SITUATIONAL AND INSTITUTIONAL DETERMINANTS OF FIRMS’ R&D SEARCH INTENSITY

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Our theory extends the situational considerations explaining firm R&D search intensity beyond the behavioral theory of the firm by including shifts in the focus of attention among bankruptcy, aspirations, and slack. We also allow that search can reflect institutionalized investment patterns within firms and industries. We find stable firm-specific R&D investment patterns (i.e., institutionalized search) and variations in R&D intensity depending on firms’ situations—including performance relative to aspirations, proximity to bankruptcy, and slack. Our empirical results evidence shifts in the focus of attention relevant to explaining R&D search intensity for subsamples of firms in different situations. Copyright © 2007 John Wiley & Sons, Ltd.

Search plays a key role in organizational evolution and adaptation. Organizations search by probing for information on alternative processes and products, and their discoveries facilitate changes in organizational routines (Greve and Taylor, 2000). Managers allocate resources to research and development (R&D) search activities in response to the threats and opportunities posed by environmental changes (Cohen and Levinthal, 1989). Searching for new technologies is a key factor affecting firms’ competitive positions (Fleming and Sorenson, 2004; Katila and Ahuja, 2002; Nelson and Winter, 1982; Rosenkopf and Nerkar, 2001; Stuart and Podolny, 1996). This study examines the considerations that frame—and constrain—the allocation of resources to R&D activities. Our theoretical arguments and empirical tests address two broad categories of behavioral determinants of R&D search intensity: situational and institutional.

Situational determinants of search include failure to attain aspirations and slack, as highlighted in Cyert and March’s (1963) behavioral theory of the firm. Their classic theory of firm behavior modeled organizations as goal-directed systems that use simple decision rules to alter their activities in response to performance feedback. To their theory, we add considerations regarding organizational responses to the threat of bankruptcy (March and Shapira, 1992; Staw, Sandelands, and Dutton, 1981) and posit that search behaviors depend on whether managers focus their attention on bankruptcy, aspirations, or slack. The focus of attention depends, in turn, on organizations’ situations (Ocasio, 1997).

We also take into account the ongoing R&D expenditures that remain relatively stable over time despite changes in an organization’s situation—what Greve (2003b) termed ‘institutionalized search.’ Institutionalization of search may also be evident in conformity to industry trends in

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1 Organizational search includes search occurring at lower levels of analysis. Although individuals and groups conduct searches, organizations provide the context (e.g., resources, coordination, and legitimacy) for search activities.
R&D expenditures. The institutional determinants of search have received little acknowledgement from researchers doing empirical research within the tradition of Cyert and March’s (1963) behavioral theory of the firm.

The empirical portion of this study examines evidence on R&D search investments across a wide range of manufacturing industries, thereby offering more general evidence than prior single-industry studies (Greve, 2003a; Makadok and Walker, 1996; Stuart and Podolny, 1996). Our empirical evidence helps sort out the relative importance of situational and institutional influences on firms’ R&D investments. Our results support the view that much R&D spending is institutionalized. Although less important, situational effects are also significant. Furthermore, our findings are consistent with the interpretation that managers shift the focus of attention relevant to R&D search intensity depending on whether performance is below or above aspirations, proximity to bankruptcy, and slack.

THEORY AND HYPOTHESES

According to Cyert and March (1963), performance relative to aspirations affects search propensity. Firms compare the difference between actual performance and aspirations, i.e., the ‘attainment discrepancy’ (Lant, 1992), and classify this gap as either favorable or unfavorable. Firms that operate below aspirations seek ways to enhance their prospects for achieving their target performance. The probability of organizational change decreases as firm performance improves relative to aspirations (Greve, 1998). When firms only just achieve aspirations, they tend to maintain current routines and have limited motivation to search for anything new (Cyert and March, 1963; Levinthal and March, 1981). Based on these arguments, a firm is expected to increase search as its performance falls below aspirations. We can state the hypothesis as follows:

Hypothesis 1: R&D search intensity increases with the distance of firms’ past performance below aspirations.

However, underperforming firms facing serious financial distress may limit search intensity. According to the ‘threat-rigidity’ hypothesis (Staw et al., 1981), threats induce psychological stress and anxiety, which have a cognitive and motivational influence on managers. Stress and anxiety lead to restrictions on information processing and tightening of controls. Firms tend to avoid new activities, conserve resources, and seek to keep existing production activities lean when their survival is threatened.

Management researchers have argued that organizations respond to financial distress by emphasizing cost reductions (e.g., Schendel, Patton, and Riggs, 1976; Starbuck and Hedberg, 1977), limiting new strategic initiatives (D’Aveni, 1989), and reducing risk taking (March and Shapira, 1987, 1992). The perceived threat of extremely poor performance causes a firm to behave conservatively (Ketchen and Palmer, 1999). Under the threat of bankruptcy, managers recognize their obligation to avoid placing their firms in danger and eliminate activities and overhead expenses that are not essential to maintaining current operations (March and Shapira, 1987). Based on these arguments, we expect that firms threatened by bankruptcy will be less likely than other poor-performing firms to search for new technologies.

