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Creating competitive advantages: Interactions between ambidextrous diversification strategy and contextual factors from a dynamic capability perspective

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ABSTRACT

Is competitive advantage sustainable? We argue that firms can create temporary and consecutive competitive advantages by pursuing an ambidextrous strategy. This depends on the capability of firms to achieve simultaneous related and unrelated diversification during periods of turbulence. However, the manner by which firms exploit and develop resources and capabilities remain a major gap in the empirical literature on the diversification–competitive outcomes relationship. Adopting a dynamic capability perspective, we examine why and how the simultaneous pursuit of ambidextrous diversification creates temporary and consecutive competitive advantages. Employing longitudinal data for 2010–2015 to test our hypotheses, we find that an ambidextrous strategy has a curvilinear influence on advantages creation in terms of efficiency and effectiveness. These effects vary by interactions with R&D investments and firm-specific uncertainty. Finally, the impact of the three-way interactions among firm-specific uncertainty, ambidextrous diversification, and R&D investments on efficiency takes the form of a U-shaped curve.

1. Introduction

Diversification refers to a firm's entry into new lines of business activities through internal business development or acquisition (Ramanujam and Varadarajan, 1989). There is an extensive discourse in the literature on the extent to which diversification influences firms competitive advantage (Chakrabarti et al., 2007; Laplume and Dass, 2012). Theoretical arguments direct towards related, being superior to unrelated diversification (e.g., Ansoff, 1965; Singh and Montgomery, 1987). In practice many successful companies; such as, Virgin Group in the United States, Tata in India, and LG in Korea, undertake simultaneously related and unrelated diversification. Their approach follows prescriptions in the ambidexterity literature that firms, "need to consistently engage in exploratory and exploitative activities simultaneously in order to achieve superior outcomes" (Uotila et al., 2009, p. 221). Use of strategic ambidexterity associates with better performance when firms are in complex contexts (Laplume and Dass, 2012; Voss and Voss, 2013).

Strategic ambidexterity involves simultaneous engaging in exploration and exploitation, and "can be achieved through combining both activities across or within functional domains," such as products and markets (Voss and Voss, 2013, p. 2). We follow Laplume and Dass (2012) in viewing ambidextrous diversification as a type of strategic ambidexterity (O'Reilly and Tushman, 2013) to achieve competitive outcomes – a topic which has remained empirically under-examined. We define ambidextrous diversification as engaging simultaneously in related and unrelated diversification. From a dynamic capability perspective, we elucidate the role of ambidextrous diversification in creating competitive advantages that are subject to technological uncertainty.

Penrose (1959) and Teece (1982) develop the notion that competitive advantage requires going beyond exploiting existing internal and external firm-specific capabilities to develop new capabilities. The literature, however, on the diversification–competitive outcomes relationship has yet to address how firms exploit and develop resources and capabilities (Pisano, 2015). The dynamic capability perspective

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offers a path to bridging this gap (Eisenhardt and Martin, 2000; Teece et al., 1997, 2007).

Dynamic capability, according to Eisenhardt and Martin (2000), presents a firm's decision making as "a dynamic capability which can be best conceptualized as a tool to enhance existing resource configuration and to strengthen the current position for long-term competitive advantages, as well as to build new resource configurations and to move into fresh competitive position for a series of temporary competitive advantage" (p.1118). In this way, strategic ambidexterity reflects a complex set of decisions and routines that enable a firm to create "competitive advantages through the reallocation of organizational resources" (cf. O'Reilly and Tushman, 2013, p. 332). To inform our research purpose, we follow Eisenhardt and Martin's (2000) view that firms pursue related and unrelated diversification simultaneously as a dynamic tool to enhance existing resource and capability configurations while achieving competitive advantage through developing new capabilities.

The dynamic capability perspective (Eisenhardt and Martine, 2000; Teece et al., 1997) positions new product development as an important outcome of R&D investments underlying a firm's dynamic capability. Research and development investments improve strategic and organizational processes that broadly address firms' needs in developing and cultivating dynamic capabilities (Eisenhardt and Martin, 2000). Through R&D investments firms strengthen their capabilities to succeed in navigating various product–market domains (Teece, 2017). Thus, R&D investments improve the stock of resources necessary for a firm to manage ambidextrous diversification for dynamic capabilities (cf. Helfat and Peteraf, 2003). This research includes R&D investments as a factor enhancing the effect of ambidextrous diversification and investigates its effect on the relationship between ambidextrous diversification and its outcomes.

Firm-specific uncertainty or environmental uncertainty unique to a firm, corresponds to the dynamic capability context that the firm seeks to address (Eisenhardt and Martin, 2000; Teece, 2007; Teece et al., 1997). Such market and technological uncertainty are factors common to all firms in the same market. Some firms, however, are able to address uncontrollable sources of uncertainty more effectively than others (Beckman et al., 2004; Burgers et al., 1993; Wiersema and Bantel, 1993). Therefore, we focus on firm-specific uncertainty as a potential moderator in our examination of the effect of ambidextrous diversification, a source of dynamic capabilities, on performance outcomes. Such an examination facilitates a more complete understanding of firms' dynamic capabilities.

The contributions of this study are three-fold. First, by drawing on dynamic capability perspective we help to clarify inconclusive findings about the effects of related and unrelated diversification. By examining ambidextrous diversification resulting from firms' strategic decision making, we provide a meaningful theoretical lens to address strategic ambidexterity issues. Furthermore, we frame a firm's strategic decision making to pursue ambidextrous diversification as a dynamic capability aiming at strengthening its competitive position in the current product–market domain and establishing competitiveness in a new product–market domain (Eisenhardt and Martin, 2000). The findings will further our understanding of how firms perceive and operate an ambidextrous diversification strategy for its competitive outcomes

Second, the results of this study lead to a detailed explanation of the impact of R&D investments and firm-specific uncertainty on the relationship between ambidextrous diversification and competitive outcomes. Applying the dynamic capability perspective, we argue that R&D investments improve firm capabilities, which Teece (2007, p. 1319) described as (a) sensing and shaping opportunities and threats (b) seizing opportunities, and (c) maintaining competitiveness by enhancing, combining, protecting, and when necessary, re-configuring business enterprises' intangible and tangible assets. Higher investments in R&D support ambidextrous diversification and improve the relationship between ambidextrous diversification and competitive outcomes. Also, as dynamic capabilities have differing manifestations at various environmental uncertainty levels (Eisenhardt and Martin, 2000), we argue that the effect of R&D investments on the ambidextrous diversification–competitive outcomes relationships differs according to the level of firm-specific. By identifying firm-specific uncertainty as a meaningful higher order contingency, we contribute by recognizing uncertainties in embedded environments as a contingency that helps firms decide whether or not to utilize strategic ambidexterity (Beckman et al., 2004). Thus, this study contributes to discussions about the fundamental issues of firms' behaviors and the conditions that are necessary for them to succeed (Rumelt et al., 1994).

