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The Structural Relationship among the Venture Company's Corporate Entrepreneurship, Positive Error Management Climate, Technology Commercialization Capability, Technological Innovation Capability and Management Performance

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ABSTRACT

In high-uncertainty environments shaped by rapid technological change, venture firm performance depends not only on technological resources but also on the organizational mechanisms that transform these resources into market value. Drawing on the resource-based view, entrepreneurial orientation theory, and error management theory, this study develops and tests an integrated structural model linking technological innovation capability and technology commercialization capability to management performance through the mediating role of corporate entrepreneurship and the moderating role of positive error management climate. Survey data were collected from employees and key informants of Korean venture firms registered with a national venture association (N > 300). Structural equation modeling was employed to test the proposed hypotheses. The results reveal that both technological innovation capability and technology commercialization capability exert significant positive effects on management performance. Corporate entrepreneurship partially mediates these relationships, indicating that technological capabilities translate into superior performance when accompanied by organizational innovativeness, proactiveness, and risk-taking behaviors. Furthermore, multi-group analysis demonstrates that positive error management climate strengthens the effects of technological capabilities on performance, suggesting that learning-oriented cultures enhance the conversion of technological resources into market outcomes. This study contributes to the literature by distinguishing innovation capability from commercialization capability and integrating technological, behavioral, and cultural determinants within a single framework. The findings provide theoretical implications for extending dynamic capabilities and entrepreneurial orientation perspectives and offer practical insights for venture firms seeking sustainable competitive advantage in technology-intensive industries.

Keywords: Venture Company, Corporate Entrepreneurship, Positive Error Management Climate, Technology Commercialization Capability, Technological Innovation Capability, Management Performance
JEL Classifications: D23, M10, M21, G40, L24, L26

1. INTRODUCTION

In an era characterized by rapid and unpredictable global transformation, it is difficult for anyone to state with certainty what the future of society will look like. Nevertheless, it is evident that the Fourth Industrial Revolution has intensified the necessity of generating and leveraging diverse forms of knowledge to secure competitiveness in technologies that will lead future societal change. In this context, it has become increasingly critical for firms to develop or acquire new technologies independently and to sustain competitive advantage through successful technology commercialization that creates technology-related market demand and facilitates market entry.

Under such circumstances, technology-based venture firms play a pivotal role as dynamic and proactive drivers of market

economies and as new engines of sustained growth. To introduce high-quality products to the market, venture firms must analyze market demands and respond effectively by supplying products and services that meet customer needs. This requires a strong technology orientation that supports both firm survival and growth (Brown and Eisenhardt, 1995).

Although it is difficult to predict in advance the precise determinants of success and failure in venture firms, numerous prior studies have attempted to minimize failure and enhance success rates by conducting comparative analyses of start-ups that have experienced success and failure (Baum et al., 2001). Early research on technology-based ventures emphasized that the technology possessed by the firm itself constitutes a core source of competitive advantage. Such studies argued that technological resources, proprietary technologies, and the accumulation of technological capabilities positively influence firm performance (Zahra, 1996).

A review of prior research on venture firm performance reveals that most studies have conceptualized entrepreneurial characteristics or managerial strategies as independent variables and examined their direct, single-dimensional relationships with management performance. However, such unidimensional approaches present inherent limitations (Covin and Slevin, 1991), highlighting the need for multidimensional analyses that incorporate organizational-level factors (Chrisman et al., 1998). Synthesizing the existing literature suggests a relative lack of research on the organizational characteristics of venture firms. Moreover, few studies have disaggregated technology-related factors into more fundamental and nuanced components to investigate their relationships with management performance. Although some studies report that technological capability significantly influences firm performance, they often treat technological capability as a broad and comprehensive construct without considering its inherent diversity (Philippi et al., 2021).

While contemporary research increasingly recognizes organizational culture as a critical determinant of management performance across various types of firms, relatively little attention has been devoted to the organizational characteristics of venture firms. Therefore, research focusing on organizational culture within venture firms is warranted, as organizational culture constitutes a fundamental source of competitive advantage and plays a decisive role in shaping the firm's essential capabilities. In particular, technology-based venture firms continuously pursue technological innovation to lead innovation trajectories and secure competitive advantage. Accordingly, technological innovation capability represents a core competency. It is one of the most crucial decision-making domains in the development of new products and technologies and is indispensable for preempting sustained competitive advantage (Kim, 2015).

Booz et al. (1982) argued that, in addition to technological innovation capability, the capability to successfully commercialize new products in the market—namely, technology commercialization capability—also exerts a significant influence on management performance. Given the importance of technological differentiation for firm profitability and growth, it is reasonable to assume that superior management performance can be achieved when technological innovation capability is effectively linked to technology commercialization capability, enabling the successful development, production, and marketing of innovation-driven products. For venture firms seeking to generate economic performance through the acquisition or development of advanced technologies, the creation of market demand through effective technology commercialization is essential. Technology commercialization capability—defined as the ability to optimize know-how beyond mere internal technologies or functions and to lead successful commercialization—is increasingly emphasized.

Research on technology commercialization began to expand actively in the 1990s, with early studies focusing primarily on process-based perspectives. For example, Richard and Steven (1995) conceptualized commercialization as the process of transforming ideas into future profits. Mitchell and Singh (1996) described the technology commercialization process as encompassing idea generation, knowledge refinement and modification, product development and production, and market launch. Building on these foundational studies, subsequent research has demonstrated that technology commercialization plays a critical role in maintaining sustained competitiveness and securing market share. From a business perspective, technology commercialization refers to the process of transforming research and development outcomes or technological research results into marketable products and business applications, encompassing all stages from laboratory research to market implementation. A substantial body of prior research has selected technology commercialization capability as an independent variable influencing research and business performance. Technologies or products developed through R&D do not automatically translate into managerial or research outcomes; rather, firms must undertake a technology commercialization process that improves and applies such technologies to production and marketing activities in order to secure competitive advantage and achieve successful market entry. The capability that enables this process is technology commercialization capability.

From this perspective, there is a pressing need for comprehensive and systematic analyses of the structural relationships among relevant variables in order to propose desirable and effective organizational directions for venture firms seeking to generate superior management performance and lead future industries. However, comprehensive research addressing these relationships remains limited. Accordingly, this study seeks to differentiate itself from prior research by examining the structural relationships among management performance, technology commercialization capability, technological innovation capability, corporate entrepreneurship, and positive error management climate in venture firms. To this end, the study targets employees working in venture firms and aims to provide meaningful practical and theoretical implications.

The primary objective of this study is to identify the structural relationships among management performance, technology commercialization capability, technological innovation

capability, corporate entrepreneurship, and positive error management climate in venture firms. Specifically, technology commercialization capability and technological innovation capability are conceptualized as independent variables; corporate entrepreneurship is modeled as a mediating variable; and positive error management climate is introduced as a moderating variable. Through empirical analysis, the study seeks to derive implications regarding their effects on management performance as the dependent variable.

