be **searched** and displayed in under three seconds, and Easy-CD Pro, which lets you copy data or audio files to CD from Windows File Manager or Explorer. Kintronics 1997”*

*“End users can **search** across approved supplier catalogs through an interface on the company's intranet. Fusitju, 1998”*

Therefore, the terms ‘play’ and ‘search’ should be excluded from the data because these terms have different meanings that cannot be interpreted as exploration.

The selection of journals. As mentioned above, the visibility of small and large firms is different across news sources. Large firms are more likely to appear in sources such as *The Wall Street Journal* and Reuters News. To capture small firms’ exploitation and exploration, the range of publications needed to be expanded. I collected textual data in the form of all news articles and newswire publications in the Factiva database from 1984 to 1998. A total of 109,490 news documents were collected. In the first data collection, all publications in the Factiva database were included to identify publications which cover all firms in the optical disk industry. 180 journals were identified in the first analysis. Then, out of these 180 journals, I selected 103 journals that fully covered the years from 1990 to 1998. Finally, news articles were collected from these 103 journals (see Appendix B) with the 15 terms noted above, excluding ‘play’ and ‘search’. The 103 journals included major journals (e.g., Dow Jones News Service and PR Newswire), industry specialized journals (e.g., *CD Computing News and CD-ROM Professional*), and regional journals (e.g., *Kyoto News and Business Times Singapore*).

The exploration score of each firm in a certain year was calculated by summing the number of words that contained the eight word roots of exploration, and the exploitation score of each firm in a certain year was measured by summing the number of words that contained the seven word roots of exploitation[4]. Table 3 describes the number of firms, total number of words that measure exploration of

[4] When exploration and exploitation scores are used in statistical analysis (e.g., regression), I recommend controlling the media visibility of each firm (Fombrun & Shanley, 1990). An individual firm’s exploration and exploitation scores are influenced by the firm’s size. I expect that variations in firms’ size lead to variation in the extent of media exposure. In turn, such variation in media exposure may influence an individual firm’s exploration and exploitation scores. Thus, the weight of individual firm’s exploration and exploitation scores varies according to the firm’s size. Previous studies adopted several ways to control media visibility. For example, Fombrun and Shanley (1990) added a control variable, media visibility, which is the number of news articles. Alternatively, following the approach taken by Tetlock, Saar Tsechansky, and Macskassy (2008), one could standardize the number of exploration and exploitation words.

all firms, total number of words that measure exploitation of all firms, and the sum of exploration and exploitation words of all firms by year. The total number of words increased by a factor of 137, from 119 (1984) words to 16,275 (1998). The total number of words per firm also rose from 60 words to 243 words. While the number of exploitation words increased by a factor of 95, from 105 (1984) to 10,011 (1998), the number of exploration words rose from 14 (1984) to 6,264 (1998), an increasing of 447 percent. While exploitation is more prevalent in the optical library industry, the relative portion of exploration to the sum of exploration and exploitation activities increased.

Table 3: The Number of Exploration and Exploitation Words by Year (All Firms)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
The number of exploitation words	105	472	639	925	1,318	2,691	2,850	4,534	4,405	5,704	7,627	5,114	6,385	7,838	10,011
The number of exploration words	14	133	201	347	653	1,169	1,433	2,336	2,815	3,736	3,598	2,708	3,200	4,812	6,264
Sum of exploration and exploitation words	119	605	840	1272	1,971	3,860	4,283	6,870	7,220	9,440	11,225	7,822	9,585	12,650	16,275
The number of firms	2	6	6	9	12	17	24	28	28	37	44	49	59	73	67
Words per firm	60	101	140	141	164	227	178	245	258	255	255	160	162	173	243

Validity tests

To establish the convergent validity of the exploration and exploitation score, I measured exploration and exploitation using patent data. The exploration and exploitation scores using patent data were calculated using the approach of Wang and Li (2008). The exploration score in a certain year was calculated by the number of citations in a firm's patent that were outside of the firm's main class of patented technology, whereas the exploitation score in a certain year was calculated by the number of citations in the patent that were within the main class of the firm's patented technology. The firm's main class of patented technology was determined by the class of patents that the firm applied for before a certain year. I computed the correlation between the exploration and exploitation scores using content analysis and the exploration and exploitation scores using patent data by firm-year (28 firms out of the 100 have patents in the optical disk industry). The correlation of the exploration scores between the two methods is 0.77 (p=0.00) and that of the exploitation scores is 0.77 (p=0.00), suggesting a high level of convergent validity.

