# Entrepreneurship, Innovation Capabilities, and External Cooperation: A Study on Technological Innovation Performance of Venture Firms in Jiangsu, China

Oswin Aganda Anaba
School of Applied Science and Arts,
Department of Liberal Studies,
Bolgatanga Technical University,
P. O. Box 767, Sumbrungu-Bolgatanga, Ghana.
oswin.aganda@bolgatu.edu.gh
corresponding author
ORCID: 0000-0002-7879-7035

Ma Zhiqiang
School of Management,
Jiangsu University, Zhenjiang,
212013, P.R., China,
E-mail: zhiqiangmajsu@gmail.com

Benjamin Azembila Asunka
School of Business and Management Studies,
Department of Marketing,
Bolgatanga Technical University,
P. O. Box 767, Sumbrungu-Bolgatanga, Ghana.
benasunka@bpoly.edu.gh
ORCID: 0000-0002-9220-3985

Leticia Amana
School of Business and Management Studies,
Department of Marketing,
Bolgatanga Technical University,
P. O. Box 767, Sumbrungu-Bolgatanga, Ghana.
lamana@bolgatu.edu.gh

Benjamin Adongo
Grace Valley International School,
PMB, Bolgatanga, Ghana.
Benjaminadongo67@gmail.com

## Abstract

It is known that open innovation has an important impact on companies' technological innovation activities. Hence, since venture firms are relatively small in size and have limited internal resources to utilize, activities to expand cooperation with external parties through open innovation are very important. Therefore, this study aims to identify and analyze the relationship between entrepreneurship, innovation capabilities, and external cooperation that affect the technological innovation performance of venture firms in Jiangsu, China. The results show that entrepreneurship has a positive effect on innovation capability, external cooperation, and technological innovation performance; innovation capability has a positive effect on external cooperation and technological innovation performance; external cooperation also has a positive effect on technological innovation performance; and innovation capability and external cooperation each play a positive mediating role in the relationship between entrepreneurship and technological innovation performance. It is concluded that innovation capability and external cooperation together positively mediate the relationship between entrepreneurship and technological innovation performance.

**Keywords:** Entrepreneurship, Innovation Capabilities, External Cooperation, Technological Innovation Performance, Venture Companies

## Introduction

In a continuously changing market competitive environment, venture businesses, which are technologically innovative SMEs, are challenged with the requirement to secure technical competitive advantage via constant innovation. Several studies have shown that innovation is a key determinant in the growth of venture organizations (Bendig et al., 2024; Chistov, Aramburu, et al., 2023; Edeh & Prévot, 2024; Huang et al., 2023).

While past technological innovation was determined by R&D budget, economies of scale, securing and efficiently utilizing excellent human resources, future technological innovation is determined by R&D

efficiency, the ability to absorb and utilize external technologies, and the ability to integrate distributed capabilities(Dimakopoulou et al., 2024).

Chesbrough et al. (2024)stated that using various external sources of knowledge beyond the company's internal boundaries in the innovation process can contribute to long-term innovation performance, and that the innovation paradigm of technology-intensive companies is shifting from "closed innovation" to "open innovation".

Open innovation is the process by which companies move from research, development, to commercialization. It is the ability to absorb external sources of technology into the company through various methods by utilizing external resources in the process of innovation. Through open innovation, venture firms aim to improve product development performance and lead the market by monetizing developed technologies(Chistov, Carrillo-Hermosilla, et al., 2023).

To improve the fit between a company's technological innovation strategy and its external environment, it is necessary to understand and analyze the resources it has and the resources it needs. In this process, firms need to strategically integrate their accumulated internal capabilities with the technological innovation goals they have established. Therefore, it is necessary to understand the innovation capabilities that affect technological innovation performance as they are the output of innovation activities and the input for future innovation activities. In particular, venture firms that are relatively small and have limited internal resources to utilize are required to expand their cooperation with the outside world through open innovation. Efficient management of resources and systematic management of technological innovation performance are important because they must be reinvested to implement new innovations in the future.

This study aims to identify the relationship between entrepreneurship (ETP), innovation capabilities (INOCA), and external cooperation (EXCO) in venture firms' technology innovation performance (TECINOP). To this end, we measure technological innovation performance by improving the qualitative evaluation indicators of technological value and systematize innovation capability into multiple dimensions to reflect the complex nature of technological innovation.

## Prior Research

### Entrepreneurship

Since Schumpeter (1934), entrepreneurship has been merged and disseminated with venture capital to boost company competitiveness, serving as a driving factor in maintaining and expanding the vitality of the market economy. As it transitions to a knowledge-based economy, it is acknowledged as a source of competitiveness, such as a company's ability to innovate, learn, and adapt to its surroundings(Baron & Shane, 2007).

Entrepreneurship in the traditional sense is the window through which opportunities for technological innovation are discovered and captured(White & Bruton, 2017) and plays a positive role in both technology-driven and market-driven innovation(Yigit & Kanbach, 2023).

Focusing on the process of technological innovation in technology-intensive firms, technological entrepreneurship is “a business leadership style that involves the use of principled decision-making to identify technological business opportunities with high growth potential, create the necessary talent and capital, and systematically manage rapid growth and the significant risks associated with it”(Kilintzis et al., 2023), and “a tool for creating new resource combinations and integrating the technical and commercial domains in a profitable way to realize technological innovation” (Burgelman et al., 2008; Idewele et al., 2021).

Entrepreneurship is closely related to a firm's ability to operate and utilize its resources(Gambardella et al., 2021; Zahra, 2021), and entrepreneurship can vary the intensity of resource efficiency and utilization capabilities(Somwethee et al., 2023). Firms with high entrepreneurship are more active in new product development(Morgan & Anokhin, 2023), and high levels of entrepreneurship increase technological innovation performance(Ince et al., 2023; Mokbel Al Koliby et al., 2024; Sari et al., 2023).

When firms realize technological innovation opportunities, it is necessary to understand and analyze the role of entrepreneurship in the process of innovation capabilities

and external cooperation that are expressed in performance. In this study, we set the ensuing hypotheses to analyze how entrepreneurship affects innovation capability, external cooperation for innovation, and its impact on technological innovation performance.

Hypothesis 1.1: Entrepreneurship will have a significant impact on innovation capability.

Hypothesis 1.2: Entrepreneurship will have a significant effect on external cooperation.

Hypothesis 1.3: Entrepreneurship will have a significant effect on technological innovation performance.

**Innovation capabilities**

As the intensity of global competition increases, companies' product life cycles are getting shorter and shorter, while the ease of imitation by competitors is increasing. In this context, businesses use innovation to improve their technology, processes, goods, services, design, and quality(Farida & Setiawan, 2022). Venture enterprises, in particular, must enhance their innovation capabilities in order to develop new technologies faster than competitors or to introduce new ideas from outside and commercialize them into new products and services.

Innovation capability is a company's ability to successfully introduce and implement new ideas to goods, services, and processes (Burns & Stalker, 2009) and to explore new opportunities or devise new solutions to given problems(Dess & Lumpkin, 2005). In addition, innovation capability is a comprehensive characteristic of a firm's specific assets, including technology, products, processes, knowledge, experience, and organization, that support and facilitate the firm's innovation strategy (Rajapathirana & Hui, 2018). It is a very important resource to ensure sustainable success by supporting and facilitating the firm's innovation strategy and an important outcome of innovation activities(Mendoza-Silva, 2021). Firm differences in innovation activities are related to specific resources, as innovation activities begin with an organization's internal identification of its core competencies(Clausen et al., 2013). Innovation capabilities enhance a firm's competitiveness(Praditya & Purwanto, 2024), especially for venture firms, which can create new technologies or apply them to goods and services faster than rivals, and a high degree of innovation capabilities influences technical innovation performance (Alghamdi & Agag, 2024).

