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경영학 석사학위논문

Determinants of Firm's R&D Intensity:

Based on 'Shifting Focus of Attention Model'

기업 연구개발 투자활동의 결정요인:
'Shifting Focus of Attention Model'을 바탕으로

2014년 2월

서울대학교 대학원

경영학과 경영학전공

조일형

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지도교수 이 경 목

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서울대학교 대학원

경영학과 경영학전공

조 일 형

조일형의 경영학 석사학위논문을 인준함

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위원장 배 증훈 (인)

부위원장 강 심훈 (인)

위원 李 京 默 (인)



Abstract

**Determinants of Firm's R&D Intensity:
Based on 'Shifting Focus of Attention Model'**

Il-hyung Cho

Department of Business Administration

The Graduate School

Seoul National University

This study investigates firm's search behavior (R&D activity) by utilizing March and Shapira's 'shifting focus of attention model'. In accordance with 'shifting focus of attention model', this research suggests that organization's search behavior is induced by its performance feedback and that the nature of this relationship is determined by whichever reference point is the focus of

organizational attention. By examining the R&D expenditures of Korea's IT device manufacturing companies from 2002 to 2012, this study shows that a degree of gap between organization's achieved performance and its aspiration level affect which reference point (among aspiration, survival, and slack) organizational attention is focused on and that firm's decision on R&D investment varies with this attention. In addition, performance-aspiration gap and a degree of stability of organizational authority have interactive effects on search behavior. Firm's R&D intensity strengthens when CEO's power in TMT (a factor that positively affects stability of authority) increases, whereas the influence of stock price volatility (a factor that negatively affects stability of authority) on firm's decision on R&D activity is not significant. The findings suggest that stability of organizational authority could function as strong factor that determines firm's search and risk taking behavior.

Keywords: R&D intensity, performance-aspiration gap, CEO power, stock price volatility, organizational attention, stability of authority

Student Number: 2012-20526

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1. Introduction

Search plays a key role in organizational evolution and adaptation (Anderson & Tushman, 1990; Bottazzi, 2001; Greve, 2003; Katila & Ahuja, 2002; Nelson & Winter, 1982; Rosenkopf & Nerkar, 2001; Chen & Miller, 2007; Chen, 2008). Organizations search by exploring for information on alternative processes and products, and their discoveries facilitate changes in organizational routines (Greve & Taylor, 2000). Managers allocate resources to R&D activities in response to the threats and opportunities posed by environmental changes (Cohen & Levinthal, 1989). Searching for new technologies is a key factor that affects firms' competitive positions (Fleming & Sorenson, 2004; Katila & Ahura, 2002; Nelson & Winter, 1982). R&D activity, however, is fraught with risk because this activity is exposed to the likelihood of adverse outcomes and the magnitude of potential loss (Greve, 2003), meaning that a firm's R&D investment does not always lead to desirable results. Given that a firm's R&D activity is one of the most crucial activities in a firm that engenders firm's competitive advantage but also involves risk that contains the possibility of undesirable outcomes, it is worthwhile to shed light on the factors or contexts that promote or restrain firm's decision on investment in R&D activity.

According to the shifting-focus-of-attention model (March & Shapira, 1992),

risk taking behavior is induced by performance, and the focus of organizational attention shapes this performance - risk taking relationship. A large number of studies actually draw upon the shifting-focus-of-attention model to shed light on the conditions under which firms are more or less likely engage in risk taking behaviors, such as diversification, product innovation, and R&D investment (Audia & Greve, 2006; Miller & Chen, 2004; Chen & Miller, 2007; Iyer & Miller, 2008). These studies reported that organizational attention is focused on one of three objectives – attaining or maintaining firms’ aspiration-levels, securing survival, or utilizing slack resources. On the basis of March and Shapira’s (1992) shifting-focus-of-attention model and its related research, I seek to examine how organizational attention varies across firm’s performance-aspiration gap – Δ |performance – aspiration| and finally to ascertain the relationship between performance-aspiration gap and R&D intensity.

In addition, I try to find out the moderating factors that could influence the relationship between performance-aspiration gap and R&D intensity. Although a growing number of studies has recently focused on the connection between performance-aspiration gap and firms’ risk taking behaviors utilizing shifting-focus-of-attention model, only a few research have strived to find out the potential moderators affecting this relationship. In this study, I take account of both TMT-level and firm-level moderators that directly influence stability of authority in an

organization and thereby determine firm's R&D intensity. As a TMT-level moderator, I examine how CEO power in TMT moderates the relationship. Research over a few decades has yielded substantial evidence that CEO and top management team are key players in crucial decision making that determines organizational outcome and strategic change (Bantel & Jackson, 1989; Hambrick & Mason, 1984; Hambrick, Cho, & Chen, 1996; Cho & Hambrick, 2006). Moreover, a myriad of research has stated that power diffusion in an organization significantly affects organizational change, risk taking, and innovation effort (Brass, 1984; Burkhardt & Brass, 1990; Ibarra, 1993; Krackhardt, 1990). All things taken together, it can be presumed that a degree of power concentration on CEO in TMT will influence stability of authority in a firm and thereby affect firm's decision on investment in R&D which is one of the most critical strategic decision making in a firm. With respect to firm-level moderators, I focus on the uncertainty that firms are facing, especially on the volatility of firm's stock price. I begin with a definition of uncertainty that underpins most others' definitions: uncertainty is the difficulty firms have in predicting the future, which comes from incomplete knowledge (Beckman, Haunschild, & Phillips, 2004). Stock price volatility is the notable uncertainty that firms face because it makes future values and cash-flow difficult to predict (Beckman, Haunschild, & Phillips, 2004). A myriad of extant studies have reported that executives' authority and power

accrues when they can cope with internal and external uncertainty (Thompson, 1967; Pfeffer & Salancik, 1978; Finkelstein, 1992). Especially, stock price volatility is the uncertainty that is regarded as a somewhat negative thing for a firm to experience, and stakeholders tend to favor high levels of stock price reliability (Beckman, Haunschild, & Phillips, 2004; Hannan & Freeman, 1984). Considering that, stability of authority and power accrues to executives when stock price volatility is low. Strategic decision making, such as decision on investment in R&D activity is a highly political process involving multiple actors (Cyert & March, 1963; Comb et al, 2007; Eisenhardt & Bourgeois, 1988). Therefore, firms need coordination capacity in order to derive one decision from conflicting or dissimilar opinions of multiple actors (Simon, 1997) when they make decision on R&D activities. Since there are a number of literatures reporting the relationship between stability of managerial power and firms' coordination capacity, I assume that stock price volatility, which is an antecedent of managerial stability of power, has indirect effect on firms' R&D intensity.