To assess the content validity of the exploration and exploitation measures, fourteen firms were selected out of the 100 firms in 1998. The sample consisted of 5 public firms and 9 private firms to reflect the ratio of public to private firms in the population. Two coders read all news in the Factiva database of the 14 firms selected for the validity test to determine whether these news items captured exploitation and exploration activities based on the concepts of exploration and exploitation that March (1991) proposed. If a coder made a decision that a certain news article did not represent exploration and exploitation activities, this entire news article was removed from the news articles for content analysis. The correlation between this manual classification and the automated classification was calculated. The correlation of exploitation is 0.67 (p=0.01) and that of exploration is 0.93 (p=0.00). This high correlation provides evidence of validity for the automated content analysis. In addition, the correlation of exploration is higher than that of exploitation. This implies that words that capture exploration are a more accurate measure than words that capture exploitation.

Additionally, as a further validity test, I examined the correlation between exploration and exploitation scores and two organization level variables—age and public status—that extant research suggests are related to a firm's level of exploration and exploitation. First, research suggests that old firms prefer exploitation to exploration (Rothaermel & Deeds, 2004). Thus, the correlation between exploitation and age is expected to be higher than the correlation between exploration and age. The results show that the correlation between exploration and age is .62 (p=0.00) and the correlation between exploitation and age is .53 (p=0.00). To test the significance of the difference between these two correlations, I used the Fisher r-to-z transformation. The results show that there is a significant difference between the two correlations (z=1.83, p=.03). Second, public firms have responsibilities and obligations to their shareholders and thus are more likely to be subject to structural inertia (Lee, 2009). As a result, they are more likely to be involved in exploitation than in exploration. The correlation between public status and exploitation is .61 (p=0.00) and the correlation between public status and exploration is .52 (p=0.00). To test the significance of the difference between these two correlations, I used the Fisher r-to-z transformation. The results show that there is a marginally significant difference between the two correlations (z=1.4, p=.08).

Reliability test

Seventeen word roots were used to identify exploration (eight word roots) and exploitation (nine word roots) in the news documents collected. The portion of individual exploitation (exploration) word roots out of the total number of exploration (exploitation) word roots during 1984 to 1998 was calculated (See Table 4). For example, 'production" was the most dominant word root out of the eight word roots that capture exploitation, consisting of about 59% of all exploitation words. 'Choice (10%)', 'implement (11%)' and 'select (13%)' followed "production'. The rest of the word roots, 'efficiency (8%)', 'execute (3%)', 'exploit (3%)' and 'refine (3%)', made up less than 10%. In the exploration word roots, 'play (26%)' was the most dominant. 'Flexibility (14%)', 'innovation (15%)', 'risk (13%)', and 'search (13%)'

followed ‘play’. The rest of the word roots such as ‘discover (6%)’, ‘explore (5%)’, ‘variation (2%)’, and ‘experiment (6%)’ comprised less than 10% of the total.

A single influential word such as ‘production’ or ‘innovation’ can have spurious effects on results. For example, the word root ‘production’ accounted for 59% of the seven word roots for exploitation and ‘innovation’ accounted for 15% of the six word roots for exploration. If such influential words have spurious effects on results, the exploration and exploitation scores using the multiple word roots do not measure exploration and exploitation activities consistently. The exploration and exploitation scores were calculated by excluding each word root from the previous content analysis. Table 5 shows the correlations among the ten exploration scores and the nine exploitation scores. The correlations among the ten exploration scores are between .97 to .99. The correlations among the nine exploitation scores are between .85 to .99. These results support the reliability for measures of exploration and exploitation using content analysis.