Unlike previous studies that focus on the inputs for technology acquisition or the performance of the technology itself, this study defines and systematizes innovation capabilities from a more holistic perspective that includes technology development and technology commercialization. Quintero and Zúñiga (2023), Yuan and Song (2022), and Duan et al. (2020) classify innovation capabilities more systematically and reflect the innovation process as a multidimensional activity that includes value chain processes. Quintero and Zúñiga (2023) added learning capabilities to the previous research on innovation capabilities and proposed seven dimensions of innovation capabilities: research and development capabilities, resource allocation capabilities, production capabilities, marketing capabilities, strategic planning capabilities, learning capabilities, and organizational capabilities.Yuan and Song (2022) classified innovation capabilities as R&D capabilities, production capabilities, marketing capabilities, resource development capabilities, organizational capabilities, and strategic capabilities, and Duan et al. (2020) classified innovation capabilities into five categories to analyze the relationship between innovation capabilities and innovation performance: R&D capabilities, innovation decision-making capabilities, marketing capabilities, production capabilities, and funding capabilities. While previous studies have considered only direct technology development as a factor affecting technological innovation, this study considers both quantitative and qualitative criteria to broadly include not only direct technological innovation activities but also management activities that support and promote them.

This innovation capability affects a company's external cooperation activities. In order to utilize external cooperation, which is a means to compensate for resources that a firm does not possess(Awan et al., 2021), internal absorptive capacity to absorb and utilize external resources is required(Aliasghar et al., 2023; Khraishi et al., 2023). Externally acquired knowledge is not only difficult to materialize, but also difficult to document and not easy to transfer between organizations. Therefore, it can be

expected that firms with high innovation capabilities, including internal technology development capabilities, will be more effective in seeking external knowledge and developing technology cooperation with customers, competitors, suppliers, universities, research institutes, etc.

Innovation capability is a key determinant of innovation performance (Robertson et al., 2023). Innovative products that result from innovation capabilities are more attractive to customers, thus affecting the competitive advantage of the firm (Wongsansukcharoen & Thaweepaiboonwong, 2023) and leading to higher profits(Chaudhuri et al., 2024). Therefore, in this study, we set the ensuing hypotheses to examine the relationship between innovation capabilities and external cooperation and technological innovation performance.

Hypothesis 2.1: Innovation capabilities will have a significant effect on external

cooperation.

Hypothesis 2.2: Innovation capability will have a significant effect on technological innovation performance.

## External cooperation

Firms engage in external cooperation to acquire technology to solve problems (Garrido-Moreno et al., 2024). Through cooperation with external organizations, firms can overcome the limitations of their limited internal resources at minimal cost. External cooperation can be divided into external knowledge exploration activities, which utilize information related to technological innovation from external organizations, and technology development cooperation activities, which are carried out by cooperating with various external partners in technology development. External knowledge exploration strategy affects innovation performance(Zan et al., 2024). Studies that have analyzed the relationship between external knowledge exploration strategies and technological innovation performance (Hervas-Oliver et al., 2021; Mei et al., 2023; Zhao, 2023) have focused on the impact of external knowledge exploration on new products or services. Furthermore, external knowledge seeking activities encompass both organizational and process innovations such as new systems, policies, and programs introduced into the firm(Alhusen et al., 2021; Cheah et al., 2021). The level of external knowledge exploration is measured by its diversity and depth, and both breadth and depth of external knowledge exploration have a positive impact on a firm's innovation performance(Asimakopoulos et al., 2020).

Deep external knowledge seeking has been found to have a positive impact on radical innovation performance and broad external knowledge seeking has been found to be effective for incremental innovation performance(Wang et al., 2020).Looking for technical sources such as suppliers and universities has been found to have a positive impact on innovation performance in high-technology industries and seeking from market sources such as customers and competitors has been found to have a positive impact on innovation performance in non-high-technology industries(Dzikowski, 2022).A firm's internal and external sources of knowledge have a positive impact on innovation performance, and knowledge exploration from group affiliates is more effective for innovation performance when the number of foreign group affiliates is higher (Frenz & Ietto-Gillies, 2023). In addition, the broader the scope of external knowledge exploration and the more innovation targets, the higher the innovation performance(Ryu et al., 2022).

On the other hand, technology development cooperation is carried out through various activities such as technology purchasing, joint R&D, contract R&D, joint venture establishment, mergers and acquisition (M&A), venture investment, participation in research consortiums, and user innovation(Vincenzi & da Cunha, 2021). A variety of successful technology development cooperation activities can lead to technological innovation outcomes.

In general, it takes a considerable period of continuous investment to derive innovative performance through the utilization of internal resources. However, since venture firms are small and have limited internal resources, they can increase their innovation performance through cooperation with external organizations(Hameed et al., 2021).

External cooperation of venture firms has been shown to affect innovation performance depending on the target, content, and utilization of external resources(Audretsch & Belitski, 2023). When external cooperation is successfully

carried out, it can overcome the limitations of weak internal resource capabilities and respond effectively to rapidly changing external environments through the effects of investment scale and risk diversification, creating synergies between different technologies and knowledge through cooperation, entering new markets, and setting standards.

Therefore, in this study, we set the ensuing hypotheses to identify the relationship between external cooperation and technological innovation performance through external knowledge exploration activities and technological cooperation development activities.

Hypothesis 3: External cooperation will have a significant impact on technological innovation performance.

## Mediating roles of innovation capabilities and external cooperation

Studies have analyzed the relationship between entrepreneurship and the success of ventures in entering the marketplace and achieving tangible outcomes(Hamzah & Othman, 2023; Kearney & Lichtenstein, 2023; Sagar et al., 2023), entrepreneurship based on the skills or ideas of the managers in the early years of establishment has a decisive impact on the performance of the firm, but the growth of the firm and changes in the environment require new abilities from the managers. Therefore, in order to maintain and develop the entrepreneurial drive of the company as the company grows and the environment changes, it will be possible to achieve sustainable growth if the entrepreneurial drive of the managers is converted into corporate capabilities.

Organizations are increasing their ability to identify and capitalize on a variety of external sources of innovation (Li et al., 2021; Somwethee et al., 2023), entrepreneurship not only directly affects performance, but also leads to performance through innovation capabilities such as marketing, R&D, technology, and networks(Davcik et al., 2021).Furthermore, CEOs' innovative management style has been shown to influence exploratory innovation activities and contribute to new product certification(Eng et al., 2023), and venture firms' marketing capabilities have been shown to increase exports, mediating the relationship between global entrepreneurship and globalization(Martin et al., 2020).

Therefore, this study analyzes the impact of entrepreneurship on technological innovation performance through innovation capability, and the ensuing hypothesis is formulated.

Hypothesis 4.1: Innovation capability will play a mediating role in the relationship between entrepreneurship and technological innovation performance.

Entrepreneurial characteristics influence the network formation process of venture firms(Yu et al., 2021), and the level of external resource utilization differs depending on the entrepreneur's willingness (Wang et al., 2022). Entrepreneurial firms are more active in external cooperation than conservative firms(Covin & Slevin, 1991), and profit- and growth-oriented firms are more active in adopting external technologies than firms that emphasize independence(Solomon & Mathias, 2020). Entrepreneurship affects external knowledge seeking activities and technology development cooperation activities, and the level of external cooperation resulting from these activities will affect the level of technological innovation of the firm(Anaba et al., 2020).

Therefore, this study analyzes the impact of entrepreneurship on technological innovation performance through external cooperation, and sets the ensuing hypothesis.

Hypothesis 4.2: External cooperation will play a mediating role in the relationship between entrepreneurship and technological innovation performance.

As we have seen, entrepreneurship affects innovation capability, innovation capability affects the level of external cooperation, and external cooperation affects technological innovation performance. Consequently, in this study, we set the ensuing hypothesis to analyze the effect of entrepreneurship on technological innovation performance through a chain mediation of innovation capability and external cooperation.

Hypothesis 4.3: Innovation capabilities and external cooperation will mediate the relationship between entrepreneurship and technological innovation performance.