Finally, this study contributes to our understanding of organizational ambidexterity in general and strategic ambidexterity in particular. O'Reilly and Tushman (2013) propose that ambidexterity is an important aspect of dynamic capabilities manifesting in the strategic decision-making process of a firm and senior managers. We are able to shed light on why such a capability may contribute to firms' long-term competitiveness as well as revealing the conditions under which such diversification produces long-term benefits for firms (O'Reilly and Tushman, 2008, 2011, 2013).

2. Theory and hypotheses development

2.1. Diversification strategy from a dynamic capability perspective

Dynamic capability refers to, "a set of specific and identifiable processes such as product development, strategic decision making, and alliancing" (Eisenhardt and Martin, 2000, p. 1105). It is used to undergird enterprise-level sensing, seizing, and reconfiguring capacities that are difficult to develop and deploy (Teece, 2007). From this perspective, dynamic capabilities are the organizational and strategic practices and routines through which firms employ resources or achieve new resource configurations in line with market emergence, variations, and evolution (Eisenhardt and Martin, 2000). Firms can make strategic choices between enhancing existing resource configurations to strengthen their current position and achieve long-term competitive advantages, and building new resource configurations to establish fresh competitive positions to gain a series of temporary competitive advantages, or even simultaneously engaging in both approaches (Eisenhardt and Martin, 2000; Judge and Miller, 1991).

Diversification is a corporate-level strategy under which a firm enters a new business, market, or industry to add long-term economic value for its shareholders. Related and unrelated diversification differs in terms of the approach to markets. Related diversification involves broadening product offerings within existing markets or moving toward closely related product–market domains (Aaker, 1980; Gluck, 1985). Unrelated diversification, by contrast, refers to businesses adding new or unrelated product lines or penetrating new markets (Rumelt, 1986). Related diversification is valuable as it creates synergy by exploiting the input factors of production (resources) across multiple products or lines of businesses (Rumelt, 1974, 1982). Unrelated diversification, by contrast, leverages existing resources and explores opportunities through technological advancements. A noteworthy example is the Virgin Group which began operations as a mail order company for records. By the 1970s Virgin had set up a record store (see Pisano and Corsi, 2012 for details). Virgin Group is now a conglomerate that functions across the banking, media, publication, retail, and airline industries. Pisano (2015) argues that the story of Virgin Group cannot be simplified as "leveraging its powerful brand that has come to stand for excellent (and entertaining) customer service" (p. 29). Such approaches are diversification that require dynamic capability since it involves the processes of exploiting existing assets and developing new capabilities in the existing resource or capability repertoire (Pisano, 2015).

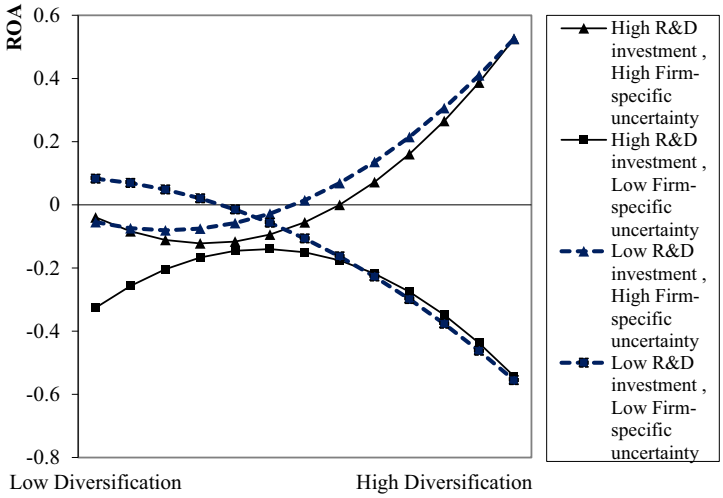

Fig. 1. Visualizing the three-way interaction effect of R&D investments, firm-specific uncertainty, and ambidextrous diversification and efficiency (measured in ROA).

2.2. Ambidextrous diversification and competitive outcomes

Conceptually, diversifying into related businesses enhances the exploitation of an existing resource and its capability configuration, while diversifying into unrelated businesses or markets requires the development of new resources and capability configurations (Eisenhardt and Martin, 2000). Ambidextrously and simultaneously achieving related and unrelated diversification is challenging as it requires cultivating and mastering two kinds of different, inconsistent processes or capabilities at the same time.

Related diversification, in general, improves firms' growth through the effective use of resources and capabilities (Penrose, 1959). Unrelated diversification, by contrast, is a financial approach with the objectives of profitability (Rumlet, 1974). Empirical findings demonstrate mixed (positive and negative) relationships between diversification and firm performance (Montgomery and Wernerfelt, 1988; Nath et al., 2010). Additionally, the relationship between diversification and firm performance may be curvilinear rather than linear (Geringer et al., 2000; Narasimhan and Kim, 2002; Palich et al., 2000). Voss and Voss (2013) focus on product and market domains to examine the effects of ambidextrous strategies (both exploitation and exploration) on revenue performance. In their work they define strategies that simultaneously include related and unrelated diversification are *combined cross-functional strategies*. This strategy represents "either a combined product exploitation and market exploration (i.e., a market development strategy) or a combined product exploration and market exploitation" (i.e., a product development strategy) which can positively impact on firms' revenue (Voss and Voss, 2013, p. 2). Voss and Voss also highlight the potential benefits that firms derive from ambidextrous diversification and these are a promising direction for further investigation.

Scholars emphasize the need to examine organizational performance from multiple perspectives including effectiveness and efficiency (Auh and Menguc, 2005). A firm can achieve effectiveness and efficiency by crafting and implementing strategies that make optimal use of resources and capabilities owned and leveraged by the firm (Barney, 1991). Effectiveness refers to the degree to which an approach is successful in achieving a desired result, while efficiency is the extent to which tasks are performed such that cost and time are minimized (Auh and Menguc, 2005). Prior research on the effects of firm diversification focuses on a single performance indicator; such as, market- or accounting-based indicators (Palich et al., 2000). To better understand the possible effects of ambidextrous diversification on firm-level outcomes, this study follows Auh and Menguc (2005) in adopting effectiveness (e.g., growth in market share or sales), efficiency (e.g., profitability or return on assets), and both (Auh and Menguc, 2005; Hambrick, 1983; Miles and Snow, 1978).