To achieve this objective, the specific research goals are as follows. First, to establish an appropriate structural model representing the relationships among management performance, technology commercialization capability, technological innovation capability, corporate entrepreneurship, and positive error management climate in venture firms. Second, to examine the direct effects of technology commercialization capability, technological innovation capability, and corporate entrepreneurship on management performance. Third, to investigate the mediating effect of corporate entrepreneurship on management performance. Fourth, to analyze the moderating effect of positive error management climate on the relationships between management performance and both technology commercialization capability and technological innovation capability.

2. THEORETICAL BACKGROUND

2.1. Venture Firms and Management Performance

Cooper (1986) defined venture firms as organizations that devote substantial effort to research and development (R&D) and emphasize the utilization of new knowledge. Management performance refers to the ultimate outcomes generated after an organization sets plans to achieve predetermined objectives and deploys its tangible and intangible resources through execution and operation. Traditionally, analyses of management performance have relied heavily on objective financial indicators, reflecting an efficiency-oriented perspective. However, Fisher (1992) argued that financial indicators are inherently backward-looking; they neither capture a firm's beliefs and intentions regarding future change nor enable reliable forecasting. Moreover, evaluating performance solely through numerical metrics makes it difficult to identify the key drivers of business success and does not provide actionable behavioral guidance for organizational members. Brewer and Speh (2000) further noted that conventional financial performance measurement systems are limited in their ability to manage and improve core processes and to provide the information required for effective decision-making.

For these reasons, non-financial indicators have been increasingly used alongside financial measures as objective performance metrics, and such an approach is also highly relevant for venture firms. Prior studies examining financial indicators in venture firms have commonly operationalized financial performance through measures such as sales growth, improvements in operating profit, and reductions in manufacturing costs, as well as profitability indicators including profit margin on sales and return on capital (Kreiser et al., 2021).

In venture firm research, it is essential to determine which indicators should be used to assess performance and to analyze the determinants of performance. Jones et al. (2001) proposed the use of financial indicators based on profitability and return on investment for assessing venture firm performance, complemented by non-financial indicators—such as market potential, growth potential, and goal attainment—to capture long-term growth. Although financial measures of performance can include employment, sales, market share, production volume, profits, and assets, these indicators are often insufficient for capturing R&D, which is central to venture firms. Accordingly, venture firm performance should also incorporate non-financial, forward-looking measures. This is because various efforts to foster early-stage venture growth—such as innovation activities, marketing initiatives, and strategies for responding to market change—may affect performance quantitatively but often have a limited immediate impact on sales (Stuart and Abetti, 1987).

At the same time, obtaining reliable financial performance information is comparatively difficult for venture firms, which are not always required to disclose financial results externally. Even when financial statements are available, irregular growth patterns may limit their usefulness as performance data. In particular, venture firms typically invest heavily in R&D during the early stages, while subsequent processes—such as prototype scaling and mass production—require substantial time, meaning that outcomes from technology and product development may not emerge in the short term. Therefore, it is necessary to examine technological performance, including technology and product innovation outcomes (Lee and Kim, 2018).

Research on technological performance began in the 1980s from a technological innovation perspective, initially focusing on performance assessment based on new product development processes (Cooper, 1986). Subsequent studies evaluated performance through indicators such as development lead time, improvements in technological capability, patent acquisition, and overall process execution. Song and Montoya-Weiss (2001) defined the technological performance of new products as the superiority of a product relative to competitors' offerings, arguing that technological success can be assessed when a product outperforms competitors in relative performance, product attributes, quality, and cost.

Although technological performance often becomes visible only over extended periods and is therefore difficult to measure precisely, prior studies have proposed various indicators. Cordero (1990) categorized technological performance in terms of the degree of technological opportunities provided and outputs such as patents and publications. Lee (2006) proposed indicators such as improved technology development capability, spillover effects of technology, cost reductions, defect-rate reductions, production quality, enhanced R&D capability, and improved product performance. Kim and Yoon (2014) classified technological performance into technological excellence, business profitability, and market growth potential, and found that the firm environment and technological innovation capability significantly affect technological performance in SMEs. Ko (2017) conceptualized

technological performance as outcomes related to embedded technological competence in products or services, technology-development know-how, development lead time, development organization, and patents, and suggested that value creation activities and value appropriation influence technological performance.

2.2. Concepts and Components of Technology Commercialization Capability, Technological Innovation Capability, Corporate Entrepreneurship, and Positive Error Management Climate

2.2.1. Technology commercialization capability: Concept and components

Nevens (1990) defined commercialization as the process of effectively translating a product from concept to market, while Mitchell and Singh (1996) described it as the process of transforming and selling ideas by leveraging technologies that can be refined or acquired. Building on these definitions, technology commercialization can be understood as the process of directly applying internally developed or adopted technologies to activities such as assimilation, improvement, production, and sales. Because technology commercialization is interpreted as a complex and comprehensive function that encompasses product development, production, and marketing, it is influenced by diverse internal and external organizational factors and requires close interdependence and collaboration. In particular, technology commercialization involves converting technologies acquired through in-house R&D, collaborative or contracted research, or technology acquisition into effective commercialization outcomes by assimilating, absorbing, and diffusing them within the organization.

The phenomenon of technology commercialization began to attract scholarly attention after being introduced in Schumpeter's (1942) theory of innovation. In Schumpeter's view, technology commercialization refers to a process through which ideas progress through stages such as R&D, production, commercialization, and practical application to introduce new product or service models that deliver both commercial and social value. The term "technology commercialization" was explicitly introduced by Nevens (1990), who argued that it entails the implementation of technologies or production processes recognized by the firm through activities such as R&D, design, manufacturing, and marketing to satisfy market demand. One influential model is Jolly's (1997) "five stages and four transitions" framework, which describes commercialization as moving from (1) imagining—applying technological value to market opportunities, (2) incubating—systematizing feasibility in terms of technology and market demand, (3) demonstrating—concretely embodying technology in products, (4) promoting—enhancing market acceptance, and (5) sustaining—maintaining products or processes over time while preserving product value. Another prominent perspective is Cooper's (1986) Stage-Gate process, which frames technology commercialization from the customer perspective—meeting consumer needs—and suggests that while stages occur sequentially, some activities may proceed in parallel to reduce time-to-market.

Technology commercialization enables firms to create technology-related market demand, enhance value creation and employment, successfully enter markets, and sustain competitive advantage by commercializing newly developed or acquired technologies. As the importance of technological competence has become increasingly salient, only firms that can develop or acquire advanced technologies and commercialize them into products and services are likely to survive in intensely competitive environments. Thus, firms must cultivate the capability to convert abstract ideas into market-recognized products and, beyond internal development, must be able to transform transferred or acquired technologies into practical offerings through productization and commercialization. In this sense, firm competitiveness depends not only on possessing superior technologies but also on technology commercialization capability—the ability to translate technologies into products and successfully enter target markets.