Hypothesis 2: R&D search intensity decreases with firms’ proximity to bankruptcy.

In addition to problemistic search, Cyert and March (1963) also identified slack search as a facilitator of organizational adaptation. Slack resources include excess inputs such as underutilized capacity and employees, as well as financial resources (Levinthal and March, 1981). A firm can invest slack resources to create an inventory of unexploited technologies as a buffer against future uncontrollable contingencies (Milliken and Lant, 1991). Slack acts as an important catalyst for innovation because it causes managers to relax controls and permit experimentation even in the face of uncertainty (Bourgeois, 1981; Greve, 2003a; Nohria and Gulati, 1996). Therefore, we can expect a positive relation between the amount of slack resources and the firm’s search intensity.

Hypothesis 3: R&D search intensity increases with firms’ slack resources.

Problemistic search and slack search arguments present alternative perspectives for hypothesizing
the effect of short-run performance above aspirations. On the one hand, performance exceeding aspirations should decrease problemistic search. On the other hand, achieving a performance exceeding aspirations is the way in which slack accumulates (Levinthal and March, 1981). Slack search is most likely to appear in firms that have persistent positive attainment discrepancies, but what about firms with short-run positive attainment discrepancies? Our contention is that firms’ responses to short-run positive results conform to the slack search argument. Short-run slack resources motivate loosening controls and greater experimentation, so R&D expenditures should rise.

**Hypothesis 4:** R&D search intensity increases with the distance of firms’ past performance above aspirations.

We recognize, however, that the logic behind problemistic search presents a countervailing argument. Only empirical evidence can resolve this matter.

For Ocasio (1997), organizations’ situations together with their internal norms and procedures influence the allocation of participants’ attention. In turn, the allocation of attention affects organizational decision making and coordinated action. The discussion surrounding Hypotheses 1 and 2 indicated two distinct factors that influence search behavior for firms performing poorly. The behavioral theory of the firm emphasizes failure to reach aspirations as a primary motivator of firm search, while the threat rigidity hypothesis highlights proximity to bankruptcy. To reconcile these perspectives, we incorporate March and Shapira’s (1987, 1992) contention that firms can shift their focus of attention. We assume that firms performing below their aspirations shift their attention between survival and aspirations according to their distance from each. The closer the firm is to a particular reference level, the higher the probability that it becomes the focus of attention.2

For underperforming firms that are directly threatened by bankruptcy, their primary focus is survival. These firms are more likely to keep existing operations lean and avoid searching for new alternatives (see Hypothesis 2). By contrast, underperforming firms that are far away from bankruptcy consider their positions relative to their aspiration levels when making resource allocation decisions. These firms search in order to solve problems and attain their target performance levels (see Hypothesis 1).

**Hypothesis 5a:** Proximity to bankruptcy is more relevant to R&D search intensity for underperforming firms that are directly threatened by bankruptcy than for underperforming firms that are not threatened by bankruptcy.

**Hypothesis 5b:** Attainment discrepancy is more relevant to R&D search intensity for underperforming firms that are not threatened by bankruptcy than for underperforming firms that are directly threatened by bankruptcy.

We also anticipate shifts in the focus of attention among firms that outperform their aspirations. They may be either aspiration-focused or slack-focused. For outperforming firms with little accumulated slack resources, their attention is on aspirations rather than slack. For such firms, managerial attention is still likely to be focused foremost on short-term investments rather than on more distant and uncertain slack-funded innovation projects (Nohria and Gulati, 1996). By contrast, for outperforming firms with abundant slack resources, managers will be more likely to make search decisions based on the amount of slack rather than on recent financial performance. For high-slack firms, slack acts as a buffer allowing the ongoing pursuit of search and innovation despite fluctuations in short-term performance (Cyert and March, 1963).

**Hypothesis 6a:** Attainment discrepancy is more relevant to R&D search intensity for outperforming firms with less slack than for outperforming firms with abundant slack.

**Hypothesis 6b:** Slack resources are more relevant to R&D search intensity for outperforming firms with abundant slack than for outperforming firms with less slack.

Previous research based on the behavioral theory of the firm has focused almost exclusively on the roles of problems and slack in motivating organizational search. However, search may also be part of the ongoing activities of organizations. Search by organizational subunits (such as R&D and marketing research departments) can respond to ongoing

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2 This is one of several specifications for the focus of attention modeled by March and Shapira (1992).
mandates, not just short-run performance feedback or fluctuations in slack. Allocation of resources to R&D can become routinized, as when R&D expenditures are based on a fixed percentage of sales, or standard shares are allocated to basic research, risky projects, and incremental innovation (Dosi, 1988). Greve (2003b: 54) referred to such ongoing search as institutionalized search.

