EXPLORATION AND EXPLOITATION WITHIN SMES: CONNECTING THE CEO’S COGNITIVE STYLE TO PRODUCT INNOVATION PERFORMANCE

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ABSTRACT

Previous research on exploration and exploitation focuses on the firm and business unit level. Therefore, conceptual and empirically validated understanding about exploration and exploitation at the individual level of analysis is scarce. This paper addresses this gap in the literature by investigating CEO’s innovation preference, delivering contributions to theory and empirical research on exploration and exploitation by developing and testing hypotheses on the relationships between a CEO’s cognitive style, his or her innovation preference, allocation of the firm’s R&D resources and innovation performance based on a sample of 254 SMEs.

Our findings show that CEOs with a more analytical cognitive style tend to prefer exploitation of existing products and markets, whereas CEOs with a more intuitive cognitive style prefer exploration of new products and markets. In line with upper-echelon theory, our data also show that such individual preference for exploration or exploitation significantly influences the allocation of R&D resources within the firm, which in-turn impacts the firm’s incremental and radical innovation performance. From a theoretical perspective, our findings point to the relevance of applying insights from cognitive psychology to better understand the innovation preferences of top managers. At the same time, we contribute to integrating insights from upper-echelon theory in research on new product innovation, illuminating how individual preferences, resource allocation decisions and innovation performance are linked to each other.

INTRODUCTION

Many scholars (e.g. Ancona et al., 2001; Benner and Tushman, 2002; Dougherty, 1992; Eisenhardt and Martin, 2000; Feinberg and Gupta, 2004; Levinthal and March, 1993; March, 1991, 1996, 2006) stress the need for companies to engage in both exploration and exploitation in order to be successful in the long run. Explorative activities can be characterized by terms such as search, variation, risk-taking, experimentation, play, flexibility and discovery (March, 1991). Exploitative activities are associated with aspects such as refinement, choice, production, efficiency, selection, implementation and execution (March, 1991). The question of how organizations manage to combine explorative and exploitative activities receives
much attention in both the academic and managerial communities. Existing research (e.g. Gibson and Birkinshaw, 2004; Tushman and O’Reilly, 1996; Lavie and Rosenkopf, 2006) mainly focuses on combining exploration and exploitation at the organizational level, pointing to structural ambidexterity and contextual ambidexterity as relevant strategies to combine exploration and exploitation. At the same time, although suggested as a promising research direction (e.g. Gupta, 2006: p. 703; Raisch and Birkinshaw, 2008: p. 297), research on exploration and exploitation at the individual level largely remained absent. The recent study of Mom et al. (2009) is a notable exception in this respect, demonstrating that managers can substantially differ in their motivation to individually combine exploration and exploitation. Moreover, they show that individual ambidexterity (i.e. the ability of individuals to simultaneously combine exploration and exploitation) depends on organizational design factors such as manager’s decision-making authority.

Although Mom et al. (2009) provide first valuable insights into exploration and exploitation at the individual level, our study aims to complement this research in two fundamental ways. First, whereas Mom et al. (2009) focus on extrinsic organizational factors that influence individual exploration and exploitation, we rely on insights from cognitive psychology (e.g. Bruner, 1956; Witkin et al., 1962; Miller, 1987; Hayes and Allinson, 1994) to hypothesize a relationship between intrinsic factors (i.e. cognitive style) and a manager’s preference for exploration and/or exploitation. Second, whereas existing research remains silent on the firm performance implications of individual exploration and exploitation, we rely on upper-echelon theory (e.g. Hambrick and Mason, 1984; Hambrick and Finkelstein, 1987) to hypothesize a relationship between top managers’ preference for exploration and/or exploitation and the firm’s product innovation performance.

In order to test our hypotheses, we rely on a unique dataset, containing information on (i) the cognitive style of 250 CEO’s of Small and Medium Sized Businesses (SMES) in the Dutch manufacturing industry as well as (ii) their firms’ product innovation performance. In this study, we focus on SMEs because we expect the link between a CEO’s preference for exploitation and/or exploration and a firm’s innovation performance to be more direct than in larger companies. Conducting structural equation analyses, our findings show that CEO’s with a more analytical cognitive style tend to prefer exploitation of existing products and markets, whereas CEO’s with a more intuitive cognitive style prefer exploration of new products and markets. In line with upper-echelon theory, our data also show that such individual preference for exploration or exploitation significantly influences the allocation of R&D resources within the firm, which in-turn impacts the firm’s incremental and radical innovation performance.