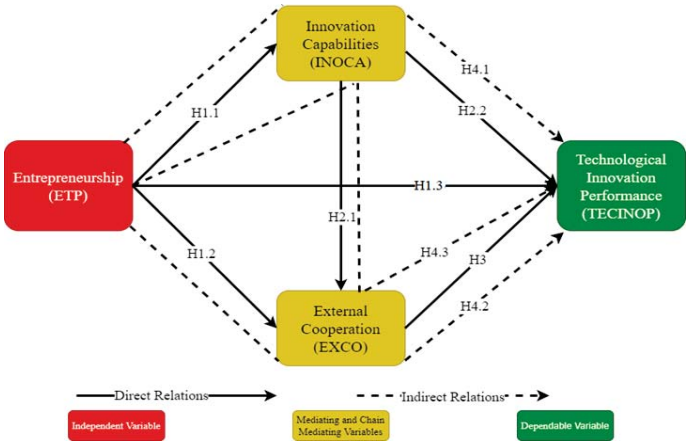
## Research Design

### Research Models

The literature reviewed above attempts to identify a significant relationship between innovation capabilities and innovation performance in technology-intensive firms. In addition, the previous studies that present entrepreneurship as a driving force for new innovations have approached entrepreneurship as a new management resource from a holistic perspective, but lack a micro approach that reflects the characteristics of technological innovation in identifying factors that significantly influence technological innovation performance.

Grounded on the innovation process viewpoint of input-output-outcome, this study establishes a stepwise model that categorizes entrepreneurship of venture firms as input, innovation capability and external cooperation as output, and firm innovation performance as outcome.In addition, the research model was designed as shown in Figure 1 to verify the impact of innovation capabilities on technological innovation performance by organizing innovation capabilities to cover the multidimensionality of the value chain in technological innovation.

**Figure 1 Research Model**




## Working definitions and metrics

The working definitions and measures of the variables of entrepreneurship, innovation capability, external cooperation and technological innovation performance discussed in this study were adapted to the characteristics of the resource-based perspective based on the item constructs applied in previous studies and measured using a five-point Likert scale.

Entrepreneurship is defined as 'the will and activity pattern of an entrepreneur who can discover technological innovation opportunities despite high uncertainties and risks in the future and create new value by utilizing the organization's innovation capabilities and technological system.' Entrepreneurship is largely divided into three categories: innovation, proactiveness, and risk-taking(Corrêa et al., 2022). It consists of innovativeness in which managers convert market-oriented ideas into products or services, proactiveness in actively challenging the market in a timely manner, and risk-taking in taking on challenges despite environmental uncertainty.

Innovation capability is defined as 'the comprehensive ability to carry out the process of developing, introducing and adopting new knowledge and processes to produce products and provide services that enable value creation'.Based on the conceptual studies ofBurgelman et al. (2008) andWhite and Bruton (2017), the variables of innovation capability were adopted from the scales used byQuintero and Zúñiga (2023),Yuan and Song (2022), andDuan et al. (2020). Accordingly, the sub-variables of innovation capability in this study are R&D capability, production capability, marketing capability, strategic planning capability, learning capability, organizational management capability, and resource allocation capability.

External cooperation for innovation activities was divided into information search and technology development cooperation. Laursen and Salter (2006) classified external knowledge exploration activities into two types, “broad external knowledge exploration” and “in-depth external knowledge exploration,” and divided the sources of external cooperation into 16 types (market, institution, standard, and other) and examined their utilization and degree of utilization on a 3-point scale (upper, middle, and lower), but this study classified them into 10 sources and measured the utilization of each source on a 5-point isometric scale.

Sources of information are (1) domestic and international

seminars, exhibitions, and fairs, (2)domestic and foreign specialized journals and related books, (3) internal company (technology development, production),(4) Suppliers (raw materials, parts, equipment), (5) Customers (demanding companies, consumers, etc.), (6) Competitors in the same industry, (7) Universities (industry-university cooperation, university-affiliated research institutes and professors), (8) Public research institutes (government-funded and invested institutions), (9) Private service companies (consulting, private research institutes), (10) Technology guidance organizations. We investigated the utilization and satisfaction of these sources of information-seeking activities.

We define diversity as "the number of external knowledge sources a firm utilizes in its innovation process.We defined diversity as "the number of external knowledge sources that a firm utilized in its innovation process." The sum of these values was defined as "the extent of extensive external knowledge exploration." Thus, if a firm did not utilize all 10 external knowledge sources, the value would be 0, and if it utilized all 10 sources, the value would be 10.

Intensity was defined as "the degree of in-depth utilization". We constructed the variable to reflect the number of external knowledge sources utilized in depth from the 10 external sources. Specifically, we measured the satisfaction level of external knowledge sources utilized by a company on a scale of 1-5. The sum of the values converted to 0 for 1-3 and 1 for 4-5 was defined as the "depth of external knowledge exploration," which is equal to 0 if all 10 external knowledge sources were not utilized significantly, and 10 if all 10 were utilized significantly.

Technology cooperation activities are (1) technology purchase; (2) joint R&D; (3) contract R&D; (4) joint venture establishment; (5) M&A; (6) venture investment; (7) participation in research consortiums; (8) user innovation; (9) cloud sourcing solution competition, utilizing collective intelligence. We measured the "number" and "success" of these technology development cooperation activities. The number was defined as the "number of R&D innovation activities". A value of 0 was assigned to a surveyed company if it did not engage in any of these R&D cooperation activities and 1 if it did, and the sum of these values was defined as the "number of R&D innovation activities." Thus, if a company did not engage in all nine R&D innovation activities, the value would be 0, and if it did, the value would be 9.

Success is defined as "the degree of success of a firm's technological innovation activities." It is measured by reflecting the degree of success of the nine technological innovation activities. Specifically, we converted the success of a company's innovation activities from 1-3 to 0 and from 4-5 to 1. We defined "success" as the sum of these numbers and values, so that the value is 0 if none of the nine innovation activities were successful and 9 if all were successful.

We considered both quantitative and qualitative perspectives of technological innovation performance.Patents reflect the results of innovation activities and the strategic performance of a firm(Anaba et al., 2022; Teece, 2018), and we refer to studies that use product and process innovation and the number of patents to measure innovation performance(Ponta et al., 2021). In this study, innovation performance is measured from both quantitative and qualitative perspectives. In the quantitative perspective, (1) the number of patent and IPRs applications, (2) the number of IPRs registrations, (3) the number of new product developments, (4) the number of existing product improvements, (5) the number of new process developments, (6) the number of existing process improvements, were summed up, and the success was measured using the same method as the technological innovation activities and converted into a scale of 0 to 6 for the number of technological innovation achievements and 0 to 1 for the success.

From a qualitative perspective, we examine the qualitative indicators of technology innovation valuation. We focused on technological innovation performance, which is considered to be directly influenced by innovation capabilities, by measuring performance in the areas of technical, marketable, and business performance, respectively. Accordingly, this study defines technological innovation performance as 'the performance realized by technological innovation activities that link the organization's innovation capabilities in multiple dimensions to achieve specific technological goals'.

## Empirical Analysis

The survey for this study was conducted among startups in Jiangsu, China. The survey was conducted through on-site visits to the R&D managers of the companies between January 15 and February 3, 2024. Of the 105 questionnaires collected, 97 questionnaires were used for the final analysis, excluding 8 questionnaires with insufficient responses.

Unlike structural equation modeling techniques such as AMOS and LISREL, which are based on likelihood-based covariance among the sample variables, PLS (Patial Least Square) structural equation estimation is based on principal component analysis and therefore does not impose sample size and normal distribution constraints on the variables and residuals(Gefen & Straub, 2005). While structural equation modeling using covariance focuses on a clear theoretical model and it's fit to the data, PLS focuses on identifying the explanatory power of latent variables based on regression analysis, so it is a method to maximize the explanatory power of the factors set in the research model.

PLS is appropriate when (1) the sample size is small, (2) the data does not satisfy normality, or (3) the independence of the measurement data is not guaranteed, and is useful for predicting causal relationships, analyzing cognitive and behavioral traits, rather than theory testing(Fornell & Bookstein, 1982).

PLS shares all the assumptions of multiple regression and is a method for creating predictive models when the number of factors is large or the multicollinearity is very high. It is also an alternative method for avoiding inappropriate results and factor uncertainty when distributional assumptions are rarely satisfied and when AMOS is applied.