The assumptions underlying institutionalized search are quite consistent with themes in the behavioral theory of the firm (Cyert and March, 1963) and related literature. Ongoing mandates to search economize on scarce managerial attention and decision-making capacity. Allocating resources to continuing search requires less managerial deliberation and explicit decision making than new initiatives. Institutionalizing search legitimizes an ongoing flow of resources to search activities. This helps avoid conflict when allocating resources. Once search is institutionalized, its inertia may be difficult to stop (Burgelman, 1991, 1996). Furthermore, as search becomes routine, organizational search competence accumulates over time. Charging a subunit with searching supports continuous roles and relationships for ongoing investigation and exchange of findings. Routinization and institutionalization promote continuity in the direction and intensity of firms' search over time (Patel and Pavitt, 1997).

Hypothesis 7: Propensities to engage in R&D search differ across firms and tend to be stable within firms over time.

The institutionalization of search occurs in response to trends outside the organization as well. Firms within the same industry may perceive a common opportunity or threat that motivates similar search patterns and commitments to invest in innovation (Michael and Wall, 1986; Patel and Pavitt, 1997). Some investment in R&D may be necessary in order to absorb the learning going on elsewhere within an industry (Cohen and Levinthal, 1990). Firms may also directly imitate one another as search strategies gain legitimacy. The tendency to imitate other organizations under conditions of uncertainty (DiMaggio and Powell, 1983) applies to organizational search. Imitation also may be pursued as a strategy to mitigate risk in contexts of competitive rivalry (Lieberman and Asaba, 2006).

Hypothesis 8: The R&D search intensity of a given firm covaries with that of rivals within its industry.

**METHOD**

**Data**

Our panel data came from Standard and Poor's Compustat database, which collects operational and financial information for all publicly traded U.S. companies. Compustat consists of three major datasets: industrial, full coverage, and research. The industrial and full coverage datasets cover active publicly traded companies, whereas the research dataset contains companies deleted from the other two databases due to bankruptcy, acquisition or merger, leveraged buyout, or becoming private companies. Because we were interested in examining the effects of proximity to bankruptcy, it was important to include all of these firms.

To keep the industry backgrounds somewhat comparable, we selected only manufacturing companies with 4-digit SIC codes from 2000 to 3999. We excluded small industries with less than five firms to avoid possible biases in our estimates of industry average R&D intensity. About 7.5 percent of sample firms were eliminated because of this selection criterion. We excluded extreme outliers that were more than four standard deviations beyond the yearly means for our major ratio variables, including R&D search intensity, past performance, and aspirations. To examine search behavior over time, we used data from 1980 to 2001.

**Variables**

**R&D search intensity**

Our dependent variable reflects firm-specific search expenditures adjusted for firm size. We used R&D expenditures divided by sales as a proxy for search intensity (see Cohen and Levinthal, 1989).\(^3\) The R&D intensity variable was skewed to the right. The median was 0.056 in the sample. Because 8 percent of the sample firms spend more on R&D

\(^3\) Data on R&D expenses are missing from Compustat for 23.8 percent of the sample firms. To examine any bias caused by the left-censored sample (unobservable minimal R&D expenses), we ran panel Tobit models corresponding to each of our regressions and found similar results as in the fixed-effect models reported here.

than their total sales (reaching a maximum of 280 times sales), mean R&D intensity was unreasonably high at 0.85 and the standard deviation was 6.37. Following the behavioral theory of the firm (Cyert and March, 1963), we reasoned that our theoretical arguments applied to firms engaged in ongoing production and sales activities, not R&D specialists. Firms with R&D expenses greater than sales may base their search investments on criteria quite distinct from those we hypothesized. As such, we restricted our sample to firms with R&D intensity less than or equal to 1. The resulting sample has median R&D intensity at 0.048, mean at 0.096, and a standard deviation of 0.146.

Firm, time, and industry effects

All models included indicator variables for firms and all but one years. Industries were defined according to 4-digit SIC categories. Industry average R&D search intensity was computed by deleting the observation firm data (i.e., there are no own-firm effects on industry average R&D intensity). Because industry prospects could influence firms’ investment decisions, we included industry sales growth as a control variable. This was computed as the percentage change in industry sales from \( t-1 \) to \( t \).

Performance

For this study, we needed a general measure of performance relevant to managers when they make resource allocation decisions. We chose return on assets (ROA). In our models, the performance variable is lagged 1 year relative to the dependent variable.

Aspirations

Cyert and March (1963) modeled aspiration formation as a linear combination of a firm’s own past performance and the experiences of other reference firms. Some researchers have followed this approach in subsequent empirical work (e.g., Bromiley, 1991; Wiseman and Bromiley, 1996); however, it is unclear how firms weight their own performances and the performances of other firms when determining their aspiration levels (Baum et al., 2005; Miller and Chen, 2004). Given this ambiguity, we chose to run two different models with different aspiration proxies: one for own-firm past performance and the other for industry median past performance. Firm aspiration is the focal firm’s performance 1 year prior to past performance (\( t-2 \)). Industry aspiration is the median performance of firms in the same 4-digit SIC industry 1 year prior to past performance (\( t-2 \)).