From a theoretical perspective, our findings point to the relevance of applying insights from cognitive psychology to better understand the innovation preferences of top managers. At the same time, we contribute to integrating insights from upper-echelon theory in research on new product innovation, illuminating how individual preferences, resource allocation decisions and innovation performance are linked to each other. From a managerial perspective, our data suggest that, in the context of SMEs, the intrinsic characteristics of the CEO might have strong predictive value for the firm’s innovation performance. These findings might be very valuable for private equity investors, venture capitalists or other actors that plan to financially invest in SMEs.
This paper is structured in five sections. First, we discuss existing research on exploration and exploitation, making an explicit distinction between ambidexterity research on the organizational and individual level. Second, we rely on insights from cognitive psychology and upper-echelon theory to develop our hypotheses. Subsequently, the methodology is discussed. Next, the results of the analyses are presented. Finally, we point to the main theoretical and managerial implications of the findings, discusses the study’s main limitations, and suggest interesting avenues for future research.

THEORETICAL BACKGROUND

Existing research on combining exploration and exploitation

Arguments in favor of the need for both exploration and exploitation are well established and accepted (Ancona et al., 2001; Benner & Tushman, 2002; Dougherty, 1992; Eisenhardt & Martin, 2000; Feinberg & Gupta, 2004; Levinthal & March, 1993; March, 1991, 1996, 2006). Although consensus exists on the need for and benefits of combining exploration and exploitation, there is considerably less agreement on the means by which organizations achieve that combination (Adler et al., 2009). Existing research points to two modi operandi for combining explorative and exploitative activities: structural ambidexterity and contextual ambidexterity.

The literature on structural ambidexterity recognizes the importance of designing organizational forms that provide a strong fit between an organization’s activities and its changing context (Duncan, 1976; Tushman & O’Reilly, 1996; Jansen et al., 2009). Structurally ambidextrous organizations consist of highly differentiated units with targeted structural integration. Each unit exhibits internal consistency in tasks, culture and organizational arrangements, but across units there is inconsistency in the activities being pursued (Tushman & O’Reilly, 1996).

Contextual ambidexterity scholars (e.g. Gibson and Birkinshaw, 2004; Adler et al., 1999; Brunner et al., 2009), however, suggest that organizations can also effectively combine exploration and exploitation by nurturing an appropriate organizational context that combines stretch, discipline, support and trust (Gibson & Birkinshaw, 2004). Gibson and Birkinshaw (2004) define contextual ambidexterity as “the behavioral capacity to simultaneously demonstrate alignment and adaptability across an entire business unit” (p. 209). Rather than creating dual structural arrangements, leaders are expected to create a supportive business-level context. Context refers to the systems, processes and beliefs that shape individual-level behaviors in an organization. This context should be designed to enable and encourage all individuals to judge for themselves how to best divide their time between the conflicting demands for exploration and exploitation (Raisch & Birkinshaw, 2008).

The role of top management in combining exploitation and exploration

Both structural and contextual ambidexterity scholars emphasize the role of top managers in fostering organizational ambidexterity. O’Reilly and Tushman (2004), for instance, conclude that “one of the most important lessons is that ambidextrous organizations need ambidextrous senior teams and managers” (p. 81). In a similar vein, Gibson and Birkinshaw (2004), emphasize the “important role played by senior executives in making an organization context effective and developing ambidexterity” (p. 223). Although these scholars acknowledge the importance of top management for implementing structural or contextual ambidexterity, studies that explore the top
management’s individual preferences for exploitation and exploration are largely absent. A notable exception is the recent study of Mom et al. (2009), studying the exploitation and exploration orientation of individual managers. In particular, they report that a manager’s decision-making authority positively influences his or her individual ambidexterity, which they define as ‘a manager’s behavioral orientation toward combining exploration and exploitation related activities within a certain period of time’ (Mom et al., 2009: p. 812).

Although Mom et al. (2009) provide valuable insights in how extrinsic organizational factors influence the preference of individual managers to focus on exploitation and/or exploration, they remain silent on the impact of intrinsic individual characteristics on managers’ preference to focus on exploration and/or exploitation. However, strong indications are present that cognitive, individual characteristics might influence a tendency toward exploration or exploitation. Organizational learning scholars (Lewin et al., 1999; March, 1991), for example, already suggest that manager’s risk aversion and learning abilities reinforce either exploration or exploitation. In particular, they argue that risk-averse decision makers are likely to prefer exploitation, since the benefits from exploitation are more proximate, certain and immediate.

In this paper, we address this research gap, examining the impact of intrinsic individual characteristics (i.e. cognitive style) on a CEO’s preference for exploitation and/or exploration. In addition, whereas existing research on individual ambidexterity remains silent on the firm performance implications of it, we assess the extent to which the CEO’s individual innovation preferences influence the innovation performance of her firm.