Technology commercialization capability is commonly defined as the capability to perform a set of activities that improve technologies and directly reflect them in production and sales (Metcalfe, 1995). Booz et al. (1982) argued that systematic commercialization capability—supported by a new product development strategy, development processes for market entry, and long-term planning—affects management performance. Nevens (1990) described technology commercialization capability as an inter-firm competitive advantage derived from cost reduction, new technology acquisition, and quality improvement, emphasizing top management commitment to goal setting and achievement. Adler and Shenhar (1990) highlighted four key dimensions: Ability to meet future demand, ability to respond to uncertainty, ability to satisfy markets, and product manufacturing capability. Hamel and Prahalad (1990) also stressed the importance of commercialization capability as a factor that directly influences production and sales through technological improvement.

Moreover, Behave (1994) suggested that systematic commercialization of technology or ideas proceeds through stages such as building production technologies, productization, mass production, market development, and distribution, requiring strong commercialization capability. Lester (1998) categorized five determinants of commercialization success: Generation of new product concepts, team formation for new product development, organizational and operational characteristics, project management, and top management attention. Rosenau (2001) similarly emphasized that top management intention is critical for enhancing commercialization capability. Yam et al. (2004) proposed seven organizational capabilities constituting technology commercialization capability: Marketing capability, manufacturing capability, R&D capability, resource allocation capability, strategic planning capability, organizational capability, and learning capability.

Taken together, prior research suggests that firms must continuously provide products and services desired by customers and that, to successfully introduce new products, technology commercialization capability—characterized by focused investment in core technologies, high technology intensity, and effective retention and accumulation of developed technologies—is essential (Bowen et al., 1994). Across the literature, while the proposed factors vary, productization capability, manufacturing

capability, and marketing capability consistently emerge as core components. Accordingly, this study defines technology commercialization capability as the firm's capability to perform all activities related to selling newly acquired or developed technologies as products or services aligned with customer needs, and operationalizes it through three primary dimensions: Productization capability, manufacturing capability, and marketing capability.

2.2.2. Technological innovation capability: Concept and components

Technology, in a broad sense, may be understood as a behavioral pattern through which organizational inputs are transformed into outputs using techniques, tools, and knowledge (Daft, 1978). In a narrower sense, technology refers to the totality of techniques, know-how, and knowledge required for development and production in manufacturing (Dahlman and Westphal, 1981).

Synthesizing prior research, innovation can be characterized as: (1) the adoption by individuals or organizations of something perceived as new, whether previously existing or not (Aiken and Hage, 1971; Marcus, 1988; Scott and Bruce, 1994); (2) a phenomenon that entails change, although not all change constitutes innovation (Mezias and Glynn, 1993; Woodman et al., 1993; Damanpour, 1996); and (3) a process oriented toward objectives such as performance improvement, environmental adaptation, and enhanced effectiveness and efficiency (Drucker, 1985; Sumii, 1986). The OECD's Oslo Manual further expands the innovation concept beyond earlier product- and process-focused views by encompassing process innovation, marketing innovation, organizational innovation, and product innovation (OECD, 2005).

Technological innovation, as a compound term, emphasizes the dynamic aspects of technological development and highlights both development and utilization. Schumpeter (1934) defined technological innovation as a set of technology-related phenomena—including market expansion and the discovery of new products and raw materials—that bring about changes in organizational structure. He argued that profit functions as a critical driver of innovation in capitalist development by serving as an incentive for entrepreneurs, motivating firms to create new combinations of inputs and to reduce the cost of producing new products through innovation.

Technological innovation also refers to the introduction of new processes or products to satisfy customer needs and enhance competitiveness and profitability (Zahra et al., 2000). It is widely recognized as essential for securing competitive advantage in intense competitive environments and encompasses both improvements to existing products and the development of new products (Adams et al., 2006; Becheikh et al., 2006). Technological innovation has been examined from diverse perspectives regarding processes, scope, methods, and sources (Rothwell, 1992). In general, consistent with Schumpeter (1934), many studies conceptualize technological innovation as the first introduction and utilization of technological change—outcomes produced by attempting new combinations or making changes in markets, resources, organizations, and production methods.

Teece et al. (1997) argued that firm success depends less on the resources a firm possesses per se than on its ability to generate and renew those resources. That is, the critical issue is not merely what resources are held, but the capabilities through which resources are acquired, accumulated, and created. In uncertain environments, firms therefore require technological innovation capability to continuously create competitive advantage and differentiation.

Marquis (1996) conceptualized technological innovation capability as the integrated set of staged activities spanning new technology development, production, and the exploration of new markets. Cummings (1997) emphasized that technological innovation capability can be enhanced by selecting individuals with innovative potential and creating a work environment that allows organizational members to focus on creative tasks, thereby maximizing creativity. Technological innovation capability is also viewed as a foundational driver of sustained competitive advantage through strategic execution, including possession of rare, difficult-to-imitate resources (Barney, 1991). As a firm-level characteristic, it supports innovation strategy and enables sustainable success (Burgelman et al., 2004). Prior studies commonly classify technological innovation capability into three broad perspectives: technological innovation systems, technology accumulation capability, and R&D capability.

2.2.3. Corporate entrepreneurship: Concept

Following Schumpeter's (1934) seminal work emphasizing entrepreneurs as agents of disruptive innovation in capitalist development, entrepreneurship began to be treated by economists as a critical element of market functioning. Schumpeter argued that entrepreneurship is the spirit that leads innovation and creative destruction, contributing to social development. Stevenson (1994) defined entrepreneurship as creative action that pursues opportunities and involves risk-taking regardless of the resources currently controlled by the firm.

In terms of research trends, entrepreneurship studies in the 1960s largely adopted behavioral science and psychology approaches, focusing on the personal characteristics of successful entrepreneurs and founders. In the 1990s, entrepreneurship developed into a more independent research domain, and scholars began to view it through two key lenses: Process and environment. Low and MacMillan (1988) emphasized the need for process-oriented research that spans stages of firm development—from opportunity recognition to founding, growth, and decline—as well as research that examines external environmental factors supporting firm creation and growth.

Overall, the focus of entrepreneurship research expanded from individual traits to firm- and organization-level phenomena as organizational activities became increasingly complex. More recently, entrepreneurship has extended beyond corporate contexts to diverse domains such as social, administrative, and political fields where change and innovation are required.