Distance from bankruptcy

We used Altman’s (1983) Z as a measure of distance from bankruptcy. Altman’s Z is defined as \( (1.2 \times \text{working capital divided by total assets}) + (1.4 \times \text{retained earnings divided by total assets}) + (3.3 \times \text{income before interest expense and taxes divided by total assets}) + (0.6 \times \text{market value of equity divided by total liability}) + (1.0 \times \text{sales divided by total assets}) \). A lower Z value means a higher likelihood of bankruptcy.

Slack

Researchers have proposed a variety of ways to measure organizational slack using accounting data (Bromiley, 1991; Cheng and Kesner, 1997; Marino and Lange, 1983; Palmer and Wiseman, 1999). Following Bourgeois (1981) and Singh (1986), we selected the current ratio (current assets divided by current liabilities) and working capital to sales ratio as proxies for available slack. We standardized and summed these variables to form a composite slack index.\(^4\)

Models

We used fixed-effects panel regression models to test our hypotheses. Hypotheses 1 and 4 suggest different search behaviors depending on whether firms perform below or above aspirations. To test these hypotheses, we incorporated an indicator variable for underperforming firms, \( I_1 \), which equals 1 if firm \( i \)’s past performance falls below (firm-specific or industry-specific) aspirations. Therefore, \( (1 - I_1) \) indicates outperforming firms

\(^4\) Although the correlation between the current ratio and the working capital-to-sales ratio was only 0.40, we found that our regression model results using the composite slack index did not vary from those using either slack measure alone. To simplify our tables, we report only the results using the composite slack index.
whose past performance meets or exceeds aspirations. We estimated the following model:

\[
S_{i,t} = \beta_1 + \beta_2 + \beta_3 S_{\text{ind},t} + \beta_4 C_{\text{ind},t} \\
+ \beta_5 I_1(P_{i,t-1} - A_{i,t-1}) + \beta_6 (1 - I_1)(P_{i,t-1} - A_{i,t-1}) \\
+ \beta_7 Z_{i,t-1} + \beta_8 K_{i,t-1} + \epsilon_{i,t} 
\]  

(1)

The dependent variable, \(S_{i,t}\), designates firm \(i\)'s R&D search intensity in period \(t\). The model includes indicator variables for firm-specific and period effects (\(\beta_1\) and \(\beta_2\)). Industry average search, \(S_{\text{ind},t}\), is measured contemporaneously with the dependent variable. \(C_{\text{ind},t}\) is the percentage growth in industry sales relative to the prior year, which controls for market demand prospects that may influence search investments. \(P_{i,t-1}\) and \(A_{i,t-1}\) are measures of firm \(i\)'s performance and aspiration level in period \(t - 1\). \(Z_{i,t-1}\) is a measure of distance from bankruptcy. \(K_{i,t-1}\) represents the amount of organizational slack at time period \(t - 1\). The use of lagged independent variables reflects the temporal ordering in our causal arguments. \(\epsilon_{i,t}\) is the error term.

To test for shifts in the focus of attention, we divided the underperforming sample into two groups—one directly threatened by bankruptcy and the other not—and estimated Equation 2 for each subsample:

\[
S_{i,t} = \gamma_1 + \gamma_2 + \gamma_3 S_{\text{ind},t} + \gamma_4 C_{\text{ind},t} \\
+ \gamma_5 I_1(P_{i,t-1} - A_{i,t-1}) + \gamma_6 Z_{i,t-1} \\
+ \gamma_7 K_{i,t-1} + \epsilon_{i,t}, \text{ if } P_{i,t-1} < A_{i,t-1} 
\]  

(2)

We selected firms with Altman's (1983) Z scores below the median for our sample of underperforming firms to isolate those firms most threatened by bankruptcy. Both attainment discrepancy (\(P_{i,t-1} - A_{i,t-1}\)) and bankruptcy (\(Z_{i,t-1}\)) variables were included in the model in order to compare their relative effects on the two underperforming groups.

We separated the outperforming firms into low-slash and high-slash firms and estimated the following model for each subsample:

\[
S_{i,t} = \delta_1 + \delta_2 + \delta_3 S_{\text{ind},t} + \delta_4 C_{\text{ind},t} \\
+ \delta_5 (P_{i,t-1} - A_{i,t-1}) + \delta_6 K_{i,t-1} \\
+ \epsilon_{i,t}, \text{ if } P_{i,t-1} \geq A_{i,t-1} 
\]  

(3)

Firms with slack resources in the top half of the outperformers were identified as the high-slash sample. Unlike Equations 1 and 2, Equation 3 does not include distance from bankruptcy because it is unlikely to be relevant to the search decisions of firms outperforming their aspirations.

