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Unraveling key factors enhancing female entrepreneurial performance in China: a pls-sem and fsqca analysis

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This study not only illuminates the complex interplay of factors affecting the entrepreneurial performance of 558 Chinese female entrepreneurs but also significantly contributes to the burgeoning literature on gender dynamics in entrepreneurship. By employing a gender-aware framework and mixed methods, including Partial Least Squares Structural Equation Modeling (PLS-SEM) and Fuzzy Set Qualitative Comparative Analysis (fsQCA), it breaks new ground in understanding the unique challenges and opportunities faced by female entrepreneurs. The identification of digital ability, opportunity development, entrepreneurial team heterogeneity, work-family conflict, and gender stereotypes as pivotal elements offer valuable insights for crafting targeted support strategies and policies to enhance female entrepreneurial performance (FEP). Furthermore, the study's revelation of two distinct pathways to enhance FEP not only provides practical guidance for aspiring female entrepreneurs but also lays the groundwork for future research to explore the nuanced interactions between these factors.

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Introduction

Female entrepreneurship has become one of the fastest-growing sectors in the global entrepreneurial ecosystem (Cardella et al. 2020), showing a thriving trend worldwide (Brush and Cooper 2012). Female entrepreneurs play a crucial role not only in driving economic growth, creating jobs, and fostering innovation but also in promoting social equity, reducing poverty, and mitigating social exclusion (Brush and Cooper 2012; Cardella et al. 2020). With the development of the global economy and increased emphasis on gender equality, the importance of female entrepreneurship is becoming increasingly prominent (Sharma et al. 2024), serving as a vital force in achieving sustainable development goals. The swift advancement of the digital economy is significantly transforming the global business landscape. The widespread application of digital technologies such as cloud computing, big data, and artificial intelligence provides entrepreneurs with unprecedented opportunities and resources, significantly impacting entrepreneurial performance (Özkazanç-Pan and Pullen 2020; Plotnikof et al. 2020). In China, a leading emerging market globally, the digital economy is expanding rapidly, creating more employment opportunities and entrepreneurial pathways for women while also introducing new challenges (Luo and Chan 2021). Understanding how the digital economy affects female entrepreneurial performance (FEP) is crucial for enhancing the competitiveness of female entrepreneurs in the digital age. The pandemic has exacerbated global structural inequalities (Özkazanç-Pan and Pullen 2020; Özkazanç-Pan and Pullen 2021; Plotnikof et al. 2020), highlighting the importance of female entrepreneurship as a means for women to engage in the labor market (Bouguerra 2015; Ennis 2019). The growth of female entrepreneurship is crucial for economic development and social equality (Deng et al. 2020; Kamberidou 2020).

Recent advancements in the digital economy have increased entrepreneurial opportunities for women, prompting a societal shift towards strengthening female entrepreneurship (Cavada et al. 2017). According to EarthWeb's 2024 female Entrepreneurs statistics show that there are about 252 million female entrepreneurs worldwide, accounting for 43% of the global entrepreneurs. With the rapid development of digital technology, the digital economy provides unprecedented opportunities for women to start their own businesses (Ughetto et al. 2020). Digital tools such as social media marketing and mobile payment have greatly lowered the entrepreneurial threshold (Yin et al. 2019; Steel 2021), overcome key gender barriers in entrepreneurship (McAdam et al. 2020; Salamzadeh et al. 2024), release the potential of digital entrepreneurship (Leong et al. 2022), and improve their entrepreneurial performance (FEP) are urgent issues in this study.

Research on female entrepreneurship has highlighted the unique challenges women face when starting and running businesses, such as limited access to information, finance, and networks (Ughetto et al. 2020). Entrepreneurial performance (EP), which measures the outcomes of entrepreneurial activities (Aboramadan et al. 2020), is significantly influenced by factors like digital ability (DA), opportunity development (OD), team heterogeneity (ETH), work (entrepreneurship)-family conflict (WFC), and gender stereotypes (GS) (Ramos and Casado-Molina 2021; Huang et al. 2022a; Xing et al. 2020; Chen et al. 2022; Cowden and Karami 2023). However, there is a lack of systematic empirical research on how the digital economy specifically affects FEP in China, despite its rapid digital development (Luo and Chan 2021; Ughetto et al. 2020). This study seeks to fill this gap by analyzing key factors within the digital economy context and uncovering the mechanisms through which they influence FEP in China.

