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Which Performance Feedback Triggers Problemistic and Institutional Search in the Semiconductor Industry? Profit vs. Growth

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Abstract

This paper investigates; first, the impact of profit and growth aspirations in triggering problemistic search; second, the existence of institutional or imitational search; and third, the influence of performance aspirations on institutional search in the global semiconductor industry. The empirical results show that the growth aspiration is a more significant performance measure affecting R&D intensity and the strong institutional search behavior is also evident in our research setting. The institutional search behavior is found to be strengthened by poor growth but weakened by low profit, suggesting a shift of attention between aspiration and survival when imitating others in R&D investment.

Keywords: R&D intensity; performance aspiration; problemistic search; institutional search

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INTRODUCTION

Firm's decision on search and risk taking has been the core interest of organizational decision making process. Specifically, the behavioral theory of the firm emphasizes the organizational processes of performance evaluation, search, and decision making (Cyert and March, 1963). This behavioral perspective claims that decision makers use an aspiration level to evaluate firm performance, and that the gap between their own performance and the aspiration level influences their behavior toward search and risk taking. Prior studies adopting this perspective mainly support that performance below the aspiration level induces risk taking while performance above the aspiration level leads to risk aversion (Cyert and March, 1963; Baum, Rowley, Shipilov, and Chuang, 2005; Greve, 1998, 2003; Kahneman and Tversky, 1979).

Business and organization studies on performance feedback often incorporate profitability as a critical performance measure. However, it would make more sense that firms actually seek multiple goals and aspirations (Cyert and March, 1963; Greve, 2008). Especially for managers and practitioners, profit and growth are two of the more essential performance measures of all (Chakravarthy and Lorange, 2007; Viguerie, Smit, and Baghai, 2007; Zook, Allen, and Smith, 2000). Sustainable profitable growth is required in order to increase the value of firms and provide returns to shareholders. Despite the importance of both profit and growth, very few firms actually manage to show either of these, and sometimes there seems to be a tension between increased profitability and sales growth. The decision making theory has also underinvestigated growth as important performance measures. But in reality, firms would either shift attention between multiple goals or consider multiple goals simultaneously and seek a satisfying solution depending on the type of decisions to be made. Obviously, the most difficult situation will arise for managers when certain decision causes conflicting consequences; helping to close the aspiration gap with respect to the first goal while widening the aspiration gap with respect to the second goal. Thus, balancing these conflicting goals as well as keeping the right goals and aspirations is critical when making a decision.

Prior studies on the behavioral theory of the firm regarding problemistic search have examined profitability (return on

assets, ROA) as performance measures and found out that when performance relative to aspiration level decreases, R&D intensity increases (Greve, 2003; Chen and Miller, 2007). Building on prior studies, our study examines both profit and growth as critical performance measures when firms decide on R&D investment. In many industries, firms make R&D investment in search of better profit because R&D helps render value-added products and services or process improvement. Moreover, investing in R&D may contribute to the first mover advantage by creating new product and service markets, in which sales growth is also achieved. Here, the effects of traditional profit aspiration and new growth aspiration are examined to see if both performance measures would significantly influence how firms decide on R&D intensity.

In addition, firms can attend to more than one reference point when determining R&D intensity. Apart from performance aspirations, firm's R&D intensity is likely to be influenced by that of other firms. This is because firms within the same industry may perceive a common opportunity or threat that motivates similar search behaviors (Michael and Wall, 1986; Patel and Pavitt, 1997). To some extent, resonance with other firms' R&D intensity may be interpreted as the consequence of signaling effect. When the other firms allocate high portion of firm resources to R&D, this investment pattern sends out signals of increasing demand and growth opportunity so that the focal firm intentionally imitates the R&D investment pattern of other firms, which may result in a series of imitation, i.e., herding (Abrahamson and Rosenkopf, 1993; Bikhchandani, Hirshleifer, and Welch, 1992). In order to stay inside the herd and not to be left out of the potential rewards, the firm's R&D intensity has positive association with that of other firms within its industry (Chen and Miller, 2007; Westphal, Seidel, and Stewart, 2001). The institutionalized R&D search may especially be evident in technology intensive industries where direction of technology evolution is highly dispersed and uncertain (DiMaggio and Powell, 1983; Majumdar, 1996; Haunschild and Miner, 1997). With this respect, we believe examining the conformity to industry trends in R&D investment will fit adequately with our empirical setting of the global semiconductor industry.