Corporate entrepreneurship has been defined in various ways. In contrast to the CEO's individual entrepreneurship, corporate entrepreneurship is a firm-wide orientation that is future-oriented,

innovative, and willing to take risks in pursuit of performance outcomes (Barringer and Bluedorn, 1999). It can also be understood as an internal organizational process and strategic choice that actively responds to constraints and pursues new opportunities (Covin and Slevin, 1991).

Prior studies have primarily examined associations between corporate entrepreneurship and outcomes such as firm performance and organizational effectiveness. For example, Zahra (1993) analyzed 102 firms and found that environmental characteristics significantly influence corporate entrepreneurship, and that corporate entrepreneurship positively affects firm growth and financial performance.

2.2.4. Positive error management climate: Concept

Errors generally refer to unintentional deviations from goals, standards, behavioral rules, or specific values (Cannon and Edmondson, 2001). A key element in this definition is unintentionality, distinguishing errors from deliberate violations of norms, rules, or conventions. The error prevention approach seeks to avoid negative outcomes by preventing errors altogether. However, as implied by the definition, human errors cannot be perfectly prevented; therefore, it is crucial to manage errors and their consequences appropriately (Van Dyck et al., 2005). In contrast, the error management approach is learning-oriented and views errors as opportunities for learning from negative outcomes (Heimbeck et al., 2003). Because errors can provide valuable information about how to achieve goals, such learning becomes possible only when errors are made visible. Keith and Frese (2005) suggested that the less individuals are affected by negative emotions stemming from errors, the more they can learn from them.

Error management has been applied and studied at the organizational level using the concept of culture or climate (Klein et al., 1994). In general, culture or climate refers to shared norms, values, and general rules-of-practice within organizations (Reichers and Schneider, 1990). Accordingly, an error management climate/culture refers to shared organizational rules and procedures that encourage open communication about errors, sharing of error-related knowledge, mutual assistance among colleagues in error situations, and rapid detection and resolution of errors.

Because failure and errors are inevitable in organizational learning and adaptation, a positive error management climate reflects the belief that learning and innovation can emerge from errors that are surfaced rather than suppressed (Van Dyck et al., 2005). Error management climate is considered particularly effective at the organizational level (Van Dyck et al., 2005) and has therefore been examined primarily in organization-level research (Klein et al., 1994). Van Dyck et al. (2005) defined error management culture as an organizational management practice in which members continuously communicate and share failures, help one another when failures occur, and detect and resolve errors quickly.

The most widely used instrument for measuring error management culture is the error management culture questionnaire developed by Van Dyck et al. (2005), which was adapted from the error orientation questionnaire (EOQ) by Rybowiak et al. (1999). Whereas the EOQ was originally developed at the individual level, Van Dyck et al. (2005) modified it into an organizational-level measurement tool.

2.3. Direct Relationships among Management Performance, Technology Commercialization Capability, Technological Innovation Capability, and Corporate Entrepreneurship

2.3.1. Technology commercialization capability and management performance

Prior studies have examined the relationship between technology commercialization-related capabilities and management performance from various perspectives. Hise et al. (1990) analyzed how the extent of marketing involvement in R&D affects management performance and found that stronger involvement is associated with higher performance. Hamel and Prahalad (1990) argued that manufacturing capability constitutes a strategic resource and that firms should strive to develop superior capabilities in products or production processes that are difficult for competitors to imitate. Song and Parry (1997) reported that stronger alignment between a firm's marketing capability and new product development projects leads to higher performance in the new product development process. Heunks (1998), studying 200 SMEs across six European countries, found that R&D innovation, manufacturing, and marketing innovation capabilities influence management performance. Dutta et al. (1999) emphasized that beyond R&D competence, marketing and manufacturing capabilities are essential for maximizing management performance in cutting-edge markets. Wind (2005) suggested that marketing capability is a key driver of management performance because it most strongly influences innovation outputs in R&D-based firms. Nath et al. (2010), analyzing 102 UK logistics-based firms, identified marketing capability as a core determinant of financial performance and emphasized a focused product portfolio strategy. Fernando et al. (2018) also found that marketing capabilities grounded in resource-based and value-related frameworks positively influence management performance.

Based on this body of evidence, although R&D and manufacturing capability are important for technology-based firms, marketing and productization capability function as critical components of technology commercialization capability to ensure that developed products are competitively launched and market share improves. Therefore, technology commercialization capability can be expected to positively affect management performance.

2.3.2. Technological innovation capability and management performance

Although the literature directly examining technological innovation capability and management performance is relatively limited, several studies provide relevant insights. Romanelli and Tushman (1986) suggested that strong management performance enables firms to accumulate internal capabilities to invest in resources such as R&D and to enhance other external capabilities, thereby positively affecting technological innovation. Cohen and Levinthal (1990) argued that technological innovation capability—enabling firms to produce products superior to existing

offerings in price, cost, and quality—helps secure competitive advantage and leads to higher performance. Schoenecker and Swanson (2002) examined the effects of technological innovation capability on management performance using indicators such as patent counts, new product launch counts, R&D expenditure, and sales as measures of R&D intensity. In addition, Kim (2018) noted that technological innovation capability has been described using diverse terms (e.g., technology orientation, technological innovation activities, innovation orientation) and suggested that key capability indicators include R&D expenditure ratios, the number of R&D personnel, and job intensity, while performance indicators include patent value, market share, the number of new products developed, patent counts, and technological and economic evaluations of innovation outcomes.

2.3.3. Corporate entrepreneurship and management performance

Since Miller (1983) advanced corporate entrepreneurship as a key factor for enhancing firm development and performance, it has been widely examined as a central determinant of both financial and non-financial performance in changing environments (Zahra and Covin, 1995; Zahra, 1993). Prior studies indicate that corporate entrepreneurship affects financial outcomes such as competitive advantage, sales growth, asset growth, and profitability (Austin et al., 2006; Lumpkin and Dess, 2001; Zahra et al., 2000; Zahra and Garvis, 2000). Other research has explored whether corporate entrepreneurship drives sustained firm growth and development by increasing financial gains through new value creation (Morris et al., 2013; Austin et al., 2006; Antoncic and Hisrich, 2001). In this literature, corporate entrepreneurship is commonly used to assess a firm's potential financial performance relative to competitors.

The positive relationship between corporate entrepreneurship and management performance aligns with broader evidence showing that entrepreneurship is a core element of firm success under uncertainty (Zahra, 1991; Covin and Slevin, 1991). Entrepreneurship can enhance outcomes by generating new knowledge through entrepreneurial activities. Morris and Kuratko (2002), based on case studies of successful firms, reported that the operation of corporate entrepreneurship yielded outcomes such as wealth creation, new business creation, innovation creation, change creation, employment creation, value creation, and growth creation.