The objective of this study is therefore examining the relationship between performance-aspiration gap and firms' R&D intensity drawing upon March and Shapira's (1992) shifting-focus-of-attention model and ascertaining the moderating effect of 1) CEO power in TMT (TMT-level factors), and 2) stock price volatility(firm-level factor). I first put forth a theoretical background and

hypotheses, and then present a data source and methods for testing the proposed hypotheses. Lastly, I discuss the implications of the study and potential future research agenda.

2. Theory and Hypotheses

The Effects of Performance-Aspiration Gap on Firms' R&D Intensity

According to the shifting-focus-of-attention model (March & Shapira, 1992), the willingness of an organization to take risk is induced by its performance, and the nature of this relationship is determined by whichever reference point is the focus of organizational attention. The original reference points presented in shifting-focus model is an aspiration level and survival, and a recently identified reference point presented in extended research is slack (Chen & Miller, 2007; Iyer & Miller, 2008). The aspiration level was first introduced in the classic behavioral theory of the firm (Cyert & March, 1963) that deems firms as goal-seeking entities pursuing aspired levels of performance. These aspiration levels can be based on firm's own past performance or on the performance of other organizations (Greve, 1998; Lant, 1992; Mezas, Chen, & Murphy, 2002; Greve, 2007). The aspiration level is the smallest satisfactory level of performance that distinguishes between perceived success and failure (Greve, 2003).

Organizational attention, however, is not always focused on the aspiration level. It is sometimes focused on organization's survival – the exhaustion of resources (March & Shapira, 1992), more generally, the threat of distress (Iyer & Miller, 2008). On the other hand, an organization may also focus on its slack – resources in excess of current performance generated from outperforming its aspiration (Chen, 2008). Given these three foci of organizational attention, four disparate conditions could take place: a condition under which a firm performs below aspiration and focuses either on 1) aspiration or on 2) survival and a condition under which a firm performs above aspiration and focuses either on 3) aspiration or on 4) slack (Chen & Miller, 2007; Iyer & Miller, 2008). So as to examine the relationship between performance-aspiration gap and R&D intensity, I first consider this relationship separately for each of these conditions and later combine them in order to draw a comprehensive conclusion.

When organization's performance is below its aspiration level, managers may be concerned with either attaining aspiration level or securing survival. When attention is focused on organization's aspiration level, it is likely that managers engage in a problemistic search so as to find out alternative courses of action that could be conducive to resolving the low performance (Cyert & March, 1963). The worse the organization's performance is, the more intensive is the search for solutions to the low performance, and the intensity leads to such activities as

exploration (March, 1991), product innovation (Greve, 2007), and R&D investment (Greve, 2003; Chen & Miller, 2007). Therefore, when attention is focused on aspiration, firm's R&D intensity increases as performance becomes worse. When attention is focused on survival, however, it is likely that managers become rigid, restrict the amount of information that they process, and only pay attention to familiar information (Staw, Sandelands, & Dutton, 1978). They also have a strong need for security and thereby are not motivated to engage in risky behaviors (Lopes, 1987). At the organizational level, in addition, a firm becomes to focus on formalized processes that highly emphasize efficiency and cost reductions or fewer new strategic initiatives (Starbuck, 1992; D'Aveni, 1989). Therefore, when attention is focused on survival, firm's R&D intensity decreases as performance worsens.

When organization's performance is above its aspiration level, on the other hand, managers may be concerned with either maintaining aspiration level or utilizing firm's slack resources. When attention is focused on aspiration, there is little incentive for changes. Instead, current organization's routines and the status quo are consolidated (Levitt & March, 1988; Greve, 2003). Managers become risk-averse and thus are inclined to avoid risky actions that could cause performance to fall below aspiration (March & Shapira, 1987). When attention is focused on slack, however, it is likely that managers alleviate controls and

consider more risk taking behaviors, such as product innovation (Greve, 2007), acquisition of other firms (Iyer & Miller, 2008), diversification (Greve & Mitsuhashi, 2007), and investment in R&D activity (Chen & Miller, 2007). Accordingly, when attention is focused on slack, firm's R&D intensity increases as more resources from outperforming are obtained.

The comprehensive relationship between performance-aspiration gap and R&D intensity can be drawn by collectively taking the conditions described above into account. Also, it is necessary to ascertain under what circumstance a firm with below-aspiration performance focuses on which reference point between its aspiration and survival. Likewise, it is necessary to identify under what circumstance a firm with above-aspiration performance focuses on which reference point between its aspiration and slack. According to shifting-focus-of-attention model and its related research (March & Shapira, 1992; Chen & Miller, 2007; Iyer & Miller, 2008), organizational attention will be focused on whatever reference point is closest. In other words, the closer an organization's performance is to its aspiration level, the greater the possibility that attention is focused on it, whereas the further an organization's performance is from its aspiration level, the greater the possibility that attention is focused on either survival or slack (Miller & Chen, 2004). The relationship between performance-aspiration gap and R&D intensity can be drawn as follows on the basis of this

attention allocation rule.

(1) When organization's performance is below aspiration level

If a performance is far below the aspiration level, organizational attention is focused on survival, which in turn decreases R&D intensity. As a performance becomes close to aspiration level, attention will be focused on aspiration and thereby lead to increased R&D intensity. As a result, the relationship between performance-aspiration gap and R&D intensity is negative when organization underperforms its aspiration level.