We argue that firms undertaking ambidextrous diversification expect to achieve both efficiency and effectiveness. By diversifying into relating business firms can achieve efficiency (as this approach exploits existing resources and capability configurations). New relating business share the cost of initial resource investments and allow a firm expedient access to new customer markets (Auh and Menguc, 2005; Penrose, 1959; Voss and Voss, 2013). Developing incremental innovation in relating businesses improves product quality through the exploitation of existing resources and capabilities which defends a firm's competitive position (Auh and Menguc, 2005). However, when a firm's aim is to satisfy the latent or new needs of customers by innovating in relating areas then they must integrate, combine, and reconfigure resources, knowledge, and capabilities. Under these circumstances, the firm focuses on effectiveness over efficiency (Auh and Menguc, 2005). Empirical results suggest that when firms place greater emphasis on the effectiveness of new product development and marketing research activities when they are primarily interested in exploring and expanding into untested markets(McDaniel and Kolari, 1987; Shortell and Zajac, 1990). Consequently, ambidextrous diversification leads to increases in firms' competitiveness deriving from gains in both efficiency and effectiveness (Fig. 1).

Firms, nevertheless, incur costs when pursuing ambidextrous diversification. Organizational architectures, including business models, structures, cultures, and reward systems, must be differentiated while, at the same time, aligned to leverage organizational resources and capabilities (O'Reilly and Tushman, 2011, 2013). The issue of aligning separate architectures becomes more prominent as a firm pursues ambidextrous diversification. Furthermore, senior managers must "tolerate and resolve the tensions arising from separate alignments" (O'Reilly and Tushman, 2011, p. 9). Due to rising tensions senior managers may no longer coalesce around a strategy of ambidextrous diversification and this undermines attempts to benefit from this situation. Thus, confronting such tensions remains a considerable challenge for senior managers (Cao et al., 2010; O'Reilly and Tushman, 2013).

Simply put, increases in ambidextrous diversification do not

associate with a continuous accrual of benefits. Rather, the positive effect of ambidextrous diversification (in terms of effectiveness and efficiency) grows at the outset. Subsequently, effectiveness and efficiency decline as costs and challenges exceed the benefits of ambidextrous diversification. Accordingly, we propose the following hypotheses:

H1a. : Pursuing ambidextrous diversification has a curvilinear effect on efficiency. In particular, the relationship between ambidextrous diversification and efficiency forms an inverted U-shaped curve.

H1b. : Pursuing ambidextrous diversification has a curvilinear effect on effectiveness. In particular, the relationship between ambidextrous diversification and effectiveness forms an inverted U-shaped curve.

2.3. Contextual factors

We further argue that contextual factors; such as, R&D investments and firm-specific uncertainty, act as distinctive contingencies influencing the relationship between ambidextrous diversification and competitive outcomes.

2.4. Moderating effect of research and development (R&D) investments

Investments in R&D underpin the capabilities that foster ideation, exploration of new technologies, and a search for creative solutions to complex problems. Such capabilities enable a firm to pursue more radical innovations. Radical product innovations are characterized by significantly new technologies, functionalities, or solutions for consumer problems. Moreover, R&D investments help improve a firm's absorptive capacity in relation to environmental challenges. This is critical to enhance the firm's ability to recognize the value of new information and knowledge before their assimilation and apply such information and knowledge to commercial ends (Cohen and Levinthal, 1990).

From a dynamic capability perspective, R&D investments improve strategic and organizational processes that broadly address firms' needs regarding the development and cultivation of dynamic capabilities (Eisenhardt and Martin, 2000). In order to succeed in exploring and exploiting various product–market domains, firms need dynamic capabilities that include sensing and seizing technological opportunities to address customer needs (Teece, 2007), while also anticipating marketplace trajectories to increase profitability and achieve long-term growth (Teece et al., 1997). Investments in R&D contribute to the development of these capabilities while also creating technological resources for a firm (Dierickx and Cool, 1989; Grabowski and Vernon, 1990).

The pursuit of ambidextrous diversification, however, may be subject to resource constraints. The results of R&D investments are an array of resources that make ambidextrous diversification desirable (cf. Cao et al., 2009). This array of resources is valuable in deepening and broadening a firm's extant know-how and capabilities towards competing in product markets by either strengthening its presence in the current product–market configuration or facilitating its entry into a new product market (Pisano, 2015). Investments in R&D, therefore, underpin the goals of ambidextrous diversification (strengthening firms' competitiveness in existing and new product markets to improve their revenue stream).

Investments in R&D may result in sunk costs, which become a barrier to both entry and exit (Antonelli et al., 2012). This, however, reduces the risk of a loss (Kahneman and Tversky, 1979; Sitkin and Pablo, 1992). Consequently, in a firm with high R&D investments, decision makers build entry barriers and competencies that facilitate the pursuit of ambidextrous diversification to achieve the desired performance (Chandler, 1962; Penrose, 1959). While we suggest that effectiveness and efficiency will decrease so long as ambidextrous diversification reports positive returns, we further propose the following:

H2a. : R&D investments moderate the relationship between ambidextrous diversification and efficiency such that the relationship is positive but concaves downward owing to diminishing returns.

H2b. : R&D investments moderate the relationship between ambidextrous diversification and effectiveness such that the relationship is positive but concaves downward owing to diminishing returns.

2.5. Moderating effect of firm-specific uncertainty

Firm-specific uncertainty refers to environmental conditions that are unique to a firm. The dynamic capability perspective focuses on how firms dynamically build and develop capabilities to tackle these challenges (Eisenhardt and Martin, 2000; Teece et al., 1997). Environmental uncertainty poses a dilemma for firms in that they need to navigate a path between both efficiency and flexibility to exploring new opportunities for future growth in order to achieve a steady revenue stream (Davies et al., 2009; O'Reilly and Tushman, 2013). Ambidextrous diversification signifies a firm's attempt to achieve both efficiency (as it exploits its current businesses) and flexibility under firm-specific uncertainty (as it explores opportunities to create new business). Ambidexterity may be conducive to firm performance and competitiveness under environmental uncertainties (Auh and Menguc, 2005; Bierly and Daly, 2007; Jansen et al., 2005, 2009).