RESULTS

Table 1 provides descriptive statistics for the final dataset. Our sample consisted of 35,970 observations from 1980 to 2001. The major two-digit industry categories were electronics and equipment (23.0% of the sample), industrial machinery and equipment (21.9%), instruments and related products (20.8%), and chemicals and allied products (14.8%). The attainment discrepancy variables using firm- and industry-based aspiration proxies are highly correlated (0.85), but the correlation between the aspiration measures themselves is modest (0.14).

Table 2 shows the fixed-effects panel regression results for models based on Equation 1. The table is organized in pairs of columns with results using firm-based aspirations presented first, followed by results using industry-based aspirations. The first pair of columns reports results for baseline models consisting only of firm and time period effects. These models explain about three-fourths of the variance in R&D search intensity. The next pair of columns reports the results for models adding industry effects to the baseline model. The third pair of columns reports the coefficients after adding to the baseline model the set of variables associated with situational explanations. The final pair of columns shows the coefficients for the full model corresponding to Equation 1.

For each of the models in Table 2, the incremental improvement in \(R^2\) beyond the baseline model is less than 1 percent. Because the variables in our baseline model are not orthogonal to the variables added in the other models, we cannot unambiguously assign the proportion of variance explained to each variable. For nonorthogonal variables, the proportion of variance explained depends on the order in which variables are added to the multivariate model. Putting in the firm and time effects first attributes to them a disproportionate amount of the total variance explained, and provides a conservative estimate of the variance explained by our other
Table 1. Descriptive statistics for the panel data

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Median</th>
<th>Mean</th>
<th>S.D.</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
<th>9.</th>
<th>10.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. R&amp;D/sales,</td>
<td>35,970</td>
<td>0.048</td>
<td>0.096</td>
<td>0.146</td>
<td>—</td>
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<tr>
<td>2. Industry R&amp;D/sales,</td>
<td>35,970</td>
<td>0.081</td>
<td>0.093</td>
<td>0.072</td>
<td>0.45</td>
<td>—</td>
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<tr>
<td>3. Industry growth,</td>
<td>35,970</td>
<td>0.082</td>
<td>0.108</td>
<td>0.309</td>
<td>0.04</td>
<td>0.07</td>
<td>—</td>
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<tr>
<td>4. (Performance − Aspiration)_{t−1, firm}</td>
<td>29,076</td>
<td>0.000</td>
<td>0.009</td>
<td>0.672</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
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<tr>
<td>5. (Performance − Aspiration)_{t−1, industry}</td>
<td>30,474</td>
<td>0.000</td>
<td>−0.076</td>
<td>0.640</td>
<td>−0.11</td>
<td>−0.02</td>
<td>0.01</td>
<td>0.85</td>
<td>—</td>
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<tr>
<td>6. Performance_{t−1}</td>
<td>33,125</td>
<td>0.038</td>
<td>−0.064</td>
<td>0.659</td>
<td>−0.12</td>
<td>−0.04</td>
<td>0.01</td>
<td>0.85</td>
<td>0.99</td>
<td>—</td>
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<tr>
<td>7. Aspiration_{t−1, firm}</td>
<td>29,347</td>
<td>0.037</td>
<td>−0.071</td>
<td>0.498</td>
<td>−0.26</td>
<td>−0.11</td>
<td>0.00</td>
<td>−0.17</td>
<td>0.37</td>
<td>0.38</td>
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<tr>
<td>8. Aspiration_{t−1, industry}</td>
<td>30,533</td>
<td>0.038</td>
<td>0.029</td>
<td>0.066</td>
<td>−0.17</td>
<td>−0.30</td>
<td>−0.05</td>
<td>−0.01</td>
<td>0.01</td>
<td>0.06</td>
<td>0.14</td>
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<tr>
<td>9. Distance from bankruptcy_{t−1}</td>
<td>27,249</td>
<td>3.530</td>
<td>5.234</td>
<td>14.171</td>
<td>0.15</td>
<td>0.13</td>
<td>0.03</td>
<td>0.30</td>
<td>0.38</td>
<td>0.38</td>
<td>0.18</td>
<td>−0.05</td>
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<tr>
<td>10. Slack index_{t−1}</td>
<td>32,762</td>
<td>−0.271</td>
<td>−0.006</td>
<td>1.532</td>
<td>0.26</td>
<td>0.18</td>
<td>0.04</td>
<td>0.07</td>
<td>0.08</td>
<td>0.07</td>
<td>0.01</td>
<td>−0.11</td>
<td>0.42</td>
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</tr>
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</table>