Table 4: Word Roots by Year

Exploitation	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total
Choice	1%	2%	3%	3%	5%	8%	8%	9%	9%	11%	10%	11%	10%	15%	10%	10%
Efficiency	3%	3%	4%	6%	6%	5%	6%	6%	9%	9%	7%	7%	8%	10%	9%	8%
Implement	1%	0%	3%	2%	3%	5%	6%	7%	14%	12%	16%	10%	11%	12%	12%	11%
Production	93%	89%	82%	76%	55%	51%	62%	59%	44%	47%	36%	52%	49%	42%	48%	49%
Select	2%	3%	3%	6%	8%	17%	12%	14%	18%	14%	11%	13%	14%	15%	13%	13%
Execute	0%	1%	1%	2%	13%	8%	2%	2%	3%	3%	4%	3%	5%	3%	3%	3%
Exploit	0%	0%	1%	2%	3%	2%	2%	2%	3%	2%	5%	3%	2%	3%	3%	3%
Refine	0%	1%	2%	3%	7%	3%	1%	1%	1%	2%	11%	1%	1%	1%	2%	3%
Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Exploration	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total
Discover	7%	2%	9%	14%	7%	8%	6%	7%	6%	5%	6%	8%	6%	8%	5%	6%
Explore	7%	4%	5%	4%	9%	6%	5%	4%	6%	5%	5%	6%	5%	6%	7%	6%
Flexibility	43%	17%	6%	8%	5%	10%	16%	12%	13%	12%	20%	10%	15%	15%	13%	14%
Innovation	21%	20%	13%	8%	16%	18%	13%	15%	18%	13%	12%	11%	14%	14%	17%	15%
Play	0%	24%	34%	25%	23%	23%	27%	29%	30%	27%	28%	31%	26%	24%	21%	26%
Risk	0%	12%	7%	17%	13%	12%	19%	15%	11%	11%	10%	12%	14%	10%	19%	13%
Search	7%	5%	4%	10%	18%	15%	8%	8%	8%	19%	13%	13%	10%	15%	13%	13%
Variation	0%	1%	3%	4%	4%	3%	2%	1%	2%	2%	2%	2%	2%	1%	3%	2%
Experiment	14%	16%	16%	10%	6%	5%	5%	8%	6%	7%	4%	7%	9%	7%	3%	6%
Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 5: The Correlations among Ten Different Exploration Scores and Nine Exploitation Scores

No	Variable	1	2	3	4	5	6	7	8
1	Sum	1							
2	discover†	0.9991*	1						
3	explore†	0.9995*	0.9983*	1					
4	flexibility†	0.9939*	0.994*	0.9929*	1				
5	innovation†	0.9979*	0.9971*	0.9973*	0.9928*	1			
6	risk†	0.9968*	0.9947*	0.9975*	0.9874*	0.9834*	1		
7	variation†	0.9994*	0.9985*	0.9987*	0.9936*	0.9876*	0.9963*	1	
8	experiment†	0.9979*	0.9969*	0.9974*	0.9901*	0.986*	0.9944*	0.9973*	1

P* < 0.05

†: The exploration score is calculated by excluding this word root

No	Variable	1	2	3	4	5	6	7	8	9
1	Sum	1								
2	choice†	0.9965*	1							
3	efficiency†	0.9992*	0.9967*	1						
4	implement†	0.9909*	0.9946*	0.9926*	1					
5	production†	0.9051*	0.8718*	0.8952*	0.8492*	1				
6	select†	0.9952*	0.9968*	0.9957*	0.9912*	0.8688*	1			
7	execute†	0.9994*	0.9976*	0.9991*	0.9937*	0.8941*	0.996*	1		
8	exploit†	0.9992*	0.997*	0.9987*	0.9939*	0.8971*	0.9942*	0.9993*	1	
9	refine†	0.9899*	0.9896*	0.9901*	0.9941*	0.8775*	0.9824*	0.9914*	0.9941*	1

