Strategic Temporal Transitions: Performance Implications of Exploration and Exploitation Transition

Jinxin Yang
Hong Kong Metropolitan University

Mengge Li
The University of Texas at El Paso

Chuntung Thomas Kiu
Hong Kong Metropolitan University

Prior research presents mixed findings on the impact of temporal shifting between exploration and exploitation on organizational performance. Our study seeks to further clarify these effects and explore the moderating role of environmental scarcity. By analyzing 1,247 firm-year observations from publicly traded U.S. high-tech firms (2009–2014), we find that temporal transitioning from exploitation to exploration negatively affects firm performance, whereas time shifting from exploration to exploitation has a positive impact. Moreover, environmental scarcity intensifies the negative performance consequences of moving from exploitation to exploration. Our findings contribute to the literature on organizational ambidexterity and learning.

Keywords: temporal transitions, exploration transition, exploitation transition, firm performance

INTRODUCTION

There is a continued ongoing debate over how firms can effectively balance and alternate between exploration and exploitation as well as how such changes impact performance. One approach that has received considerable attention in the literature is temporal transition (Gupta, Smith, and Shalley, 2006; Raisch & Birkinshaw, 2008; Raisch & Tushman, 2016; Tushman & O'Reilly, 1996; Zimmermann, Raisch, and Birkinshaw, 2015), which suggests that firms must adjust their levels of exploration and exploitation over time (Brown & Eisenhardt, 1997; Nickerson & Zenger, 2002). Recent studies have produced mixed results on the impact of temporal transition on firm performance (Burgelman, 2002; Gupta et al., 2006; Kang & Kim, 2020; Mudambi & Swift, 2014; Romanelli & Tushman, 1994; Swift, 2016). Competitive advantage scholars who argue for positive performance implications insist that high-performing firms can simultaneously pursue exploration and exploitation by focusing on divergent objectives at different times (Cyert & March, 1963; Kang & Kim, 2020; Levinthal & March, 1993), while organizational inertia scholars hold a negative view that firms face significant challenges when rotating between conflicting organizational routines and abilities for exploration and exploitation (Kang & Kim, 2020; Lee & Puranam, 2016; Posen & Levinthal, 2012).

Although the literature on temporal transitions between exploration and exploitation has provided valuable insights into how firms engage in organizational ambidexterity, we argue that it may be overly simplistic and biased to consider strategic transitions between exploration and exploitation as a whole unit of analysis. Instead, it is necessary to analyze them separately, given the inherent intricacy involved in the temporal transition from exploration to exploitation (hereafter referred to as exploitation transition) and the temporal transition from exploitation to exploration (hereafter referred to as exploration transition). In this study, we aim to extend current research by further examining the dynamism of performance implications of exploration and exploitation transition in a decoupling way. In addition, we also explore the moderating effect of environment scarcity on the corresponding performance implications of exploration and exploitation transition.

By integrating insights from the organizational learning and ambidexterity literature, we argue that while the exploration transition has a negative effect on firm performance, the exploitation transition has a positive effect on firm performance. Besides, we also contend the moderating effect of environment scarcity on the performance implications of such temporal transitions. Using a final sample data consisting of 1,247 firm-year observations of the U.S. publicly traded firms in the high tech sector from 2009 to 2014, we empirically tested our hypotheses and our findings basically support out predictions, revealing the difference in performance implications between the exploration and exploitation transition. Furthermore, we also find that environmental scarcity weakens the positive relationship between exploitation transition and firm performance.

Our study contributes to the literature on organization ambidexterity and organizational learning. First and foremost, we add to the organization ambidexterity research by enhancing the understanding of the complex and paradoxical nature of the performance implications of exploration and exploitation transitions. Previous research has attempted to illustrate the conflicting performance implications in a whole unit of analysis of temporal transitions between exploration and exploitation. However, taking a holistic perspective to explain temporal transitions could be oversimplistic and biased. By conducting a decoupling analysis of the exploration and exploitation transitions, we can effectively distinguish the inherent complexity between them and gain a deeper understanding of their distinct impacts on firm performance. Our findings reveal that the exploitation transition positively affects firm performance, whereas the exploration transition has a negative effect.

Furthermore, our study contributes to the organizational learning literature by emphasizing the necessity to differentiate exploration and exploitation transition due to their intrinsic intricacy based on organizational learning. The exploration transition involves complex learning tasks and characteristics, an extended learning period, and a high level of learning difficulty. On the other hand, the exploitation transition is characterized by relatively simpler tasks and characteristics, a shorter learning period, and lower difficulty in organizational learning. It is such two types of temporal transitions that encompass the differences in intrinsic organizational learning characteristics that determine their distinctiveness in the ultimate performance implications. The divergent characteristics of organizational learning associated with exploration and exploitation transition provide some addition to the relevant literature.

Third, we also enhance the understanding of the interplay between environmental scarcity and temporal transition performance implications. We argue that temporal transitions are not only directional but also context dependent. Specifically, the exploration transitions become particularly challenging for firms when they interact with environmental scarcity. This interaction hinders the firm's ability to achieve a smooth process of adaptation and ultimately affects its performance negatively. On the other hand, exploitation transitions can also be affected by environmental scarcity. This interaction may lead to organizational dysfunction that ultimately results in a decline in firm performance.

LITERATURE REVIEW

Organization Ambidexterity Between Exploration and Exploitation

A debate has been ongoing regarding the effective management of the organizational ambidexterity issue. Two widely-discussed approaches in the literature are balancing and temporal transitions (Gupta,

Smith, &Shalley, 2006; Raisch & Birkinshaw, 2008; Raisch & Tushman, 2016; Tushman & O'Reilly, 1996; Zimmermann, Raisch, and Birkinshaw, 2015). The balancing approach proposes that firms perform exploration and exploitation simultaneously (Gupta et al., 2006; Raisch, Birkinshaw, Probst, and Tushman, 2009). Competitive firms are able to strike the organizational balance in ambidexterity structurally, behaviorally, contextually (Stadler, Rajwani, and Karaba, 2014) and dually (Li et al., 2023). For example, strategic business units (Gupta et al., 2006; Lavie, Stettner, and Tushman, 2010; Simsek, 2009), external partners (Hill & Birkinshaw, 2008; Lavie & Rosenkopf, 2006; Rothaermel & Deeds, 2004), and top management coordination (Andriopoulos & Lewis, 2009; Mom, Van Den Bosch, and Volberta. 2007, 2009; Smith & Tushman, 2005) can be taken by high-performing organizations to allocate resources in a consistent way to create conditions under which balance can be viable for effective long-term survival (Stadler et al., 2014). While the temporal transition approach indicates that firms alter exploration and exploitation as necessary over time (Brown & Eisenhardt, 1997; Nickerson & Zenger, 2002). Resource constraints as the primary concern for firms to achieve the ambidextrous goal results in a trade-off situation instead. Firms face a choice of exploratory or exploitative activities to invest in. If they decide to invest heavily in exploitation, they have fewer resources available for exploration and vice versa. Advocates for a temporal transition solution hold the notion, therefore, that firms can direct more resources towards exploitation when they need to commercialize in the short term while redirecting more resources towards exploration when they need to promote technological advantages; this discretionary behavior of temporal transition between exploration and exploitation may dramatically alleviate the trade-off situation. In fact, some empirical studies have provided relevant evidence that parallels with the temporal transition claim (Kang & Kim, 2020; Mudambi & Swift, 2014; Swift, 2016). For example, Swift (2016) found that firms on average can benefit from executing the sequential transitioning strategy between exploration and exploitation.