Environmental factors may also shape this relationship, including firm age, firm size, and industry. Environmental hostility and environmental dynamism represent firm-level environmental conditions (Wales et al., 2011; Moreno and Casillas, 2008). Environmental dynamism refers to uncertain conditions involving rapidly changing customer needs and competitor behaviors, short product life cycles, and high levels of innovation (Moreno and Casillas, 2008; Wiklund and Shepherd, 2005; Lumpkin and Dess, 1996; Zahra, 1993). Conversely, hostile environments are characterized by unfavorable conditions such as abrupt change and powerful competitors.

Corporate entrepreneurship may influence performance not only through external environmental conditions but also through internal factors. One critical internal factor is the development of human resources with entrepreneurial attributes through education and training (Wiklund and Shepherd, 2005), because entrepreneurial performance outcomes depend heavily on human resources and their capabilities. As the importance of entrepreneurial human resources has been recognized, attempts have been made to identify and build entrepreneurial characteristics. Morris et al. (2013) proposed entrepreneurial characteristics distinct from managerial traits, including opportunity recognition, opportunity evaluation, risk management and coping, clear vision, perseverance and grit, problem-solving ability, resource influence, value creation, guerrilla skills, self-efficacy, focus and adaptability, resilience, and relationship-building as innovative behavioral traits. Kyndt and Baert (2015) also proposed entrepreneurial characteristics—based on diverse ages and experiences in sustainable work environments—including learning orientation, sensitivity to the social environment, market insight, opportunity recognition, networking, persuasiveness, future planning, independence, awareness of return on potential investment, self-awareness, perseverance, and decisiveness. However, the relationship between these constructed entrepreneurial characteristics and management performance has not been sufficiently examined. The present study differentiates itself by extracting entrepreneurial characteristics from innovation leaders responsible for innovation tasks within large Korean enterprises and investigating how each characteristic influences corporate entrepreneurship outcomes and expected management performance.

In sum, entrepreneurial characteristics can be positioned as core drivers that enhance management performance through activities such as new product development and new market exploration, thereby allowing the establishment of relationships between corporate entrepreneurship outcomes and expected management performance.

2.4. The Mediating Role of Corporate Entrepreneurship

2.4.1. Corporate entrepreneurship as a mediator between technology commercialization capability and management performance

Direct studies employing identical constructs to examine the relationship between technology commercialization capability and corporate entrepreneurship are difficult to identify. Nevertheless, based on findings from conceptually similar variables, corporate entrepreneurship can be expected to play a mediating role in the relationship between technology commercialization capability and management performance. Relevant prior studies include the following.

Dorf and Byers (2005) argued that technological entrepreneurship identifies and develops high-growth technology opportunities. They suggested that such opportunities consist of technologically feasible products that meet high value creation conditions, strong intellectual property, sustainable competitive advantage, high market growth potential, and business models with demonstrated success. These opportunities may be based on either radical technological breakthroughs or incremental technological improvements and may target existing markets or create entirely

new markets. White and Bruton (2007) viewed entrepreneurship as a catalyst for technological innovation and emphasized that, as innovation paradigms shift from closed to open innovation, actors in the technological innovation domain must play boundary-spanning roles through technological entrepreneurship. They argued that entrepreneurship is a starting point for developing innovation capabilities to create value and sustain competitive advantage, and that technological entrepreneurship plays a distinct role as a window into technological innovation. Antoncic and Prodan (2008) noted that technological entrepreneurs often possess broad technological knowledge but may lack managerial knowledge necessary for success in newly established technology-intensive firms; therefore, technological entrepreneurship must incorporate risk-taking. They further suggested that technological entrepreneurship is a key driver for stimulating new competitive growth in advanced economies and for creating performance in transitional competitive regimes. Burgelman et al. (2004) argued that technological entrepreneurship creates new resource combinations to realize technological innovation and integrates technological and commercial domains in profitable ways, thereby providing momentum for innovation processes. In their view, technological entrepreneurship functions as a linkage between technological and commercial domains: while discoveries and inventions may lack immediate commercial value, their integration and development into products and processes can generate new product development that delivers value through technological innovation. Such technological entrepreneurship may appear at the individual level or through collective combination activities among diverse organizational participants.

With respect to the relationship between corporate entrepreneurship and management performance, prior research consistently indicates a direct positive effect (Zahra, 1993; Zahra and Covin, 1995; Lumpkin and Dess, 1996; Covin and Miles, 1999; Zahra and Garvis, 2000; Hayton, 2005; Bierwerth et al., 2015).

Taken together, it is reasonable to posit that venture firms' technology commercialization capability influences corporate entrepreneurship, which in turn affects management performance, implying a mediating role of corporate entrepreneurship in this relationship.

2.4.2. Corporate entrepreneurship as a mediator between technological innovation capability and management performance

Similarly, studies directly examining the relationship between technological innovation capability and corporate entrepreneurship using identical constructs are difficult to locate. However, based on evidence from conceptually similar variables, corporate entrepreneurship may plausibly mediate the relationship between technological innovation capability and management performance.

For example, Lee (2013) found that, in the relationship between entrepreneurship and technological innovation, the entrepreneurial dimensions of innovativeness, proactiveness, and risk-taking all had statistically significant effects on both product innovation and process innovation. This suggests that CEO-level entrepreneurship—innovativeness, proactiveness, and risk-taking—constitutes a critical factor for successful technological innovation. Lee (2017) reported that founder/CEO capability positively affects technological innovation outcomes. Specifically, prior experience in the same industry significantly influenced the number of applications and registrations of industrial property rights, suggesting that greater industry experience increases attention to intellectual property aligned with technology and market trends and motivates efforts to expand such assets as tools for sustainable growth amid increasing disputes over industrial property. The relationship between CEO knowledge level and innovation outcomes was weaker than that for industry experience but remained significant, implying that greater industry-specific knowledge increases technology development outcomes and the quantity of industrial property held. These findings indicate that entrepreneurial characteristics are important determinants of technological innovation. Yang (2013) further reported that, among entrepreneurship characteristics, future orientation significantly influences process management and change management, while risk-taking significantly influences change management; autonomy and aggressiveness did not show significant effects on process management or change management.

Integrating these findings suggests that venture firms' technological innovation capability influences corporate entrepreneurship, which subsequently affects management performance, supporting the plausibility of a mediating effect of corporate entrepreneurship.

2.5. The Moderating Role of Positive Error Management Climate

Organizational culture has been treated in prior research as a factor correlated with various organizational effectiveness variables. Kluger and DeNisi (1996), in their study on feedback intervention (FIs), argued that error management allows individuals to obtain information about their mistakes or errors, and that increased awareness of deficiencies functions as feedback, ultimately facilitating learning effects—especially in situations involving novel or unfamiliar tasks. Van Dyck et al. (2005) also suggested that errors in organizations can generate not only negative outcomes but also positive outcomes, including learning and innovation. Therefore, when errors occur, it may be more important to focus not solely on the errors themselves but on how they are managed to generate positive outcomes. Positive error management climate refers to shared organizational rules or procedures aimed at detecting and resolving errors quickly, and Keith and Frese (2005) reported that such a climate influences the realization of the positive effects of errors.