(2) When organization's performance is above aspiration level

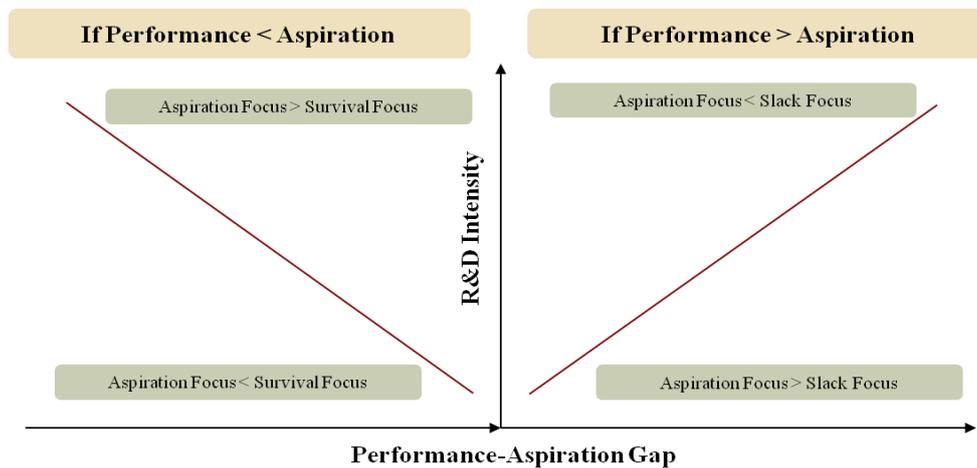
If a performance is in the neighborhood of aspiration level, there is little incentive for changes, and R&D intensity decreases as a result. This intensity, however, gradually increases as a performance becomes far above the aspiration level and the likelihood of a slack focus is higher. Accordingly, the relationship between performance-aspiration gap and R&D intensity is positive when organization outperforms its aspiration level.

H1A. The effect of performance-aspiration gap on R&D intensity is negative when performance is below aspiration level

H1B. The effect of performance-aspiration gap on R&D intensity is positive when performance is above aspiration level

<Figure 1>

The Relationship between Performance-Aspiration Gap and R&D Intensity



The Moderating Effect of CEO power in TMT (TMT-level Factors)

The “dominant coalition of a firm”, which is TMT, consists of the CEO and several senior managers, and management, in most cases, is a shared process in which TMT collectively shapes organizational outcomes (Finkelstein, 1992).

Although the CEO is usually the most powerful member of TMT, this is not always the case. For instance, managers with large shareholdings may be more powerful than a CEO. In addition, a few studies comparing explained variance of organizational outcomes using CEOs or groups of top managers have found that the latter units of analysis yielded superior results (Bantel & Jackson, 1989; Finkelstein, 1992). All these evidences demonstrate that CEOs share power with other senior managers in TMTs.

Power here is defined as the ability to get things done the way one wants them to be done (Salancik & Pfeffer, 1977), and the power is meaningful only if a given actor is powerful relative to certain others (Emerson, 1962). From this point of view, CEO power in TMT is the power that the CEO has over other managers of TMT (Greve & Mitsuhashi, 2007). Given that organizational strategic changes are results of a highly political process involving multiple actors, shifting coalitions, and abundant exercise of power among TMT members (Cyert & March, 1963; Combs et al, 2007; Eisenhardt & Bourgeois, 1988), concentrated power on a CEO in TMT is an essential for CEO to initiate strategic changes. Pfeffer (1981) observed that ‘when power is concentrated, political conflicts in goals and in definitions of technologies are resolved by the imposition of a set of preferences and a view of technology which reflects the position of the dominant coalition controlling organization’. Also, concentration of power enables

powerful actors to limit the flexibility in interpreting organizational goals and external environments and to develop norms and value systems in organizations that reflect their own preference, which results in greater ability to lead organizations to where they want to explore (Greve & Mitsuhashi, 2007). As such, CEO power in TMT gives a CEO useful means to trigger strategic changes (Pfeffer, 1981).

Firm's R&D investment is an appropriate outcome for testing how power concentration on a CEO affects strategic change. As mentioned, Firm's R&D activity is searching for new technologies that ensures firm's strategic advantage (Fleming & Sorenson, 2004; Nelson & Winter, 1982; Katila & Ahura, 2002) and long-term survival (Greve & Mitsuhashi, 2007). This activity, however, is fraught with risk because there is a possibility of adverse outcomes and the magnitude of potential loss (Greve, 2003), and some subunits will bear the burden of risk taking more heavily than others (Mone, McKinley, & Barker, 1998). Since other executives in TMT also play critical roles in the formulation and implementation of strategies involving risk-taking, and they have a clear self-interest for their own business-units (Greve & Mitsuhashi, 2007; Abebe, Angriawan, & Liu, 2011), decision making on investment in R&D activity may lead to intra-team conflicts in TMTs. Power concentration on a CEO in TMT refers to a situation in which a CEO possesses excessive power compared to other executives. Therefore, a

powerful CEO can resolve the intra-team conflicts occurring in TMT and initiate investment in R&D activity with less time and administrative effort (Pfeffer, 1981) as long as he or she has motives for the activity.

CEOs have political incentives to engage in R&D activities because such strategic change is an opportunity to reward proponents, punish opponents, and finally rebuild coalitions, consolidating their positions (Greve & Mitsuhashi, 2007). Furthermore, this kind of activity has a symbolic value because it indicates that the CEO is enthusiastic about strategy making. Strategic change provides legitimacy to a CEO whose competence and capabilities as professional leader might be evaluated by external constituents and organizational members (Pfeffer, 1981). It also enhances CEO's reputation about his or her influence that could prevent opponents' criticism (March, 1966). Lastly, such strategic change provides CEOs with a chance to move organizations into strategic areas in which they can exhibit their expertise and capabilities (Greve & Mitsuhashi, 2007). By matching firms' strategic domain with their own knowledge and skills through strategic change, CEOs can justify their existence in the organizations and secure their positions and long-term survival in firms.