Conflicting Performance Implications of Temporal Transitions between Exploration and Exploitation

Temporal transition suggests that firms become organizationally ambidextrous by alternating between exploration and exploitation (Brown & Eisenhardt, 1997; Kang, Kang, and Kim, 2017; Kang & Kim, 2020; Lavie & Rosenkopf, 2006; Rothaermel & Deeds, 2004). The literature indicates that firm performance is subject to the sequential shifts between exploration and exploitation taken by firms. One group of scholars support that performance benefits from practicing the temporal transitions (Gupta et al., 2006; Mudambi & Swift, 2014; Swift, 2016). The perspective articulates maintaining the appropriate balance between exploration and exploitation increases the firm's adaptability (March, 1991) and firms deal more effectively with dynamic ambidexterity by defending current advantages through exploitation as well as offering new advantages through exploration (Mudambi & Swift, 2014; Swift, 2016). In contrast, the other group of scholars defines that performance is retarded by executing the temporal transitions (Kang & Kim, 2020). This perspective conceptualizes a temporal transition as punctuated leaps between exclusive periods of exploration and exploitation (Burgelman, 2002; Romanelli & Tushman, 1994). Facing an august challenge of shifting between dramatically contrary and conflicting routines and abilities, firms must pay undivided attention to either exploration or exploitation during one particular time frame (Kang & Kim, 2020), thereby leading to performance deterioration due to systematical friction cost and path dependence problem.

The two perspectives of performance implications of temporal transitions result from varying organization theory literature. Positive performance implication of a temporal transition is rooted in organizational ambidexterity theory (Cybert & March, 1963; Tushman & O'Reilly, 1996). Cybert and March (1963) argue that effective organizations are capable of resolving conflicting tasks by clinging to diverging objectives at different times. Firms have ability to simultaneously pursue exploration and exploitation, even as firms are prone to the pursue of exploration during relatively dynamic periods while switching to the pursue of exploitation during the relatively stable times (Levinthal & March, 1993). To achieve a dynamic balance between exploration and exploitation over time, firms ambidextrously switch their focus over a period involves a bunch of significant and compact transitions between differentiated combinations of exploration and exploitation (Kang & Kim, 2020). Put differently, firms could essentially

engage in exploration and exploitation simultaneously even as they dynamically remain in adaptation between exploration and exploitation. The idea of positive performance of a temporal transition implies firms deal more effectively with ambidexterity by defending current advantages through exploitation as well as shaping new advantages through exploration (Mudambi & Swift, 2014; Swift, 2016), because they are efficient in as well as good at leaping between exploration and exploitation and tend to outperform other peers that are less efficient (Anderson & Tushman, 2001).

Negative performance implication originates from punctuated equilibrium theory (Burgelman, 2002; Romanelli & Tushman, 1994), where firms are supposed to approximate stable periods of exploitation intertwined with sparse episodes of exploration (Kang & Kim, 2020). Firms allocate resources and attention to exploration and exploitation in a sequential fashion (Brown & Eisenhardt, 1997) by implementing discrete policies with inconsistent benefits in each period (Lee & Puranam, 2016; Posen & Levinthal, 2012). Firms are immensely challenged by rotating between contrary and conflicting routines and abilities for exploration vs. exploitation (Kang & Kim, 2020). In result, catering to the necessity of changing between exploration and exploitation, constant mutual switches of routines and capabilities in demand for exploration vs. exploitation are likely to increase systematic friction cost and decrease organizational efficiency, in turn impeding firm survival and development (Eisenhardt & Martin, 2000; Nelson & Winter, 1982; Rivkin, 2000; Teece, Pisano, and Shuen, 1997; Winter, 2003). Path dependence (Lavie & Rosenkopf, 2006), in addition, is another indispensable account for the negative performance implication of a temporal transition, either causing firms to continue to pursue exploration (exploitation) beyond the expected levels resulting in over-exploration (over-exploitation) (Kang, Kang, and Kim, 2017; Lavie & Rosenkopf, 2006; Levinthal & March, 1993; Nickerson & Zenger, 2002; Wang & Li, 2008) or causing a mismatch for firms between exploitative (exploratory) organizational structures presented and exploratory (exploitative) organizational structures required.

HYPOTHESES DEVELOPMENT

Furthering Understanding on Performance Implications of Temporal Transitions

We argue that the two polarized performance implications of temporal transitions between exploration and exploitation might be oversimplified and biased. Ambidexterity perspective considered temporal transitions as a whole unit of analysis, disregarding the fundamental differences in organizational inputs (i.e., routines, structures, capabilities, resources etc.) and intrinsic characteristics (i.e., search range, time horizon, degree of risk etc.) for exploration and exploitation per se, whereas punctuated equilibrium perspective overstated the symmetrical differences between exploration and exploitation even to the point of conflicting and antagonizing. However, we argue that the differences between exploration and exploitation transition are systematically asymmetric, and it needs further study.

We therefore attempt to further decouple the analysis of the exploration and exploitation transitions by integrating the classic exploration-exploitation framework (March, 1991) with organizational learning literature. It is anticipated that temporal transitions exhibiting significant bilateral directionality will have divergent impacts on firm performance. More precisely, we predict the exploration transition has a negative effect on firm performance, while the exploitation transition has a positive effect. We associate the intrinsic heterogeneities between exploitation and exploration transitions with their unique organizational learning characteristics that organizations encounter during the respective strategic transitions.