HYPOTHESES
In this section, we develop hypotheses on (i) the impact of a CEO’s cognitive style on her preference for exploitation or exploration, and (ii) the effects of such individual innovation preference on the firm’s R&D investments and innovation performance. Figure 1 provides a graphical illustration of our hypotheses.

The impact of cognitive style on a CEO’s innovation preference
In order to investigate the relationship between a CEO’s individual characteristics and her innovation preference (i.e. individual preference for exploitation and/or exploration), we will focus on a CEO’s information processing strategies; the way he or she acquires, stores and uses knowledge. More specifically, we concentrate on cognitive style, a core concept in cognitive psychology that is defined as ‘the consistent individual differences in preferred ways of organizing and processing information and experience’ (Messick, 1976: p. 5).

Several scholars stress the importance of cognitive style to better understand organizational behavior. Schweiger (1983: 143), for instance, points out: ‘If research indicates [. . .] that particular cognitive styles are more appropriate than others for the conduct of particular managerial activities, then normative recommendations concerning the selection and placement of individuals for these activities may be warranted. In addition, if it is found that cognitive styles are subject to modification, then the development of training programs in the industrial setting, or modifications of current business school curricula in the academic setting, may be critical.’ In line with these arguments, scholars (e.g. Kirton, 1980; McHale and Flegg, 1985; Ash, 1986; Mitchell, 2004; Armstrong and Hird, 2009) study the relevance and consequences of cognitive style in contexts such as team composition, training and
development. In these studies, cognitive style is operationalized in terms of Wilson’s (1988) cognitive style classification, which relies on Ornstein’s (1977) brain hemispherical research to identify different cognitive functions and associate them with the right and left hemispheres in the human brain.

Individuals that have a cognitive style associated with left-brain functions prefer to converge information. The term often used to describe left-brain thinking is “analysis” (e.g., Agor, 1986; Hammond et al., 1986; Allinson and Hayes, 1996). Analysis refers to judgment based on mental reasoning and a focus on detail. Analysts (left-brain dominant) tend to be more compliant, favor a structured approach to problem solving, depend on systematic methods of investigation, recall verbal material most readily and are especially comfortable with ideas requiring step by step analysis (Allinson and Hayes, 1996).

Individuals that have a cognitive style associated with right-brain functions prefer to diverge information. The term often used to describe right-brain thinking is “intuition” (e.g., Agor, 1986; Hammond et al., 1986; Allinson and Hayes, 1996). Intuition refers to immediate judgment based on feeling and the adoption of a global perspective. Intuitivists (right-brain dominant) tend to be relatively nonconformist, prefer an open-ended approach to problem solving, rely on random methods of exploration, remember spatial images most easily, and work best with ideas requiring overall assessment (Allinson and Hayes, 1996).

We expect that the cognitive style might strongly impact its preference for exploration or exploitation. Exploration is rooted in variance-increasing activities and creates futures that may be quite different from the organization's past (Smith and Tushman, 2005). It is associated with experimentation, improvisation, and creativity (Flynn and Chatman 2001, Rivkin and Siggelkow 2003, Van de Ven et al. 1999). For these activities, diverging information is essential (Allinson and Hayes, 1996), suggesting the importance of right-brain functions. We therefore expect that individuals, who have an intuitive cognitive style are likely to prefer explorative activities above exploitative activities.

Exploitation is rooted in variance-decreasing activities and builds on an organization's past (Smith and Tushman, 2005). It is associated with efficiency, focus, and standardization (Flynn and Chatman 2001, Rivkin and Siggelkow 2003, Van de Ven et al. 1999). Hence, for these activities, converging information and left-brain functions are essential (Allinson and Hayes, 1996). We therefore expect that individuals with an analytic cognitive style are likely to prefer exploitative activities to explorative activities.

H1: The more a CEO has an analytic (intuitive) cognitive style, the more he or she prefers exploitative (explorative) activities

The impact of a CEO’s innovation preference on firm performance

In the field of strategy, explanations of organizational behavior is traditionally viewed as flows of information and decisions, detached from the people involved (Aguilar, 1967; Allen, 1979; Bourgeois, 1980; Mintzberg, Raisinghani, & Theoret, 1976). In contrast, Upper Echelon theory (Hambrick and Mason, 1984) states that organizational outcomes such as strategic choices and performance levels are partially predicted by managerial background characteristics. From this perspective, organizational outcomes are viewed as reflections of the values and cognitive bases of powerful actors in the organization (ADD Reference).
If strategic choices have a large behavioral component, they are likely to reflect the idiosyncrasies of decision makers. March and Simon (1958), for instance, already argued that each decision maker brings his or her own set of cognitive base to an administrative situation, reflected by knowledge or assumptions about future events, knowledge of alternatives, and knowledge of consequences attached to alternatives. They also reflect his or her values: principles for ordering consequences or alternatives according to preference. These are in place at the same time the decision maker is being exposed to an ongoing stream of potential stimuli both within and outside the organization. The decision maker brings a cognitive base and values to a decision, which create a screen between the situation and his / her eventual perception of it (Hambrick and Mason, 1984).