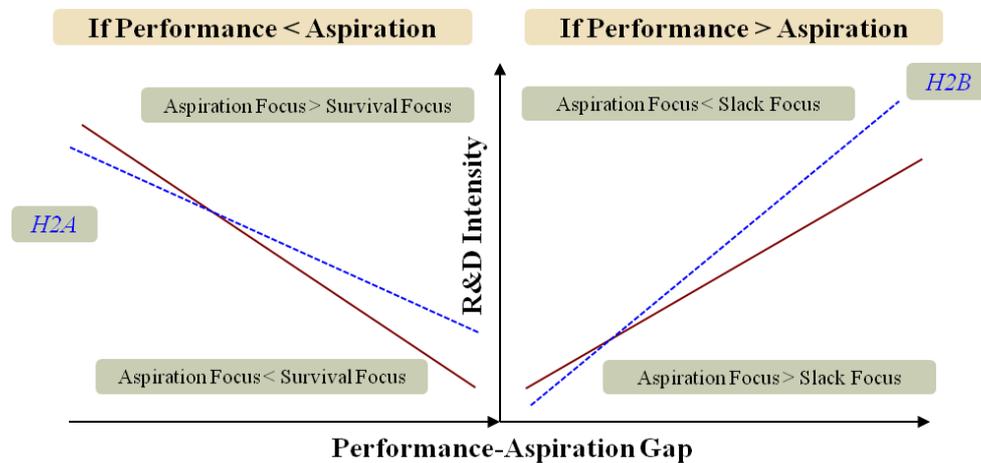
H2A. When performance is below aspiration level, CEO power in TMT moderates the relationship between performance-aspiration gap on R&D

intensity, with the relationship being weaker with a high-level of power concentration

H2B. When performance is above aspiration level, CEO power in TMT moderates the relationship between performance-aspiration gap on R&D intensity, with the relationship being stronger with a high-level of power concentration

<Figure 2>

The Moderating Effect of CEO Power in TMT



The Moderating Effect of Stock Price Volatility (Indirect Effect of Firm-level Factor)

What is common in research of uncertainty is that uncertainty is the difficulty organizations have in anticipating the future, which occurs from incomplete knowledge and that organizations try to reduce uncertainty because “certainty renders existence meaningful and confers confidence in how to behave and what to expect from the physical and social environment” (Hogg & Terry, 2000). Stock price volatility is also one of the noticeable uncertainties facing the organizations since it makes firms’ future value and cash-flow difficult to predict (Beckman, Haunschild, & Phillips, 2004). Accordingly, stock price volatility is considered to be somewhat adverse to firms, and stakeholders tend to favor high-level of stock price reliability (Beckman, Haunschild, & Phillips, 2004; Hannan & Freeman, 1984). A number of studies report that power and authority accrue to executives when they efficiently handle diverse internal and external uncertainty (Crozier, 1964; Thompson, 1967; Pfeffer & Salancik, 1978; Finkelstein, 1992) because ability to cope with uncertainty shows others that executives are capable of ensuring future organizational stability. Stock price is especially an important indicator of firm’s financial performance (Bernanke & Gertler, 2001), and thus stock price volatility may be regarded as firm’s financial performance instability.

There are a large number of studies showing the relationship between firm's financial performance and executives' power. Boeker (1992), for instance, ascertained that executives' dismissal was more likely to occur when firm's financial performance was poor and thereby made executives' power low. Also, Ocasio (1994), by examining the CEO succession, found that CEO power decreases under adverse economic conditions that lead to poor financial performance. More directly, Warner, Watts, and Wruck's research (1988) demonstrates that firm's executives are consistently monitored by diverse stakeholders and that their power and authority become attenuated, or they, in many cases, are dismissed by these monitors if stock price performance is undesirable. All things taken together, we can presume that stock price volatility will negatively affect the managerial authority and power.

Research over a few decades has reported the relationship between authority and power structure throughout an organization and organization's strategic changes, such as innovation or R&D investment (Brass, 1984; Burkhardt & Brass, 1990; Ibarra, 1993; Krackhardt, 1990). These studies argue that the more power the centrally positioned people possess in an organization, the more organizational strategic changes are likely to occur (Mone, Mckinley, & Barker, 1998). In an organization where the power is diffused, "no single center has complete control over organizational policy, and the cooperation of different coalitions is required

to initiate change” (Mone, Mckinley, & Barker, 1998). In contrast, in an organization where power converges on the centrally located people, there is a tendency to invest these centrally positioned people, which is normally TMT in a firm, with final decision making authority. In this case, although these change behaviors engender substantial level of resistance or differing opinions of diverse groups (Mone, Mckinley, & Barker, 1998), TMT that consists of senior executives has power and authority to implement major, and sometimes controversial, changes with less time and administrative effort by efficiently drawing one decision from various viewpoints of others.

If this organizational coordination capacity, which is defined as organization’s integration capabilities of deriving one decision from conflicting or dissimilar opinions or decisions (Simon, 1997; Grant, 1996), decreases, firm’s R&D intensity attenuates in such a way that reduced coordination capacity increases cost (Bae & Kang, 2010). As mentioned above, such activity as R&D is a collective work process and requires coordination among various organizational constituents involved because they may have different interests or because they may not always agree on whether the R&D activity is valuable and on how the result of this activity is applied (Teece, 2007). In this situation, firm’s lack of coordination capacity increases cost for deriving one efficient decision. For example, firms may need more experienced and well-informed human resources

who are able to derive an acceptable conclusion from different opinions that arise in the course of R&D (Bae & Kang, 2010) instead of leaving decision-making process to executives. Also, organizations may need to bear costly face-to-face interactions or develop additional procedures or routines that facilitate coordination among dissimilar and conflicting opinions. If the cost is substantial and thereby outweighs the benefit from R&D, a firm will scale down its R&D activity (Bae & Kang, 2010).

To sum up, stock price volatility negatively influences executives' authority and power, which in turn reduces organizational coordination capacity. When the coordination capacity diminishes, cost for R&D activity increases. As a result, firm's R&D intensity attenuates due to the indirect effect of stock price volatility.