After examining the effects of profit, growth aspirations, and institutionalized investment pattern on R&D intensity, the final empirical portion of this study looks into how the institutionalized

search pattern changes when the firm is situated below the profit or growth aspiration level. Since the firm's R&D intensity is expected to covary with that of other firms within its industry and performance below aspirations presumably makes the firm to take more risk, it is likely that the positive relationship between the industry's average R&D intensity and the firm's R&D intensity would be strengthened when the firm's performance relative to aspiration level decreases. Also, prior studies claim that firms tend to incorporate more social comparison as a basis for making decisions especially when performance is low (Kraatz, 1998; Phillips and Zuckerman, 2001). Hence, firms will imitate or behave similar to other firms when their own performance measures are below aspirations, reinforcing the institutional search. Our empirical results support most of these ideas and present meaningful contributions in integrating the decision making on problemistic and institutionalized search.

THEORY AND HYPOTHESES

Organizational change involves risk whether it is about increasing the search intensity or actually pursuing new strategic actions. According to the behavioral theory of the firm, decision makers interpret organizational performance by comparing it with social and historical aspiration levels and these aspiration levels influence the firm's decision on change (Cyert and March, 1963). That is, an aspiration level is used by "bounded rational" decision makers to determine the boundary between satisfying and unsatisfying conditions in continuous measures of performance (March and Simon, 1958). Thus, risk taking depends on specific goals and aspirations, and the behavior differs by actors' current position whether they are above or below the aimed aspiration level (Greve, 1998; March, 1988; March and Shapira, 1992). In particular, Kahneman and Tversky (1979) contend that individual's risk taking appears to increase when people fail to attain a goal or aspiration level. Also in business situations, managers tend to report taking fewer risks when performance exceeds their goals (March and Shapira, 1987; Singh, 1986) and high organizational risk taking is associated with low performance relative to aspirations (Bolton, 1993; Bowman, 1982; Bromiley, 1991). Prior research has shown that the negative association between risk taking and performance

is applicable to firm's decision on R&D investment because R&D corresponds to the search stage of the behavioral theory of the firm which suggests search and innovation launch jointly contribute to the risky firm innovations (Greve, 2003). That is, the problemistic search is stimulated when organizational performance is below the aspiration level, resulting in increased R&D.

Nonetheless, there are certain situations that make firms to refrain from taking risks even if they were positioned below the aspiration level. According to Staw et al. (Staw, Sandelands, and Dutton, 1981), too much threat and stress make firms to avoid new activities and conserve resources as described as 'the threat-rigidity thesis' because their immediate concern involves survival. Since most decision makers have a strong need for security and thus endeavor to avoid bad outcomes, they may become even more risk averse when adoption of additional organizational changes are considered to jeopardize the survival of the firms (Lopes, 1987; Milliken and Lant, 1991). For instance, Chen and Miller (2007) show how threat of bankruptcy stops firms from altering their activities in response to low performance. In a similar vein, Audia and Greve (2006) argue that managers of firms with a limited stock of resources perceive low performance as a warning of firm failure so that decreases in performance below the aspiration level lead to less risk taking in small firms. The key argument is that at certain situations, decision makers may shift their focus of attention between the aspiration level for performance and the survival point.

Since firm's behavior depends on performance aspirations, it is critical to correctly recognize what performance measures or goals they are aiming to attain. In the field of strategic management and organization theory, the popular performance measures usually involve profitability such as ROA (Return on Asset), ROS (Return on Sales), and ROE (Return on Equity). Prior research on problemistic search also employed ROA when assessing the performance gap relative to aspirations. However, it is more substantial to claim that firms may also attend to such goals as market share, sales (absolute size), and sales growth. Firms may refer to different goals depending on the type of decisions to be made or even seek multiple goals simultaneously on certain matters (Baum et al., 2005; Greve, 1998, 2008; Bourgeois III, 1985).