First, built on March's (1991) the exploration-exploitation framework, differentiated internal characteristics between exploitation and exploration determine more formidable challenges faced by the exploration transition than the exploitation transition. Firms are associated with more risks when engaging in a temporal transition from exploitation to exploration than the other way around (DiMasi, Hansen, & Grabowski, 2003; Dyer, 1996). Different than exploitation, exploration implies a broader irregular search process, associated with longer time horizons, that moves firms towards to a more unpredictable exploration trajectory (Anderson & Tushman, 2001; Argyres, 1996; Swift, 2016), accompanied by a higher degree of "uncertain and often negative" (March, 1991: p85) outcomes. Firms on average switch from exploitation to exploration "only when they have no alternatives" (Mudambi & Swift, 2014: p129) because exploration

implies a higher irreversible cost (Barnett & Freeman, 2001; He & Wong, 2004). Once the profound change from exploitation to exploration fails, firms need to pay a heavy price (Hannan & Freeman, 1977; Barnet & Freeman, 2001; Swift, 2016).

Second, organizational learning research between exploitation and exploration also indicates that more inputs of resources (i.e., effects and costs) might translate into fewer learning outcomes (Hoang & Rothaermel, 2010; Koza & Lewin, 1998) when firms engage in the exploration transition. It is well established that organizational learning literature taps into the tensions inherent in different types of exploitative vs. exploratory knowledge (Hoang & Rothaermel, 2010; Lavie & Rosenkopf, 2006; Park, Chen, & Gallagher, 2002; Pisano, 1996; Rothaermel, 2001; Rothaermel & Deeds, 2004). The exploration transition, occurring at a higher level of the learning curve, inevitably entails performance deterioration. Firms face more learning difficulties in leveraging their past or external exploitative experiences to enhance performance in subsequent exploratory projects. This is primarily because exploitation primarily focuses on making local adjustments to existing processes by leveraging current knowledge, whereas exploration places greater emphasis on substantial development by exploring new and unknown knowledge domains (Hoang & Rothaermel, 2010; March, 1991). The utilization of exploitative knowledge, acquired through transitional learning by doing in relatively homogeneous contexts, is insufficient to effectively transfer into exploratory knowledge needed to address new and cutting-edge challenges in relatively heterogeneous contexts (Hoang & Rothaermel, 2010). In the process of exploitation, the learning task is relatively simple and focused, increasing the likelihood of success and high performance for firms. On the other hand, exploration involves more complex and sophisticated learning tasks without clear focal points, posing challenges for organizational learning within firms (Hoang & Rothaermel, 2010).

In summary, the exploration transition presents significant challenges characterized by inherent high-risk, long time periods, and high levels of uncertainty. Additionally, it involves learning curve problems at a high level, discontinuous learning modes, and complex learning tasks. Collectively, these factors lead to negative implications for performance. Thus, we have

Hypothesis 1. *The temporal transition from exploitation to exploration has a negative effect on firm performance.*

In contrast, we expect that the exploitation transition has a positive effect on firm performance. Specifically, the exploration transition is less susceptible to the two main detriments mentioned above. During the exploitation transition, firms possess the capacity to maintain a relatively ambidextrous approach. In this scenario, firms are more likely to generate profits and commercialize value within a specialized focus, operating within a shorter time horizon and with less risky inputs compared to the exploration transition. As a result, firms in the exploitation transition do not encounter the challenges associated with high-risk, long-time periods, and strong uncertainty that are inherent in the exploration transition. Meantime, the exploitation transition is less prone to experiencing performance deterioration due to high level of learning curve problem compared to before. When firms undergo the exploitation transition, they have the advantage of easily accumulating and leveraging relevant exploitative experiences from previous endeavors or external sources (Pisano, 1996). Moreover, the relatively simple learning tasks involved in the exploitation transition are more likely to benefit exploitative projects. Furthermore, firms are inherently opportunistic in their pursuit of profits during the exploitation phase (Bens, Nagar, Skinner, and Wong, 2003; Gunny, 2010). For example, Anand and his colleagues (2016) have demonstrated that experience capabilities, developed through positive learning processes, have a subsequent positive impact on performance and that this reinforced effect goes beyond the direct learning effect due to the selection effect. In other words, the managerially opportunistic motives to the exploitation transition may further enhance performance via selection effect.

In summary, the exploitation transition does not face the disadvantages of high-risk, long-time periods, high levels of uncertainty. In addition, it relates to a low level of learning curve, relevant continuous learning modes, and relevant simple learning tasks. Based on these arguments, we can make the following:

Hypothesis 2. *The temporal transition from exploration to exploitation has a positive effect on firm performance.*

Moderating Role of Environmental Scarcity on Strategic Temporal Transitions

A key principle in strategic management, as highlighted by Bourgeois (1985), is the significance of aligning environmental factors with an organization's capabilities and resources. This alignment is crucial for achieving an increase in performance. By understanding and adapting to the external environment, while leveraging internal strengths and resources, organizations can enhance their competitive advantage and drive improved performance outcomes. Based on the arguments and hypotheses discussed earlier, we suggest that the effects of transitioning between temporal exploitation and exploration may lead to more (or less) pronounced performance heterogeneity given the environmental factors. This heterogeneity is likely to be observed when these transitions occur in markets that are relatively more (or less) resource and opportunity (Castrogiovanni, 1991; Dess & Beard, 1984; Staw & Szwajkowski, 1975).

In scarce environments, the challenges and opportunities associated with the exploration transition may have a greater impact on performance implications, resulting in a wider range of performance variation among firms. Conversely, in markets with munificent resources and opportunities, the performance heterogeneity resulting from these transitions may be less pronounced. Environmental scarcity, as opposed to environmental munificence, refers to the degree of available resources and opportunities within a given task environment (Dess & Beard, 1984). This factor impacts the survival and expansion potential of firms (Hannan & Freeman, 1977) as well as the way firms operate, grow, and adapt to change (Bradley, Aldrich, Shepherd, and Wiklund, 2011; Cyert & March, 1963). In resource-scarce environments, constraints can hinder the implementation of novel approaches and strategies focused on the exploration transition. We argue that the negative performance effects of the exploration transition could be amplified under such conditions of limited resources. The exploration transition necessitates significant investments of inputs over an extended period of time. In resource-scarce settings, these resource demands may strain the organization's capabilities to effectively pursue exploration-transitioning activities, leading to greater negative performance implications. On one hand, environmental scarcity can make it more challenging for firms to sustain such exploration transition strategies, which further diverts resources away from immediate priorities and ultimately leads to decreased efficiency and loss of profitability. On the other hand, high degree of risk and uncertainty embedded in the exploration transition would pose a larger threat in resource-scarce environments, where the consequences of poor performance and even failure are more severe. Thus, we predict:

Hypothesis 3. *Environmental scarcity strengthens the negative relationship between the temporal transition from exploitation to exploration and firm performance.*

Meanwhile, we also propose that the positive performance effects of the exploitation transition could be mitigated when interacting with the presence of environmental scarcity. When resources in an environment become sparse, competition tends to intensify, as highlighted in prior research (Dess & Beard, 1984). It has been suggested that scarcity of resources is associated with lower efficiency in information processing, reduced discretion in decision-making, and increased organizational inertia (Richard, Murthi, and Ismail, 2007; Wiersema & Bantel, 1993; Yasai-Ardekani, 1989). These circumstances not only hinder the overall benefits of information processing and decision-making that come with a strategic emphasis on the exploitation transition but also give rise to conflicts, tensions, and divisions among various departments or functions within organizations. This is particularly true due to the resource scarcity in the environment. Consequently, the presence of environmental scarcity dampens the overall performance of the firm during the exploitation transition.