Following the Upper Echelon Theory arguments that strategic choices in companies are partially explained by managers’ cognitive base and values, we expect that the CEO’s innovation preference has a significant impact on strategic decision making. Specifically, we hypothesize that the CEO’s preference for exploration or exploitation significantly influences how the firm allocates R&D resources to explorative and exploitative activities.

H2: The stronger the CEO’s innovation preference for exploitation (exploration), the higher the percentage of R&D resources that are allocated to exploitative (explorative) activities within the firm.

It is increasingly recognized that product innovation performance is a multi-dimensional phenomenon, encompassing both the improvement of existing products (incremental innovation performance) as well as the generation of new products (radical innovation performance). Moreover, evidence is provided that, whereas incremental innovation requires exploitative activities, radical innovation benefits from explorative activities. Therefore, we expect that the allocation of R&D resources across exploitative and explorative activities substantially influences a firm’s incremental and radical innovation performance:

H3a: Higher allocation of R&D resources to exploitative activities increases a firm’s incremental product innovation performance

H3b: Higher allocation of R&D resources to exploitative activities decreases a firm’s radical product innovation performance

METHODOLOGY

Sample
In order to test our hypotheses, we rely on a sample of Dutch SME companies. To select firms, we started from the Nedsoft database, which contains company information on 703432 Dutch companies. As this study focuses on product innovation in SME companies, we excluded all non-manufacturing companies and all companies with more than 250 employees. We also removed all companies of which no contact information was available. We sent a questionnaire to the 2523 remaining companies and a reminder a week after. In the end, we managed to collect 254 valid responses, representing a 10.1% response rate.
Measures

cognitive style
To measure a manager’s cognitive style, we adopted the Cognitive Style Index (CSI) from Allinson and Hayes (1996). It is the most widely used measure for cognitive style in management science and it uses the terms “analysis” and “intuition” to describe left-brain and right-brain thinking respectively. The CSI measures cognitive style on a bipolar analytic - intuitive dimension and contains 38 items (true; uncertain; false). Some examples of these items are:

“Formal plans are more of a hindrance than a help in my work”
“I am most effective when my work involves a clear sequence of tasks to be performed”
“My approach to solving a problem is to focus on one part at a time”
“I am inclined to scan through reports rather than read them in detail”

The CSI score is calculated by the sum of all 38 item scores (true = 2, neutral = 1, false = 0), of which some are reverse coded. The higher the CSI score, the more analytical the cognitive style of the respondent. A low CSI score, on the other hand, refers to the presence of an intuitive cognitive style.

To test the internal structure of the CSI, Allison and Hayes used a factor analysis. Since the inter-item correlations of the tool tend to be low with little variance the authors used a factor analysis of parcels of 6 items. Following the same methodology as Allison and Hayes, we grouped the different items in the same parcels to test if the CSI has a uni-factorial structure. By conducting an exploratory factor analysis (principal components method) we produced a single factor solution. According to Kline (1994, p. 95) our sample is large enough for confirmatory maximum likelihood factor analysis, which is shown in appendix 1. The chi-square value indicates that the hypothesized single factor solution is confirmed and that this accounts for over half the variance. The CSI scores as composed by our data show a sample mean score of 37.86 (see table 2). To check for reliability, we computed the Cronbach’s alpha (0.77), which is satisfactory.

CEO’s innovation preference
Following He and Wong (2004) and Mom et al. (2009), we conceptualize exploration and exploitation activities as two separate dimension of innovation activities, rather than as two ends of a continuum. In order to measure exploration and exploitation on the individual level, we adopted a scale from Mom et al. (2009). This scale is based on the features by which March (1991) characterized exploration and exploitation, and uses seven items to measure a manager’s preference for explorative activities, and seven items measuring a manager’s preference for exploration activities. All items are measured on a five-point Likert scale ranging from “a very small extent” to “a very large extent” of engagement in explorative and exploitative activities. We checked the reliability of the scale by computing Cronbach’s alpha (0.79 for exploration and 0.83 for exploitation). We also checked for discriminant validity by conducting confirmatory factor analysis (see appendix 2).