P* < 0.05

†: The exploitation score is calculated by excluding this word root

CHAPTER 5

Discussion

Research in the exploration and exploitation literature has depended on survey-based measures and patent-based measures. The survey-based measures have been used extensively by researchers because they measure exploration and exploitation in terms of market and product conceptualizations. However, survey-based measures cannot easily provide longitudinal data, which make it possible to understand the evolution of exploration and exploitation. It is desirable to capture both exploration and exploitation longitudinally because both activities change over time (He & Wong, 2006). Patent-based measures can provide longitudinal data on exploration and exploitation. However, patent-based measures do not fully represent a firm's innovative activities (Gittelman, 2008). Accounting-based measures (R&D expenditures data in the U.S. Census Bureau database) are one alternative in measuring exploration and exploitation. Although accounting-based measures have several strengths such as accuracy of operational definition, high generalizability, and longitudinal scope, the data used in them are less accessible than data collected through other approaches.

Press-based measures were adopted to overcome the weaknesses of the two approaches mentioned above (Uotila et al., 2009). This approach provides broad coverage of firms' activities for exploration and exploitation and enables the collection of longitudinal data. However, the content analytic approach Uotila and colleagues (2009) used also has its limitations in that the selection of news journals did not adequately capture exploration and exploitation of both large and small firms, and some of their search terms that represent exploitation and exploration are not appropriate in every industry. In addition, although Uotila and colleagues (2009) argued that the operationalization of exploration and exploitation using content analysis is highly generalizable, I showed that the operationalization Uotila et al. (2008) used is not generalizable across industries because the search terms need to be altered according to industry.

In this paper, I compared four approaches for measuring exploration and exploitation. In addition, I showed how to improve on the press-based measures used by Uotila and colleagues (2009) and to use them in a single industry study. First, the press-based measures used by Uotila and colleagues (2009) have the fewest weaknesses when studies focus on a single industry. However, in cross industry studies, researchers need to compare strengths and weaknesses of the four different measures of exploration and exploitation. Second, researchers need to change the selection of journals and search terms in order to accurately capture exploration and exploitation using the press-based measures that Uotila et al. (2009) used. The selection of journals should be determined according to the industry, time period, and characteristics of the research sample (size and nationality). If sample firms include small firms as well as large ones, one major news source is not appropriate to measure exploration and exploitation of all firm types. Because small firms are less likely to appear in a major journal, journals that cover the specific industry should be used to reduce the risk of different coverage of large and small firms. The nationality of firms in a sample also influences the selection of journals. For example, if sample firms include many Asian firms, journals that cover the Asian region should be included. Seventeen terms were suggested to capture exploration and exploitation. However, some terms do not accurately measure exploitation and exploration in particular industries. Thus, the selection of search terms also should be based on an analysis of the particular industry being studied. As mentioned above, 'search' is not an appropriate search term in the Internet industry and 'play' should be excluded in the game industry. In addition, search terms in service industries such as banking and restaurants need to be chosen carefully. For example 'production' is the most dominant search word in this study. It is reasonable to choose 'production' as an exploitation word because previous studies examined the effect of exploration and exploration in the manufacturing industry (Ming, 2010; Uotila et al., 2009). However, 'production' may not represent exploitation activities in service industries because service is provided or offered, not produced, to satisfy the needs of customers. Thus, researchers need to fully understand the industry they are examining to choose appropriate search terms.

This research provides an improved way for utilizing press-based measures for exploitation and exploration in a single industry study. Uotila et al. (2009) opened new avenues for the measure of these activities. The content analysis they used captured exploration and exploitation in a relatively easy way because the data were collected from publicly available news articles (Uotila et al., 2009). This study adds to the empirical evidence for the appropriateness of press-based measures and suggests ways to accurately capture exploration and exploitation using this approach. I hope that this paper motivates researchers to enhance their measurement of exploitation and exploration using a content analysis approach.