In summary, firms that undergo a temporal exploitation transition and operate in conditions of resource scarcity are expected to exhibit even weaker performance. The competition intensification and the associated challenges related to information processing, decision-making, and organizational dynamics further undermine the positive performance effects that could be derived from the exploitation transition.

As a result, the performance implications for these firms are likely to be more negative compared to those operating in resource-abundant environments. Thus, we can predict:

Hypothesis 4. *Environmental scarcity weakens the positive relationship between the temporal transition from exploration to exploitation and firm performance.*

METHOD

Sample

In this study, we examine the performance implications of firms as they transition between exploitation and exploration strategies over time as well as the moderating effect by environment scarcity. Our research draws upon data from publicly listed high tech firms in the S&P 1500 between 2009 and 2014. To ensure a representative sample, we sourced our initial data from Compustat, which provides comprehensive market and accounting information on all publicly traded firms in the U.S. and applied a set of rigorous selection criteria. In particular, we focused exclusively on S&P 1500 high tech firms, as they offer an optimal basis for testing our hypotheses due to their representation of a wide range of exploitation and exploration transitions, which helps to capture a diverse range of strategic change contexts that firms face. We used the Technology Industries and Occupations Standards for NAICS Industry Data (Paytas & Berglund, 2004) to filter the high-tech firms from the sample, with the first four digits of the NAICS representing industries such as basic chemical manufacturing ("3251") or computer systems design services ("5415"). Second, we took into consideration the personal characteristics of the CEO and integrated a relevant dataset from Execucomp, as previous studies have demonstrated the significant impact that powerful CEOs have on the decision for the firm's exploitation and exploration transitioning strategies (Papadaki & Barwise, 2002; Pearce & Robinson, 1987). Third, we limited our analysis to the period after 2008, as the financial crisis had the potential to exert a significant influence on firms transitioning strategy on exploitation and exploration. To ensure an adequate level of maturity (Baron & Bielby, 1980), we only retained firms that were at least three years old, thereby enabling us to observe their transitioning tendencies. Lastly, we excluded observations with missing values, resulting in a final sample of 1,247 firm-year observations that consist of 336 publicly listed high-tech firms in the US from 2009 to 2014.

Measures

Firm Performance

Previous research examining the relationship between strategic change and firm performance (Zhang & Rajagopalan, 2010) has primarily used return on assets (ROA). In our study, we have taken a step further to mitigate the estimation bias by employing the change in ROA (ΔROA) to measure firm performance and eliminate potential endogeneity issues. Moreover, we have focused on financial performance measures instead of market-based measures, which are primarily based on perceptions and evaluations of future viability or growth potential by investors (Gentry & Shen, 2010). Financial- or accounting-oriented measures, in contrast, reflect the realized financial outcomes of firms (Wang, Holmes, Oh, and Zhu, 2016). ROA is calculated by dividing net income by total assets, and ΔROA represents the difference in ROA between two consecutive years. In our estimation models, we lead dependent variable ΔROA and ROA, respectively, by one year (t+1) because it takes some time for firms to manifest the dependent variable.

Exploitation and Exploration Transition

To measure the *exploitation* and *exploration transition*, we followed Swift (2016) and looked at the firm's largest one-year change in R&D expenditure between 2009 and 2014, which is normalized with variances for each firm based on the GARCH model (Bollerslev, 1986; Engle, 1982). This model estimates the firm's R&D expenditure trend over time and generates residuals that indicate the frequency and extent to which R&D investment differs from the predicted trend. Firms with large residuals have a significant change in their R&D expenditure profile. The maximum of the absolute values for all residuals for each firm is taken to measure the magnitude of the transition between exploration and exploitation. Two new

variables are created based on the residuals with the largest absolute values: a positive variable indicates sudden and significant increases in R&D spending (exploration transition), and a negative variable indicates sudden and significant decreases in R&D spending (exploitation transition).

Environmental Scarcity

In order to assess the environmental capacity to sustain growth, *environmental scarcity* or munificence is commonly utilized, as quantified by the five-year average growth in sales and operating income for each industry (Dess & Beard, 1984; Rasheed & Prescott, 1992). We conducted a regression analysis of industry sales or operating income on the year and computed the antilog of the regression slope coefficient (beta) to determine the indicator for environmental scarcity.

Control Variables

To account for potential confounding factors across multiple levels of analysis that may be associated with our focal variables and underlying mechanisms, we have implemented several controls. At the external level, we have controlled for environmental complexity and dynamism (Connelly, Haynes, Tihanyi, Gamache, and Devers, 2016) because these factors determine the extent to which a firm can leverage its available resources and opportunities for strategic transitions between exploitation and exploration (Finkelstein & Boyd, 1998). *Environmental dynamism*, which represents the inability to sustain growth, is computed as the antilog of the standard error of each regression slope coefficient from the relevant regression analysis (Keats & Hitt, 1988). *Environmental complexity* is indicated by the heterogeneity of market size and power of industry participants and is measured using the dynamic industry concentration index, which is the Herfindahl-Hirschman index (HHI) of all firms' market share in an industry in a given year (Fischer & Pollock, 2004).

At the firm level, we control for *firm size, M/B ratio, firm slack, R&D intensity,* and *firm diversification*. *Firm size* is calculated as the natural logarithm of the total number of employees listed in the company during the year (Josefy, Kuban, Ireland, and Hitt, 2015). As a measure of market performance, we use the *M/B ratio*, which is the ratio of the firm's market value to its book value. *Firm slack* is determined by the annual working capital ratio (Finkelstein & Hambrick, 1990), which reflects the firm's excess cash holdings over future needs. Since research has shown that R&D-based innovation drives firm performance (Cohen & Levinthal, 1990), *R&D intensity* is also included as a control variable. Firm diversification is estimated using an HHI based on the firm's sales from different two-digit SIC industry groups (Kaul, 2012).