By combining the scales for exploration and exploitation, we create a measure for a CEO’s preference for exploration and/or exploitation. We subtracted the mean score of the seven exploration items from the mean score of the seven exploitation items. In this way, a CEO that has a tendency toward exploration will
have a negative score (min. -5) and a CEO that has a tendency toward exploitation will have a positive score (max. 5) on the Individual Innovation Preference variable. An ambidextrous CEO that equally prefers exploration and exploitation will have a neutral score (0).

**R&D resource allocation**

We measured a firm’s R&D resource allocation by asking the respondents how in the past three years their R&D resources were allocated across (i) exploitative innovation activities, which were defined as projects focused on R&D activities such as fundamental research, experiments and building of prototypes, and (ii) explorative innovation activities, which were defined as projects focused on R&D activities such as standardization, optimization, fine-tuning and up-scaling. Based on this information, we constructed the variable R&D Resource Allocation representing the percentage of R&D resources invested in exploitative activities. Variable scores can range from 0 (no R&D resources allocated to exploitation) to 100 (all R&D resources allocated to exploitation).

**radical and incremental product innovation performance**

Following previous research (Faems et al. 2005; de Visser et al., 2010; Neyens et al., 2011) we used the composition of turnover in 2009 in order to make a distinction between incremental and radical product innovation performance. The proportion of turnover in 2009 attributed to new products that were introduced during the last three years is regarded as an indicator of radical product innovation performance. Likewise, the percentage of turnover in 2009 attributed to improved products that were introduced during the last three years is seen as an indicator of incremental product innovation performance. In order to obtain a normal distribution, our analyses include the logarithm of 1+ the proportion of turnover attributed to (1) new products and (2) improved products.

**control variables**

The period of time a CEO is tenured in the firm might impact a CEO’s orientation toward exploration and exploitation since he or she is more experienced (Tushman and O’Reilly, 1996). Hence we included a variable measuring how long respondents have been working in the company to control for this effect. The degree to which a manager engages in risk-taking activities is also influenced by the manager’s age (Vroom and Pahl, 1971). Older managers are less likely to engage in risky activities than younger managers. As exploration is associated with risk-taking activities (March, 1996), we included a variable to control for age effects on a CEO’s innovation preference. Education is related to the cognitive ability of individuals to process information and may therefore be related to a manager’s ambidexterity (Papadakis, 1998). We therefore controlled for educational effects on a CEO’s innovation preference by including a dummy variable measuring whether the respondent has a master’s degree or not.

In the innovation literature considerable attention is devoted to the relationship between innovation performance and environmental dynamics (e.g. Jansen et al., 2005; Sorensen and Stuart, 2000; Levinthal and Posen, 2009). Firms that operate in a dynamic environment, tend to be more innovative than firms that operate in a stable environment (Hannan and Freeman, 1984). We therefore adopted a four-item scale from Jansen et al. (2006) to control for environmental factors that might influence breakthrough and incremental innovation performance. To check for reliability, we...
computed the Cronbach’s alpha (0.83), which is satisfactory. Second, we expect that R&D intensity has an impact on innovation performance (Singh, 1986). Hence we included a variable measuring the R&D investments / sales ratio to control for this effect. Finally, because of potential industry differences in terms of product innovation performance, the study controlled for them by introducing industry dummies. A distinction was made among 7 industries. The “other” sector was used as the reference category in the study’s analyses. Table 1 provides an overview of the frequencies of the different industries.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textile</td>
<td>8</td>
<td>6.6</td>
</tr>
<tr>
<td>Wood</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>Construction</td>
<td>8</td>
<td>6.6</td>
</tr>
<tr>
<td>Plastic</td>
<td>11</td>
<td>9.0</td>
</tr>
<tr>
<td>Metal</td>
<td>49</td>
<td>40.2</td>
</tr>
<tr>
<td>Software</td>
<td>14</td>
<td>11.5</td>
</tr>
<tr>
<td>Other</td>
<td>29</td>
<td>23.8</td>
</tr>
</tbody>
</table>

Table I: industry frequencies and percentages

RESULTS

Descriptive statistics

Table 2 gives an overview of the most important descriptive statistics. The means for the variables radical innovation performance and incremental product innovation performance are 0.22 and 0.26. Taking into account that this study uses logarithmic transformation for these variables, the implication is that, on average, respondents attributed 26.35% to their sales to new products and 30.61% to improved products. This also implies, that on average 43.03% of their sales was attributed to products that were introduced before 2007 and have not been improved since then.