Among various performance goals, profit and growth are most popular performance measures of all (Chakravarthy and

Lorange, 2007; Viguerie et al., 2007; Zook et al., 2000), especially for managers and practitioners. Although the significance of profitability is well understood in the business domains, the growth aspect is somewhat less appreciated. We all know intuitively that growth is good, but do not realize how important it is to firm's value and competitive position. Relative growth rates among rivals are directly linked to market share increase and sometimes, preemptive pricing and capacity addition could be used to buy market shares or high sales growth (Stern and Deimler, 2006). When a firm occupies larger market share or higher sales growth compared to rivals, its relative cost may be lowered due to economies of scale or learning curve effect. In their study on the performance of 100 largest US corporations during the two most recent business cycles, Viguerie et al. (2007) found that growth was more vital for firm survival than total return to shareholders. Also, organizations facing a decline of market demand enter R&D races to win greater market share (Ramrattan, 1998) and innovation via R&D increases demand through technical and style changes (Scherer, 1967). This process would likely result in surpassing the rivals' growth rates. Accordingly, sustainable profitable growth which requires both profit and growth is needed to survive and increase the value of firms. Despite such importance of both profit and growth, research has so far concentrated on profitability and the decision making theory has underinvestigated growth as performance measures with an exception with Greve (2008). Greve empirically tested how size and performance (loss) aspirations in time t affect growth in size in time t+1. In this paper, we anticipate profit and growth aspirations to exert similar influences on R&D intensity, inducing more risk taking as each performance gap below firm's aspirations gets greater.

> **H1a:** R&D intensity increases with the distance of firms' past profit below aspirations.
>
> **H1b:** R&D intensity increases with the distance of firms' past growth below aspirations.

In addition to performance aspirations, firm's R&D intensity is likely to be influenced by that of other firms because organizations learn from other organizations and may imitate their actions. There exist many theories explaining why firms imitate and Lieberman and Asaba (2006) have organized them into two categories: information-

and rivalry-based theories. The information-based theory argues that firms follow others that are perceived as having superior information whereas the rivalry-based theory emphasizes that firms imitate others to maintain competitive parity or limit rivalry. Regarding the level of R&D investment, firms may intentionally follow others' leads because other firms' high R&D intensity can be interpreted as a signal of expected demand and growth opportunity. When the other firms allocate large portion of resources to R&D, the competing firms may exploit the information contained in the behavior of others and imitate rather than rely solely on their private information due to information asymmetry among players in the industry (Bikhchandani et al., 1992; Banerjee, 1992). In addition, following others' investment pattern may arise from the pursuit of legitimacy and this tendency will be salient when environmental uncertainty is high because uncertainty strengthens the importance of social considerations (Abrahamson and Rosenkopf, 1993; DiMaggio and Powell, 1983; Haunschild and Miner, 1997; Festinger, 1954). These actions are all related with information-based theory of imitation.

On the other hand, the rivalry-based theory emphasizes imitation as a way to mitigate competitive rivalry through maintaining firms' relative positions or neutralizing the aggressive actions of rivals (Chen and MacMillan, 1992; Genesove and Mullin, 2001; Gimeno, Hoskisson, Beal, and Wan, 2005). Sometimes, the structural features of competition such as multimarket contacts between the focal firm's competitors affect the firm's mimetic action (Hsieh and Vermeulen, 2009). Firms often pursue homogenous strategies instead of a risky differentiation in order to ease the intensity of competition or reduce risk by enforcing tacit collusion among rivals. For example, R&D investments among rivals are apt to correlate positively because firms may adopt similar behavior to prevent others from leading the race. Also, prior studies on innovation or learning spillover contend that ability to perceive and copy lucrative products or practices effectively depends on the firm's absorptive capacity accumulated via its own R&D, and the firm may have to invest in its own R&D to use the freely available knowledge of others (Cohen and Levinthal, 1990), implying a positive relationship between the firm's own and rivals' R&D intensities. Thus in order to stay inside the herd and not to be left out of the potential rewards, the firm's R&D intensity would have positive association with that

of other firms within its industry through either a simple act of imitation or interorganizational learning purposes. This argument is also in congruence with the rivalry-based theory of imitation since the purpose is aimed at maintaining relative competitive position.

Even without the emphasis on the act of imitation, prior studies contend that learning processes are present at the population and community levels most prominently in the form of vicarious learning from the experience of other organizations (Levitt and March, 1988; Miner and Haunschild, 1995). Managers allocate resources to R&D search activities in response to threats and opportunities posed by environmental changes (Cohen and Levinthal, 1989) and firms within the same industry is likely to perceive a common opportunity or threat that motivates similar search patterns (Michael and Wall, 1986; Patel and Pavitt, 1997). Therefore, the firm's R&D intensity is highly conformable to industry trends in R&D investment and the firm's behavior may not necessarily be intentional (Chen and Miller, 2007). Consequently, firms' decisions on R&D intensity do not depend solely on their own problemistic search processes but also get influenced by institutional or mimetic search processes.