Appendix A: Summary of Selected Research on Exploration and Exploitation (2002-2010)

Studies / year	Theoretical lens	Data	Unit of analysis	Sample	Key Findings
Alexander, Jansen, van den Bosch, & Volberda (2010)	Leadership (TMT*)	Survey	Organization	705 small and medium-sized firms in diverse industries	They found that both external and internal advice seeking are important determinants of a firm's exploratory innovation. In addition, they found that top management team heterogeneity facilitates firms to act upon internal advice by combining different perspectives and developing new products and services.
Audia & Goncalo (2007)	Organizational learning	Patent	Individual	Individuals who filed a patent	The results show that successful inventors were more likely to generate new patents, but these patents tended to be less divergent from their previous work and the tendency of successful inventors to generate incremental ideas was more pronounced among inventors who work alone and among inventors who work in organizations with weaker norms for exploration.
Auh & Menguc (2005)	Strategic management	Survey	Organization	260 in various sectors	This study explores the contingency role that competitive intensity plays in explaining the relationship between exploration/exploitation and firm performance. The results show that defenders benefit from exploration while prospectors benefit from exploitation as competition increases.
Beckman (2006)	Leadership (TMT)	Archival	Organization	170 young high-technology firms in California's Silicon Valley	The results suggest that team composition is an important antecedent of firm ambidexterity. Founding team with common prior company affiliations engaged in exploitation, whereas diverse prior affiliations encouraged exploration. A mix of common and diverse prior affiliations was found to be a precursor of ambidexterity.
Bierly, Fariborz & Santoro (2009)	Organizational learning	Survey	organization	438 university research centers (URCs) in 11 industry sectors	This study examines various organizational conditions that influence a firm's ability to apply external knowledge to explorative and exploitative innovations. Technological relatedness, a common measure of absorptive capacity, is negatively associated with the application of external knowledge to explorative innovations.

(continued)

Studies / year	Theoretical lens	Data	Unit of analysis	Sample	Key Findings
Cao, Gedajlovic, & Zhang, (2009)	Technological innovation	Survey	organization	200 SMEs in China	They unpack this construct into one with two dimensions of the balance dimension of ambidexterity (BD) and the combined dimension of ambidexterity (CD) and find that BD is more beneficial to resource-constrained firms, whereas CD is more beneficial to firms having greater access to internal and/or external resources.
Ebben & Johnson (2005)	Contingency theory	Survey	organization	Two samples of 200 (web site) and 144 (survey) privately-held small firms	They found that small firms that pursue efficiency strategies or flexibility strategies outperform those that attempt to pursue both and size is used as a configurational attribute to develop competing hypotheses on whether efficiency strategies or flexibility strategies are better suited for small firm performance.
Gibson & Birkinshaw (2004)	Organizational design	Survey	Business unit (or branch)	4,195 individuals from 41 business units in ten multinational firms	The findings suggest that a context characterized by a combination of stretch, discipline, support, and trust facilitates contextual ambidexterity. Ambidexterity is found to mediate the relationship between context and firm performance
Groysberg & Lee (2009)	N/A	Content analysis	Individual	799 individual equity analysts and 254 individual fixed-income analysts were ranked	They found that stars hired to explore (initiate new activities) experience a short- and long-term performance decline; by contrast, stars who join new firms to exploit (reinforce existing activities) suffer only a short-term drop in performance.
He & Wong (2004)	Organizational learning	Survey	organization	206 manufacturing firms	They find evidence for the ambidexterity hypothesis by demonstrating that the interaction between exploration and exploitation innovation is positively related to sales growth and that the relative imbalance between both innovation types is negatively related to sales growth.
Im & Rao (2009)	Organizational learning	Survey	organization	Logistics industry	This study focuses on a particular aspect of learning—namely, explorative and exploitative knowledge sharing—and examines its impact on the performance of long-term relationships. They found that both exploratory and exploitative knowledge sharing lead to relationship performance gains, that such sharing is enabled by the ambidextrous management of the relationship, and that such sharing is facilitated by ontological commitment.