Moreover, we have controlled for *CEO tenure, CEO ownership,* and *CEO duality*, which have been demonstrated in prior literature to influence crucial decisions on strategic transitions and subsequently affect corporate performance (Adams, Almeida, and Ferreira, 2005; Faccio, Marchica, and Mura, 2016; Krause, Semadeni, and Cannella, 2014). *CEO tenure* is measured as the number of years the executive has held the CEO position; *CEO ownership* is the percentage of common shares and options owned by the CEO; and *CEO duality* is a binary variable indicating whether the CEO also serves as the chairperson of the board.

Analysis

Our final sample consisted of 1,247 firm-year observations across 336 publicly listed high-tech firms in the US from 2009 to 2014. Given our short panel dataset in a longitudinal design, we used Generalized Estimating Equations (GEE) model, which is a flexible modelling technique that accounts for autocorrelation and heteroscedasticity (Liang & Zeger, 1986). This modelling technique has been widely adopted in previous studies of strategic innovation (Ahuja & Katila, 2001; Gambeta., Koka, aand Hoskisson,2019; Vanacker, Collewaert, and Zahra, 2017). Additionally, we employed fixed-effect models as a robustness test to control unobserved intrafirm heterogeneity and year effects (Wooldridge, 2010). All control variables and independent variables were lagged by one year to establish the potential causality. Year dummy variables were also included to control for possible contemporaneous correlations (Certo & Semadeni, 2006). Moderation effects were tested using the moderated multiple regression approach, and the independent and moderating variables were mean centered before their product terms were created. We

also conducted additional analyses to examine potential suppression or enhancement effects caused by control variables, and the results remained consistent.

RESULTS

Table 1 shows the means and standard deviations of all variables and the correlations between them. To check for multicollinearity, we computed the variance inflation factors (VIF), for which the scores range from 1.01 to 1.57 with a mean score 1.21, indicating that multicollinearity is not a major concern.

TABLE 1
MEANS, STANDARD DEVIATIONS, AND CORRELATIONS OF VARIABLES

Variables	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Exploration transition	0.082	0.274													
(2) Exploitation transition	0.027	0.163	-0.064*												
(3) Firm performance	0.009	0.109	-0.079*	0.070*											
(4) Environmental dynamism	0.029	0.018	-0.017	0.021	0.039										
(5) Environmental complexity	0.244	0.195	-0.002	0.000	0.024	0.104*									
(6) Environmental scarcity	0.041	0.054	0.028	-0.043	-0.026	-0.024	-0.132*								
(7) R&D intensity	0.159	0.254	-0.013	0.015	0.166*	-0.084*	-0.236*	0.144*							
(8) Firm slack	2.765	2.175	0.012	0.044	-0.078*	-0.008	-0.183*	0.077*	0.293*						
(9) M/B ratio	3.293	3.453	0.031	0.000	-0.005	-0.120*	-0.056*	0.018	0.077*	-0.090*					
(10) Firm size	1.847	1.325	-0.078*	-0.027	-0.017	-0.079*	0.148*	-0.019	-0.340*	-0.457*	0.003				
(11) Firm diversification	1.320	0.695	-0.034	0.008	-0.018	0.015	0.113*	-0.026	-0.227*	-0.143*	-0.013	0.307*			
(12) CEO duality	0.893	0.310	-0.059*	-0.015	-0.022	0.039	0.000	-0.047	-0.065*	-0.008	-0.039	-0.019	-0.042		
(13) CEO tenure	9.936	7.179	0.021	-0.022	-0.022	-0.051*	-0.066*	0.057*	0.009	0.144*	0.002	-0.100*	-0.034	0.083*	
(14) CEO ownership	1.802	3.670	0.033	-0.014	-0.024	-0.117*	-0.085*	0.057*	0.044	0.071*	0.038	-0.213*	-0.065*	0.007	0.549*

* $p < 0.05$, N = 1,247

Exploration Transition

Table 2 displays the outcomes of Generalized Estimating Equations (GEE) that forecast firm performance implications concerning exploration transition. Model 1 serves as the baseline model with only control variables, while Model 2 examines the primary impacts of exploration transition. Lastly, Model 3 is the full model that explores the interaction effects between exploration transition and environmental scarcity.

TABLE 2
PANEL DATA GEE MODELS PREDICTING EFFECTS OF EXPLORATION TRANSITION ON FIRM PERFORMANCE

ΔROA	Model 1		Model 2		Model 3	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Constant	-.007	(.026)	-.007	(.026)	-.001	(.026)
Environmental dynamism	-.204	(.306)	-.192	(.305)	-.011	(.306)
Environmental complexity	.069	(.081)	.074	(.082)	.086	(.082)
R&D intensity	.036**	(.015)	.036**	(.015)	.036**	(.015)
Firm slack	-.002	(.001)	-.002	(.001)	-.002	(.001)
M/B ratio	-.000	(.001)	.000	(.001)	.000	(.001)
Firm size	-.001	(.002)	-.001	(.002)	-.001	(.002)
Firm diversification	.002	(.003)	.002	(.002)	.002	(.002)
CEO duality	.008	(.009)	.007	(.010)	.007	(.010)
CEO tenure	-.000	(.000)	-.000	(.000)	-.000	(.000)
CEO ownership	-.001	(.001)	-.000	(.001)	-.000	(.001)
Exploration transition			-.029**	(.012)	-.024*	(.014)
Environmental scarcity					-.196***	(.067)
Exploration transition × Environmental scarcity					-.109	(.222)
Year fixed effects	Yes		Yes		Yes	
Firm fixed effects	Yes		Yes		Yes	
Sample size	1,247		1,247		1,247	
Firms	336		336		336	

All tests are two-tailed: *** p<.01; ** p<.05; * p<.1. Robust standard errors are shown in parentheses.
Coefficients of year and firm fixed effects are not shown due to space constraints.

Hypothesis 1 proposes that exploration transition is negatively related to firm performance. In Model 2 in Table 2, the regression coefficient of exploration transition is negative and statistically significant (b = -.29, p < .05), indicating that exploration transition negatively influences change in firm performance. Thus, Hypothesis 1 is supported. Further, marginal effects analysis shows that the expected number of ΔROA decreases by 2.87% for one standard deviation increase in exploratory transition, holding all other variables constant.

Hypothesis 3 proposes that environmental scarcity strengthens the negative relationship between an exploration transition and firm performance. The moderating effect of environmental scarcity is tested in Model 3, Table 2. The result shows that the product term of exploration transition and environmental scarcity is negative and statistically insignificant (b = -.109, p > .1). Thus, Hypothesis 3 is not supported.