> **H2:** R&D intensity is positively affected by other firms' R&D intensity.

Lastly, we posit that the strength of institutional search or mimetic search will be contingent on performance feedback. That is, the institutional search is anticipated to be strengthened by negative performance feedback because firms tend to incorporate and be more sensitive to social comparison when their performance is below aspirations. In prior studies, it has been verified that more social comparison is made as a basis for making decisions especially when performance is low (Kraatz, 1998; Phillips and Zuckerman, 2001). Furthermore in the area of performance-aspiration feedback, prior studies show that experiential learning from others is more influential as the focal firm's performance deviates from aspiration levels (Baum and Dahlin, 2007), and the focal firm is apt to converge with rivals in strategic positioning when performance is further below aspirations (Park, 2007). Hence, firms will be more likely to imitate or behave similar to other firms when their performance measures are problematic. In our study, this moderating hypothesis implies that not only profit but also growth aspirations would

influence the institutional search behaviors when firms' profit and growth are positioned below aspirations. Accordingly, we hypothesize,

> **H3a:** The positive relationship between own and other firms' R&D intensity becomes stronger for firms below profit aspirations.
>
> **H3b:** The positive relationship between own and other firms' R&D intensity becomes stronger for firms below growth aspirations.

METHOD

Data

The setting for our empirical analysis is the global semiconductor industry during the period 1987-2007. The industry is technologically very intensive with an average R&D intensity ranging up to 25% of annual sales. Although the industry's growth is continuous, it has characteristics of a cyclical pattern with high volatility. Sometimes firms experience dramatic cyclical swings so that firms are required to possess high degree of flexibility and innovative capability in order to constantly adjust to the rapid pace of change in the market. Moreover, many products embedding semiconductor devices often have a very short life cycle so that semiconductor firms must keep developing new devices and be ready with the next generation product technology. On the other hand, many categories of semiconductor devices are standardized due to the digital nature of products and the price-performance is systematically determined by the market. As a result, semiconductor firms are exposed to international competition under the pressure of price erosion and race to introduce new products first to market.

Semiconductor companies engage in the design and fabrication of semiconductor devices. However, if we look closely into the industry value chain, the business operations differ substantially between companies. Some firms are classified as an IDM (integrated device manufacturer) which designs, manufactures, and sells integrated circuit (IC) products. While IDM handles manufacturing in-house, a fabless, another type of business operation, outsources production to a third-party, called a foundry. Other than these three types

of business operations, many other forms of business players are distributed in the industry ranging from semiconductor equipment makers, back-end assemblers, component manufacturers, and software/IP (intellectual property) specialists. In addition to multiple forms of business operations, the wide variety of semiconductor products can offer a chance to compare different profit and growth rates in a similar environment. However, some peculiar characteristics regarding profit and growth aspects of the industry should also be noted. Although the industry experiences a health two-digit sales growth, an average profitability is rather low. Many start-ups with entrepreneurship may enter the semiconductor industry as a fabless because this type of operation does not require heavy initial investment but the fierce competition offers only little rewards. Indeed, the average ROA and sales growth of our sample firms correspond to -0.0215 and 0.291 respectively (with outliers excluded), and about one quarter of firms have a rather short operation experience of nine years or younger. It will also be interesting to find out how profit and growth aspirations affect firms' R&D investment when the two aspects of industry sentiment are strikingly different.

For above reasons, we considered the semiconductor environment as a good industry to analyze the determinants of R&D intensity. Our financial panel data came from Standard and Poor's Compustat North America and Global database, selected by 4-digit semiconductor SIC code 3674. A total of 627 firms were found with 3,843 company-year observations during the period. In addition, we used various sources including company websites, Hoover's database, Yahoo Finance, Wikipedia and Google for information on founding years (for company age) and type of business operations they pursue.

Variables

R&D intensity. R&D intensity is measured as R&D expenditures divided by sales (Greve, 2003; Chen and Miller, 2007). Original panel data had 3,365 observations on R&D intensity, but mean value was unreasonably high at 0.96 with maximum value of 694.82 and standard deviation of 14.44. In order to alleviate skewed distribution and apply the behavior theory of the firm (Cyert and March, 1963) to firms engaged in ordinary production and sales activities, not R&D

specialists, firms with R&D intensity greater than 1 were excluded from our analysis as in Chen and Miller (2007). This resulted in treating 142 observations of R&D intensity as missing values (4.2 percent of original observations), rendering mean R&D intensity of 0.15 and standard deviation of 0.15.