This study aims to supplement the above gaps and employs the gender consciousness framework and social role theory to construct a comprehensive research model examining FEP from micro-, meso-, and macro-level perspectives. Specifically, it explores how digital ability (DA) and opportunity development (OD) at the micro level, entrepreneurial team heterogeneity (ETH) at the meso level, and work (entrepreneurship)-family conflict (EFC) and gender stereotypes (GS) at the macro level influence FEP. Using female entrepreneurs as the focus, the study validates hypotheses through partial least squares structural equation modeling (PLS-SEM) and explores factor interactions using fuzzy set qualitative comparative analysis (fsQCA). This study contributes to the literature by expanding the theoretical boundaries of female entrepreneurship research and providing a more holistic understanding of the mechanisms influencing female entrepreneurial performance in the digital era. Practically, it offers valuable insights for policymakers and entrepreneurs seeking to enhance female entrepreneurial success in China and potentially other emerging markets. Therefore, the main research question of this paper is as follows:

RQ1: *What are the key factors influencing female entrepreneurial performance in China' s digital economy?*

RQ2: *How do these key factors interact to affect female entrepreneurial performance?*

Literature and hypotheses development

A gender-aware framework for women. Markets, Money, and Management are essential for entrepreneurs to start and develop their businesses. Therefore, previous theories explaining entrepreneurship typically involve the three basic structures of market, money, and management, or the "3Ms" framework, which includes developing market opportunities, acquiring capital, and managing human and organizational capital. Brush et al. (2009) argue that entrepreneurship is a social activity, and when studying a particular group in the entrepreneurial ecosystem, researchers must consider that group as a (control) variable (Berger and Kuckertz 2016). Entrepreneurship is not only influenced by the micro-environment of markets, finance, and management but also by meso- and macro-level factors such as family, social, and cultural norms (Salamzadeh et al. 2023; Welsh et al. 2017), where the influence of family and socio-cultural factors on women may be more significant than that of men (García-Sánchez et al. 2023). Drawing on institutional theory, Brush et al. (2009) adds "Mother" and "Meso/Macro environment" to extend and regulate the "3Ms." The "5Ms" gender consciousness framework is constructed to provide a research framework for furthering a comprehensive understanding of female entrepreneurship.

The framework consists of five elements: market, capital, management, meso-environment, and macro-environment. In this framework, "motherhood" is at the center; the market is a source of opportunities for all entrepreneurs; capital and management are indispensable factors to enter the market and can be considered enablers of opportunities. "Maternity" not only refers to women's natural and social role but also represents a metaphor for the entrepreneur's family and environment, closely related to unequal family power relations and the definition of social norms and expectations of a women's societal role.

Therefore, this study draws on Brush et al.'s (2009) gender awareness framework to explore the factors that facilitate and hinder EP among Chinese female entrepreneurs.

Social Role Theory. Social Role Theory, proposed by Eagly, suggests that societal expectations and norms for different gender roles influence individual behavior and performance (Eagly 1987). In the entrepreneurial context, the societal construct of female gender roles often clashes with the stereotypical image of