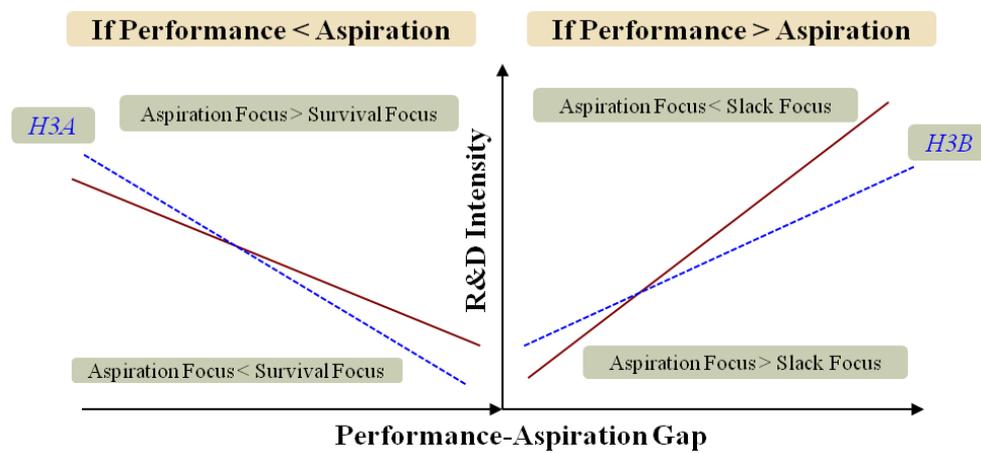
H3A. When performance is below aspiration level, stock price volatility moderates the relationship between performance-aspiration gap on R&D intensity, with the relationship being stronger with a high-level of stock price volatility

H3B. When performance is above aspiration level, stock price volatility moderates the relationship between performance-aspiration gap on R&D

intensity, with the relationship being weaker with a high-level of stock price volatility

<Figure 3>

The Moderating Effect of Stock Price Volatility



3. Methods

Data Sources

The major data sources of this study are KIS-VALUE DATABASE and DART DATABASE. KIS-VALUE DATABASE collects operational and financial information for all Korean publicly traded companies. This data set has widely been selected and used in earlier research that investigates firms in Korea

involving longitudinal time spans and multiple industries. DART DATABASE provides various kinds of information and reports related to Korean publicly traded firms.

For this study, I used KIS-VALUE data set in order to extract firms' financial and operational data (e.g., amount of investment on R&D, sales, average total assets, net income, and stock price) and used annual reports of firms provided by DART DATABASE so as to collect information about firms' TMT members (e.g., CEO's tenure and firm's founder). To examine the R&D intensity across time, I used longitudinal data from 2002 to 2012.

Sample

For the empirical test of the hypothesis, I constructed a firm-level panel data over the period 2002 to 2012. To keep the industry background comparable, I selected only IT device manufacturing companies traded in Korean stock market (both KOSPI and KOSDAQ) with six-digit standard industrial classification (SIC) codes provided by KIS-VALUE DATABASE (C26000). A number of observations had to be dropped because their value for R&D expenses or financial performance was missing. Therefore, the final data set includes the life of 251 firms including 53 exited firms in 10 year firm period resulting observations for a total of 1980 events.

Variables

Dependent Variable.

R&D intensity: This variable measures the magnitude of the technological R&D effort. I used R&D expenditures divided by sales (Cohen & Levinthal, 1989; Greve, 2003; Chen, 2008; Chen & Miller, 2007) as a proxy for R&D intensity.

Independent Variables.

Past performance: Among many of organizational performance measures, I chose return on assets (ROA) as a performance measure relevant to firms' R&D decisions. In a number of related studies (Greve, 2003; Chen, & Miller, 2007; Chen, 2008), ROA was proven to be preferable to return on equity (ROE) because ROE is affected by a firm's mix of equity and debt (i.e., utilizing ROA can avoid distortions caused by differences in financial leverage across firms). Although either ROA or ROS is preferable, ROA was selected in this study since it is more frequently used than ROS (Greve, 2003). The performance variable was lagged 1 year relative to the dependent R&D intensity variable.

Aspiration: Cyert and March (1963) modeled aspiration formation as a linear

combination of a firm's own past performance (historical comparison) and the experiences of other reference firms in the industry (social comparison). Some research has utilized this method in subsequent empirical studies (Bromiley, 1991; Greve, 2003). However, it is ambiguous how organizations weight their own performances and the performances of other organizations when deciding their aspiration levels (Miller & Chen, 2004). Due to this ambiguity, several extended research began to run two different models with different aspiration proxies: one for own-firm past performance and the other for industry median past performance (Chen & Miller, 2007; Chen, 2008)

Also, there are other studies that run only one model using either firm's past performance or industry median past performance as an aspiration proxy (Bromiley, 1991; Deephouse & Wiseman, 2000; Wiseman & Bromiley, 1996). Like these research, I used one aspiration proxy (Firm's past performance) because industry median past performance is not a meaningful variable in the study that analyzes a single industry.

Organizational aspiration is adaptive, so organizations modify their aspirations on the basis of their performance in the previous years (Lant, 1992; Greve, 2003). Organizations model aspirations as an exponentially weighted moving average of past performances (Chen, 2008) (see Equation (1)). In such a situation, aspirations adapt to performance but at a slower rate than the change in

performance (Chen, 2008).

$$A_{i,t-1} = (1 - \alpha_1) P_{i,t-2} + \alpha_1 A_{i,t-2} \quad (1)$$

I tried a different weight for (α_1) from 0 to 1 by increments of 0.1 and found the same results in the data. I report the results based on $\alpha_1 = 0.2$, which displays the highest model log-likelihood. Therefore, the aspiration at time t-1 (i.e., the aspiration variable was lagged 1 year relative to the dependent R&D intensity variable) is a weighted combination of the focal firm's performance at t-2 (with a weight of 0.8) and at t-3 (with a weight of 0.2).

Moderating Variables.