Under the dynamic capability perspective, firms facing high firm-specific uncertainty must create and harness multiple business models (Teece, 2010, 2018) which represent increasing ambidextrous diversification. Evolution of business models integrates both the design of product-market strategies as well as the establishment of production systems and value chains. These business models generally revise or extend existing business practices in that they exploit a firm's existing capabilities or value network (related diversification) for efficiency gains. Business model revisions or extensions may lead firms to related diversification in their current industry. By sharing know-how, capabilities, and even production systems or distribution channels, a firm can improve its capacity to capture efficiency gains (e.g., economies of scope) despite pertinent uncertainties (Palepu, 1985; Wernerfelt and Montomery, 1988).

A new business model can deviate from the existing ones (cf. Teece, 2010, 2018), indicating unrelated diversification. As unrelated diversification drives firm growth by fostering entrepreneurship (cf. March 1991) or search initiatives (Chang, 1996) it can be useful under environmental uncertainties. Entrepreneurship is defined by identifying new business opportunities in product–market domains that improve the firm's growth and profitability prospects (particularly when the current product market is highly competitive) (Chang, 1996). Unrelated diversification also helps firms spread business risks across industries, reducing total risks while increasing the possibility of steady revenue and profit (Palich et al., 2000).

Thus, firms can realize the potential benefits of related and unrelated diversification under varying levels and types of environmental uncertainties when competing in a range of product–market domains. Market power is the manifestation of dynamic capabilities in the face of uncertainty (Palich et al., 2000). Ambidextrous diversification aids a firm in improving both efficiency and effectiveness when there are firm-specific environmental uncertainties. The effect is positive but, due to the presence of diminishing returns presents as a downward concave. Accordingly, we hypothesize the following:

H3a. : Firm-specific uncertainty moderates the relationship between ambidextrous diversification and efficiency such that the relationship is positive and, due to diminishing returns, presents as a downward concave.

H3b. : Firm-specific uncertainty moderates the relationship between ambidextrous diversification and effectiveness such that the

relationship is positive and, due to diminishing returns, presents as a downward concave.

2.6. Moderating effect of R&D investments and firm-specific uncertainty

The success of ambidextrous diversification requires the renewal of resources and capabilities (Teece, 2019) for both general and application-specific purposes (Pisano, 2015). Firms that are capable of creating and renewing resources and capabilities will excel in and master ambidextrous diversification to strengthen their competitiveness.

Investments in R&D accrue and develop technological resources that contribute to firms' capabilities (Dierickx and Cool, 1989; Grabowski and Vernon, 1990). Such capabilities also facilitate the coordination and integration of resources for strategic agility (Teece, 2017). This enables managers to reduce or even close gaps in the portfolio of resources and capabilities required to respond to opportunities and identified threats. Opportunities and threats in uncertain environments can be elusive and unpredictable. Nonetheless, R&D investments improve strategic agility under such circumstances because they foster the creation of new knowledge and novel solutions (Nonaka and Toyama, 2007), which help firms understand and fulfill new developmental paths. The reconfiguration of new knowledge and novel solutions further addresses changes resulting from opportunities and threats (Teece, 2007, 2009), helping firms to succeed in various product–market domains (Teece, 2019). Thus, strategic agility represents effectiveness and long-term growth and helps improve a firm's competitiveness.

A new capability may emerge in the course of an R&D project. This capability, however, might not persist and become a dynamic capability in the absence of conscious recognition and nurturing. In highly uncertain environments, information or knowledge about new opportunities can be vague (Gans and Stern, 2010; Teece, 1981). Entrepreneurs and managers should, therefore, develop distinct organizational capabilities for knowledge creation (Nelson, 1991). In this process, R&D investment plays a primary role in fostering the development of organizational capabilities and by cultivating and transforming such capabilities into distinctive competencies.

We argue that R&D investments are more effective in highly uncertain, rather than stable environments due to the effects of ambidextrous diversification on efficiency and effectiveness. We anticipate that firms, in highly uncertain environments, who pursue ambidextrous diversification through R&D investments initially report positive effects in terms of efficiency and effectiveness. Such positive effects plateau over time as the environment become more uncertain and turbulent before eventually declining owing to diminishing returns. Nevertheless, the plateau persists longer in uncertain, than in stable environments. Thus, we propose:

H4a. : In uncertain environments, the joint effect of R&D investments and firm-specific uncertainty on the relationship between ambidextrous diversification and efficiency is more prominent. Specifically, the positive relationship is more prominent and lasts longer before eventually concaving downward owing to diminishing returns.

H4b. : In uncertain environments, the joint effect of R&D investments and firm-specific uncertainty on the relationship between ambidextrous diversification and effectiveness is more prominent. Specifically, the positive relationship is more prominent and lasts longer before eventually concaving downward owing to diminishing returns.

3. Methods

3.1. Sample and data

We focus on manufacturing companies as it aligns with our research objectives. Our initial sample includes manufacturing firms listed on Compustat's annual database and the Center for Research in Security Prices (CRSP) monthly returns file. More specifically, it includes non-financial companies listed on the NYSE, AMEX, and NASDAQ. The advantage of using panel data instead of cross-sectional data is the ability to demonstrate a more accurate causal relationship among the variables (Certo and Semadeni, 2006). Data represent a 6 year period (2010 to 2015) for a final sample of 1313 manufacturing firms that provide 7650 firm-year observations.

3.2. Dependent variables

3.2.1. Effectiveness and efficiency

Since business performance is a multidimensional construct (Hart, 1992), we assess it along two dimensions – effectiveness and efficiency. Following Auh and Menguc (2005), we measure firm effectiveness as the sales growth rate and firm efficiency as profitability in return on assets (ROA). Broadly, ROA is defined as income before extraordinary items deflated by average total assets. In strategic management research ROA is commonly used as a proxy for firms' financial performance because it assesses the efficiency of a firm's resource usage. An alternative is to use sales growth rates which are more easily available, and do not suffer from accounting measurement problems. Sustained sales growth or growth rate is a reliable proxy indicator for other dimensions of superior firm performance (Henderson, 1999; Timmons, 1999). We apply a logarithmic transformation to the annual data to enhance the normality of the variable's underlying distribution.