Exploitation Transition

Table 3 presents the outcomes of GEE models that forecast firm performance implications concerning exploitation transition. Model 1 acts as the baseline model with only control variables, whereas Model 2

examines the primary impacts of exploitation transition. Lastly, Model 3 is the full model that explores the interaction effects between exploitation transition and environmental scarcity.

TABLE 3
PANEL DATA GEE MODELS PREDICTING EFFECTS OF EXPLOITATION TRANSITION ON FIRM PERFORMANCE

ΔROA	Model 1		Model 2		Model 3	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Constant	-.007	(.026)	-.009	(.026)	-.007	(.026)
Environmental dynamism	-.204	(.306)	-.176	(.304)	-.018	(.296)
Environmental complexity	.069	(.081)	.064	(.081)	.100	(.079)
R&D intensity	.036**	(.015)	.036**	(.014)	.035**	(.014)
Firm slack	-.002	(.001)	-.002	(.001)	-.002	(.001)
M/B ratio	-.000	(.001)	-.000	(.001)	-.000	(.001)
Firm size	-.001	(.002)	-.001	(.002)	-.001	(.002)
Firm diversification	.002	(.003)	.002	(.003)	.002	(.003)
CEO duality	.008	(.009)	.009	(.009)	.009	(.009)
CEO tenure	-.000	(.000)	-.000	(.000)	-.000	(.000)
CEO ownership	-.001	(.001)	-.001	(.001)	-.000	(.001)
Exploitation transition			.050**	(.024)	.072***	(.021)
Environmental scarcity					-.159**	(.065)
Exploitation transition × Environmental scarcity					-.629***	(.234)
Year fixed effects	Yes		Yes		Yes	
Firm fixed effects	Yes		Yes		Yes	
Sample size	1,247		1,247		1,247	
Firms	336		336		336	

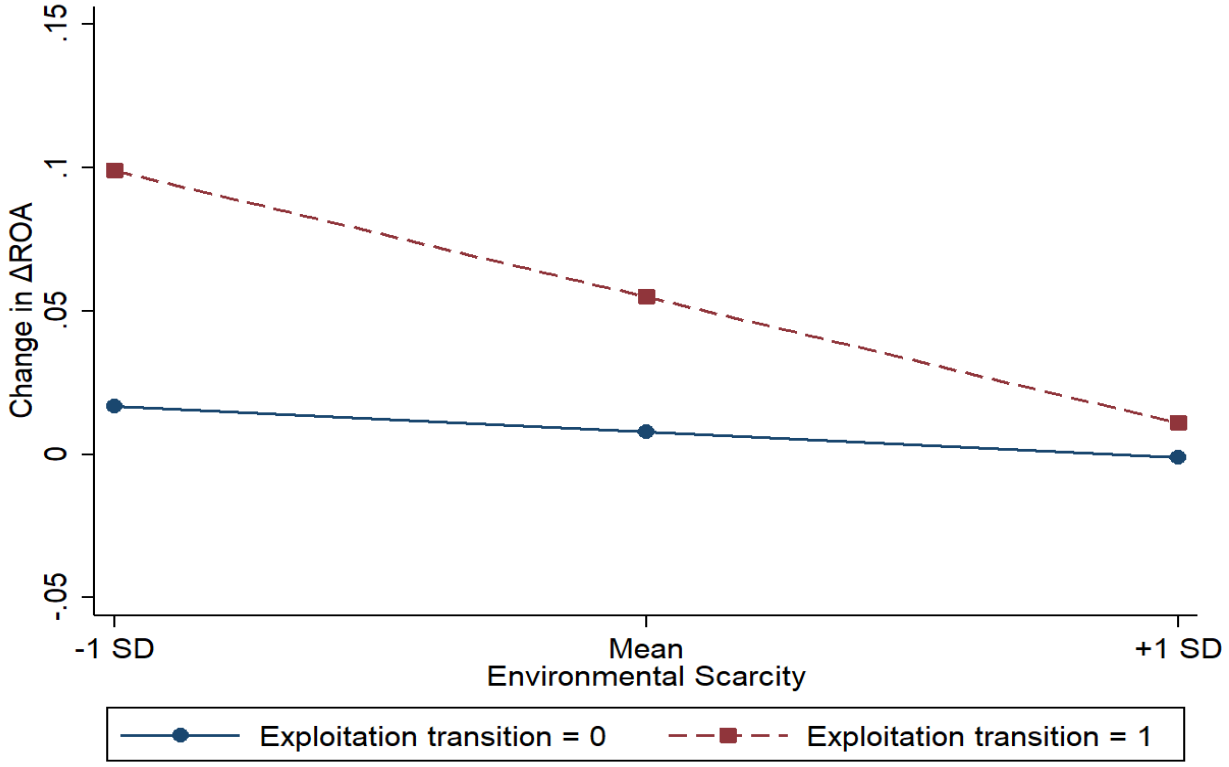
All tests are two-tailed: *** p<.01; ** p<.05; * p<.1. Robust standard errors are shown in parentheses.
Coefficients of year and firm fixed effects are not shown due to space constraints.

Hypothesis 2 postulates a positive association between exploitation transition and firm performance. The findings from Model 2 in Table 3 reveal that the regression coefficient of exploitation transition is positively significant (b = .05, p < .05), implying a positive relationship between exploitation transition and firm performance implications. Hence, Hypothesis 2 is supported. Additionally, the marginal effects analysis shows that the projected amount of ΔROA increases by 4.89% for a one standard deviation increase in exploitation transition, keeping all other variables constant.

In line with Hypothesis 4, which suggests that environmental scarcity weakens the favorable correlation between an exploitation transition and firm performance, Model 5 in Table 3 was employed to test the moderating effect of environmental scarcity. The results indicate that the product term of exploitation transition and environmental scarcity is negatively significant (b = -.629, p < .01), indicating that

environmental scarcity negatively moderates the connection between exploitation transition and firm performance. While the exploitation transition has been found to have a positive impact on firm performance, its effect is reduced by environmental scarcity, leading to less positive implications. This outcome aligns with the aforementioned Hypothesis 4, which predicted that such moderation effects would occur. The interaction plot is displayed in Figure 1.

FIGURE 1
MODERATING EFFECTS OF ENVIRONMENTAL SCARCITY ON EXPLOITATION TRANSITION AND FIRM PERFORMANCE



Based on the findings presented in Figure 1, it is evident that the relationship between exploitation transition and its impact on firm performance is influenced by the degree of environmental scarcity. A slope analysis was conducted to examine this observation further. The results indicate that as the moderator of environmental scarcity increases, the gradient of the linear equation decreases. Specifically, when exploitation transition is low (0), the slope of the equation is -.159, and it is statistically significant at a 95% confidence level ($p = .014$). However, when exploitation transition is high (1), the slope becomes more negative at -.629, and it remains significantly different from zero even at a 99% confidence level ($p = .007$). Furthermore, the two slopes at the different levels of exploitation transition are significantly distinct, with a statistical significance level of $p = .01$.