(continued)

Studies / year	Theoretical lens	Data	Unit of analysis	Sample	Key Findings
Isobe, Makino & Montgomery (2004)	Technological innovation	Survey	organization	302 small and medium-sized manufacturing firms in Japan	This study 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. Exploitation and exploration have different effects on firm performance.
Jansen, George, Van den Bosch & Volberda (2008)	Leadership (TMT)	Survey	Business unit (or branch)	Dutch branches of a large European financial services firm (89 branches)	The results show that a senior team shared vision and contingency rewards are associated with a firm's ability to combine high levels of exploratory and exploitative innovations. They also found that the executive director's transformational leadership increases the effectiveness of senior team attributes in ambidextrous organizations and moderates the effectiveness of senior team social integration and contingency rewards.
Jansen, Vera, & Crossan (2009)	Leadership (TMT)	Survey	Business unit (or branch)	Dutch branches of a large European financial services firm (211 branches)	They found that transformational leadership behaviors contribute significantly to adopting generative thinking and pursuing exploratory innovation. Transactional leadership behaviors, on the other hand, facilitate improving and extending existing knowledge and are associated with exploitative innovation.
Jansen, Tempelaar, Bosch, and Volberda (2009)	Leadership (TMT)	Survey	Organization	452 companies in various industries	The previously asserted direct effect of structural differentiation on ambidexterity operates through informal senior team (i.e., senior team social integration) and formal organizational (i.e., cross-functional interfaces) integration mechanisms.
Jansen, van den Bosch, & Volberda (2005)	Technological innovation	Survey	Business unit (or branch)	Dutch branches of a large European financial services firm (220 branches)	The study reveals that multiunit firms develop ambidextrous organizational units to compete in dynamically competitive environments. Moreover, the authors establish that units with decentralized and densely connected social relations are able to act with ambidexterity.
Jansen, van den Bosch, & Volberda (2006)	Technological innovation	Survey	Business unit (or branch)	Dutch branches of a large European financial services firm (220 branches)	The results show that centralization negatively affects exploratory innovation, whereas formalization positively affects exploitative innovation. Pursuing exploratory innovation was found to be more effective in dynamic environments and pursuing exploitative innovation was more beneficial in competitive environments.

(continued)

Studies / year	Theoretical lens	Data	Unit of analysis	Sample	Key Findings
Katila & Ahuja (2002)	Technological innovation	Patent	Organization	250 robotics companies in Europe, Japan, and North America	They found that search depth is curvilinearly (taking an inverted U-shape) related to the number of new products introduced by a firm. There is a linear relationship between search scope and the number of new products. The interaction of search depth and scope is positively related to the number of new products introduced by a firm.
Kyriakopoulos & Moorman (2004)	Marketing	Survey	Business unit (or branch)	500 Dutch business units from the food processing industry	This study found that market orientation is found to facilitate a complementarity of high levels of marketing exploration and marketing exploitation strategies that results in improved new product financial performance.
Nemanich & Vera (2010)	Technological innovation	Survey	Team	71 work teams	The results show that transformational leadership behaviors and the development of a learning culture, characterized by psychological safety, openness to diverse opinions, and participation in decision-making, promote ambidexterity at the team level.
Lavie & Rosenkopf (2006)	Strategic management	Content analysis	Organization	547 U.S. software firms	They found that absorptive capacity and organizational inertia impose conflicting pressures for exploration and exploitation with respect to the value chain function of alliances, the attributes of partners, and partners' network positions.
Lavie, Kang, & Rosenkopf (2010)	Strategic management	Content analysis	Organization	2587 U.S. software firms	The results show that firms do not typically benefit from balancing exploration and exploitation within the function domain (technology versus marketing and production alliances) and structure domain (new versus prior partners). Nevertheless, firms that balance exploration and exploitation across these domains by engaging in research and development alliances while collaborating with their prior partners, or alternatively, by forming marketing and production alliances while seeking new partners, gain in profits and market value.
Lubatkin, Simsek, Ling, & Veuga (2006)	Leadership (TMT)	Survey	Organization	154 firms' (SME) CEOs and 405 of their TMT members in New England	They found that top management team behavioral integration is found to facilitate the processing of disparate demands essential to attaining ambidexterity in SMEs. Furthermore, the findings suggest that the joint pursuit of an exploratory and exploitative orientation affects performance.