Performance (Profit and Growth). We incorporated general measures of profit and growth as firm performance. Return on assets (ROA) and annual sales growth were chosen for profit and growth performances respectively. Again, in order to adjust extreme outliers, we excluded ROAs that were less than three negative standard deviations and growth rates that were greater than three positive standard deviations (0.78 percent and 0.38 percent of original observations were treated as missing values).

Aspirations. Both social and historical aspirations were considered for testing our hypotheses. For social aspirations, we referred to the experience of other reference firms as in prior research (Greve, 2003; Bromiley, 1991). In so doing, we delineated reference groups according to eleven types of business operations among our 627 sample firms and computed mean ROA and mean sales growth for each group's social aspirations at (t-1). For historical aspirations, a firm's own prior year performance was used: focal firm's ROA one year prior to past profit (t-2) and sales growth during two prior years (from t-3 to t-2). Two separate models were analyzed with social and historical aspirations and we obtained similar results for both models. Here, we report results for social aspirations only.

Industry R&D intensity. Industry R&D intensity was computed by taking an average R&D intensity of reference firms to examine the institutional search pattern. Own-firm effects were removed by excluding the observation firm data when computing the average search intensity. Again, reference group was narrowed down according to eleven types of business operations.

Firm effect (Age, Size, Slack, Actual Rivalry). As firm specific control variables, we included age, size, slack, and actual rivalry. The natural logarithm of sales was entered as a measure of firm size, and two kinds of slacks were used, absorbed and unabsorbed,

because each of these slacks have been found to affect R&D search intensity differently in the prior study (Greve, 2003). Absorbed slack was computed as the ratio of SGAE (selling, general, and administrative expenses) to sales and unabsorbed slack as the ratio of quick assets (current assets – inventories) to liabilities (Greve, 2003; Bromiley, 1991; Bourgeois and Singh, 1983). Because degree of rivalry that a firm was facing could also influence its R&D intensity, actual rivalry was entered, measured by reference group HHI (Herfindahl-Hirschman Index) less the contribution by own-firm market share.

Industry effect (Chip industry sales growth). As mentioned above, one of the representative characteristics of semiconductor industry is strong cyclicality. To control for industry effects that could influence firm's investment decision, annual chip industry sales growth from t-2 to t-1 was used. Since chip market is positioned at the final downstream of semiconductor industry (right before the end-products market such as PCs and electronic devices), it is reasonable to assume that the chip industry sales reflect the macro industry sentiments for our sample firms. The data came from SIA (Semiconductor Industry Association).

Models

Fixed effects panel regression models with first-order autoregression (AR1) were used to test our hypotheses, controlling for significant firm differences in R&D intensity. Hypotheses 1a and 1b were set to examine R&D search behaviors in period t depending on the degree of difference between firms' actual performance and aspirations in period (t-1) when firms were below profit and growth aspirations. Hypothesis 2 was designed to test institutional search behaviors and evidence for firms imitating or learning vicariously. A firm's R&D intensity in period t was regressed with average R&D intensity in period t-1 of other firms that belong to the focal firm's reference group.

To test hypotheses 3a and 3b, we needed to form interaction variables between the focal firm's performance below aspirations and other firms' R&D intensity. We were mainly interested to examine how a firm's institutional search behavior would be influenced by its past performance position and derive an implication about

motives of such institutional search. If negative performance feedback strengthens the institutional search as we hypothesized, the performance gap below profit and growth aspirations will have a positive moderating effect on the institutional search behavior because those firms below aspirations will have strong initiatives to imitate and catch up other firms. All five hypotheses were tested by coefficient estimates and a combination of significance of individual coefficients and F-tests of coefficient differences.

RESULTS

Table 1 reports descriptive statistics for the dataset used in our final analysis, showing means, standard deviations, and correlations between variables. There seems to be no high multicollinearity problem between variables. Although we started with a total of 627 firms and 3,843 company-year observations, the sample used in the final analysis consisted of about 285 firms and 1,835 observations due to the lagging effects of dependent variables and missing values in the database.

Table 2 shows the fixed effects panel regression results for models 1 to 7. Model 1 on the first column is the baseline model consisting only control variables. Independent variables are added to the baseline model to test our hypotheses in models 2 to 7, with model 7 showing the coefficients for the full model. Among control variables, only firm size and slacks are found to be statistically significant throughout our models. The larger the firm size and the slacks, the higher the firm's R&D intensity is. The number of observations used in each model is indicated at the bottom of the table along with autocorrelation coefficient, R^2, and F-statistics.