A review of prior research on the moderating effect of positive error management climate suggests that although some studies have examined it as a moderating variable, few have assessed moderation within the specific relationships proposed in this study. Nevertheless, based on evidence that positive error management climate influences innovative behavior and that it has operated as a moderator in relationships between other independent variables and innovative behavior, this study formulates the hypothesis that positive error management climate will moderate the relationships between technology commercialization capability, technological innovation capability, and management performance.

3. RESEARCH METHODS

3.1. Research Model

Based on the foregoing review of the theoretical background, this study establishes a research model that examines the structural relationships among venture firms' management performance, technology commercialization capability, technological innovation capability, corporate entrepreneurship, and positive error management climate, as presented in Figure 1.

As illustrated in Figure 1, the structural model specifies technology commercialization capability and technological innovation capability as exogenous variables, corporate entrepreneurship as a mediating variable, positive error management climate as a moderating variable, and management performance as an endogenous variable.

Specifically, technology commercialization capability is expected to exert a direct positive effect on management performance and to have an additional positive effect on management performance through the mediation of corporate entrepreneurship. Likewise, technological innovation capability is expected to have a direct positive effect on management performance and to influence management performance positively through corporate entrepreneurship. Corporate entrepreneurship is also expected to have a direct positive effect on management performance. In addition, positive error management climate is hypothesized to moderate the relationships between management performance and both technology commercialization capability and technological innovation capability.

To enable objective measurement of the latent constructs included in the structural model, observable indicators were specified for each latent variable. Technology commercialization capability was measured through productization capability, manufacturing capability, and marketing capability. Technological innovation capability was operationalized through technological innovation systems, technology accumulation capability, and R&D capability.

Hypothesis 1. The hypothesized structural relationship model—specifying management performance as an endogenous variable, technology commercialization capability and technological innovation capability as exogenous variables, corporate entrepreneurship as a mediating variable, and positive error management climate as a moderating variable—will exhibit an acceptable model fit.

Hypothesis 2. Technology commercialization capability, technological innovation capability, and corporate entrepreneurship will have direct effects on management performance.

Hypothesis 2-1. Technology commercialization capability will have a direct positive effect on management performance.

Hypothesis 2-2. Technological innovation capability will have a direct positive effect on management performance.

Hypothesis 2-3. Corporate entrepreneurship will have a direct positive effect on management performance.

Hypothesis 3. Corporate entrepreneurship will mediate the relationships between the capability variables and management performance.

Hypothesis 3-1. Technology commercialization capability will positively influence management performance through the mediation of corporate entrepreneurship.

Hypothesis 3-2. Technological innovation capability will positively influence management performance through the mediation of corporate entrepreneurship.

Hypothesis 4. Positive error management climate will moderate the relationships between management performance and the capability variables.

Hypothesis 4-1. Positive error management climate will moderate the relationship between technology commercialization capability and management performance.

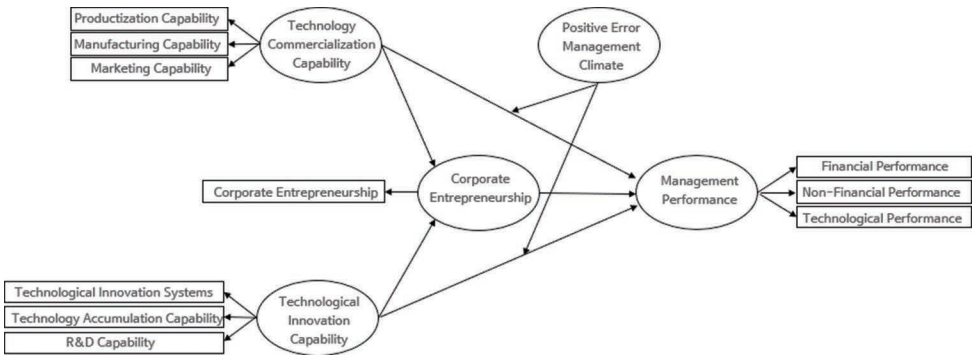
Hypothesis 4-2. Positive error management climate will moderate the relationship between technological innovation capability and management performance.

3.2. Research Participants

3.2.1. Population

The target population comprises employees working at firms that are registered as member companies of venture-related associations. These associations aim to promote inter-firm exchange and to build a virtuous, sustainable ecosystem within the industry. Organizations through which venture firms commonly obtain membership for various benefits and networking opportunities include the Korea Venture Business Association, the Small and Medium Venture Business Association, the Gyeonggi

Figure 1: Research model



Venture Business Association, the Busan Venture Business Association, the Korea Venture Capital Association, the Korea Business Incubation Association, and the Korea Women Venture Association.

Among these organizations, the Korea Venture Business Association is a representative association with a large number of member firms. As of January 2026, the association comprises eight regional chapters (Gangwon, Gyeongnam, Gwangju–Jeonnam, Daegu–Gyeongbuk, Busan, Ulsan, Jeonbuk, and Jeju) and has 17,993 registered member companies.

3.2.2. Sampling

In this study, the sample size was determined by considering both (a) the size required to represent the population and (b) the minimum sample size needed for structural equation modeling (SEM). Although scholars differ regarding the appropriate sample size for SEM, many argue that it should be set by taking into account both the estimation method and model fit considerations. Maximum likelihood (ML), the most commonly used estimation method in SEM, generally requires a minimum sample size of approximately 100-150. As the sample size increases beyond this level, ML estimation becomes more sensitive in detecting differences among data; thus, a sample size of 200 is often treated as a critical threshold for SEM testing, and the use of 200 or more cases is widely recommended.

Accordingly, this study determined that at least 200 responses were necessary and set the minimum target sample size at 200 or above. In addition, to account for the response rate, outliers, and careless or insincere responses, the study aimed to secure more than 300 responses.

As noted above, the population consists of employees working at venture firms affiliated with venture-related associations that promote inter-firm exchange and ecosystem development. Based on these considerations, the study drew the sample from employees of venture firms registered with the Korea Venture Business Association, which has the largest number of member companies. Specifically, employees engaged in R&D and technology commercialization-related tasks were selected as respondents. Convenience sampling was employed based on data accessibility and feasibility, and sampling was conducted repeatedly until the target of 300 responses was met.

In addition, to obtain survey responses that appropriately represent the organizational context of the sampled venture firms, it is necessary to identify key informants within each organization (Jeong, 2004). Therefore, key informants were selected from individuals expected to best represent firm-level conditions—namely, CEOs, executives, and team leaders. A pilot survey was conducted with these respondents to assess their suitability for the study, after which the main survey was administered.