*Correlations with absolute values greater than 0.02 are significant at the $p < 0.05$ level.
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<tbody>
<tr>
<td>Firm effects(^a)</td>
<td>**</td>
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<tr>
<td>Time effects(^a)</td>
<td>**</td>
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<td>**</td>
</tr>
<tr>
<td>Industry R&amp;D/sales,</td>
<td>0.138(^{**})</td>
<td>0.133(^{**})</td>
<td>0.139(^{**})</td>
<td>0.134(^{**})</td>
<td>(0.020)</td>
<td>(0.018)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Industry growth, (^b)</td>
<td>−0.310</td>
<td>−0.353(^*)</td>
<td>−0.374(^*)</td>
<td>−0.374(^*)</td>
<td>(0.191)</td>
<td>(0.172)</td>
<td>(0.170)</td>
</tr>
<tr>
<td>(I_1 (\text{Performance}<em>{t-1} - \text{Aspiration}</em>{t-1}))(^b)</td>
<td>−0.267(^*)</td>
<td>−0.196(^*)</td>
<td>−0.272(^{**})</td>
<td>−0.201(^*)</td>
<td>(0.104)</td>
<td>(0.084)</td>
<td>(0.104)</td>
</tr>
<tr>
<td>((1 - I_1) (\text{Performance}<em>{t-1} - \text{Aspiration}</em>{t-1}))(^b)</td>
<td>0.035</td>
<td>−1.667(^{**})</td>
<td>0.038</td>
<td>−1.681(^{**})</td>
<td>(0.015)</td>
<td>(0.425)</td>
<td>(0.149)</td>
</tr>
<tr>
<td>Distance from bankruptcy, (^b)</td>
<td>0.016(^*)</td>
<td>0.021(^*)</td>
<td>0.017(^{**})</td>
<td>0.021(^*)</td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Slack composite index, (^b)</td>
<td>0.012(^*)</td>
<td>0.013(^*)</td>
<td>0.012(^*)</td>
<td>0.013(^*)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Model (F)</td>
<td>1.67(^*)</td>
<td>2.55(^{**})</td>
<td>4.00(^{**})</td>
<td>5.39(^{**})</td>
<td>32.15(^{**})</td>
<td>26.93(^{**})</td>
<td>31.79(^{**})</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.753</td>
<td>0.739</td>
<td>0.754</td>
<td>0.740</td>
<td>0.761</td>
<td>0.745</td>
<td>0.762</td>
</tr>
<tr>
<td>(N)</td>
<td>25078</td>
<td>25110</td>
<td>25078</td>
<td>25110</td>
<td>25078</td>
<td>25110</td>
<td>25122</td>
</tr>
</tbody>
</table>

\(\dagger\) \(p < 0.1\); \(\ast\) \(p < 0.05\); \(\ast\ast\) \(p < 0.01\); standard errors are in the parentheses.

\(^a\) Models include firm and period effects but their coefficients are not included in this table.

\(^b\) The coefficient and standard errors are multiplied by \(10^2\).
variables. Nevertheless, the results point to the importance of firm-specific institutional influences on search relative to situational considerations.

The attainment discrepancy coefficient for underperforming firms \((I_1 = 1)\) is negatively associated with R&D search intensity in all of the firm aspiration and industry aspiration models. This finding implies that the farther past performance falls below aspirations, the higher the firm’s spending on R&D search. This finding is consistent with the problemistic search argument (Hypothesis 1).

Distance from bankruptcy (Altman’s \(Z\)) is positively associated with search intensity. In other words, firms decrease their search efforts as they approach bankruptcy. This is in keeping with the threat-rigidity argument (Hypothesis 2). Our results show significant positive relations between slack and R&D search intensity. This finding is consistent with the slack search argument (Hypothesis 3).

As for the effect of recent performance above aspirations \((I_1 = 0)\), we found search decreases as performance rises above the industry median. However, we did not find a consistent significant relation between distance above firm aspirations and R&D search intensity. These results disconfirm Hypothesis 4. Instead, they point to reductions in R&D intensity as firms outperform others in their industry.

Each of our models included firm and period effects. \(F\)-tests show that not all of these coefficients are zero (i.e., the joint effects are significant). Consistent with Hypothesis 7, the significant firm fixed effects reflect idiosyncratic search determinants for individual firms that persist over time. The significant period effects indicate time-varying macro-environmental influences on search investment across all industries and firms. Contemporaneous industry average R&D search intensity has positive and significant relations with firm search in all of our models, as anticipated in Hypothesis 8. The other industry variable, industry sales growth, was negatively associated with search in the models. As industry growth rates rise, firms appear to favor exploitation of current technologies over exploration of potential innovations.

Table 3 shows our results for the models based on Equations 2 and 3. These models allow for shifts in the focus of attention relevant to firm search behavior. The underperforming firms were divided into those more directly threatened by bankruptcy (i.e., those with Altman’s \(Z\) scores in the lower half of the underperformers) and those less threatened. Our results show that the search investments of underperforming firms directly threatened by bankruptcy depend on both attainment discrepancy and distance from bankruptcy. Slack has a positive effect on search spending.