3.3. Independent and moderating variables

3.3.1. Ambidextrous diversification

Strategic management studies generally adopt an entropy index to measure a firm's diversification strategy with dependent or independent variables (e.g., Hill et al., 1992; Hoskisson et al., 1993; Rumelt, 1982). We also adopt this approach to represent the related and unrelated diversification strategies of each firm. Following Rumelt (1982), we compute ambidextrous diversification, or the sum of related and unrelated diversification data, using segment data reported by the companies in accordance with Statement 131 of the Financial Accounting Standards Board (Financial Accounting Standards Board [FASB], 1997) and compiled by Standard and Poor in their Compustat segment file.

3.3.2. R&D investments

We draw on Griliches and Mairesse's (1995) argument that more recent R&D investments tend to be more valuable in measuring a firm's R&D. In addition, we account for the lagged effect (2-year lag) of R&D expenditure on performance. Then, as in previous studies (e.g., Hall and Mairesse, 1995; Wakelin, 2001), we define R&D as research and development expenditures scaled by total assets at the beginning of year *t*. All missing values in Compustat are assigned the value of zero.

3.3.3. Firm-specific uncertainty

In this study we use stock price volatility to measure uncertainty "because a high degree of price volatility is likely to correspond to managerial perceptions of uncertainty, which in turn could impact a firm's decision making" (Beckman et al., 2004, p.265). Following Beckman et al. (ibid.) we treat firm-specific uncertainty as the standardized daily volatility of the chosen firm's stock. We calculate daily volatility as the coefficient of variation for firm *j*'s annual daily stock closing price. Dividing the standard deviation by the mean renders the measurement of uncertainty interpretable across firms with varying price ranges.

3.4. Control variables

Following previous studies (Beckman et al., 2004; Voss and Voss, 2013), our analysis also control for firm size, age, market

orientation, and market uncertainty. We measure firm size as a logarithm of the firm's total assets. Firm age is measured as a logarithm for the number of years since the founding year. Market orientation is estimated as the international sales ratio. We use the standard deviation of cash flows from operating activities over the past three years for the two-digit Standard Industrial Classification (SIC) as a proxy for market uncertainty. Following Beckman et al., p.265), "market uncertainty is operationalized as the mean operating cash flow volatility of all sampled firms in the focal firm's industry". In this case, the focal firm is in the chemistry industry and we measure market uncertainty as "the mean coefficient of variation for operating cash flows for all firms in the chemistry industry for the representative year (excluding the focal firm)". "If a firm's industry operating cash flow experiences high variance relative to its average, then the focal firm (and other firms in the same industry) is experiencing high market uncertainty" (Beckman et al., ibid.).

4. Analyses and results

4.1. Model specification

Estimating panel data models with ordinary least squares (OLS) often results in heteroscedastic error terms and autocorrelation, which can lead to biased and inconsistent results (Bliese, 2000; Certo and Semadeni, 2006; Kenny and Judd, 1986). An alternative approach, we adopt here, is to use fixed- or random-effects models to estimate panel models (Certo and Semadeni, 2006; Halaby, 2004; Sanders, 2001). We perform Hausman's (1978) specification tests on the regressions for each hypothesis and find that the fixed-effects models are appropriate for all regressions ($p < 0.001$). We also use Hausman's test to check for possible simultaneity bias, for example, internal uncertainty and ambidexterity. A fixed-effects model focuses on within-firm variation over time and can address the concern that the coefficients are biased using time-invariant firm heterogeneity. Accordingly, all analyses are estimated using the fixed-effects option in STATA.

5. Analytical results

Table 1 lists the means, standard deviations, and pairwise correlations for the variables in this study.

Tables 2 and 3 summarize the regression results for the effects of ambidextrous diversification on efficiency (ROA) and effectiveness (sales growth rate), the moderating effects of R&D investments and firm-specific uncertainty, and the joint interactions among R&D investments and firm-specific uncertainty in the relationships between ambidextrous diversification and ROA (models 3–5 in Table 2) and sales growth rate (models 8–10 in Table 3). Models 1 and 6 are the unconstrained controls-only model. We include our control variables (firm size, age, and market orientation) in the regression analysis to examine the direct effect on ROA and sales growth rate. The results show that firm size, age, and market orientation associate significantly with ROA and sales growth rate.

In Hypotheses 1a and 1b, we propose that pursuing ambidextrous diversification reports a curvilinear relationship with efficiency and effectiveness. To test the hypotheses, we include ambidextrous diversification, squared ambidextrous diversification, and control variables in models 2 and 7. The results show that ambidextrous diversification and squared ambidextrous diversification are significantly positive ($\beta = 0.036, p < 0.001$; $\beta = -0.021, p < 0.001$ in Model 2 and $\beta = 0.018, p < 0.05$; $\beta = -0.04, p < 0.01$ in Model 7), thus supporting Hypotheses 1a and 1b. These results indicate that pursuing ambidextrous diversification does have a curvilinear effect on efficiency and effectiveness.

We, subsequently, include R&D investments, the interaction term for R&D investments and ambidextrous diversification, squared ambidextrous diversification, and control variables in models 3 and 8 to predict efficiency and effectiveness. The results reveal that the interaction term for R&D investments and ambidextrous diversification is negative ($\beta = -0.088, p \geq 0.05$ in Model 3) and the interaction term of R&D investments and squared ambidextrous diversification is positive and significant ($\beta = 0.144, p < 0.05$ in Model 3). In addition, Model 8 shows that the interaction term for R&D investments and ambidextrous diversification is positive ($\beta = 0.265, p \geq 0.05$ in Model 8), and the interaction term for R&D investments and squared ambidextrous diversification is positive and significant ($\beta = 0.168, p < 0.01$ in Model 8). These results fail to support Hypotheses 2a and 2b, which predict that R&D investments positively moderate the relationship between ambidextrous diversification and efficiency and effectiveness.

Next, we examine the hypothesis that firm-specific uncertainty moderates the relationship between ambidextrous diversification and efficiency and effectiveness (Hypotheses 3a and 3b). To test Hypothesis 3a, we insert firm-specific uncertainty and the interactions between ambidextrous diversification and firm-specific uncertainty in Model 4 when predicting efficiency. Model 4 shows that the interaction between ambidextrous diversification and firm-specific uncertainty is positive ($\beta = 0.015, p > 0.05$) and the interaction term of firm-specific uncertainty and squared ambidextrous diversification is negative ($\beta = -0.007, p > 0.05$). Hypothesis 3a is, therefore, directionally supported. Hypothesis 3b predicts effectiveness. The results show that the interaction between ambidextrous diversification and firm-specific uncertainty is positive ($\beta = 0.034, p > 0.05$) and the interaction term of firm-specific uncertainty and squared ambidextrous diversification is negative ($\beta = -0.007, p > 0.05$) as shown in Model 9, thus directionally supporting Hypothesis 3b.