3.3. Survey Instrument

To examine the structural relationships among venture firms' management performance, technology commercialization capability, technological innovation capability, corporate entrepreneurship, and positive error management climate, this study employed a questionnaire as the primary data collection instrument. Survey items were adapted and revised from measurement scales used in prior studies to fit the context and purpose of the present research.

The questionnaire comprised five sections in total, including (a) items measuring the study constructs and (b) a section assessing respondents' general characteristics. To enhance the validity and reliability of the survey instrument, expert review and a pilot test were conducted prior to the main survey.

3.4. Data Collection

Data for the main survey were collected through an online questionnaire. Prior to distributing the survey, the researcher contacted collaborators either through face-to-face meetings or telephone calls to explain the purpose of the study and provide relevant instructions and precautions. Subsequently, the questionnaire or a link to the online survey was distributed to the participants. Data collection was conducted in February 2026.

3.5. Data Analysis

To test the proposed hypotheses, the returned questionnaires were coded and analyzed using SPSS (Statistical Package for the Social Sciences) 22.0 and AMOS (analysis of moment structures) 21.0. The empirical analyses were conducted as follows. First, frequency analysis was performed to examine the demographic and general characteristics of the survey respondents. Second, descriptive statistical analysis was conducted to assess the normality of the measurement instruments. Third, confirmatory factor analysis (CFA) was performed on the factors identified through exploratory factor analysis to verify the convergent validity of each measurement variable and the latent constructs. Fourth, bivariate correlation analysis was conducted to examine the relationships among the measurement variables. In addition, average variance extracted (AVE) and construct reliability analyses were performed to assess discriminant validity. Fifth, to test the proposed hypotheses, the structural model's path coefficients were estimated and examined using structural equation modeling. Sixth, to assess the mediating effects of corporate entrepreneurship on the relationships between the independent variables and the dependent variable, indirect effects were analyzed using the bootstrapping method.

4. RESEARCH RESULTS AND DISCUSSION

4.1. Measurement Model Assessment

To examine the structural relationships among venture firms' management performance, technology commercialization capability, technological innovation capability, corporate entrepreneurship, and positive error management climate, this study employed structural equation modeling (SEM). Prior to testing the structural model, confirmatory factor analysis (CFA) was conducted to assess the validity and reliability of the measurement model.

The overall fit of the measurement model was satisfactory: $\chi^2(340) = 512.34$ ($P < 0.001$), $\chi^2/df = 1.51$, CFI = 0.964, TLI = 0.958,

RMSEA = 0.038, and SRMR = 0.041. These indices indicate an excellent model fit, suggesting that the latent variable structure specified in this study adequately represents the observed data.

All standardized factor loadings of the observed variables exceeded 0.72 ($P < 0.001$), demonstrating strong item reliability. Construct reliability (CR) values ranged from 0.82 to 0.91, and average variance extracted (AVE) values ranged from 0.58 to 0.74, confirming convergent validity. In addition, the square roots of the AVE values for each latent construct were greater than the corresponding inter-construct correlation coefficients, thereby establishing discriminant validity.

The skewness and kurtosis values met the criteria for normality, and multicollinearity diagnostics indicated that all variance inflation factor (VIF) values were below 3, confirming that excessive correlations among independent variables were not present.

4.2. Structural Model Results

The structural model demonstrated an acceptable level of fit: $\chi^2/df = 1.63$, CFI = 0.957, TLI = 0.952, and RMSEA = 0.041. These indices exceed commonly accepted thresholds, indicating that the proposed causal structure is statistically valid.

First, technological innovation capability had a significant positive effect on management performance ($\beta = 0.42$, $t = 6.81$, $P < 0.001$). This finding suggests that venture firms' R&D competence and technology accumulation capabilities positively influence not only financial performance but also non-financial performance. Technological capability functions not merely as an internal resource but as a core strategic asset that generates competitive advantage.

Second, technology commercialization capability also exerted a significant positive effect on management performance ($\beta = 0.35$, $t = 5.94$, $P < 0.001$). This result implies that beyond the development of technology itself, the capability to successfully transform technology into market value directly contributes to performance creation. In other words, venture firm performance is maximized when technological development capability is combined with market-oriented execution capability.

Third, corporate entrepreneurship had a significant positive effect on management performance ($\beta = 0.28$, $t = 4.73$, $P < 0.001$). This finding indicates that internal organizational innovativeness, proactiveness, and risk-taking serve as facilitators of performance creation. Venture firm performance is therefore closely associated not only with the level of technological assets but also with an organizational climate that encourages entrepreneurial behavior.

4.3. Mediating Effect of Corporate Entrepreneurship

Bootstrapping analysis (5,000 resamples) was conducted to test the mediating effects. The results revealed that corporate entrepreneurship significantly mediated the relationship between technological innovation capability and management performance ($\beta = 0.13$, 95% CI [0.08, 0.21]).

Similarly, corporate entrepreneurship significantly mediated the relationship between technology commercialization capability and management performance ($\beta = 0.09$, 95% CI [0.05, 0.17]).

These findings indicate partial mediation. Technological capabilities influence performance not only directly but also indirectly by promoting entrepreneurial behaviors that amplify performance outcomes. This empirical evidence confirms that performance is maximized when technological resources are effectively integrated with organizational entrepreneurial actions.

4.4. Moderating Effect of Positive Error Management Climate

To test the moderating effect of positive error management climate, multi-group structural model comparisons were conducted. The sample was divided into high and low error management climate groups. The comparison revealed a statistically significant difference in path coefficients between the two groups ($\Delta\chi^2 = 14.72$, $P < 0.01$).

In the high error management climate group, the path coefficient between technological innovation capability and management performance was $\beta = 0.51$, whereas in the low group it was $\beta = 0.29$. Similarly, the relationship between technology commercialization capability and management performance was stronger in the high-level group.

These findings suggest that in organizations where failures are perceived as learning opportunities rather than grounds for punishment, the transformation of technological capability into performance outcomes is strengthened. A positive error management climate enhances organizational learning speed and buffers uncertainty arising during technological implementation processes.

4.5. Discussion of Findings

This study comprehensively examined the structural relationships among technological innovation capability, technology commercialization capability, corporate entrepreneurship, and positive error management climate in explaining venture firm management performance. The results indicate that all proposed hypotheses were statistically supported, suggesting that technological capabilities and organizational-cultural factors operate complementarily in shaping venture firm performance.

First, technological innovation capability exerted a significant positive effect on management performance. This finding is consistent with the resource-based view (RBV; Barney, 1991), which emphasizes technological innovation as a core capability for generating sustainable competitive advantage. It also aligns with prior studies (e.g., Zahra, 1996; Lee et al., 2001) demonstrating the direct impact of technological capability on firm performance. Particularly in venture firms, accumulated technological knowledge and R&D competence function not merely as assets but as strategic resources for preempting market opportunities.