For underperforming firms not directly threatened by bankruptcy, distance from bankruptcy is not a significant determinant of search. The results show a negative effect for attainment discrepancy and a positive effect for slack in both models. These findings indicate that underperforming firms that are directly threatened by bankruptcy are more responsive to distance from bankruptcy than those not threatened, consistent with Hypothesis 5a. However, the results suggest that attainment discrepancy is relevant for underperforming firms regardless of whether they are directly threatened by bankruptcy or not. Hypothesis 5b is not supported.

We split the outperforming firms into low-slack and high-slack groups. Outperforming firms were classified as high-slack if their composite slack values were in the top half of the outperformers. For firms with less slack, attainment discrepancy has a significant positive effect, while slack is insignificant. By contrast, for outperforming firms with abundant slack, both the amount of slack available to them and attainment discrepancy are significant determinants of search investments. Unlike the findings for our full sample (Table 2), the effect of attainment discrepancy is positive among outperformers. This is consistent with the interpretation of short-run performance above aspirations as stimulating R&D search, as reflected in Hypothesis 4. It appears that among firms that outperform their aspirations, slack becomes relevant to making search investments only when firms accumulate substantial slack. This result is consistent with Hypothesis 6b. We do not see evidence

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5 If we switch to a random-effects model, thereby treating the firm effects as part of the error term, the situational determinants and industry effects explain 12 percent and 20 percent of the variance in the full firm-aspiration and industry-aspiration models, respectively.

6 There were no differences when we used the 20th and 35th percentile as alternative cut-off points.

7 The results were generally consistent when using the 65th and 80th percentiles as alternative cut-off points.
Table 3. Fixed-effects panel regressions for R&D search intensity: results for four subsamples

<table>
<thead>
<tr>
<th></th>
<th>Underperformers threatened by bankruptcy (Lower 50% Z)</th>
<th>Underperformers not threatened by bankruptcy (Higher 50% Z)</th>
<th>Outperformers with less slack resources (Lower 50% slack)</th>
<th>Outperformers with abundant slack resources (Higher 50% slack)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Firm aspiration</strong></td>
<td><strong>Industry aspiration</strong></td>
<td><strong>Firm aspiration</strong></td>
<td><strong>Industry aspiration</strong></td>
<td><strong>Firm aspiration</strong></td>
</tr>
<tr>
<td><strong>Time effects</strong></td>
<td><strong>Effects</strong></td>
<td><strong>Effects</strong></td>
<td><strong>Effects</strong></td>
<td><strong>Effects</strong></td>
</tr>
<tr>
<td>Industry R&amp;D/sales,</td>
<td>0.060</td>
<td>0.111*</td>
<td>0.214**</td>
<td>0.095†</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.052)</td>
<td>(0.043)</td>
<td>(0.055)</td>
</tr>
<tr>
<td>Industry growth,</td>
<td>0.046</td>
<td>0.214**</td>
<td>0.095**</td>
<td>0.214**</td>
</tr>
<tr>
<td></td>
<td>(0.0437)</td>
<td>(0.489)</td>
<td>(0.043)</td>
<td>(0.531)</td>
</tr>
<tr>
<td>(Performance(_t-1 - ) Aspiration(_t-1))(^b)</td>
<td>-0.750**</td>
<td>-1.404**</td>
<td>-4.443**</td>
<td>-4.999**</td>
</tr>
<tr>
<td></td>
<td>(0.217)</td>
<td>(0.211)</td>
<td>(0.984)</td>
<td>(1.048)</td>
</tr>
<tr>
<td>Distance from bankruptcy(_t-1)(^b)</td>
<td>0.091**</td>
<td>0.210**</td>
<td>0.013</td>
<td>-0.010</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.028)</td>
<td>(0.010)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Slack composite index(_t-1)</td>
<td>0.012**</td>
<td>0.008*</td>
<td>0.017*</td>
<td>0.017**</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Model (F)</td>
<td>3.22**</td>
<td>3.87**</td>
<td>6.79**</td>
<td>7.49**</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.838</td>
<td>0.769</td>
<td>0.851</td>
<td>0.843</td>
</tr>
<tr>
<td>Baseline(^c) (R^2)</td>
<td>0.836</td>
<td>0.765</td>
<td>0.846</td>
<td>0.837</td>
</tr>
<tr>
<td>(N)</td>
<td>6295</td>
<td>6209</td>
<td>6289</td>
<td>6197</td>
</tr>
</tbody>
</table>

\(\dagger p < 0.1; \ ^* p < 0.05; \ ^{**} p < 0.01; \) standard errors are in parentheses.

\(^a\) Cut-off points are the lowest 50\% Altman’s \(Z\) for the underperforming sample and highest 50\% slack for the outperforming sample.

\(^b\) The coefficient and standard errors are multiplied by 10\(^2\).

\(^c\) Baseline models include only firm fixed effects and time effects.