Models 2 and 3 test the problemistic search behaviors with respect to profit and growth aspirations (Hypotheses 1a and 1b). The finding implies that the past profit performance below aspiration does not have significant impact on the firm's R&D intensity, not supporting Hypothesis 1a which anticipates the problemistic search with respect to profit aspiration (Models 2, 5, and 7). On the other hand, the finding in Model 3 is consistent with anticipated result in which the greater the difference of past growth performance below aspiration, the higher the firm's R&D intensity, having a negative coefficient with statistical significance

Table 1. Descriptive statistics

Variable	Mean	Sdt. Dev.	1	2	3	4	5	6	7	8	9	10	11	12
1.RDI(t+1)	0.155	0.142	1.000											
2.Industry growth	0.113	0.187	-0.059	1.000										
3.Actual rivalry	0.029	0.074	-0.014	0.094	1.000									
4.Size	5.114	1.786	-0.169	0.024	-0.117	1.000								
5.Age	20.696	15.264	-0.297	-0.014	-0.118	0.353	1.000							
6.Absorbed slack	0.329	0.252	0.653	-0.088	-0.006	-0.389	-0.197	1.000						
7.Unabsorbed slack	2.285	15.018	0.087	-0.007	-0.001	-0.056	-0.018	0.079	1.000					
8.ROA-Aspiration<0	-0.047	0.168	-0.210	0.030	0.004	0.317	0.110	-0.516	0.013	1.000				
9.ROA-Aspiration>0	0.087	0.104	-0.083	-0.033	-0.067	0.062	-0.110	-0.219	0.044	0.235	1.000			
10.Growth-Aspiration<0	-0.180	0.232	-0.152	0.006	0.060	0.140	-0.017	-0.157	-0.015	0.120	0.124	1.000		
11.Growth-Aspiration>0	0.186	0.698	0.069	0.012	-0.022	-0.104	-0.164	0.052	0.009	-0.073	0.091	0.207	1.000	
12.Industry RDI	0.159	0.085	0.496	-0.164	-0.044	-0.154	-0.234	0.393	0.099	-0.023	0.271	-0.178	0.020	1.000

Correlations with absolute values greater than 0.04 are significant at $p < 0.05$ level.

Table 2. Fixed-effect panel regression with AR(1)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Industry growth	-0.007 (0.009)	-0.007 (0.009)	-0.011 (0.009)	0.003 (0.010)	0.004 (0.010)	-0.003 (0.010)	-0.001 (0.010)
Actual rivalry	-0.083 (0.075)	-0.088 (0.074)	-0.085 (0.073)	-0.106 (0.074)	-0.120* (0.073)	-0.104 (0.072)	-0.113 (0.071)
Size	0.036*** (0.007)	0.036*** (0.007)	0.041*** (0.007)	0.032*** (0.007)	0.035*** (0.007)	0.038*** (0.007)	0.039*** (0.007)
Age	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.002 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Absorbed slack	0.145*** (0.015)	0.147*** (0.016)	0.132*** (0.016)	0.136*** (0.018)	0.163*** (0.023)	0.118*** (0.019)	0.155*** (0.023)
Unabsorbed slack	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)
ROA - Aspiration < 0		0.028 (0.018)			-0.054 (0.036)		-0.056 (0.037)
ROA - Aspiration > 0		-0.031 (0.031)			-0.042 (0.031)		0.001 (0.031)
Growth - Aspiration < 0			-0.031*** (0.009)			0.012 (0.020)	0.013 (0.020)
Growth - Aspiration > 0			-0.009 (0.005)			-0.016** (0.006)	-0.015** (0.006)
Industry RDI				0.245*** (0.071)	0.264*** (0.071)	0.180** (0.074)	0.194*** (0.074)
Industry RDI x ROA - Aspiration < 0					0.547** (0.215)		0.563*** (0.215)
Industry RDI x Growth - Aspiration < 0						-0.256*** (0.095)	-0.260*** (0.096)
Constant	-0.072*** (0.018)	-0.067*** (0.018)	-0.099*** (0.018)	-0.082*** (0.019)	-0.088*** (0.019)	-0.104*** (0.019)	-0.112*** (0.020)
Autocorrelation coefficient	0.471	0.463	0.464	0.418	0.403	0.4	0.38
Model F	24.33***	17.93***	20.46***	18.67***	14.25***	17.40***	14.42***
R^2 (Within)	0.086	0.085	0.096	0.079	0.086	0.104	0.111
Number of observations	1,835	1,831	1,826	1,798	1,794	1,789	1,785