CEO power in TMT: On the basis of extant research (Abebe, Angriawan, & Liu, 2011; Hambrick, Cho, & Chen, 1996), TMT, in this study, is limited to senior managers of the firm with a title of vice president or above. Finkelstein (1992) put forth following four measures that are appropriate to operationalize the power concentration on a CEO in TMT: (a) The ratio of a CEO's total cash compensation to the average compensation of other executives of the TMT, (b) CEO duality (i.e., whether or not the CEO is also the chairperson of the board), (c) number of CEO's corporate and non-profit board appointments, and (d) whether or not the CEO is

also founder of the firm. The first measure of power concentration on a CEO is the CEO's relative cash compensation (i.e., average CEO cash compensation in a focal period / average TMT cash compensation in a focal period). It examines the pay disparity between the CEO and the other managers in TMT, and it is considered that power is concentrated on a CEO as the ratio becomes higher. The second measure is the duality status of the CEO. A value of "1" is assigned if the CEO is also a chairperson and "0" otherwise. As a number of studies report, CEOs who are also chairpersons possess higher level of power compared to other managers and thereby are able to dictate the agenda for board meetings, to control information flows among board members, and to build a powerful coalition within the senior management (Abebe, Angriawan, & Liu, 2011). The third measure takes account of the number of other board appointments the CEO has in profit or nonprofit firms. This measure analyzes the "prestige power" put forth in Finkelstein's (1992) study. The larger number of other board appointments the CEO has, the more power is concentrated on the CEO in TMT. The last measure of power concentration on a CEO considers whether or not the CEO is also founder of the firm. If the CEO is a founder of the firm, high-level of power is concentrated on the CEO. A value of "1" is assigned if the CEO is also a founder and "0" otherwise.

Among these four measures, I utilized CEO's founder status to operationalize

the CEO power in TMT because CEO's founder status is the most widely used measure in previous literatures that examined TMT's power structure. I slightly modified Finkelstein's measure and modeled two conditions to determine three categories of founder status: (1) the CEO is the founder or a relative of the founder, and (2) the CEO has the same last name as another officer of the firm. If neither of these conditions is present, then the variable is coded as 0 (Daily & Johnson, 1997). If one of these conditions is met, the variable is coded as 1 (Daily & Johnson, 1997). If both conditions are met, the variable is coded as 2 (Daily & Johnson, 1997).

In addition, I utilized CEO's tenure to operationalize CEO power in TMT. There are a number of studies reporting that managerial power increases as a manager obtains longer tenure (Hill & Phan, 1991). According to these research, the longer the tenure of CEOs, the more entrenched they are likely to become and the more power to pursue their own interest.

Stock price volatility: On the basis of Beckman, Haunschild, and Phillips's (2004) study, I operationalized the stock price volatility as the standardized monthly volatility of the focal firm's stock in the year prior to the R&D intensity change (i.e., the stock price volatility variable is lagged 1 year relative to the dependent R&D intensity variable). A formula for monthly stock price volatility

is as follows:

Standard Deviation (Firm's Monthly Closing Price, Year i, Firm j)

Average (Firm's Monthly Closing Price, Year i, Firm j)

The index 'i' means the previous year before R&D intensity change, and index 'j' represents each of the firms in the sample. If a firm's stock price undergoes high-level of variance relative to its average, the focal firm is experiencing high-level of stock price volatility.

Control Variables.

Firm size: A myriad of studies have reported the relationship between organizational size and firm's strategic change, such as innovation and R&D effort (Cohen & Klepper, 1996; Ettlie & Rubenstein, 1987; Greve, 2003; Chen, 2008). Firm size determines firms' capabilities to invest in innovations. Therefore, I included the logarithm of total assets of the firm to control for size effects.

Firm age: A number of research found out that firms' innovation effort varies with different stages of their lives (Hansen, 1992; Huergo & Jaumandreu, 2004). In general, studies reported that firm age is inversely related to firm's innovation effort. Therefore, I controlled for firm age that may influence organizational

R&D intensity.

Industry stock price volatility: Firm's stock price may be affected by its industry's overall stock price trend. Therefore, we can presume that firm's stock price volatility may also be influenced by its industry's stock price volatility. I operationalized industrial stock price volatility as the mean monthly stock price volatility of all sampled firms in the focal firm's industry grouping in the year prior to the firm's R&D investment (Beckman, Haunschild, & Phillips, 2004). For instance, if KIS-VALUE DATABASE categorizes the focal firm as a member of the vehicle-manufacturing industry, industrial stock price volatility is measured as the mean monthly price coefficient of variation for all firms in the vehicle-manufacturing industry for the representative year (not including the focal firm). If a firm's industrial stock price undergoes high variance relative to its average, the focal firm is facing high industrial stock price volatility (Beckman, Haunschild, & Phillips, 2004).

Previous R&D intensity: I controlled for firm's one year lagged R&D intensity because allocation of resources to R&D activity becomes routinized (Dosi, 1988; Chen, 2008).

4. Results

Table 1 displays basic statistics for the final data set. The final sample includes 1980 observations from 2002 to 2012. The mean of R&D intensity (R&D-to-sales ratio) is 0.013, and the minimum value and maximum value are 0 and 20.05. Except for correlation between R&D intensity and previous R&D intensity (0.76) and between CEO tenure and CEO founder status (0.66), other correlations among variables are not high overall.

Table 1. Descriptive Statistics for Panel Data

No	Variable	Mean	Dev	Min	Max	1	2	3	4	5	6	7	8	9
1	R&D Intensity	0.013	0.031	0	20.05	-								
2	Performance – Aspiration (When performance < Aspiration)	0.107	0.250	0.001	4.958	-0.04	-							
3	Performance – Aspiration (When performance > Aspiration)	0.084	0.146	0.001	2.156	0.1	-0.01	-						
4	CEO tenure	8.56	7.27	1	44	0.25	-0.01	0.02	-					
5	CEO founder status	0.896	0.992	0	2	0.32	-0.08	-0.00	0.66	-				
6	Stock price volatility	0.236	0.137	0.005	0.999	-0.01	0.19	0.13	-0.14	-0.09	-			
7	Firm size(Ln)	24.93	1.27	20.06	32.52	0.06	-0.08	-0.10	0.06	-0.07	-0.09	-		
8	Firm age	17.97	11.06	1	62	-0.11	-0.07	0.01	0.09	-0.19	-0.05	0.32	-	
9	Industry stock price volatility	0.240	0.044	0.193	0.337	-0.04	0.06	0.05	-0.02	0.00	0.30	-0.02	0.00	-
10	Previous R&D intensity	0.029	0.496	0	20.05	0.76	-0.01	0.08	0.19	0.29	-0.02	0.03	-0.15	-0.04

Note. $N = 1,980$

The dependent variable – R&D intensity – is highly skewed and left censored. As the assumption for normal distribution could not be met in the ordinary least squares (OLS) regression model, the panel Tobit model was used. Table 2 provides the panel Tobit regression results for R&D intensity. Model 1 is a baseline model that has control variables; model 2 includes variables testing hypothesis 1A and 1B; model 3 consists of all variables including moderating variables in order to test hypothesis 2A, 2B, 3A, and 3B. Furthermore, I additionally adds model 4, 5, and 6 so as to verify the effect of each moderating variable separately in case there is multi-collinearity among those variables.