Second, technology commercialization capability significantly influenced management performance. This result underscores

that the ability to convert technology into market value, rather than innovation itself, is a direct determinant of performance. The findings empirically support Jolly's (1997) stage model of technology commercialization and Mitchell and Singh's (1996) emphasis on the importance of market application processes. By distinguishing technological innovation capability from technology commercialization capability, this study provides a more refined explanation of how both development capability and execution capability jointly contribute to performance.

Third, corporate entrepreneurship not only had a direct effect on management performance but also partially mediated the relationships between technological capabilities and performance. This supports prior research on entrepreneurial orientation (Covin and Slevin, 1991; Wiklund and Shepherd, 2003) and aligns with the theoretical perspective of Lumpkin and Dess (1996), which emphasizes the interaction between strategic resources and entrepreneurial behavior. The results indicate that technological resources do not automatically translate into performance; rather, their impact is amplified through entrepreneurial execution and behavior.

Fourth, positive error management climate strengthened the relationships between technological capabilities and management performance. This finding is consistent with Edmondson's (1999) theory of psychological safety and the error management culture framework proposed by Van Dyck et al. (2005). The results demonstrate that a culture that frames errors as learning opportunities rather than punishable events enhances performance by buffering uncertainty and accelerating learning during technological innovation and commercialization processes. Given that venture firms operate in high-risk and high-uncertainty environments, this finding offers particularly meaningful implications.

In sum, this study presents an integrated model of venture firm performance by simultaneously examining structural technological capabilities (technological innovation capability and technology commercialization capability), a behavioral mediating factor (corporate entrepreneurship), and a cultural moderating factor (positive error management climate). By moving beyond single-variable explanations of performance, this research contributes theoretically by proposing an expanded framework that integrates technological, behavioral, and cultural determinants of venture firm performance.

5. SUMMARY, CONCLUSION, AND IMPLICATIONS

5.1. Summary

The purpose of this study was to comprehensively identify the structural determinants of venture firms' management performance. Specifically, technological innovation capability and technology commercialization capability were specified as independent variables, corporate entrepreneurship as a mediating variable, and positive error management climate as a moderating variable. The effects of these variables on management performance were examined using structural equation modeling.

The empirical findings can be summarized as follows. First, technological innovation capability exerted a significant positive effect on management performance. This indicates that technological development capability and accumulated R&D competence constitute a fundamental basis for value creation in venture firms. Second, technology commercialization capability had a direct and strong positive effect on management performance. This result suggests that beyond merely possessing technology, the ability to convert technology into market value is a more immediate determinant of performance outcomes. Third, corporate entrepreneurship had a direct positive effect on management performance and partially mediated the relationships between technological innovation capability, technology commercialization capability, and management performance. This implies that technological resources are translated into performance outcomes through entrepreneurial execution processes. Fourth, positive error management climate significantly moderated the relationships between both technological innovation capability and technology commercialization capability and management performance. Organizations that perceive errors as opportunities for learning exhibited stronger effects of technological capabilities on performance.

Overall, the findings confirm that venture firm performance is not determined by a single factor but is generated through a complex structure in which technological capabilities, entrepreneurial behaviors, and organizational culture interact dynamically.

5.2. Conclusion

The major conclusions of this study are as follows. First, venture firm performance can be explained through a dual technological capability structure. Technological innovation capability represents the ability to create new knowledge, whereas technology commercialization capability reflects the ability to transform such knowledge into market value. This study empirically demonstrates that both capabilities independently contribute to performance. Technological development and commercialization are not isolated processes but continuous and complementary capabilities essential for performance creation. Second, technological capabilities are linked to performance through entrepreneurial execution. The mediating effect of corporate entrepreneurship indicates that technological resources do not automatically translate into superior performance. Only when accompanied by entrepreneurial behaviors—such as innovativeness, proactiveness, and risk-taking—do technological capabilities generate enhanced performance outcomes. This finding provides integrated support for both the resource-based view and entrepreneurial orientation theory. Third, positive error management climate functions as a performance amplifier. A culture that interprets errors as learning opportunities rather than grounds for punishment strengthens the impact of technological capabilities on performance. In the high-uncertainty environment faced by venture firms, the way failures are managed is not merely a supplementary factor but a core condition influencing performance outcomes. Organizations that suppress failure may inhibit experimental technological initiatives, whereas those that leverage failure as a learning resource can accelerate innovation speed.

In conclusion, sustainable performance creation in venture firms requires not only strengthening technological development capabilities but also fostering an entrepreneurial organizational climate and institutionalizing systems for learning from failure.

5.3. Implications

5.3.1. Theoretical implications

First, future research should examine technological capabilities and organizational culture from a multilevel perspective. Longitudinal studies are needed to explore how individual-level entrepreneurship interacts with organization-level culture over time. Second, because this study utilized cross-sectional data, causal interpretations should be approached with caution. Future research should employ panel data to examine the dynamic relationships between capability accumulation and performance changes over time. Third, further research should disaggregate the sub-dimensions of technology commercialization capability (e.g., productization capability, manufacturing capability, marketing capability) to explore more refined mediation and moderation structures.

5.3.2. Practical implications

First, venture firms should secure specialized personnel for technology commercialization alongside investments in technological development. A balanced transition from R&D-centered organizational structures to more market-oriented execution structures is required. Second, firms should establish HR, evaluation, and compensation systems that promote internal entrepreneurship. Excessive punishment for failure may discourage innovative attempts; thus, performance evaluation systems that reward challenging and exploratory initiatives are necessary. Third, organizations should institutionalize platforms and systems for sharing and learning from errors. Error cases should be accumulated as organizational assets and leveraged to prevent recurrence and promote innovation.

5.3.3. Policy implications

First, governments should expand customized support programs aimed at strengthening venture firms' technology commercialization capabilities. Beyond R&D subsidies, integrated policies that link market entry, marketing support, and global expansion are required. Second, policies supporting second attempts by firms with prior failure experiences should be strengthened. In environments where failure is negatively stigmatized, innovation ecosystems may be weakened. Third, policy-level support for consulting and training programs that enhance venture firms' organizational culture is necessary. In particular, support for building error management cultures and learning organizations can accelerate technological innovation performance.

5.4. Limitations

This study is based on self-reported survey data; therefore, the possibility of common method bias cannot be entirely ruled out. Additionally, because the analysis focused on a specific group of venture firms, caution is warranted in generalizing the findings. Nevertheless, this study is meaningful in that it empirically validated a structural model integrating technological capabilities, corporate entrepreneurship, and organizational culture, thereby contributing to the theoretical advancement of venture firm performance research.

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