Finally, we hypothesize that R&D investments and firm-specific uncertainty jointly moderate the relationship between ambidextrous diversification and effectiveness and efficiency. The effect is more prominent and long lasting in uncertain environments (Hypotheses 4a and 4b). To test Hypothesis 4a, we insert the three-way interactions among R&D investments, firm-specific uncertainty, and ambidextrous

Table 1
Means, standard deviations, and correlations.

Variables	Mean	Std.	1	2	3	4	5	6	7
1. Firm size (log of total assets)	6.15	2.20	–						
2. Firm age (log of firm age)	2.67	0.76	0.47**	–					
3. International sales ratio	0.30	0.81	0.07**		–				
4. Ambi-diversification	0.41	0.51	0.48**	0.42**	0.02*	–			
5. R&D investment ratio	0.13	0.28	−0.30**	−0.28**	−0.04**	−0.26**	–		
6. Firm-specific uncertainty	0.15	1.16	−0.25**	−0.23**	−0.03**	−0.16**	0.05**	–	
7. ROA	−0.02	0.12	0.27**	0.19**	0.04**	0.14**	−0.31**	−0.25**	–
8. Sales growth rate	0.13	0.50	−0.02*	−0.13**	−0.15**	−0.06**	0.17**	0.17**	−0.002

$N = 408$. Firm assets are indicated in million USD.
* $p < 0.05$.
** $p < 0.01$.

Table 2
Regression results for efficiency measured in ROA.

	Model 1 ROA β (t value)	Model 2 ROAβ (t value)	Model 3 ROA β (t value)	Model 4 ROA β (t value)	Model 5 ROA β (t value)
Constant	−0.123 (−24.26)***	−0.121 (−22.56)***	−0.089 (−16.23)***	−0.079 (−12.79)***	−0.054 (−8.33)***
Firm size	0.009 (14.24)***	0.008 (13.28)***	0.008 (12.28)***	0.008 (12.22)***	0.007 (11.87)***
Firm age	0.019 (11.15)***	0.016 (9.10)***	0.012 (6.89)***	0.012 (6.57)***	0.011 (5.95)***
International sales ratio	0.003 (2.34)*	0.003 (2.35)*	0.003 (1.84)	0.003 (1.81)	0.002 (1.58)
Ambi-diversification		**0.036 (5.04)*****	0.020 (2.55)*	0.008 (0.62)	−0.042 (−2.95)**
Ambi-diversification^2		**−0.021 (−4.04)*****	−0.017 (−2.91)**	−0.012 (−1.21)	0.015 (1.42)
R&D investment			−0.095 (−20.05)***	−0.094 (−19.94)***	−0.236 (−18.89)***
R&D investment × Ambi-diversification			**−0.088 (−1.25)**	−0.091 (−1.29)	0.404 (2.98)**
R&D investment × Ambi-diversification			**0.144 (2.00)***	0.149 (2.04)*	−0.164 (−1.16)
Firm uncertainty				−0.010 (−3.34)***	−0.027 (−8.09)***
Firm uncertainty × Ambi-diversification				0.015 (1.11)	0.061 (3.96)***
Firm uncertainty × Ambi-diversification^2				−0.007 (−0.63)	−0.031 (−2.61)**
Firm uncertainty × R&D investment					0.121 (12.26)***
Firm uncertainty × R&D investment × Ambi-diversification					**−0.469 (−3.56)*****
Firm uncertainty × R&D investment × Ambi-diversification^2					**0.304 (2.16)***
Number of observations	7690	7650	7650	7628	7628
R^2	0.061	0.065	0.113	0.114	0.131

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

diversification and those among R&D investments, firm-specific uncertainty, and squared ambidextrous diversification (Model 5) when predicting efficiency (ROA). Model 5 shows that the three-way interaction term for R&D investments, firm-specific uncertainty, and ambidextrous diversification is negative and significant ($\beta = -0.469$, $p < 0.001$) and that for R&D investments, firm-specific uncertainty, and squared ambidextrous diversification is positive and significant ($\beta = 0.304$, $p < 0.05$). Thus, Hypothesis 4a is not supported. Hypothesis 4b predicts effectiveness (sales growth rate). The results show that the three-way interaction term for R&D investments, firm-specific uncertainty, and ambidextrous diversification is negative and significant ($\beta = -0.527, p > 0.05$) and that for R&D investments, firm-specific uncertainty, and squared ambidextrous diversification is positive and significant ($\beta = 0.56$, $p < 0.05$). Thus, Hypothesis 4b is not supported.

6. Discussion

Firms achieve competitive advantages through the exploitation of both existing and developing internal and external firm-specific capabilities (Penrose, 1959; Teece, 1982; Wernerfelt, 1984). However, a major empirical gap that remains in the literature as to how firms exploit and develop resources and capabilities under diversification–competitive outcomes (Pisano, 2015). Our study finds that pursuing ambidextrous diversification has significantly curvilinear effects on efficiency (ROA) and effectiveness (sales growth rate). The curvilinear relationship between ambidextrous diversification and efficiency and that between ambidextrous diversification and effectiveness form an inverted U-shaped curve. In addition, our findings reveal that the curvilinear relationship between ambidextrous diversification and efficiency and that between ambidextrous diversification and effectiveness form a U-shaped curve when a firm with high R&D investments confronts high firm-specific uncertainty.

6.1. Theoretical implications

Our findings on curvilinear relationships between ambidextrous diversification and competitive advantages contribute to the extant literature. First, our findings broadly align with Uotila et al. (2009) argument that organizations must be capable of exploiting existing businesses and exploring new market spaces for long-term survive. Our specific findings, however, go beyond those of Uotila et al. by offering an explanation about how firms exploit and develop resources and capabilities to pursue an ambidextrous strategy.