CONCLUSION

Our empirical results give a heightened sense of importance to institutionalized search. In our models, most of the explained variance in R&D intensity is due to firm effects. Time period and industry effects were also significant, but their contributions to the total variance explained were modest. After controlling for firm and time effects, the other variables explain only a small portion of the total variance in R&D search intensity. Our results give a conservative estimate of the portion of variance explained by these variables because nonorthogonal variables entered first into the model get greater credit for the variance explained than the last variables added. Nevertheless, our findings highlight the role of institutionalized search and cause us to recast the behavioral explanations for R&D search in a role that is marginal and auxiliary to institutionalized search.

Findings from our overall sample of U.S. manufacturing companies (Table 2) supported three of our four initial hypotheses. Consistent with the problematic search argument in the behavioral theory of the firm (Hypothesis 1), we found that R&D search intensity rises as performance falls below aspirations. Also consistent with the behavioral theory of the firm was the finding that slack is positively related to search (Hypothesis 3). Proximity to bankruptcy, in general, reduces R&D search, as anticipated in Hypothesis 2. The expectation that firms increase search in response to performance above aspirations (Hypothesis 4) was not supported in our analysis of the total sample, but did receive support in our analysis of the outperformer subsamples (see Table 3). These results were largely consistent with expectations based upon Cyert and March's (1963) behavioral theory of the firm and prior research pointing to rigidity or conservatism as firms approach bankruptcy (Staw et al., 1981; March and Shapira, 1992).

Motivated by prior research on situated attention (Ocasio, 1997) and shifting focus of attention (March and Shapira, 1987, 1992), we investigated whether the variables relevant to explaining R&D search intensity varied for firms in different circumstances. Our theoretical arguments were based on a proposed framework of three reference points and four situations. In theory, firms may be (1) performing below aspirations and focused on survival, (2) performing below aspirations and focused on aspirations, (3) performing above aspirations and focused on aspirations, or (4) performing above aspirations and focused on slack. March and Shapira (1992) proposed the first three categories, but not the fourth.

Our empirical results in Table 3 showed that the variables influencing R&D search differ across subsamples based on proximity to bankruptcy, performance relative to aspirations, and slack. Proximity to bankruptcy is relevant to R&D search intensity for underperforming firms close to bankruptcy but irrelevant for underperforming firms that are not threatened by bankruptcy. Slack is a determinant of search investment decisions for outperforming firms with high accumulated slack, but not for outperforming firms with less slack. By adding the possibility of becoming slack-focused, we presented three reference points, in contrast to prior work considering only aspirations (e.g., Cyert and March, 1963) or aspirations together with bankruptcy (e.g., March and Shapira, 1992). Our results suggest that firms can simultaneously attend to more than one reference point when determining R&D search intensity. Performance relative to aspirations is relevant across all firms, but the importance of distance from bankruptcy and slack differs according to firms’ situations.

This study draws together situational and institutional determinants within a behavioral perspective on organizational search. Prior behavioral research on search has highlighted attainment discrepancy and slack effects, but has neglected institutionalized search. This neglect reflects a breach between researchers following Cyert and March (1963) and those following Nelson and Winter (1982). Our theoretical arguments acknowledge the inertia associated with the routinization and institutionalization of search. Continuity of firm-specific R&D activities over time carries the implication that firms’ dynamic capabilities are tied closely to their past search practices. This path dependency places firms on distinct technological trajectories (Dosi, 1988) resulting in ongoing—but not static—competitive advantages and disadvantages. By bringing in situational considerations, our study informs a core underdeveloped issue in evolutionary theory, namely, the determinants that drive endogenous changes in routines when...
routines act as organizational memory and repositories of organizational capabilities (Becker et al., 2005). Situational determinants—including those that involve shifts in the focus of attention—are significant, but provide modest explanatory power relative to ongoing firm-specific R&D investment patterns.

Our findings alert managers to the importance of the internal institutional environment surrounding R&D. Institutionalized resource allocation patterns and R&D routines can either help organizations absorb useful knowledge and generate new innovations (Cohen and Levinthal, 1990; Fiol, 1996) or they can produce dysfunctional myopia and rigidity (Levinthal and March, 1993). Over time, continuity in resource allocation and search routines contributes to heterogeneity in organizational capabilities and performances (Ahuja and Katila, 2004). Our theoretical arguments point to the importance of framing effects in managers’ willingness to change. Our results suggest that how managers set their aspirations (e.g., relative to past performance or the performances of competitors) and whether they choose to attend to the threat of bankruptcy or slack resources affect the propensity to search. Managers can contribute to the entrenchment of existing routines or to organizational change depending on how they direct organizational attention (Ocasio, 1997). They may even be able to move organizations beyond responding to performance feedback to taking proactive actions based on anticipated contingencies (Gavetti and Levinthal, 2000; Tsoukas and Shepherd, 2004).

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REFERENCES