Note: *** p<0.01, ** p<0.05, * p<0.1; Standard errors are in the parentheses.

at $p<0.01$ level. These results suggest that the growth aspiration is more of a significant performance measure that triggers problemistic search in our empirical setting. We suspect it is due to the rather peculiar characteristics of the semiconductor industry such that almost a half of sample firms experience negative ROA even with a healthy growth. Since we operationalized the mean ROA as profit aspirations, someone can raise a question of how effective a negative profit aspiration may be in stimulating problemistic search for firms below the aspiration. In spite of such low mean ROA, our sample shows a healthy sales growth with the mean value of 0.291 and this turns out to be an effective stimulus for problemistic search as anticipated. However, this result is not stable in other models and the problemistic search behavior with respect to growth aspiration is evident only when growth performance exceeds the aspiration level in the full model, partially supporting the negative association.

Hypothesis 2 is confirmed in Model 4 and the rest of our models. The positive and statistically significant coefficient for other firms' average R&D intensity indicates that a firm increases search intensity when the other firms have high search intensity. This positive association can be interpreted as valid institutional search in imitating others and provides a justification for firm's responding behavior in seeking population level learning. Moreover, Models 5 and 6 show our results for testing Hypotheses 3a and 3b, which examine the moderating effect of performance aspirations on institutional search. The positive and significant coefficient of interaction variable in Model 5 indicates how strength of institutional search is alleviated when a firm is farther below the profit performance aspiration (Notice that since the value of interaction variable is negative, a positive coefficient implies the overall effect on R&D intensity is negative). The result suggests that when a firm is underperforming relative to profit aspirations, it has weaker incentives to follow or imitate others in R&D investment. Thus Hypothesis 3a is not supported. Here, although the problemistic search behavior with respect to profit has anticipated negative sign for coefficient, it is not statically significant. On the contrary, the negative and significant coefficient of interaction variable in Model 6 indicates when a firm is farther below the growth aspirations, it reinforces institutional search intensity as anticipated in Hypothesis 3b. Here, the problemistic search behavior is evident with coefficient of expected signs and significance only when a firm

is positioned above the growth aspiration. However, main effects of institutional search behavior remained positive and significant in each of Models 5 and 6.

Model 7 provides estimated coefficients for the full model. Again, problemistic search pattern is confirmed only when a firm is positioned above the growth aspiration while other cases do not render statistically significant coefficients. On the other hand, supports for Hypotheses 2 and 3b remain stable and strong in the full model. That is, institutional search intensity has positive and significant coefficient, as anticipated in Hypothesis 2. Moreover, the institutional search intensity is negatively affected by profit aspiration and positively affected by growth aspiration, consistent only with Hypothesis 3b. The results are interesting that when a firm is underperforming with respect to profit aspiration, the institutional search behavior is seemed to be under the influence of threat rigidity and firms are less eager to follow other firms' R&D investment trend. However, when a firm is underperforming with respect to growth aspiration, the institutional search behavior is affected by stronger social comparison and imitation. The opposite moderating effects may imply the decision makers' shift of focus between performance aspirations and survival when following others' risky actions. Since the semiconductor industry's greatest merit can be found in high sales growth, firms positioned under growth aspirations are likely to become risk seeking to exploit that 'growth-performance' aspirations while firms experiencing negative ROA (i.e. firms positioned under profit aspirations) are likely to become risk averse because the decision makers are more concerned with the survival point. Overall, our findings highlight how firms' R&D intensity is affected by performance feedback and institutional search processes, and also show the institutional search behavior being influenced by focus of attentions between performance aspirations and survival.

We have also tried the random-effects model and performed the Hausman specification test (Hausman, 1978) to check for the appropriateness of the model. The result rejected the null hypothesis and the fixed-effects model rather than random-effects model was found to be more appropriate. Moreover, since about 16% of observations had to be dropped from the regressions because their value for R&D expenses was missing, we have checked for any selection bias. We utilized a two-step Heckman selection modeling (the dependent variable takes the value of 1 if the firm's

R&D intensity is nonzero and not greater than 1, and a value of 0 otherwise) on the entire raw sample and then incorporated the inverse Mills ratio calculated from the first stage into the panel regression models in the second stage (Heckman, 1979). Throughout the models, the estimated coefficient for the selectivity bias parameter (inverse Mills ratio) is not significant, suggesting that selection bias is not a concern for our data.