PLS test statistics are used to test the validity of the results of confirmatory factor analysis (CFA), internal consistency confirmatory factor analysis, internal consistency, discriminant validity, convergent validity, conformity (discriminant validity), convergent validity, and goodness of fit. In addition, the research hypotheses are tested by bootstrapping to estimate the significance of the path coefficients. These features make this study an appropriate method to analyze the causal relationship between ETP, INOCA, EXCO and TECINOP for venture firms with a relatively small sample size.

## Setting up an Innovation Department structure chart

Using SmartPLS, a model that considers the correlation between variables for factors affecting technological innovation performance was set up as shown in Figure 2 and 3. The path model was built by setting technological innovation performance as an endogenous variable as a result of entrepreneurship, innovation capability, and external cooperation level.

**Figure 2 PLS Algorithm Structure diagram**

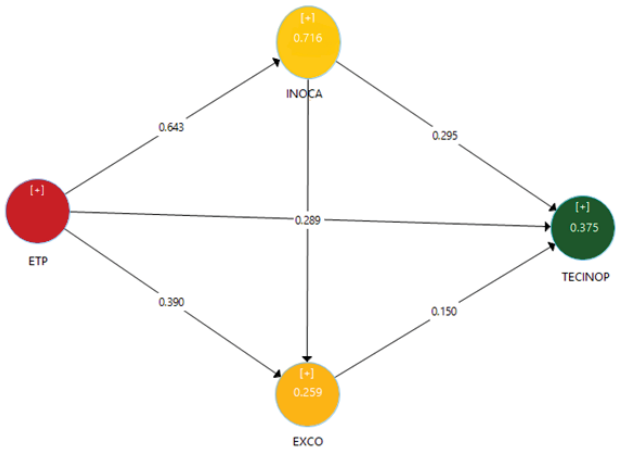
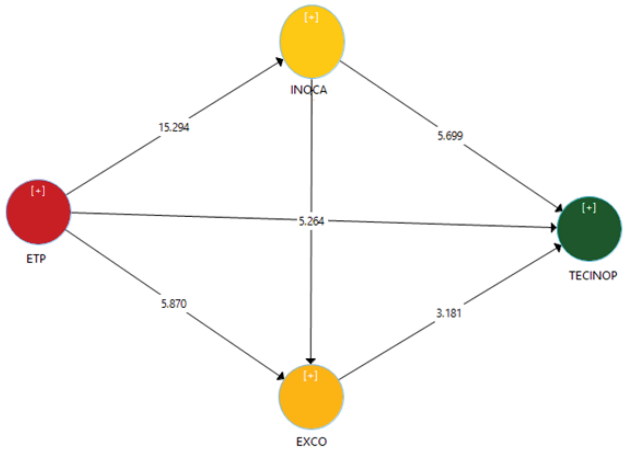



**Figure 3Bootstrapping Structure diagram**



### Confirmatory Factor Analysis

Research models are evaluated for convergent validity, internal consistency (reliability), and discriminant validity. In general, a variable is considered to have convergent validity and internal consistency if the cross-loading value of the individual items, composite reliability/construct reliability (CR), Cronbach's alpha is above 0.7, and averaged variance extracted (AVE) is above 0.5(Chin, 1998). Discriminant validity is recognized when the square root of the mean variance extracted is greater than the correlation coefficient between the other constructs (Rönkkö & Cho, 2022).

### Reliability and Focused Feasibility Analysis

The reliability test results for the metrics are shown in Table 1. Each variable items that did not meet the criterion of 0.7 were removed(Milton et al., 2011). The item 'Implementing technology development to pursue growth' was removed to measure risk-taking, which constitutes entrepreneurship; 'Analyzing product life cycle' to measure marketing capability, which constitutes innovation capability; and 'Possessing learning ability' to measure organizational management capability.

**Table 1 Reliability analysis**

| Composition concept | | Number of initial items | Number of final items | Cronbach Alpha |
|---|---|---|---|---|
| Entrepreneurship | Innovativeness | 3 | 3 | 0.7615 |
| | Proactiveness | 3 | 3 | 0.8354 |
| | Risk-taking | 3 | 2 | 0.8692 |
| Innovation Capability | R&D | 5 | 5 | 0.8880 |
| | Production | 5 | 5 | 0.9236 |
| | Marketing | 5 | 4 | 0.9042 |
| | Organizational Management | 5 | 4 | 0.8122 |

Table 2 shows the exploratory factor analysis (EFA) of 8 items comprising entrepreneurship and 18 items comprising innovation capability. As a result, entrepreneurship was composed of two factors, innovativeness and proactiveness, with factor loadings exceeding 0.6, and innovation capability was composed of three factors, R&D capability, production capability, and marketing and organizational capability. As shown in Table 3, the composite reliability and Cronbach's α of each latent variable in the measurement model are all above 0.7, and the average variance extracted of each latent variable is above 0.5, indicating that the measurement model is valid and reliable(Chin, 1998; Fornell & Larcker, 1981).

**Table 2 Confirmation factor analysis**

| Variable | Measurement variables | ETP (Entrepreneurship) | INOCA (Innovation capabilities) |
|---|---|---|---|
| etp11 | Proactively identify customer needs | 0.7705 | |
| etp12 | Try a new approach to a technical problem | 0.6615 | |
| etp13 | Encourage new idea generation | 0.6669 | |
| etp14 | Strive to stay ahead of your competitors | 0.7142 | |
| etp15 | Actively seek information to recognize change | 0.7951 | |
| etp16 | Actively pursue technology competitive advantage | 0.7652 | |
| etp21 | Taking potential risks with technology development | 0.8818 | |
| etp22 | Taking risks for technology development | 0.8711 | |

| Variable | Measurement variables | ETP (Entrepreneurship) | INOCA (Innovation capabilities) |
|---|---|---|---|
| inoca11 | Better R&D capabilities than competitors | | 0.7555 |
| inoca12 | Ensure sufficient R&D staffing | | 0.8050 |
| inoca13 | R&D capabilities to keep up with technology changes | | 0.7096 |
| inoca14 | Have core technology for flagship products | | 0.6209 |
| inoca15 | Experienced in core technology R&D | | 0.6853 |
| inoca21 | Have more production capacity than your competitors | | 0.7874 |
| inoca22 | Efficiently deploy and operate production facilities | | 0.8687 |
| inoca23 | Effective operation of production systems for technology development | | 0.8020 |
| inoca24 | High level of production inspection and quality control | | 0.6029 |
| inoca25 | Properly manage your production process | | 0.7765 |
| inoca31 | Have better marketing skills than your competitors | | 0.7667 |
| inoca32 | Come out with a system that quickly stimulate the needs of customers | | 0.6597 |
| inoca33 | Create the right marketing strategy | | 0.7166 |
| inoca34 | Run the right marketing channels | | 0.6681 |
| inoca35 | Conduct regular meetings to stay on top of market trends | | 0.7325 |
| inoca36 | Share information and knowledge across the organization | | 0.7883 |
| inoca37 | Create an external network to learn about market technology changes | | 0.6205 |
| inoca38 | Leverage market technology competitor trend analysis | | 0.6551 |

**Table 3 PLS Summary Statistics**

| | AVE | Composite Reliability | R Square | Cronbach Alpha | Communality | Redundancy |
|---|---|---|---|---|---|---|
| ETP | 0.8745 | 0.9330 | | 0.8572 | 0.8745 | |
| INOCA | 0.8486 | 0.9439 | 0.7157 | 0.9110 | 0.8486 | 0.6002 |
| EXCO | 0.8907 | 0.9422 | 0.2595 | 0.8773 | 0.8907 | 0.0287 |
| TECINOP | 0.9181 | 0.9573 | 0.3753 | 0.9108 | 0.9181 | 0.1417 |

## Discriminant Validity Analysis

To validate discriminant validity between a measure and a concept, the variance explained by a concept on its own measure (variance extracted) must be greater than the variance explained by other measures (correlation coefficient squared).