Second, our findings resonate with Eisenhardt and Martin (2000) and suggest that strategic decision making involves the processes of acquiring, deploying, integrating, and reconfiguring resources to match market conditions and face market changes (Eisenhardt and Martin, 2000). Our findings, however, further support the argument that ambidextrous diversification is a dynamic tool that firms use, on the one hand, to enhance the existing resource and capability configuration to create competitive advantages and, on the other, to develop a new resource and capability configuration to achieve fresh competitive positions for a series of temporary competitive advantages (Eisenhardt and Martin, 2000).

Third, Voss and Voss (2013) find that strategic ambidexterity creates linear competitive revenue outcomes. Our findings, however, present an inverted U-shaped relationship between ambidextrous diversification and competitive outcomes. Our findings further indicate changes of such a relationship under differing contexts, i.e., R&D

Table 3
Regression results for effectiveness measured in sales growth.

	Model 6 Sales Growth Rate β (t value)	Model 7 Sales Growth Rate β (t value)	Model 8 Sales Growth Rate β (t value)	Model 9 Sales Growth Rate β (t value)	Model 10 Sales Growth Rate β (t value)
Constant	0.229	0.221	0.144	0.226	0.238
	(10.16)***	(9.33)***	(5.73)***	(8.07)***	(8.07)***
Firm size	0.020	0.021	0.022	0.022	0.022
	(7.46)***	(7.46)***	(8.05)***	(7.95)***	(7.91)***
Firm age	−0.079	−0.075	−0.063	−0.069	−0.069
	(−10.59)***	(−9.39)***	(−7.75)***	(−8.44)***	(−8.47)***
International sales ratio	−0.090	−0.090	−0.089	−0.089	−0.089
	(−14.02)***	(−14.04)***	(−13.89)***	(−14.11)***	(−14.10)***
Ambi-diversification		**0.018**	0.012	0.021	0.043
		(1.89)*	(1.84)*	(0.48)	(0.90)
Ambi-diversification^2		**−0.040**	−0.021	−0.055	−0.085
		(−2.17)**	(−2.57)**	(−0.95)	(−1.30)
R&D investment			−0.223	−0.220	−0.145
			(−8.06)***	(−8.04)***	(−2.21)*
R&D investment × Ambi-diversification			**0.265**	0.275	0.732
			(0.83)	(0.86)	(1.19)
R&D investment × Ambi-diversification^2			**0.168**	0.150	0.629
			(2.52)**	(2.46)**	(1.99)*
Firm uncertainty				−0.079	−0.090
				(−5.71)***	(−5.43)***
Firm uncertainty × Ambi-diversification				0.034	0.070
				(0.56)	(0.99)
Firm uncertainty × Ambi-diversification^2				−0.007	−0.035
				(−0.14)	(−0.64)
Firm uncertainty × R&D investment					0.085
					(1.28)
Firm uncertainty × R&D investment × Ambi-diversification					**−0.527**
					(−0.87)
Firm uncertainty × R&D investment × Ambi-diversification^2					**0.560**
					(1.98)*
Number of observations	7590	7577	7577	7555	7555
R^2	0.041	0.041	0.051	0.057	0.057

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

investments and firm-specific uncertainties. In doing so, we hope that we have brought insight to the focal relationship, and we encourage future research to follow our line of enquiry to advance insight and knowledge.

Fourth, we adopt a dynamic capability perspective to examine the underlying decision-making process employed by firms and their decision makers, and explain the inconclusive views on the combination of related and unrelated diversification (Montgomery and Wernerfelt, 1988; Nath et al., 2010; Narasimhan and Kim, 2002; Palich et al., 2000). Our findings suggest the need to investigate further firms' and decision makers' intentions to pursue ambidextrous strategies. The dynamic capability perspective appears to be a particularly useful lens to do so.

Fifth, our findings also provide interesting insights on the interactions between contextual factors (R&D investments and firm-specific uncertainty) and a firm's strategic ambidexterity. Existing research on ambidexterity focuses on uncertainties that emerge from externalities in a firm's environment, such as environmental dynamism, complexity, competitiveness and competitors, and industry technologies (e.g., Jansen et al., 2006; Lin et al., 2007; Raisch and Hotz, 2008; Simsek et al., 2009; Wang and Li, 2008). Uotila et al. (2009) use R&D spending as a proxy for industry environmental dynamism. Beckman et al. (2004) attempt to incorporate firm-specific uncertainty to examine the effect of firm-specific uncertainty on exploitation and exploration, respectively. We draw on dynamic capability to understand how R&D dynamically facilitates resources and capabilities, firms' reactions to uncertainties unique to the firm, and ways to enhance competitive advantages. Thus, the findings further our understanding of the relationship between strategic ambidexterity and competitive advantage.

However, we find, contrary to our hypotheses, that as R&D spending increases, the relationship between ambidextrous diversification and competitive outcomes in both efficiency and effectiveness shows exponential growth (without any evidence of diminishing returns). According to Uotila et al. (2009); p.223, firms in an industry with high R&D intensity "have much more opportunities to increase potential advantages from successful exploration." However, firms' capacity to exploit these opportunities may be constrained due to the high risk of technology obsolescence that leads to a down turn in performance. This suggests that when firms make sufficient investments in R&D to renew and develop core technologies, they are capable of seizing and exploiting advantageous opportunities. This explains why the impact of ambidextrous diversification on competitive outcomes in both efficiency and effectiveness shows exponential growth under increasing R&D investments.

The findings relating to the exponential curves must be examined and interpreted with caution. This is particularly the case for the relationship between ambidextrous diversification and efficiency. As growth implies increased consumption of resources, then a firm's limited resources will be completely depleted at some point. Alternatively, the maximum efficiency may imply the ratio of output to input reaches a hundred percent. Of course, our efficiency measure is in and of itself a ratio, creating a possibility for exponential growth which means the transforming process accelerates. In reality, the rate of acceleration

cannot grow indefinitely, and consequently, the growth of efficiency may, over time, slow down. Thus, the actual curve may resemble an S-shape (Gao et al., 2013; Modis, 2007; Phillips and Linstone, 2016; Sanwal, 2017). That is, the extent of R&D investments is yet to reach a point where the positive returns of ambidextrous diversification begin to concave downward. Finding such a tipping point is important and a subject for future research (Phillips, 2007). The results also suggest that engaging in ambidextrous diversification requires significant R&D investments. Despite the potential concern about efficiency, ambidextrous diversification, under the support of knowledge and capabilities accumulated through R&D activities, may indeed accelerate firm effectiveness (cf., Kang et al., 2019).