In summary, our analysis supports Hypothesis 1, which suggests a negative association between exploration transition and firm performance. However, we did not find evidence supporting Hypothesis 2, which proposed that environmental scarcity strengthens this negative relationship. On the other hand, our findings support Hypothesis 3, indicating a positive association between exploitation transition and firm performance. Furthermore, Hypothesis 4 received support, suggesting that the positive effect of exploitation transition on firm performance is attenuated by environmental scarcity. To rigorously evaluate the robustness of our findings, we also utilized fixed-effects panel regression and obtained consistent results.

Robustness Analysis

Table 4 displays the outcomes of fixed-effects panel regression that forecast firm performance concerning exploration transition. Model 1 serves as the baseline model with only control variables, while Model 2 examines the primary impacts of exploration transition. Lastly, Model 3 is the full model that explores the interaction effects between exploration transition and environmental scarcity.

TABLE 4
FIXED EFFECTS PANEL REGRESSION MODELS PREDICTING EFFECTS OF EXPLORATION TRANSITION ON FIRM PERFORMANCE

ROA	Model 1		Model 2		Model 3	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Constant	-.229***	(.055)	-.220***	(.055)	-.214***	(.056)
Environmental dynamism	-.120	(.301)	-.114	(.293)	-.039	(.275)
Environmental complexity	.002	(.074)	.008	(.074)	.016	(.074)
R&D intensity	-.052	(.068)	-.048	(.068)	-.048	(.068)
Firm slack	-.022***	(.006)	-.023***	(.006)	-.023***	(.006)
M/B ratio	.002	(.002)	.002	(.002)	.002	(.002)
Firm size	-.051***	(.019)	-.044***	(.020)	-.042***	(.020)
Firm diversification	-.007	(.007)	-.008	(.007)	-.007	(.007)
CEO duality	.006	(.011)	.003	(.011)	.002	(.011)
CEO tenure	-.001	(.001)	-.001	(.001)	-.001	(.001)
CEO ownership	-.002	(.003)	-.002	(.003)	-.002	(.003)
Exploration transition			-.031***	(.011)	-.033***	(.014)
Environmental scarcity					-.086	(.063)
Exploration transition × Environmental scarcity					.058	(.186)
Year fixed effects	Yes		Yes		Yes	
Firm fixed effects	Yes		Yes		Yes	
Sample size	1,247		1,247		1,247	
R-squared	.065		.072		.073	

All tests are two-tailed: *** p<.01; ** p<.05; * p<.1. Robust standard errors are shown in parentheses.
Coefficients of year and firm fixed effects are not shown due to space constraints.

In Model 2 in Table 4, the regression coefficient of exploration transition is negative and statistically significant (b = -.031, p < .01), indicating that exploration transition negatively influences change in firm performance. Thus, Hypothesis 1 that proposes exploration transition is negatively related to firm performance is supported. And the moderating effect of environmental scarcity is tested in Model 3, Table 4. The result shows that the product term of exploration transition and environmental scarcity is positive and statistically insignificant (b = .058, p > .1). Thus, Hypothesis 3 that argues environmental scarcity strengthens the negative relationship between an exploration transition and firm performance is not supported.

Furthermore, Table 5 presents the outcomes of fixed-effects panel regression that forecast firm performance concerning exploitation transition. Model 1 acts as the baseline model with only control variables, whereas Model 2 examines the primary impacts of exploitation transition. Lastly, Model 3 is the full model that explores the interaction effects between exploitation transition and environmental scarcity.

TABLE 5
FIXED EFFECTS PANEL REGRESSION MODELS PREDICTING EFFECTS OF EXPLOITATION TRANSITION ON FIRM PERFORMANCE

ROA	Model 1		Model 2		Model 3	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Constant	-.229***	(.055)	-.230***	(.055)	-.223***	(.055)
Environmental dynamism	-.120	(.301)	-.123	(.302)	-.059	(.279)
Environmental complexity	.002	(.074)	.002	(.074)	.002	(.074)
R&D intensity	-.052	(.068)	-.052	(.068)	-.052	(.068)
Firm slack	-.022***	(.006)	-.022***	(.006)	-.022***	(.006)
M/B ratio	.002	(.002)	.002	(.002)	.002	(.002)
Firm size	-.051***	(.019)	-.052***	(.019)	-.051***	(.020)
Firm diversification	-.007	(.007)	-.007	(.007)	-.006	(.007)
CEO duality	.006	(.011)	.006	(.011)	.005	(.011)
CEO tenure	-.001	(.001)	-.001	(.001)	-.001	(.001)
CEO ownership	-.002	(.003)	-.002	(.003)	-.002	(.003)
Exploitation transition			.007	(.029)	.008	(.028)
Environmental scarcity					-.058	(.062)
Exploitation transition × Environmental scarcity					-.471***	(.219)
Year fixed effects	Yes		Yes		Yes	
Firm fixed effects	Yes		Yes		Yes	
Sample size	1,247		1,247		1,247	
R-squared	.065		.065		.068	

All tests are two-tailed: *** p<.01; ** p<.05; * p<.1. Robust standard errors are shown in parentheses.
Coefficients of year and firm fixed effects are not shown due to space constraints.

The findings from Model 2 in Table 5 reveal that the regression coefficient of exploitation transition is positively insignificant (b = .007, p > .1). Hence, Hypothesis 2 that postulates a positive association between exploitation transition and firm performance is supported. While Model 5 in Table 5 was employed to test the moderating effect of environmental scarcity. The results indicate that the product term of exploitation transition and environmental scarcity is negatively significant (b = -.471, p < .01), indicating that environmental scarcity negatively moderates the connection between exploitation transition and firm performance, which is consistent with Hypothesis 4 that suggests that environmental scarcity weakens the favorable correlation between an exploitation transition and firm performance.

DISCUSSION

Building upon the literature on ambidexterity and organizational learning, this research delves deeper into the impact of strategic temporal transitions on firm performance by decoupling the exploration from exploitation transitions. We theorize and test the relationship between exploitation/exploration transitions and firm performance as well as the moderating effects of environmental scarcity. The empirical results provide moderate support for our hypotheses. When a firm temporally transits from exploitation to exploration, it tends to experience a decline in performance, while it has an increase in performance temporally transiting from exploration to exploitation. Although environmental scarcity is prone to dampen the performance improvement implication of exploitation transition, it does not necessarily, interestingly, lead to amplify the performance deterioration of the exploitation transition. The unexpected finding may be because the impact of environmental scarcity on the exploration transition is more intricate and context-dependent (Mavroudi, Kesidou, & Pandza, 2020).