To test the hypotheses, structural equation modeling (SEM) with manifest variables is used. Compared with ordinary linear regression models, this technique has two advantages (Sels et al., 2006). First, the method enables hypothesized relationships between variables to be defined and tested. The output indicates whether the model is supported by the data as a whole and gives a significance test for the various individual relationships. Second, a variable in a SEM model can be either dependent or independent. This allows for testing the indirect influence, if any, of certain variables.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Min/max</th>
<th>S</th>
<th>LN (Incremental Innovation)</th>
<th>LN (Radical Innovation Performance)</th>
<th>Allocation of R&amp;D Resources (% Exploitation)</th>
<th>CEO’s Innovation Preference (Exploitation – minus Exploration)</th>
<th>Cognitive Style Index</th>
<th>R&amp;D Investments % of Sales</th>
<th>Market Dynamics</th>
<th>CEO’s Age</th>
<th>CEO’s Period of Tenure in the Firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN (Incremental Innovation Performance)</td>
<td>.2584</td>
<td>.00/.59</td>
<td>.13120</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LN (Radical Innovation Performance)</td>
<td>.2232</td>
<td>.00/.69</td>
<td>.14368</td>
<td>-.099</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allocation of R&amp;D Resources (% Exploitation)</td>
<td>53.20</td>
<td>0/100</td>
<td>26.861</td>
<td>.176</td>
<td>-.299**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| CEO’s Innovation Preference (Exploitation  
(minus) Exploration)                        | -.1780 | -2.57/2.00 | .98997 | -.161                       | -.216*                               | .206*                                       | 1                                           |                       |                             |                  |          |                                  |
| Cognitive Style Index                       | 37.86  | 13/63   | 10.680  | -.007                       | -.051                                | -.055                                       | .214*                                       | 1                     |                             |                  |          |                                  |
| R&D Investments % of Sales                  | 2.87   | 1/4     | .872    | .192*                       | .379**                               | -.137                                       | -.193*                                      | -.025                 | 1                                           |                  |          |                                  |
| Market Dynamics                             | 3.55   | 2/5     | .788    | .073                        | .245**                               | -.057                                       | -.248**                                     | -.141                 | .338**                                   | 1                 |          |                                  |
| CEO’s Age                                   | 49.14  | 29/66   | 9.217   | -.030                       | -.016                                | -.005                                       | .002                                       | .199                  | .082                                    | .037             | 1        |                                  |
| CEO’s Period of Tenure in the Firm          | 16.23  | 1/40    | 8.915   | -.078                       | -.111                                | -.082                                       | .151                                       | .151                  | -.040                                   | -.042            | .441**   | 1                                |
* correlation is significant at the 0.05 level (two-tailed)

** correlation is significant at the 0.01 level (two-tailed)

Table II: descriptive statistics and correlations

The goodness-of-fit overview (Table 3) indicates that our initial theoretical model is not adequately supported by the data. To optimize the model, we added the variables Market Dynamics, Industry, and R&D Intensity to control for their effects on CEO’s Innovation Preference and Allocation of R&D Resources. These relationships can be accounted for theoretically and enriches our understanding of the relationships we hypothesized. The Goodness-of-fit measures (Table 3) indicate that the optimized model is effectively supported by the data. Below, we first discuss the effect of Cognitive Style on a CEO’s Innovation Preference. Subsequently, the effect of a CEO’s Innovation Preference on a Firm’s Allocation of R&D Resources and effects of a Firm’s Allocation of R&D Resources on Radical and Incremental Product Innovation Performance are evaluated. The standardized path coefficients are listed in Table 4. The results of the test of the optimized model are also represented in Figure 2.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Theoretical Model</th>
<th>Optimized Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentler’s Comparative Fit Index</td>
<td>0.9302</td>
<td>0.9687</td>
</tr>
<tr>
<td>Bentler and Bonett’s Normed Fit Index</td>
<td>0.8519</td>
<td>0.9298</td>
</tr>
<tr>
<td>Chi-Square Test (p-Value)</td>
<td>0.0771</td>
<td>0.1607</td>
</tr>
</tbody>
</table>

Table III: goodness-of-fit measures

* p<.05; ** p<.01

Figure 2: results of optimized model
In line with our first hypothesis, we observe a positive relationship between the Cognitive Style Index score and a CEO’s Innovation Preference. This result confirms that a more analytical cognitive style increases the CEO’s preference for exploitation, whereas a more intuitive cognitive style increases the CEO’s preference for exploration. Our data also show a positive relationship between a CEO’s Innovation Preference and a firm’s Allocation of R&D Resources. Based on how these variables our measured, this result implies that, when the CEO has a stronger preference for exploitation, the share of R&D resources that are spent on exploitative activities will be larger. In contrast, a stronger CEO preference for exploration will trigger an increase in the allocation of R&D resources to explorative activities. These results confirm that, within SMEs, the individual preference of CEO has a strong impact on firm-level allocation decisions.