As shown in Table 4, the AVE of entrepreneurship (0.8745) and the AVE of innovation capability (0.8486) are both larger than the square of (0.8460) ^2=0.7157, which is the largest correlation coefficient in the correlation matrix between latent variables(Fornell & Larcker, 1981). In addition, the correlation coefficients between the dimensions that are exogenous variables are all below 0.9, indicating that multicollinearity among the dimensions is not significant.

**Table 4 Discriminative validity**

| | ETP | TECINOP | EXCO | INOCA |
|---|---|---|---|---|
| ETP | 0.9351 | | | |
| INOCA | 0.8460 | 0.9212 | | |
| EXCO | 0.4412 | 0.4767 | 0.9438 | |
| TECINOP | 0.4882 | 0.3255 | 0.3798 | 0.9582 |

The diagonal values are the square root of the average variance extracted (AVE)

**Nomological Validity Analysis**

In the measurement model, there is a positive correlation between each dimension of firm characteristics and technological innovation performance, which is justified(Anderson & Gerbing, 1988).

**Path Analysis of Structural Models**

**Analyze the goodness-of-fit and explanatory power of structural models**

PLS is used to maximize the explanatory power of endogenous variables or minimize structural errorand does not use the goodness-of-fit indices used in covariance structural models such as AMOS or LISREL (Chin, 1998). Instead, the predictive power and overall goodness of fit are judged by synthesizing the following three factors (Chin, 1998).

First, the coefficient of determination R2, which represents the explanatory power of the endogenous variables, is used as a predictive sum index, which is categorized into high (0.26 or higher), medium (0.13 to 0.26), and low(0.02 to 0.13). The R2 of the endogenous variables, INOCA, EXCO, and TECINOP, are 0.7157, 0.2595, and 0.3753, respectively. These results can be interpreted as a reflection of the homogeneous group characteristic of the extremely limited scope and small sample size of the study, which is measured on technologically innovative ventures in Jiangsu, China.

Second, we use the redundancy of endogenous variables as an index of predictive fit, which is categorized as high (above 0.375), medium (0.125 to 0.375), and low (below 0.125)(Kok et al., 2021), and a value greater than 0 is considered to be predictive fit. The redundancy of INOCA, EXCO, and TECINOP is 0.6002, 0.0287, and 0.1417, respectively.

Third, the overall fit of the structural model is measured as the square root of the average of the R2 of all endogenous variables multiplied by the average of the commonality of each dimension, and is categorized as high (0.36 or higher), medium (0.25 to 0.36), and low (0.10 to 0.25). The overall goodness of fit is high at 0.6304.

**Test the significance of path coefficients**

To test the significance of the hypotheses, the standardized path coefficients from the SmartPLS algorithm and the t-values of the path coefficients from SmartPLS bootstrapping (Henseler & Schuberth, 2023) are summarized in Table 5, along with the significance test results. Since it is a one-tailed test of the directional hypothesis, the path coefficients and hypothesis are significant if $|t| > 1.65$ at the significance level $\alpha = 0.05$.

**Table 5 PLS path analysis results**

| Hypothesis | Paths | PathCoeff.(P) | Mean | STDEV | T Statistics | P Values | Verification of results |
|---|---|---|---|---|---|---|---|
| Hypothesis 1.1 | ETP -> INOCA | 0.643 | 0.641 | 0.042 | 15.294*** | 0.000 | Adopted |
| Hypothesis1.2 | ETP -> EXCO | 0.390 | 0.388 | 0.066 | 5.870*** | 0.000 | Adopted |
| Hypothesis1.3 | ETP -> TECINOP | 0.257 | 0.256 | 0.049 | 5.215*** | 0.000 | Adopted |
| Hypothesis2.1 | INOCA -> EXCO | 0.289 | 0.289 | 0.055 | 5.264*** | 0.000 | Adopted |

| Hypothesis | Paths | PathCoeff.(P) | Mean | STDEV | T Statistics | P Values | Verification of results |
|---|---|---|---|---|---|---|---|
| Hypothesis2.2 | INOCA -> TECINOP | 0.295 | 0.290 | 0.052 | 5.699*** | 0.000 | Adopted |
| Hypothesis3 | EXCO -> TECINOP | 0.150 | 0.153 | 0.047 | 3.181*** | 0.002 | Adopted |
| Hypothesis4.1 | ETP -> INOCA - >TECINOP | 0.190 | 0.186 | 0.037 | 5.168*** | 0.000 | Adopted |
| Hypothesis4.2 | ETP -> EXCO -> TECINOP | 0.059 | 0.060 | 0.023 | 2.593*** | 0.010 | Adopted |
| Hypothesis4.3 | ETP -> INOCA -> EXCO -> TECINOP | 0.028 | 0.029 | 0.011 | 2.472*** | 0.014 | Adopted |

*p< .1 (t>1.65) **p < .05 (t>1.96) ***p < .01 (t>2.58)

To test whether ETP, INOCA and EXCO influence TECINOP, we tested hypotheses 1 to 4 of the structural model.

As a result of testing hypotheses 1 to 4, comparing the path coefficients of the structural model, it was found that "entrepreneurship (0.257) > innovation capability (0.295)> external cooperation (0.150)" affects technological innovation performance. First, entrepreneurship is a resource that enables venture firms to seize new innovation opportunities and take risks to realize new commercial value as a starting point for innovation, so it should be reflected in technological innovation performance. These results are consistent with previous studies such as Covin and Slevin (1986). Second, the impact of innovation capabilities on technological innovation performance has been verified in previous studies(Wang & Hu, 2020), and R&D capabilities, production process capabilities, and marketing capabilities lead to performance. Third, the ability to explore and utilize a large amount of external knowledge in a broad and deep manner this is supported by previous studies like Zan et al. (2024) that have shown high innovation performance.

On the other hand, the innovation capabilities required as a company grows are often limited by the small size and weak internal resources of venture firms.

As venture companies are small in size and have weak internal resources, their utilization is limited. Therefore, there is a great opportunity to actively compensate for the lack of resources and skills through external cooperation rather than internal innovation capabilities.It was found that there is a great opportunity to actively compensate for the lack of resources and skills through external cooperation rather than internal innovation capabilities, which significantly affects technological innovation performance.

An empirical analysis of domestic manufacturers shows that,external knowledge seeking has a positive impact on a firm's product, process, and organizational innovation performance. The results support previous studies that show that extensive and in-depth external knowledge seeking positively affects not only product innovation but also process innovation and organizational innovation, and that external cooperation plays an important role in a firm's innovation performance.

We tested Hypotheses 4.1, 4.2, and 4.3 to determine whether entrepreneurship affects technological innovation performance through innovation capabilities and external cooperation.

Hypothesis 4.1,indirect effect of ETP ->INOCA -> TECINOP is 0.190 (0.643×0.295), Hypothesis 4.2,indirect effect of ETP ->EXCO ->TECINOP is 0.059 (0.390×0.150), Hypothesis 4.3,indirect effect of ETP -

>INOCA ->EXCO ->TECINOP is 0.028 (0.643×0.289×0.150), Sobel test (Preacher & Leonardelli, 2001), all hypotheses 4.1, 4.2, and 4.3 were found to be significant. The mediation effect is judged to be partial when both the direct effect of the independent variable on the dependent variable and the mediating effect are statistically significant, and the full mediation effect is judged to be statistically significant when the mediating effect is statistically significant while the independent variable has no direct effect on the dependent variable(Babin et al., 2008).

The results of this study can be judged to have a partial mediation effect because both the effect of entrepreneurship on innovation capability and external cooperation on innovation performance and the effect of innovation capability and external cooperation on innovation performance are statistically significant. Therefore, it can be concluded that entrepreneurship of venture firms increases the level of innovation capability and external cooperation, which are the mediating variables, and that the level of innovation capability and external cooperation has a positive effect on technological innovation performance.

**Conclusions and Limitations**

Despite many research results showing that entrepreneurship has a positive effect on technological innovation and performance, the role of entrepreneurship in innovation capabilities and external cooperation has been insufficiently clarified. In this study, we examined the technological innovation performance of venture companies.