(continued)

Studies / year	Theoretical lens	Data	Unit of analysis	Sample	Key Findings
Mom, Bosch, & Volberda (2009)	Leadership (TMT)	Survey	Individual	755 managers in five large companies in U.S.	This study reveals that a manager's decision-making authority positively relates to this manager's ambidexterity, whereas formalization of a manager's tasks has no significant relationship with this manager's ambidexterity.
Phene, Tallman, & Almeida (2010)	Technological innovation	Patent	Inter-organization	141 merge sample in semiconductor industry	The results show that an acquirer firm's ability to develop exploratory innovation is a function of three key factors: opportunity, ability, and extent of control of target firm post-acquisition.
Ming (2010)	Technological innovation	Content analysis	Organization	98 firms in HDD industry	Exploitation to the exclusion of exploration generally undermines firms' long-term viability. However, this general pattern does not guarantee the long-term benefit of each individual exploration attempt.
Cao, Simsek & Zhang (2010)	Leadership (TMT)	Survey	Organization	122 small- to medium-sized enterprises	They envision that the CEO's network extensiveness will positively impact ambidexterity and that this impact will be bolstered when the CEO–TMT interactional interface, including communication richness, functional complementarity, and power decentralization, enables the entire TMT to process disparate information demands essential to attaining ambidexterity.
Quintana & Benavides (2008)	Strategic management	Patent	Organization	Biotechnology sector	The results show that a diversified technology base positively affects innovative competence. Furthermore, technological diversification is found to have a stronger effect on exploratory than on exploitative innovative capability.
Rothaermel & Alexandre (2009)	Technological innovation	Survey	Organization	470 firms in U.S. manufacturing sector	They found that the relationship between technology sourcing mix and firm performance is an inverted U-shape. Moreover, higher levels of absorptive capacity allow a firm to more fully capture the benefits resulting from ambidexterity in technology sourcing.
Rothaermel, Frank & Deeds (2004)	Strategic management	Content analysis	Organization	325 biotechnology firms	They proposed a product development path beginning with exploration alliances predicting products in development, which in turn predict exploitation alliances and that concludes with exploitation alliances leading to products on the market.

(continued)

Studies / year	Theoretical lens	Data	Unit of analysis	Sample	Key Findings
Sidhu, Commandeur, &Volberda (2007)	Strategic management	Survey	Organization	240 publicly and privately held companies in the Dutch metal and electrical engineering sector	They found that the value of supply-side, demand-side, and spatial exploration and exploitation is contingent on the environment. While boundary-spanning supply-side search is found to be positively associated with innovation in more-dynamic environments typical of the entrepreneurial regime phase of technology evolution, such exploration appears to hurt innovation in less-dynamic environments.
Sidhu, Volberda & Commandeur (2004)	Strategic management	Survey	Organization	240 publicly and privately held companies in the Dutch metal and electrical engineering sector	The results show that more environmental dynamism, a stronger organization mission, a prospector orientation and larger slack resources are associated with a greater exploration orientation.
Uotila, Maula, Keil, & Zahra (2009)	Strategic management	Content analysis	Organization	Manufacturing firms in S&P 500 between 1989 – 2004/ organization (SIC code 2000-3999 and 7370 – 7379)	The study shows that there is a tradeoff between exploration and exploitation and that the optimal balance between exploration and exploitation depends upon environmental conditions. They found 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.
Venkatraman, Lee, & Iyer (2006)	Strategic management	Content analysis	Organization	1005 software firms	They distinguish between simultaneous and sequential forms of ambidexterity as an organizational capability to balance exploration and exploitation. The results show that sequential ambidexterity significantly predicts sales growth as a main effect, as well as jointly with a set of contingency effects.
Wang & Li (2008)	Strategic management	Patent	Organization	570 U.S. manufacturing firms	They found that deviation from the optimal search, in the form of either overexploitation or over-exploration, is detrimental to organizational performance. Furthermore, the negative effect of search deviation on organizational performance varies with environmental dynamism; that is, overexploitation is expected to become more harmful, whereas over-exploration becomes less so with an increase in environmental dynamism.