As stated in H3 and H4, firms that allocate more R&D Resources to exploitative activities were expected to perform higher in terms of Incremental Innovation Performance, and lower in terms of Radical Innovation Performance. These hypotheses are supported by our data as Allocation of R&D Resources (% Exploitation) has a significant (p<.05) positive direct effect on Incremental Innovation Performance, and a significant (p<.01) negative effect on Radical Innovation Performance.

Regarding our control variables, we observed a significant (p<.05) negative impact of Market Dynamics on CEO’s Innovation Preference; in more dynamic markets, CEOs tend to have stronger preference for explorative activities. Further, a significant (p<.05) positive relationship between R&D intensity and Radical Innovation Performance was found; companies that invest more in R&D show higher Radical Innovation Performance. The data also point to a number of industry effects. Compared to other industries, companies in the Textile Industry perform significantly better.
lower in terms of Incremental (p<.05) and Radical (p<.10) Innovation Performance. Finally, CEOs in the Software industry demonstrate a significantly (p<.10) lower Preference for exploitation compared to other industries. The total effects of Cognitive Style Index on Radical and Incremental Innovation Performance are -0.00899 and 0.0072, respectively. These findings suggest that a more analytic Cognitive Style of the CEO, results in lower Radical Innovation Performance and higher Incremental Innovation Performance of the firm.

**DISCUSSION AND CONCLUSION**

In this section, we first discuss the theoretical implications of our study. In particular, 1) the relevance of cognitive psychology to better understand innovation preference and 2) the relevance of upper-echelon theory to better understand link between individual preferences and innovation performance. Subsequently, we point to the main managerial implications. Finally, we discuss the main limitations of this study and suggest interesting avenues for future research.

**Implications for CEO’s innovation preference**

Whereas the current literature on exploration and exploitation mainly focuses on factors on the business unit and firm level, scholars have begun to investigate individual characteristics to explain differences in orientation toward explorative and exploitative activities. Recently, Mom et al. (2009) identified extrinsic factors that impact a manager’s tendency toward exploration and exploitation (e.g. formal structural mechanisms and personal coordination mechanisms). With this study, we complement these with insights into an intrinsic factor that plays a significant role in explaining an individual’s Innovation Preference: cognitive style.

Our data support our theses that CEOs that have a cognitive style associated with left-brain functions prefer to converge information and therefore prefer exploitative to explorative activities, whereas CEOs that have a cognitive style associated with right-brain functions prefer to diverge information and therefore prefer explorative to exploitative activities. These findings point to the relevance of applying insights from cognitive psychology to better understand the innovation preferences of top managers.

**Innovation performance implications of CEO’s innovation preference**

We contribute to integrating insights from upper-echelon theory in research on new product innovation. Our findings illuminate how individual preferences, resource allocation decisions and innovation performance are linked to each other. Our study supports the view that strategic decision-making is influenced by the cognitive base of a top manager. Previous studies (e.g. Raisch and Birkinshaw, 2008; Virany, 1992; He and Wong 2004) pointed to the important role of senior managers in an organization’s deciding between investing in exploration and exploitation. Upper Echelon studies already suggested several factors that impact the strategic direction and performance levels of a firm, such as age, functional tracks, other career experiences, education, socioeconomic roots and financial position (Hambrick and Mason, 1984). Our findings show how individual preferences for explorative and exploitative activities add to these factors, how they influence strategic decision-making on allocating resources to exploration and exploitation and firm performance.
Managerial implications

From a managerial perspective, these findings have important implications for organizations that seek a new CEO. Particularly in cases where it is the goal to alter or sustain the company’s current innovation strategy, a candidate’s Cognitive Style and Innovation Preference might be worth assessing. In the context of mergers, acquisitions, venture capital and hedge funds, for example, our findings might have implications. Venture capitalists that consider investing in a company might want to assess the CEO’s Cognitive Style and Innovation Preference in order to find out whether his or her style and preference matches the strategic innovation route they look out to.

In organizations that pursue a Defender (Miles and Snow, 1978) type of strategy, that invests a great deal of resources in solving the problem of how to produce and distribute goods or services as efficiently as possible, a more analytic CEO might better fit the strategic direction than a rather intuitive individual. His or her convergent thinking is better suited for exploiting existing concepts in the most efficient way. Conversely, in an organization that pursues a Prospector type of strategy, whose prime capability is that of finding and exploring new product and market opportunities (Miles and Snow, 1978), an intuitive CEO might better fit than an analytic type. His or her divergent thinking may fit better with maintaining a reputation as an innovator in product and market development than the convergent thinking focus of an analytic type of CEO.