**Summary of the study**

Entrepreneurship has a positive effect on innovation capability, external cooperation, and technological innovation performance. Innovation capability has a positive influence on external cooperation and technological innovation performance, and external cooperation has also been shown to have a positive influence on technological innovation performance. In addition, innovation capability and external cooperation were each found to play a positive mediating role in the relationship between entrepreneurship and technological innovation performance. It was confirmed that a chain mediation of innovation capability and external cooperation play a positive mediating role in the relationship between entrepreneurship and technological innovation performance.

**Managerial implications**

Managers' active will and drive to innovate and acceptance of calculated risks allow them to launch more new products faster than their competitors. It has been shown that superior research and development, product/process, and organizational innovation capabilities compared to competitors serve as a source of technological innovation that enables a broad and in-depth exploration of external knowledge, thereby achieving technological innovation results.

Venture companies are established and operated based on the entrepreneurial drive of their managers. When managerial abilities based on entrepreneurship are internalized as corporate capabilities, they can respond flexibly to the environment, become competitive, and achieve sustainable growth. As venture companies with small corporate sizes and limited resource utilization grow and the scope of roles required of managers expands, the entrepreneurship drive of managers becomes embedded in the company's innovation capabilities, leading to technological innovation performance through in-depth and extensive cooperation with the outside world. The total effect will increase as it is created.

**Contributions of the study**

The study focused on comprehensively analyzing the innovation capabilities and external cooperation that operate in the process starting from the entrepreneurship drive of a venture company to technological innovation performance. Innovation capabilities were identified as organizational capabilities including research and development, products/processes, and marketing, and the mediating role of these innovation capabilities on technological innovation performance was examined by measuring various external knowledge sources broadly and in depth.

**Limitations of the study**

First, due to the difficulty in measuring business experience due to the different timing of startup and registration as a venture business, the moderating effect according to business experience could not be analyzed. It is believed that the internalization process of entrepreneurship can be well explained if the moderating effect of career experience is reflected. Second, innovation activities play an important role in the growth of services as well as manufacturing industries, and empirical comparative studies of external cooperation and innovation performance across industries and sectoral characteristics are needed. Third, external cooperation was divided into information acquisition and research and development and analyzed in terms of diversity and intensity. The question of which sources to utilize in various types of external cooperation will appear differently depending on the characteristics and innovation goals of each individual company. Therefore, it is necessary to understand in more depth the impact of different external knowledge sources on innovation performance and the optimal level for each type of external knowledge source utilization.

**Statements and Declarations**

**Disclosure statement:**No potential conflict of interest was reported by the authors.

**Competing interests:**Authors have no competing interest to disclose.

**Authors' contributions:**All authors contributed equally to this study.

**Funding:**No funding was sort for this study

Availability of data and material:Data will be available upon reasonable request from the corresponding author

## References

- Alghamdi, O., & Agag, G. (2024). Competitive advantage: A longitudinal analysis of the roles of data-driven innovation capabilities, marketing agility, and market turbulence. Journal of Retailing and Consumer Services, 76, 103547. https://doi.org/http://dx.doi.org/10.1016/j.jretconser.2023.103547
- Alhusen, H., Bennat, T., Bizer, K., Cantner, U., Horstmann, E., Kalthaus, M., . . . Töpfer, S. (2021). A new measurement conception for the 'doing-using-interacting'mode of innovation. Research Policy, 50(4), 104214.
- Aliasghar, O., Sadeghi, A., & Rose, E. L. (2023). Process innovation in small-and medium-sized enterprises: The critical roles of external knowledge sourcing and absorptive capacity. Journal of Small Business Management, 61(4), 1583-1610. https://doi.org/http://dx.doi.org/10.1080/00472778.2020.1844491
- Anaba, O. A., Ma, Z., Li, M., Su, J., & Asunka, B. A. (2022). Efficiency evaluation of manufacturing firms in China. The case of patent-intensive industries. International Journal of Manufacturing Research, 17(1), 59-81.
- Anaba, O. A., Zhiqiang, M., Mingxing, L., & Asunka, B. A. (2020). Understanding the Financial Efficiency of Military and Civilian integration Enterprises: The case of Jiangsu, Zhejiang, and Shanghai Provinces of China. Pacific Business Review International, 12(7), 24-43.
- Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. Psychological bulletin, 103(3), 411. https://doi.org/http://dx.doi.org/10.1037/0033-2909.103.3.411
- Asimakopoulos, G., Revilla, A. J., & Slavova, K. (2020). External knowledge sourcing and firm innovation efficiency. British Journal of Management, 31(1), 123-140. https://doi.org/http://dx.doi.org/10.1111/1467-8551.12367
- Audretsch, B. D., & Belitski, M. (2023). The limits to open innovation and its impact on innovation performance. Technovation, 119, 102519. https://doi.org/http://dx.doi.org/10.1016/j.technovation.2022.102519
- Awan, U., Nauman, S., & Sroufe, R. (2021). Exploring the effect of buyer engagement on green product innovation: Empirical evidence from manufacturers. Business Strategy and the Environment, 30(1), 463-477. https://doi.org/http://dx.doi.org/10.1002/bse.2631

- Babin, B. J., Hair, J. F., & Boles, J. S. (2008). Publishing research in marketing journals using structural equation modeling. Journal of marketing theory and practice, 16(4), 279-286. https://doi.org/http://dx.doi.org/10.2753/MTP1069-6679160401
- Baron, R. A., & Shane, S. (2007). Entrepreneurship: A process perspective. The psychology of entrepreneurship, 19-39.
- Bendig, D., Göttel, V., Eckardt, D., & Schulz, C. (2024). Human capital in corporate venture capital units and its relation to parent firms' innovative performance. Research Policy, 53(6), 105003. https://doi.org/http://dx.doi.org/10.1016/j.respol.2024.105003
- Burgelman, R. A., Christensen, C. M., & Wheelwright, S. C. (2008). Strategic management of technology and innovation. McGraw-Hill/Irwin.
- Burns, T., & Stalker, G. (2009). The organization of innovation. In Knowledge Management and Organisational Design (pp. 77-92). Routledge.
- Chaudhuri, R., Chatterjee, S., Mariani, M. M., & Wamba, S. F. (2024). Assessing the influence of emerging technologies on organizational data driven culture and innovation capabilities: A sustainability performance perspective. Technological Forecasting and Social Change, 200, 123165. https://doi.org/http://dx.doi.org/10.1016/j.techfore.2023.123165
- Cheah, S. L.-Y., Ho, Y.-P., & Li, S. (2021). Search strategy, innovation and financial performance of firms in process industries. Technovation, 105, 102257.
- Chesbrough, H., Radziwon, A., Vanhaverbeke, W., & West, J. (2024). The Oxford Handbook of Open Innovation. Oxford University Press. https://doi.org/http://dx.doi.org/10.1093/oxfordhb/9780192899798.001.0001
- Chin, W. W. (1998). The partial least squares approach to structural equation modeling. Modern methods for business research, 295(2), 295-336.
- Chistov, V., Aramburu, N., Florit, M. E. F., Peña-Legazkue, I., & Weritz, P. (2023). Sustainability orientation and firm growth as ventures mature. Business Strategy and the Environment, 32(8), 5314-5331. https://doi.org/http://dx.doi.org/10.1002/bse.3418
- Chistov, V., Carrillo-Hermosilla, J., & Aramburu, N. (2023). Open eco-innovation. Aligning cooperation and external knowledge with the levels of eco-innovation radicalness. Journal of Open Innovation: Technology, Market, and Complexity, 9(2), 100049. https://doi.org/http://dx.doi.org/10.1016/j.joitmc.2023.100049
- Clausen, T. H., Korneliussen, T., & Madsen, E. L. (2013). Modes of innovation, resources and their influence on product innovation: Empirical evidence from R&D active firms in Norway. Technovation, 33(6-7), 225-233. https://doi.org/http://dx.doi.org/10.1016/j.technovation.2013.02.002
- Corrêa, V. S., Queiroz, M. M., Cruz, M. A., & Shigaki, H. B. (2022). Entrepreneurial orientation far beyond opportunity: the influence of the necessity for innovativeness, proactiveness and risk-taking. International journal of entrepreneurial behavior & research, 28(4), 952-979. https://doi.org/http://dx.doi.org/10.1108/IJEBR-06-2021-0518
- Covin, J. G., & Slevin, D. P. (1986). The development and testing of an organizational-level entrepreneurship scale. Frontiers of entrepreneurship research, 1(3), 628-639.
- Covin, J. G., & Slevin, D. P. (1991). A conceptual model of entrepreneurship as firm behavior. Entrepreneurship theory and practice, 16(1), 7-26. https://doi.org/http://dx.doi.org/10.1177/104225879101600102
- Davcik, N. S., Cardinali, S., Sharma, P., & Cedrola, E. (2021). Exploring the role of international R&D activities in the impact of technological and marketing capabilities on SMEs' performance. Journal of Business Research, 128, 650-660. https://doi.org/http://dx.doi.org/10.1016/j.jbusres.2020.04.042
- Dess, G. G., & Lumpkin, G. T. (2005). The role of entrepreneurial orientation in stimulating effective corporate entrepreneurship. Academy of Management Perspectives, 19(1), 147-156. https://doi.org/http://