* TMT refers to top management team

Appendix B: The List of Journals

No	Journal name	Category	Nationality	No	Journal name	Category	Nationality
1	The Atlanta Journal - Constitution	regional	US	53	Marketing Week	specialized	UK
2	Aerospace Daily	specialized	US	54	Media Week	specialized	UK
3	Agence Europe	regional	Belgium	55	Mobile Satellite News	specialized	US
4	Agence France-Presse	regional	France	56	National post (Canada)	regional	Canada
5	AP Online	major	US	57	Network Computing	specialized	US
6	Associated Press Newswires	major	US	58	Newsbytes News Network	specialized	US
7	Audio Week	specialized	US	59	Optical Memory News	specialized	US
8	Aviation Week & Space Technology	specialized	US	60	Orange County Business Journal	regional	US
9	Bangkok Post	regional	Thailand	61	Orange County Register	regional	US
10	Bank Automation News	regional	US	62	Worcester Telegram & Gazette	regional	US
11	Barron's	major	US	63	PC Magazine	specialized	US
12	Birmingham Post	regional	UK	64	PR Newswire (US)	major	US
13	Broadcast	specialized	UK	65	PR Week	major	UK
14	Business Times Singapore	regional	Singapore	66	Productivity Software	specialized	US
15	Business Wire	major	US	67	Property Week	specialized	UK
16	BYTE	specialized	US	68	Report on IBM	specialized	US
17	CD Computing News	specialized	US	69	Reuters News	major	UK
18	CD-ROM Professional	specialized	US	70	Rochester Business Journal	regional	US
19	Chicago Sun-Times	regional	US	71	San Diego Daily Transcript	regional	US
20	Computer Workstations	specialized	US	72	Science	specialized	US
21	Computergram International	specialized	UK	73	Software Magazine	specialized	US
22	Computers in Libraries	specialized	US	74	South China Morning Post	regional	Hong Kong
23	Computing	specialized	UK	75	Straits Times	regional	Singapore
24	CONSUMER ELECTRONICS	specialized	US	76	Sydney Morning Herald	regional	Australia
25	Data Communications	specialized	US	77	The Arizona Daily Star	regional	US
26	Datamation	specialized	US	78	The Asian Wall Street Journal	major	Hong Kong
27	Denver Post	regional	US	79	The Australian Financial Review	regional	Australia
28	Design Week	specialized	UK	80	The Boston Globe	regional	US
29	Document Imaging Report	specialized	US	81	The Economic Times (India)	regional	India
30	Dow Jones News Service	major	US	82	The Economist	major	UK
31	EDGE: Work-Group	specialized	US	83	The Engineer	specialized	UK

	Computing Report						
32	Electronic Buyers' News	specialized	US	84	The Globe and Mail	regional	Canada
33	Electronic Commerce News	specialized	US	85	The Guardian	regional	UK
34	Electronic Engineering Times	specialized	US	86	The Independent - London	regional	UK
35	Electronic News	specialized	US	87	The Lancet	regional	UK
36	Electronics Times	specialized	US	88	The New York Times	major	US
37	EMedia Professional	specialized		89	The Northern Echo	regional	UK
38	eMediaweekly	specialized	US	90	The Observer	regional	UK
39	Financial Times	major	UK	91	The Salt Lake Tribune	regional	US
40	Government Computer News	specialized	US	92	The San Francisco Chronicle	regional	US
41	Houston Chronicle	regional	US	93	The Scotsman	regional	UK
42	Imaging Update	specialized	US	94	The Sunday Times	regional	UK
43	Independent On Sunday	major	UK	95	The Times	major	UK
44	Information Today	specialized	US	96	The Toronto Star	regional	Canada
45	InformationWeek	specialized	US	97	The Wall Street Journal (Europe)	major	US
46	InternetWeek	specialized	US	98	The Washington Times	regional	US
47	Irish Times	regional	Ireland	99	Tokyo Financial Wire	regional	US
48	Japan Economic Newswire (Kyoto News)	regional	Japan	100	USA Today	regional	US
49	Jiji Press English News Service	regional	Japan	101	VARBusiness	specialized	US
50	LAN Product News	specialized	US	102	Wall Street & Technology	specialized	US
51	LAN Times	specialized	US	103	Yorkshire Post	regional	UK
52	Manchester Evening News	regional	UK				

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