Researchers in temporal transitions recently have begun unraveling the mechanisms of their performance implications in different aspects. For example, Mudambi and Swift (2014) found that only high-performing firms can benefit increased performance from temporal transitions between exploration and exploitation, while these transitions fail the other inferior firms on average (Swift, 2016). Instead of focusing on the type of firms in performing, Mavroudi et al. (2020) examine the performance implications of temporal transitions based on the speed dimension and find high-speed temporal transitions decrease firm performance based on a longitudinal design on sampling Spanish innovative firms. In addition, Luger, Raisch, and Schimmer (2018) find high level of ambidexterity between exploration and exploitation during discontinuous environmental change, it's negative to firm performance, while it turns to positive during incremental environmental change. Similarly, Kang and Kim (2020) find that a discontinuous leap has a negative effect on firm performance while an incremental leap has a positive effect. Nonetheless, our research makes a valuable contribution to the understanding of the connection between temporal transitions and firm performance by untangling the exploration and exploitation transitions focusing on their inherent directionality, which sets it apart from previous studies on temporal transitions.

Our findings also reveal that environmental scarcity influences the relationship between exploitation transition and firm performance. Surprisingly, it fails to impact on the relationship between exploration transition and firm performance. Despite no direct evidence to defy our initial hypothesis, this finding aligns with Mavroudi et al. (2020), who argue that the complexity of performance implications of temporal transitions is firm- and context-specific and find that high-speed transitioning damages firms' performance that operate in large-scale R&D investment, while it benefits firms within the industry that is technologically dynamic. Besides, Mavroudi, Kesidou, and Pandza (2023) also find out that firms taking a consistent R&D-strategy with their counterparts within the industry tend to have a performance decline, whilst firms that adopt an R&D-strategy different from the industry's dominant R&D-strategy will likely have a performance enhancement. Therefore, we have enough reasons for that the exploration transition may inherently take the influence of resource constraint into account. Additionally, the temporal transitions should make use of the unique characteristics of resources and situational factors to examine and separate the performance consequences from an integrated perspective. For example, Sabidussi, Lokshin, and Duysters (2023) find that environmental turbulence can differently moderate the performance implications of simultaneous ambidexterity and temporal transitions.

Theoretical Implications

Our study contributes to the literature on strategic temporal transition and organization ambidexterity by enhancing the understanding of sophisticated nature of the performance implications of exploitation/exploration transitions. Although previous research has attempted to illustrate the contradictory performance implications of temporal transitions between exploration and exploitation, these studies have tended to treat them as a whole unit of analysis. However, such a whole unit of analysis approach may be oversimplistic and biased, as a result, our study highlights the importance of separating exploitation transition from exploration transition by considering their inherent heterogeneities. To better

understand their respective divergent implications on firm performance, we find that the exploration transition has a positive effect on firm performance while the exploitation transition has a negative effect.

Furthermore, our study contributes to the organizational learning literature by emphasizing the necessity to differentiate exploration and exploitation transition due to their intrinsic intricacy based on organizational learning. The exploration transition involves complex learning tasks and characteristics, an extended learning period, and a high level of learning difficulty. On the other hand, the exploitation transition is characterized by relatively simpler tasks and characteristics, a shorter learning period, and lower difficulty in organizational learning. It is such two types of temporal transitions that encompass the differences in intrinsic organizational learning characteristics that determine their distinctiveness in the ultimate performance implications. The divergent characteristics of organizational learning associated with exploration and exploitation transition provide some addition to the relevant literature.

Managerial Implications

Our findings underline the inherent paradox between ensuring short-term survival through local exploitation and securing long-term sustainability through global exploration, particularly for high-tech companies operating in dynamic external environments. Therefore, it is crucial for top managers to recognize that the temporal exploitation and exploration transitions within firms are inherently different and a whole unit perspective may be boss-eyed and biased. Consequently, firms require a further understanding and orchestration of environmental factors, organizational learning elements, and intrinsic characteristics to specific forms of transitions to facilitate their value-creating nature and generate sustainable competitive advantage for firms. Furthermore, our study brings attention to how environmental scarcity reduces the performance benefits associated with transitioning to temporal exploitation. This underscores the importance for decision-makers to have a strong understanding of when to make the transition to exploitation in environments rich in resources, in order to fully capitalize on the financial advantage it offers.

Limitations and Future Research

It is essential to acknowledge our research limitations. Given the limitations of our data sample, we are not entirely surprised by the lack of support for H3 as aforementioned. Our study employed a short panel of five-year window dataset within a homogenous high-tech industry, which may have led to insufficient variability in environmental scarcity and inadequate statistical power to detect significant effects. It is imperative for future studies to explore and validate these relationships in diverse sectors, ensuring a holistic understanding of the implications. Second, we also fail to detect the implications of CEO personal characteristics as moderators, despite their inclusion as controls. The lack of significance on CEO personal characteristics in our data sample can be attributed to the high-tech industry's innovation-oriented natural properties. The individual characteristics of a CEO may not necessarily be closely linked to, or dependent upon the firm-specific knowledge and information related to temporal exploration/exploitation transitions. Given the dynamic nature of high-tech firms, it is imperative that they continually alter their temporal exploration/exploitation strategies to enhance their adaptability and then firm performance. As a result, it is crucial for future studies to explore CEO interpersonal characteristics in a comprehensive manner. The literature on social capital theory provides support for the view that social connections and relationships may facilitate the exchange of firm-specific knowledge and information and foster collaborative innovation (Cao, Maruping & Takeuchi, 2006; Cao, Simsek, & Jansen, 2015). Certain inquiries that merit attention include the following: What is the impact of a CEO's social capital on a firm's transitions between temporal exploration and exploitation? How does CEO structural embeddedness, characterized by bonding embeddedness versus bridging embeddedness, influence these transitions?

CONCLUSION

In our research, we build upon existing literature on organizational ambidexterity and organizational learning to examine the distinct effects of temporal exploitation and exploration transitions on firm

performance, as well as the moderating role of environmental scarcity. Our study focuses on a sample from the high-tech industry in the U.S., and our findings reveal that the exploration transition has a negative impact on firm performance, while the exploitation transition has a positive effect. Furthermore, we have observed a weakening phenomenon wherein environmental scarcity diminishes the positive impact of the exploitation transition on performance. These results contribute to our understanding of how firms can navigate the trade-off between exploration and exploitation and shed light on the importance of considering environmental scarcity in shaping the outcomes of temporal transitions.

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