dx.doi.org/10.5465/ame.2005.15841975

- Dimakopoulou, A., Gkypali, A., & Tsekouras, K. (2024). Technological and non-technological innovation synergies under the lens of absorptive capacity efficiency. Journal of Business Research, 176, 114593. https://doi.org/http://dx.doi.org/10.1016/j.jbusres.2024.114593
- Duan, Y., Wang, W., & Zhou, W. (2020). The multiple mediation effect of absorptive capacity on the organizational slack and innovation performance of high-tech manufacturing firms: Evidence from Chinese firms. International Journal of Production Economics, 229, 107754. https://doi.org/http://dx.doi.org/10.1016/j.ijpe.2020.107754
- Dzikowski, P. (2022). Product and process innovation patterns in Polish low and high technology systems. Equilibrium. Quarterly Journal of Economics and Economic Policy, 17(3), 747-773. https://doi.org/http://dx.doi.org/ 10.24136/eq.2022.026
- Edeh, J., & Prévot, F. (2024). Beyond funding: The moderating role of firms' R&D human capital on government support and venture capital for regional innovation in China. Technological Forecasting and Social Change, 203, 123351. https://doi.org/http://dx.doi.org/10.1016/j.techfore.2024.123351
- Eng, T.-Y., Mohsen, K., & Wu, L.-C. (2023). Wireless information technology competency and transformational leadership in supply chain management: implications for innovative capability. Information Technology & People, 36(3), 969-995. https://doi.org/http://dx.doi.org/10.1108/ITP-06-2021-0489
- Farida, I., & Setiawan, D. (2022). Business strategies and competitive advantage: the role of performance and innovation. Journal of Open Innovation: Technology, Market, and Complexity, 8(3), 163. https://doi.org/http://dx.doi.org/10.3390/joitmc8030163
- Fornell, C., & Bookstein, F. L. (1982). Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. Journal of Marketing research, 19(4), 440-452. https://doi.org/http://dx.doi.org/10.2307/3151718
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing research, 18(1), 39-50. https://doi.org/http://dx.doi.org/10.2307/3151312
- Frenz, M., & Ietto-Gillies, G. (2023). Indicators of Absorptive Capacity: A Policy-Led, Dimensional Approach. Theoretical Framework and Estimates for 24 Countries and 24 UK Sectors. Theoretical Framework and Estimates for, 24.
- Gambardella, A., Heaton, S., Novelli, E., & Teece, D. J. (2021). Profiting from enabling technologies? Strategy Science, 6(1), 75-90. https://doi.org/http://dx.doi.org/10.1287/stsc.2020.0119
- Garrido-Moreno, A., Martín-Rojas, R., & García-Morales, V. J. (2024). The key role of innovation and organizational resilience in improving business performance: A mixed-methods approach. International Journal of Information Management, 77, 102777. https://doi.org/http://dx.doi.org/10.1016/j.ijinfomgt.2024.102777
- Gefen, D., & Straub, D. (2005). A practical guide to factorial validity using PLS-Graph: Tutorial and annotated example. Communications of the Association for Information systems, 16(1), 5. https://doi.org/http://dx.doi.org/10.17705/1CAIS.01605
- Hameed, W. U., Nisar, Q. A., & Wu, H.-C. (2021). Relationships between external knowledge, internal innovation, firms' open innovation performance, service innovation and business performance in the Pakistani hotel industry. International Journal of Hospitality Management, 92, 102745. https://doi.org/http://dx.doi.org/10.1016/j.ijhm.2020.102745
- Hamzah, M. I., & Othman, A. K. (2023). How do locus of control influence business and personal success? The mediating effects of entrepreneurial competency. Frontiers in Psychology, 13, 958911. https://doi.org/http://dx.doi.org/10.3389/fpsyg.2022.958911

- Henseler, J., & Schuberth, F. (2023). Partial least squares as a tool for scientific inquiry: Comments on Cadogan and Lee. European Journal of Marketing, 57(6), 1737-1757. https://doi.org/http://dx.doi.org/10.1108/EJM-06-2021-0416
- Hervas-Oliver, J.-L., Sempere-Ripoll, F., & Boronat-Moll, C. (2021). Technological innovation typologies and open innovation in SMEs: Beyond internal and external sources of knowledge. Technological Forecasting and Social Change, 162, 120338. https://doi.org/http://dx.doi.org/10.1016/j.techfore.2020.120338
- Huang, S., Battisti, M., & Pickernell, D. (2023). The roles of innovation strategy and founding team diversity in new venture growth. Journal of Business Research, 158, 113653. https://doi.org/http://dx.doi.org/10.1016/j.jbusres.2023.113653
- Idewele, I. O. E., Andah, R. A., & Ridwan, M. (2021). The effect of enterprise on managerial innovation capacity. Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences, 4(2), 2643-2657. https://doi.org/http://dx.doi.org/10.33258/birci.v4i2.1971
- Ince, H., Imamoglu, S. Z., & Karakose, M. A. (2023). Entrepreneurial orientation, social capital, and firm performance: The mediating role of innovation performance. The International Journal of Entrepreneurship and Innovation, 24(1), 32-43. https://doi.org/http://dx.doi.org/10.1177/14657503211055297
- Kearney, C., & Lichtenstein, B. (2023). Generative emergence: Exploring the dynamics of innovation and change in high-potential start-up ventures. British Journal of Management, 34(2), 898-914. https://doi.org/http://dx.doi.org/10.1111/1467-8551.12604
- Khraishi, A., Paulraj, A., Huq, F., & Seepana, C. (2023). Knowledge management in offshoring innovation by SMEs: role of internal knowledge creation capability, absorptive capacity and formal knowledge-sharing routines. Supply Chain Management: An International Journal, 28(2), 405-422. https://doi.org/http://dx.doi.org/10.1108/SCM-05-2021-0256
- Kilintzis, P., Avlogiaris, G., Samara, E., & Bakouros, Y. (2023). Technology entrepreneurship: A model for the European case. Journal of the Knowledge Economy, 14(2), 879-904. https://doi.org/http://dx.doi.org/10.1007/s13132-022-00950-x
- Kok, B. C., Choi, J. S., Oh, H., & Choi, J. Y. (2021). Sparse extended redundancy analysis: variable selection via the exclusive LASSO. Multivariate behavioral research, 56(3), 426-446. https://doi.org/http://dx.doi.org/10.1080/00273171.2019.1694477
- Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. Strategic management journal, 27(2), 131-150. https://doi.org/http://dx.doi.org/10.1002/smj.507
- Li, Z., Anaba, O. A., Ma, Z., & Li, M. (2021). Ghanaian SMEs amidst the COVID-19 pandemic: Evaluating the influence of entrepreneurial orientation. Sustainability, 13(3), 1131.
- Martin, S. L., Javalgi, R. R. G., & Ciravegna, L. (2020). Marketing capabilities and international new venture performance: The mediation role of marketing communication and the moderation effect of technological turbulence. Journal of Business Research, 107, 25-37. https://doi.org/http://dx.doi.org/10.1016/j.jbusres.2019.09.044
- Mei, L., Rentocchini, F., & Chen, J. (2023). Antecedents of strategic ambidexterity in firms' product innovation: External knowledge and internal information sharing. Journal of Small Business Management, 61(6), 2849-2878. https://doi.org/http://dx.doi.org/10.1080/00472778.2021.1944635
- Mendoza-Silva, A. (2021). Innovation capability: a systematic literature review. European Journal of Innovation Management, 24(3), 707-734. https://doi.org/http://dx.doi.org/10.1108/EJIM-09-2019-0263
- Milton, K., Bull, F., & Bauman, A. (2011). Reliability

and validity testing of a single-item physical activity measure. British journal of sports medicine, 45(3), 203-208. https://doi.org/http://dx.doi.org/10.1136/bjsm.2009.068395