According to the results of model 2, both hypothesis 1A and 1B are supported, but receive weak support ($p < 0.1$). As predicted, R&D intensity of firms that showed unsatisfactory performances decreases as the gap between performance and aspiration becomes more considerable, while firms that outperformed their aspiration increase R&D investment as their performances become far beyond aspiration level. The model 3 tests the moderating effects of CEO power (direct effect on organization's stability of authority) and stock price volatility (indirect effect on organization's stability of authority). The coefficients for the interaction term of CEO tenure and performance – aspiration gap in model 3 are positive and significant ($p < 0.01$) both when performance is below and when above aspiration, meaning that CEO power attenuates the negative influence of

underperforming firms' performance – aspiration gap on R&D intensity and that it strengthens the positive influence of outperforming firms' performance – aspiration gap on R&D intensity; the results are the same in model 4 ($p < 0.01$). On the other hand, the coefficients for the interaction term of CEO founder status and performance – aspiration gap in model 3 is positive, but not statistically significant. Also, the coefficient in model 5 is significant only when firm's performance is above aspiration. Therefore, hypothesis 2A and 2B are partially supported. The argument in hypothesis 3A and 3B – that stock price volatility moderates the relationship between performance – aspiration gap and firm's R&D intensity – are not supported both when firm's performance is below aspiration and when above aspiration considering that model 3 does not show any significant result with respect to the interaction effect of stock price volatility and performance – aspiration gap. Although model 6 displays negative coefficients for the interaction term of stock price volatility and performance – aspiration gap, it is significant only when performance is below aspiration. Since the results testing the moderating influence of stock price volatility displayed in model 3 and 6 are not consistent overall, hypothesis 3A and 3B are not supported.

All models include four control variables (firm size, firm age, industry stock price volatility, and previous R&D intensity). The results show continuity in firms' R&D investment and support including previous R&D intensity as an

important control variable. Firm size is another crucial control variable considering that the coefficients for the firm size are positive and highly significant in all models ($p < 0.01$). This result buttresses the argument that firm size determines firm's capability to invest in innovations. Firm age and industry stock price volatility are not significant in general.

Table 2. Panel Tobit Regressions for R&D Intensity

Model Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	- 0.042** (0.016)	- 0.042** (0.015)	- 0.039* (0.015)	- 0.038* (0.015)	- 0.040** (0.015)	- 0.045** (0.015)
Firm size(Ln)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)
Firm age	- 0.000 (0.000)	- 0.000 (0.000)	- 0.000 (0.000)	- 0.000 (0.000)	- 0.000 (0.000)	- 0.000 (0.000)
Industry stock price volatility	- 0.005 (0.010)	- 0.006 (0.011)	- 0.008 (0.011)	- 0.008 (0.011)	- 0.006 (0.011)	- 0.005 (0.011)
Previous R&D intensity	0.653** (0.037)	0.667** (0.039)	0.676** (0.044)	0.694** (0.047)	0.682** (0.043)	0.674** (0.040)
Performance – Aspiration (When performance < Aspiration)		- 0.002† (0.002)	- 0.009 (0.008)	- 0.012** (0.004)	- 0.003 (0.002)	0.008 (0.006)
Performance – Aspiration (When performance > Aspiration)		0.008† (0.005)	- 0.013 (0.015)	- 0.001 (0.007)	- 0.002 (0.007)	0.015 (0.013)
CEO tenure	0.001** (0.000)	0.0005** (0.0001)	0.0002† (0.0001)	0.0003* (0.0001)	0.0004** (0.0001)	0.0005** (0.0001)
CEO founder status	0.003** (0.000)	0.003** (0.001)	0.004** (0.001)	0.003** (0.001)	0.003** (0.001)	0.003** (0.001)
Stock price volatility	0.004 (0.004)	0.004 (0.004)	0.007 (0.004)	0.005 (0.004)	0.004 (0.004)	0.007 (0.004)
CEO tenure * P – A < 0			0.003** (0.001)	0.002** (0.001)		
CEO tenure * P – A > 0			0.002** (0.001)	0.001** (0.000)		
CEO founder status * P – A < 0			0.016 (0.007)		0.003 (0.006)	
CEO founder status * P – A > 0			0.016 (0.009)		0.001* (0.005)	

Stock price volatility * P - A < 0			- 0.011 (0.012)			- 0.022* (0.011)
Stock price volatility * P - A > 0			0.009 (0.036)			- 0.018 (0.034)
<hr/>						
Wald Chi-square	859.40	883.20	888.77	905.56	901.60	895.83
Log-likelihood	3929.5009	3904.8346	3917.5241	3913.9584	3907.0046	3906.9738
N	1,980	1,980	1,980	1,980	1,980	1,980
<hr/>						

Note. †p < 0.1, *p < 0.05, **p < 0.01

5. Conclusion and Discussion

This research shows the result that is in accordance with March and Shapira's (1992) 'shifting focus of attention model'. If an organization underperforms slightly below its aspiration, it strives to search for alternative actions to resolve current unsatisfactory situation and thereby increase search intensity. On the other hand, if an organization shows undesirable performance that is far below its aspiration and thereby is threatened by survival issue, it becomes more rigid and has incentive to avoid engaging in risky behaviors that might engender any further damage to a firm. Organizations show different behaviors in case they outperform their aspiration. If an organization achieves satisfactory performance outcome that is slightly above its aspiration, it becomes more risk-averse and is inclined to focus on current routines and status quo so as to avoid any other risky actions that could cause performance to fall below aspiration. When organizational attention is focused on slack due to desirable performance that significantly exceeds aspiration, on the other hand, a firm alleviates controls and takes account of more search behaviors.