CONCLUSIONS

Our research has attempted to provide implications regarding the importance of both profit and growth aspirations, institutional search, and the interaction between institutional search and performance aspirations. Although organizations seek to meet aspiration levels on multiple goals, many interests have been focused only on profit-wise performance. The findings partly suggest that growth rate was more influential aspirations regarding the R&D intensity of semiconductor firms. We expect such firm behaviors will be stronger for industries at growth stage or where products are relatively standardized so that new product introduction is more critical than differentiation of existing products. In addition to the performance aspirations, institutional search behavior was evident in our analyses. Institutional search can be interpreted as a means to keep in balance with other firms and also as firms' effort to seek and absorb R&D spillovers. Since it was recognized from prior research that firms tend to be more sensitive to social comparison when their performance is below aspirations, we contended institutional search behavior would be strengthened when performance is low. Our results support that the institutional search gets stronger only for underperforming firms relative to growth aspirations. On the contrary, underperforming firms with respect to profit aspirations reduced their institutional search which was quite the opposite of what we have anticipated. It could be argued that in industries with the negative mean ROA, underperforming firms in terms of profitability are facing serious distress that 'threat rigidity' prevails. In this situation, decision makers become more risk averse and behave conservatively by reducing institutional search. These empirical evidences point to the importance of firms' situational considerations when pursuing the institutional search. That is, the

strength of institutional search is affected by firm's position relative to performance aspirations, weakening it when the firm is under the concern for survival and strengthening it when the firm is under the concern for performance aspiration. In short, we can generally claim that the firm's R&D intensity is not determined solely by its own problemistic search processes but is also affected by institutional search processes. Moreover, the negative performance feedback is found to moderate institutional search pattern. Such implications are valuable since a firm's R&D intensity has been analyzed with an integrating lens of problemistic and institutional search behaviors. Firms respond to performance aspirations and have strong incentives to stay in balance with other firms when making decisions on R&D intensity.

Before discussing future research topics that could stem from this study, it is important to consider limitations of our research setting. First, semiconductor industry is volatile with frequent M&As, new startups entering the market, short span of life, and diversified conglomerates also participating. Also its products are widely fragmented and it is not rare that firms change forms of business operations or pursue multiple business operations simultaneously (for example, shift from IDM to fabless or IDMs providing foundry service at the same time). These industry characteristics make it hard to categorize reference firms accurately and although we tried to assign the most representative type of business operations in identifying reference firms, some errors would be inevitable. This might be the main reason that potentially important control variables such as actual rivalry and age were found not to be statistically significant. Second, since our study is based on a single industry, the generalization of results should be made with caution. Although profit and growth are most salient performance indices and firms are assumed to make satisficing decisions based on these performance aspiration levels, some exceptions should also hold. For instance, industries at declining stage would have weak incentives for sales growth so that growth aspirations should likely have different effect depending on industry life cycle. Thus, acknowledging some of performance aspirations can be industry-specific is important before deriving the general conclusion about profit and growth aspirations. Given that the semiconductor industry involves a high level of economies of scale, firms may pursue aggressive price competition at the expense of profit erosion

to drive out rivals from the market. This may be one reason that firms are sensitive to falling below social growth aspiration levels.

By drawing problemistic and institutional search together, our results show how institutional search and incentives for seeking R&D spillovers change based on different performance gap. A few related topics are worth discussing for further studies. First, future study may consider relative strength of performance aspirations and institutional search depending on a firm's R&D capability. When a firm has strong R&D capability, it may have low incentives for seeking R&D spillovers or institutional search, making performance aspirations a dominant factor in determining R&D intensity. In addition, another type of performance measures such as technological performance can be considered. Technological performance may be computed by the impact or composition of firms' patent stocks and it would be interesting, for instance, to examine the performance aspiration of technological breadth or depth on R&D intensity. Moreover, since reference group membership is critical for empirically testing both social aspirations and institutional search, it may be meaningful to consider other dimension of competition. Our study delineated reference groups based on the type of business operations, but with such high number of n (=627) and fragmented product applications, more localized search behavior model should have been persuasive. That is, a focal firm would likely pick its reference firms by considering various factors including their size, product applications, and target customers and narrow down the rivalry scope. These additional contingencies will help us understand how localized the actual decision making criteria would be.

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