Furthermore, the impact of the three-way interactions among firm-specific uncertainty, ambidextrous diversification, and R&D investments on efficiency forms a U-shaped relationship. This indicates that efficiency gradually declines to its lowest point when firms pursue low to moderate levels of ambidextrous diversification. This might be due to the fact that the benefits of R&D input are lagged and have yet to emerge fully. Moreover, the effect and nature of firm-specific uncertainty remains to be explored and understood.

When the pursuit of ambidextrous diversification extends beyond the moderate level, the benefits of R&D investments emerge in the form of managing newly created resources and capabilities for profitability in the face of firm-specific uncertainty (Pitelis and Teece, 2010; Teece, 2019). An increase in R&D investments helps firms exploit advantageous opportunities residing in firm-specific uncertainties (Teece, 2007, 2018) and consequently, efficiency grows. The three-way interaction results are generally consistent with the concept of economies of scale, which represents cost advantages that an enterprise obtains as a result of its operational scale (Colander, 2008). However, under such uncertain environments, the effect of three-way interactions among firm-specific uncertainty, ambidextrous diversification, and R&D investments on effectiveness shows exponential growth without diminishing returns. This suggests that in environments with high firm-specific uncertainty, adequate investments in R&D makes ambidextrous diversification more significant and effective.

Finally, can competitive advantage be sustainable? Recent discussion supports the notion of transient, or temporary advantage (McGrath, 2013). Under significant ambiguity, predictions about the future are elusive and vague (Gans and Stern, 2010; Teece, 1981). The firm cannot decide on what competitive advantage to sustain (Satell, 2015). We argue that by pursuing ambidextrous diversification firms are capable of creating a series of transient advantages that facilitate survival. That is, strategic continuity toward ambidextrous diversification results in transient advantages associating with superior performance (Moss et al., 2014). As argued above, ambidextrous diversification involves the processes of acquiring, deploying, integrating, and reconfiguring resources and capabilities to match market conditions and to tackle market changes (Eisenhardt and Martin, 2000). McGrath (2013) emphasizes such processes are a means to create transient advantages for exploitation that help to defy obsolescence.

Furthermore, as firms continuously improve their technological resources and capabilities, they are better equipped to leap from transient, to distinctive advantage. Firms might cling to a transient advantage despite it being outdated. Core rigidities, or strategic liabilities may emerge, which could lead to competency traps (Levitt and March, 1988) so that performance suffers (Heracleous et al., 2017). Nonetheless, firms with rare and valuable technological resources and capabilities, along with R&D investment that expedites learning (Vecchiato, 2015), are capable of transforming weaknesses to strengths in uncertain environments, which create benefits (Sirmon et al., 2010). Some firms may even engage in sustainability-oriented innovation (Inigoa and Albareda, 2019; Furlana and Vinelli, 2018) whereby rare and valuable technological resources and capabilities enable firms to move from one transient position to another for competitive advantage (McGrath, 2013; Useem, 2000).

6.2. Managerial implications

The argument in this study and the derived empirical support offer several important implications for decision makers. We employ a practical approach common to public firms to measure ambidexterity. The advantage of this approach is that it reflects important and frequently employed corporate strategic activities. Thus, our findings have direct relevance for a firm's decision makers. Further, our findings indicate that the combination of related and unrelated diversification does exert a curvilinear influence on competitive advantages in terms of firms' effectiveness and efficiency. Therefore, in addition to including an ambidextrous planning strategy, as suggested by Bodwell and Chermack (2010), our findings point managers towards adjusting the extent of ambidextrous diversification to create advantages.

Prior studies indicate that uncertainty arising from externalities, including market and industry uncertainties, typically have a positive impact on ambidexterity performance. However, scholars also caution that external uncertainties comprising factors common to all firms in the same market cannot be controlled or reduced by the actions of a single firm (Beckman et al., 2004; Burgers et al., 1993; Wiersema and Bantel 1993). However, our findings suggest that decision makers can take advantage of controllable contextual factors (R&D investments and firm-specific uncertainty) to create competitive advantages through strategic ambidexterity.

Furthermore, our study indicates that the extent to which ambidextrous diversification creates competitive advantages and further strengthens these advantages depends on the degree to which firms dynamically adjust ambidextrous diversification in line with R&D investments and specific uncertainties. Substantial investments in R&D render ambidextrous diversification execution more significant and effective in environments with high firm-specific uncertainties.

7. Limitations and future research directions

The findings of this study should be viewed in light of its limitations, which provide meaningful direction for future research. First, in an effort to link theoretical concepts with practical strategic activities, we measure strategic ambidexterity as a combination of two commonly used strategic activities within firms. Our measures of firm-specific uncertainty (using stock price volatility as a proxy for managerial perceptions of uncertainty; Beckman et al., 2004) differ from other studies and may have influenced our results. Future research should conduct compares the measures used in this study with those in other research. Furthermore, our study defines greater strategic ambidexterity as a firm's increasing efforts to pursue related and unrelated diversification simultaneously. It is possible that attempts to undertake a high level of related and unrelated diversification can overwhelm a firm's ability to execute both well. In other words, there may be limitations to ambidexterity. As firms engage in increasing levels of ambidexterity, the cognitive complexity significantly increases (Lin and McDonough, 2014), potentially overwhelming managers' abilities to deal with it. Thus, there is a need to investigate the psychological impact of ambidexterity on decision makers and firm members.

Second, it is important to consider other factors influencing the focal relationship. Economics scholars, for example, suggest that managers' achievement of ambidexterity associates more associated with performance than with exploration and exploitation strategies. Several scholars note that "the relationship between diversification and performance is complex and is affected by intervening and contingent variables such as type of relatedness, the capability of top managers and industry structure" (Hoskisson and Hitt, 1990; Kerin et al., 1990). Additionally, the skill with which managers pursue ambidexterity could also have an important influence on a firm's performance and competitive advantages.

Finally, since the data constrain our ability to indicate precisely when ambidextrous activities are optimal in terms of the degree of

related and unrelated diversification activities to be employed, the possibility of an optimal point remains speculative and warrants additional research. Furthermore, the exponential curves unveiled by our data analyses, albeit interesting, might deserve more research for the purpose of validation.

CRediT authorship contribution statement

Hsing-Er Lin: Conceptualization, Writing - original draft, Writing - review & editing. **I-Chieh Hsu:** Writing - review & editing. **Audrey Wenhsin Hsu:** Formal analysis. **Hsi-Mei Chung:** Writing - review & editing.

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Supplementary materials

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