- Mokbel Al Koliby, I. S., Abdullah, H. H., & Mohd Suki, N. (2024). Linking entrepreneurial competencies, innovation and sustainable performance of manufacturing SMEs. Asia-Pacific Journal of Business Administration, 16(1), 21-40. https://doi.org/http://dx.doi.org/10.1108/APJBA-09-2021-0480
- Morgan, T., & Anokhin, S. (2023). Entrepreneurial orientation and new product performance in SMEs: The mediating role of customer participation. Journal of Business Research, 164, 113921. https://doi.org/http://dx.doi.org/10.1016/j.jbusres.2023.113921
- Ponta, L., Puliga, G., & Manzini, R. (2021). A measure of innovation performance: the Innovation Patent Index. Management Decision, 59(13), 73-98. https://doi.org/http://dx.doi.org/10.1108/MD-05-2020-0545
- Praditya, R. A., & Purwanto, A. (2024). Linking The Influence of Dynamic Capabilities and Innovation Capabilities on Competitive Advantage: PLS-SEM Analysis. PROFESOR: Professional Education Studies and Operations Research, 1(02), 6-10.
- Preacher, K. J., & Leonardelli, G. J. (2001). Calculation for the Sobel test. Retrieved January, 20, 2009.
- Quintero, S. I. C., & Zúñiga, C. A. (2023). Innovation capabilities, innovation strategies and performance: an empirical analysis in SMEs. Technology Analysis & Strategic Management, 1-16.
- Rajapathirana, R. J., & Hui, Y. (2018). Relationship between innovation capability, innovation type, and firm performance. Journal of Innovation & Knowledge, 3(1), 44-55. https://doi.org/http://dx.doi.org/10.1016/j.jik.2017.06.002
- Robertson, J., Caruana, A., & Ferreira, C. (2023). Innovation performance: The effect of knowledge-based dynamic capabilities in cross-country innovation ecosystems. International Business Review, 32(2), 101866. https://doi.org/http://dx.doi.org/10.1016/j.ibusrev.2021.101866
- Rönkkö, M., & Cho, E. (2022). An updated guideline for assessing discriminant validity. Organizational Research Methods, 25(1), 6-14. https://doi.org/http://dx.doi.org/ 10.1177/1094428120968614
- Ryu, D., Baek, K. H., & Yoon, J. (2022). Linking external knowledge search to innovation ambidexterity in SMEs. Science, Technology and Society, 27(2), 159-171. https://doi.org/http://dx.doi.org/10.1177/09717218221074905
- Sagar, G., Anand, B., Perumalla Varalaxmi, A. S., & Raj, S. (2023). The role of entrepreneurship in economic growth and development. Journal of Survey in Fisheries Sciences, 10(1S), 5940-5955.
- Sari, D., Kusuma, B. A., Sihotang, J., & Febrianti, T. (2023). The role of entrepreneurial marketing & innovation capability in the performance of SMEs during covid-19 pandemic: Evidence of MSMEs in West Java. Cogent business & management, 10(1), 2194091. https://doi.org/http://dx.doi.org/10.1080/23311975.2023.2194091
- Schumpeter, J. A. (1934). The Theory of Economic Development. Harvard University Press. https://doi.org/http://dx.doi.org/10.1007/0-306-48082-4_3
- Solomon, S. J., & Mathias, B. D. (2020). The artisans' dilemma: Artisan entrepreneurship and the challenge of firm growth. Journal of Business Venturing, 35(5), 106044. https://doi.org/http://dx.doi.org/10.1016/j.jbusvent.2020.106044
- Somwethee, P., Aujirapongpan, S., & Ru-Zhue, J. (2023). The influence of entrepreneurial capability and innovation capability on sustainable organization performance: Evidence of community enterprise in Thailand. Journal of Open Innovation: Technology, Market, and Complexity, 9(2), 100082. https://doi.org/http://dx.doi.org/10.1016/j.joitmc.2023.100082
- Teece, D. J. (2018). Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. Research Policy,

47(8), 1367-1387. https://doi.org/http://dx.doi.org/10.1016/j.respol.2017.01.015

- Vincenzi, T. B. D., & da Cunha, J. C. (2021). Open innovation and performance in the service sector. Innovation & Management Review, 18(4), 382-399. https://doi.org/http://dx.doi.org/10.1108/INMR-01-2020-0004
- Wang, C., Chin, T., & Lin, J.-H. (2020). Openness and firm innovation performance: the moderating effect of ambidextrous knowledge search strategy. Journal of Knowledge Management, 24(2), 301-323. https://doi.org/http://dx.doi.org/10.1108/JKM-04-2019-0198
- Wang, C., & Hu, Q. (2020). Knowledge sharing in supply chain networks: Effects of collaborative innovation activities and capability on innovation performance. Technovation, 94, 102010. https://doi.org/http://dx.doi.org/10.1016/j.technovation.2017.12.002
- Wang, X., Cai, L., Zhu, X., & Deng, S. (2022). Female entrepreneurs' gender roles, social capital and willingness to choose external financing. Asian Business & Management, 21(3), 432. https://doi.org/http://dx.doi.org/10.1057/s41291-020-00131-1
- White, M. A., & Bruton, G. D. (2017). The management of technology and innovation. Cengage.
- Wongsansukcharoen, J., & Thaweepaiboonwong, J. (2023). Effect of innovations in human resource practices, innovation capabilities, and competitive advantage on small and medium enterprises' performance in Thailand. European Research on Management and Business Economics, 29(1), 100210. https://doi.org/http://dx.doi.org/10.1016/j.iedeen.2022.100210
- Yigit, A., & Kanbach, D. K. (2023). The significance of technology-driven entrepreneurship activities: Lessons from SMEs operating in the manufacturing industry. Cogent business & management, 10(1), 2185069. https://doi.org/http://dx.doi.org/10.1080/23311975.2023.2185069
- Yu, W., Choi, M., & Zheng, J. (2021). How do different types of entrepreneurial networks and decision-making influence the identification of entrepreneurial opportunities? Frontiers in Psychology, 12, 683285. https://doi.org/http://dx.doi.org/10.3389/fpsyg.2021.683285
- Yuan, X., & Song, W. (2022). Evaluating technology innovation capabilities of companies based on entropy-TOPSIS: the case of solar cell companies. Information Technology and Management, 23(2), 65-76. https://doi.org/http://dx.doi.org/10.1007/s10799-021-00344-6
- Zahra, S. A. (2021). The resource-based view, resourcefulness, and resource management in startup firms: A proposed research agenda. Journal of Management, 47(7), 1841-1860. https://doi.org/http://dx.doi.org/10.1177/01492063211018505
- Zan, F., Leong, Y. C., Ismail, N. A., Chu, M., Saif, A. N. M., & Islam, K. A. (2024). Knowledge sharing and innovation performance: The mediating role of open innovation. Global Business and Organizational Excellence, 43(3), 32-45. https://doi.org/http://dx.doi.org/10.1002/joe.22235
- Zhao, J. (2023). Coupling open innovation: Network position, knowledge integration ability, and innovation performance. Journal of the Knowledge Economy, 14(2), 1538-1558. https://doi.org/http://dx.doi.org/10.1007/s13132-022-00932-z
-