In accordance with a number of literatures, this study demonstrates the importance of stability of authority when organizations engage in strategic changes, such as R&D activity, product innovation, or diversification. As the

result of this study reports, CEO's power and authority, which directly lead to organizational stability of authority, positively affect firm's R&D investment. It buttresses the argument that stability of authority caused by a high level of CEO's power among TMT members is conducive to organization's capacity to coordinate conflicting opinions of diverse organizational constituents and thereby to derive one decision when firms consider risk taking behaviors. However, hypotheses testing indirect effect of stock price volatility on firm's search intensity are not supported. This result may be because managerial power and authority are more associated with financial performance that already occurred during executives' term of office (Ocasio, 1994; Daily & Johnson, 1997) than with future financial uncertainty. As mentioned, stock price volatility renders firm's future value and cash-flow difficult to predict (Beckman, Haunschild, & Phillips, 2004) and thus is regarded as firm's financial instability. In other words, although stock price volatility is undesirable indicator of firm's future financial stability, it may not be directly deemed as poor financial performance caused by managerial incompetence. Accordingly, firm's stock price volatility may not negatively influence managerial power and thereby not affect stability of authority of organization.

There are some theoretical contributions of this study. First, this study provides more sophisticated viewpoint that explains firm's search behavior using

March and Shapira's (1992) 'shifting focus of attention model'. A number of previous literatures investigating firm's search and risk taking behaviors have been utilizing Cyert and March's (1963) classic behavioral theory of the firm. According to argument presented in 'A behavioral theory of the firm', managers evaluate organizational performance relative to their aspiration level and initiate problemistic search that increases firm's risk taking behaviors in order to overcome current unsatisfactory circumstance when performance is low, while they decrease risky behaviors in order to maintain status quo when performance is high compared to aspiration. However, this argument does not consider the fact that organizational attention could be focused not only on aspiration but also on survival and slack. By taking account of more reference point that organization could focus on and thereby suggesting diverse case of organizational decision making on risk taking, this study enriches a research area investigating firm's search behaviors. Second, this research is the most comprehensive test of the March and Shapira's (1992) model to date that includes both TMT-level and firm-level factors moderating the relationship between performance-aspiration gap and R&D intensity. A few studies have taken account of the moderating effects, such as firm's expectation of its future performance level (Chen, 2008) or deadline proximity (Lehman et al, 2011), on search intensity. However, this research is the first one that takes power structure among organizational constituents and

stability of authority in an organization into account encompassing both TMT and organizational level, and the results suggest that stability of organizational authority should be deemed as a crucial factor that influence firm's search behaviors.

This study was conducted based on single-industry samples (IT device manufacturing companies traded in Korean stock market). Thus, future theoretical work could be enriched if it investigates firm's search behaviors in various industries whose characteristics differ from IT industry or if it conducts cross-industry study. Measures to operationalize the CEO power should be more diverse as well. Due to the limitation of data source, this research operationalized the CEO power only on the basis of CEO's tenure and CEO's founder status. Besides, although the moderating effect of CEO tenure was verified, the effect of CEO founder status was not supported. Therefore, future research should take account of various measures associated with CEO power, such as CEO's relative cash compensation (i.e., average CEO cash compensation in a focal period / average TMT cash compensation in a focal period), duality status of the CEO (i.e., whether CEO is also a chairperson or not), and the number of other board appointments the CEO has (Finkelstein, 1992). Considering that the moderating effect of stock price volatility was not supported, I suggest that further study identify the influence of other indicators for firm's financial

performance such as sales and net income that are more directly associated with managerial competence and thus are more appropriate to measure managerial power and authority than stock price volatility is. Also, it could be prospective to ascertain the other factors, such as competence of organization's human resource or organizational HR practices that may affect the relationship between performance feedback and firm's search behavior.

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요약(국문초록)

기업 연구개발 투자활동의 결정요인:
‘Shifting Focus of Attention Model’을 바탕으로

서울대학교 대학원
경영학과 경영학전공
조일형

본 연구는 March와 Shapira의 ‘shifting focus of attention model’을 활용하여 기업의 탐색활동(본 연구에서는 연구개발 투자활동)을 결정짓는 요인에 대하여 고찰하고 있다. ‘shifting focus of attention model’에서 제시된 바와 일맥상통하게 본 연구는 조직의 탐색활동이 조직이 과거에 창출한 성과 수준에 의해 영향을 받으며 궁극적으로는 조직의 주의 (attention)가 어떤 기준(reference point)에 집중되어 있는지에 따라 결정됨을 시사한다. 그리고 2002년에서 2012년 까지 한국 IT 기업의 연구개발 투자비용을 토대로 분석한 결과 실제 성과와 열망수준

(aspiration)의 차이는 조직의 주의가 열망 수준, 생존(survival), 여유 자원(slack) 중 어느 기준에 집중되는지에 영향을 미치고 기업의 연구개발 투자 강도 역시 이 조직의 주의 집중 변화에 따라 다르게 나타나고 있음을 보여준다. 또한 조직 내 정치권력 상의 안정성(stability of authority)이 성과 - 열망수준 차이와 기업의 연구개발 투자 강도와의 관계를 조절하는 것으로 나타났다. 구체적으로 기업의 연구개발 투자는 최고경영진 내에서 최고경영자의 힘이 강할 때(조직 내 정치권력 상의 안정성에 긍정적인 효과를 주는 경우) 확대되는 반면, 기업의 주가변동성(stock price volatility)이 높을 때에는(조직 내 정치권력 상의 안정성에 부정적인 효과를 주는 경우) 유의미한 결과를 보이지 않았다. 위의 결과는 향후 기업의 탐색활동에 대한 연구 분야에 조직 내 정치권력 상의 안정성이 기업의 위험부담 활동(risk-taking behavior)에 영향을 주는 중요한 요인이 될 수 있음을 시사한다.

주요어: 연구개발 강도, 성과 - 열망수준 차이, 최고경영자의 힘, 주가변동성, 조직 주의, 조직 내 정치권력 상의 안정성

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