Limitations and future research

In this study we conceptualize exploration and exploitation activities as two separate dimension of innovation activities, rather than as two ends of a continuum (cf. He and Wong, 2004; Mom et al., 2009). Hence we operationalized these concepts as orthogonal variables, assuming that a CEO’s explorative and exploitative activities are not mutually exclusive. However, it can be argued that on an individual level, exploration and exploitation compete for a limited amount of an individual’s working time, and should therefore be viewed as two ends of a continuum (Gupta et al., 2006). Such a trade-off relationship between a CEO’s explorative and exploitative activities were not incorporated in our measures, representing an interesting avenue for future research. Second, the measure of cognitive style we adopted from Allinson and Hayes is gender-sensitive. We, however, did not take this into account in our study. We therefore suggest future studies to incorporate the impact of gender on the relationship between cognitive style and innovation preference. Third, we did not include financial measures in our analyses. We encourage future studies to investigate financial firm performance effects of firm innovation performance.

Finally, a limitation of our study concerns generizability. It is an interesting empirical question as to whether our findings generalize to larger firms. Compared to SMEs, innovation outcomes at larger firms are often influenced by a broader set of factors beside the CEO’s innovation preference, such more complex organizational systems, which make strategic decision-making less straight forward. In addition, the influence of CEO at larger firms may be affected by external governance pressures from an independent board of directors and shareholders. We suspect, that the statistical relationships between a CEO’s Cognitive Style, CEO’s Innovation Preference, Allocation of R&D Resources and Innovation Performance may not be as strong as what we found with our sample of SMEs (cf. Mom et al., 2009).
REFERENCES


Duncan, R. (1976). The ambidextrous organization: Designing dual structures for


innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. Management Science, 52(11), 1661-1674.


APPENDIX

<table>
<thead>
<tr>
<th>Parcel</th>
<th>Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.98</td>
</tr>
<tr>
<td>2</td>
<td>0.65</td>
</tr>
<tr>
<td>3</td>
<td>0.67</td>
</tr>
<tr>
<td>4</td>
<td>0.60</td>
</tr>
<tr>
<td>5</td>
<td>0.51</td>
</tr>
<tr>
<td>6</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Eigenvalue: 3.09
Variance explained: 51.43
Chi-square (df=9): 4.53
Significance: 0.87

Appendix 1: factor analysis of cognitive style index item parcels

<table>
<thead>
<tr>
<th>To what extent did you, last year, engage in work related activities that can be characterized as follows:</th>
<th>Factors 1</th>
<th>Factors 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A manager's exploration activities (Chronbach's alpha: 0.79)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Searching for new possibilities with respect to products/services, processes, or markets</td>
<td>-0.31</td>
<td>0.64</td>
</tr>
<tr>
<td>Evaluating diverse options with respect to products/services, processes, or markets</td>
<td>-0.27</td>
<td>0.68</td>
</tr>
<tr>
<td>Focusing on strong renewal of products/services or processes</td>
<td>-0.25</td>
<td>0.65</td>
</tr>
<tr>
<td>Activities of which the associated yields or costs are currently unclear</td>
<td>0.04</td>
<td>0.65</td>
</tr>
<tr>
<td>Activities requiring quite some adaptability of you</td>
<td>0.12</td>
<td>0.62</td>
</tr>
<tr>
<td>Activities requiring you to learn new skills or knowledge</td>
<td>-0.02</td>
<td>0.71</td>
</tr>
<tr>
<td>Activities that are not (yet) clearly existing company policy</td>
<td>-0.16</td>
<td>0.61</td>
</tr>
<tr>
<td><strong>A manager's exploitation activities (Chronbach's alpha: 0.83)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities of which a lot of experience has been accumulated by yourself</td>
<td>0.72</td>
<td>-0.05</td>
</tr>
<tr>
<td>Activities which you carry out as if it were routine</td>
<td>0.75</td>
<td>-0.19</td>
</tr>
<tr>
<td>Activities which serve existing (internal) customers with existing services/products</td>
<td>0.61</td>
<td>-0.16</td>
</tr>
<tr>
<td>Activities of which it is clear to you how to conduct them</td>
<td>0.80</td>
<td>-0.14</td>
</tr>
<tr>
<td>Activities primarily focused on achieving short-term goals</td>
<td>0.46</td>
<td>-0.09</td>
</tr>
<tr>
<td>Activities which you can properly conduct by using your present knowledge</td>
<td>0.81</td>
<td>-0.05</td>
</tr>
<tr>
<td>Activities which clearly fit into existing company policy</td>
<td>0.70</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Extraction method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Explained Variance: 49%

Appendix 2: factor analysis for CEO’s innovation preference