entrepreneurs, as observed by Xu et al. (2023). This conflict is not confined to developed nations; in developing countries, traditional gender role beliefs also impose constraints on women. These beliefs act as barriers, limiting their access to vital information and skills, as highlighted by Md. Shajahan et al. (2022), which are crucial for entrepreneurial success. Social Role Theory not only explains the formation of gender stereotypes but also reveals how these stereotypes restrict women's opportunities in entrepreneurship (Eagly and Karau 2002). Liñán et al. (2020) argues that gender stereotypes significantly contribute to performance differences between male and female entrepreneurs. According to Social Role Theory, society often expects women to prioritize caregiving, leading to increased work-family conflict, which can negatively affect their entrepreneurial performance. In patriarchal societies like China, it is considered natural for women to take care of the family (Blalock and Lyu 2023), further increasing the barriers for women to become entrepreneurs (Huang et al. 2021). Additionally, related research indicates that women face disadvantages in acquiring digital skills (Oggero et al. 2020), which also limits their competitiveness in the modern entrepreneurial environment. Social role expectations significantly influence women's career choices and entrepreneurial behavior (Eagly and Karau 2002), affecting their self-view and the obstacles and resources they encounter in entrepreneurship (Brush et al. 2009), thereby affecting how women identify and develop entrepreneurial opportunities. Therefore, this paper integrates Social Role Theory into the theoretical framework (Fig. 1) to comprehensively understand how societal expectations and resource access jointly influence FEP in China, providing a theoretical basis for enhancing FEP.

Digital ability (DA). DA refers to the availability of digital expertise (Gurbaxani and Dunkle 2019), the essence of which is the effective application of ICT and smart devices (Pan et al. 2022). In general, DA can be summarized as follows: innovative technical talent is already available within the company; the necessary visionary/innovative abilities are available to ascertain the appropriate agenda strategy; digital skills to execute the strategy are available; and the ability of entrepreneurs and managers to assign grades according to their personal level of knowledge of digital transformation.

Digital transformation is entering a new period of global economic governance (Paradise 2019). Entrepreneurial behavior centered on digital technologies is improving the structure of economic activities and business models today (Pan et al. 2022). Entrepreneurs advantage agenda capabilities to accredit companies to create, deploy, and assure abstract assets that abutment above and abiding business performance (Tortora et al. 2021). Additionally, the digital reputation built by entrepreneurs using digital abilities has a positive effect on their firms' financial and non-financial performance (Rosamartina et al. 2022).

In the entrepreneurial landscape, women depend more on access to public resources than men (Maclaran and Chatzidakis 2021), which aligns with a gender-aware framework for women to emphasize the importance of considering gender-specific challenges and opportunities in entrepreneurial contexts (Brush et al. 2009). Digital transformation provides a more digital public sphere; the most significant differences amid high- and low-performing companies exist in digital abilities and technology assets. Therefore, entrepreneurs in today's aggressive ambiance charge admit and ahead the changes brought by technology, assess their potential impact, enhance their own and company's digital abilities, and accept how to use agenda technology to actualize and abduction amount for their companies (Gurbaxani and Dunkle 2019). Therefore, we make the following proposition:

Proposition 1: *DA has a positive effect on EP.*

Opportunity development (OD). Entrepreneurial opportunities refer to whether entrepreneurs think that there are good entrepreneurial opportunities in their area (Huang et al. 2024), which determines the allocation of resources and the growth mode of entrepreneurship (Ge et al. 2016) and is one of the key elements in the entrepreneurial process (Clark and Ramachandran 2019). OD is reflected in an entrepreneur's ability to actively structure, organize, and control internal and external resources in which the entrepreneur attempts to commercialize the opportunity (Huang et al. 2022a). The characteristics of opportunity exploitation are that entrepreneurs develop products or services, obtain appropriate human resources, gather financial resources, and establish organizations based on perceived entrepreneurial opportunities (Kuckertz et al. 2017).

Businesses face high uncertainty and risk and often require long-term investment to achieve returns, so business performance relies heavily on the entrepreneur's ability to effectively exploit opportunities (Ge et al. 2016). Brush et al. (2009) in a gender-aware framework for women mentions "market" as one of the key 3Ms required for entrepreneurs to launch and grow ventures. Therefore, opportunity identification and development by female entrepreneurs in market can help firms creatively combine resources and use them to generate higher profits, positively impacting EP (Huang et al. 2022b). Aspiring entrepreneurs must react quickly to changing conditions, take innovative actions, and explore new avenues to successfully exploit entrepreneurial opportunities (Quaye and Mensah 2019). OD can help entrepreneurs generate revenue and eventually achieve entrepreneurial success (Tajpour et al. 2018). However, due to the gender norms of female roles and behaviors in Chinese society, women's lack of confidence will affect OD (Hernandez et al. 2012), which in turn affects entrepreneurial performance. Therefore, we make the following proposition:

Proposition 2: *OD has a positive effect on EP.*

Entrepreneurial team heterogeneity (ETH). ETH refers to the differences amid ambitious aggregation associates in age, gender, education, assignment experience, cerebral concepts, values, and added aspects (Pelled, 1996). Team member heterogeneity can affect a firm's strategy and outcomes (Mehrabi et al. 2020). By examining the relationship between the variation in education, work experience of team members, and team productivity, Hambrick and Mason (1984) found a positive relationship between education and work experience heterogeneity and team performance. By examining entrepreneurial teams and strategic agility, Xing et al. (2020) found that highly heterogeneous management teams can provide multifaceted information to a firm and help it make sound decisions in a complex, competitive environment, which produces good performance. Zhang and Zhu (2021) found that different team members have different knowledge and skills. This implies that teams with a high level of heterogeneity have the potential to exhibit strong cognitive and information-processing capabilities. These capabilities can be beneficial for companies to identify unique and novel information and drive optimal changes in organizational structures and processes. Therefore, we make the following proposition:

Proposition 3: *ETH positively affects EP.*

Work (entrepreneurship)–family conflict (WFC). WFC is a frequent problem for female entrepreneurs when starting a business because of cultural norms and gender biases (Hsu et al. 2016). Women are often considered to assume the "natural" obligation of the guardians of a good family atmosphere

(Vučeković et al. 2021). Entrepreneurship is defined as a career choice (Edelman et al. 2016), and women are more influenced by their families than men concerning work, especially entrepreneurship (Ester and Roman 2017; Rosado-Cubero et al. 2022). Work-family conflict can be accepted as a blazon of inter-role battle that occurs back the demands and pressures of both assignment and ancestors roles are adverse in assertive ways (Greenhaus and Beutell 1985). Typical issues faced by women entrepreneurs related to WFC include conflict with spouse, family responsibilities, and parental obligations (Kim and Ling, 2001; Kirkwood and Tootell 2008). In essence, while personal issues can disrupt any entrepreneur's business and family life, the impact on female entrepreneurs is particularly pronounced.

A gender-aware framework for women suggests that the FEP can be explained at the family level (Brush et al. 2009). Family support is essential for women entrepreneurs who want to start and develop their own business ventures; emotional support from family members can provide psychological assistance for women entrepreneurs in dealing with business problems or encouraging them in their entrepreneurial choices (Kaciak and Welsh 2020), which is essential for maintaining business performance during difficult times (Hilbrecht 2016). Research shows that women entrepreneurs' excessive parenting and family responsibilities can affect their success and that an environment of family conflict and unwelcome business ideas is also detrimental to female entrepreneurship (Basco 2015), especially in highly competitive and dynamic environments. Balancing WFC causes entrepreneurs to adjust their entrepreneurial orientation, significantly affecting business performance during the rapid growth phase (Chen et al. 2022; Kallmuenzer et al. 2018). Agarwal and Agrawal (2023) explores the balance of work and family to motivate female entrepreneurs based on the social role theory. Thus, we propose the following proposition:

Proposition 4: *WFC negatively affects EP.*

Gender stereotypes (GS). GS refers to the cultural perceptions held by a specific group regarding the expected behaviors of men and women (Malmström et al. 2020). These stereotypes encompass the beliefs and norms that differentiate men from women (Gupta et al. 2013), which are embedded within societal expectations and cultural norms, which are part of the meso/macro environment (Brush et al. 2009). Women are often characterized as nurturing, supportive, kind, and emotionally expressive (Gupta et al. 2009). Previous studies suggest that male entrepreneurs may outperform their female counterparts (Robb and Watson 2012). This may be attributed to the influence of entrepreneurial performance by entrepreneurial personality traits, values and resources (Sriram and Mersha 2017). Entrepreneurship is viewed as a largely male-dominated field associated with qualities such as competitiveness, confidence, and extraordinary achievement, which may give male entrepreneurs an advantage over female entrepreneurs (Gupta et al. 2009). Additionally, these male stereotypes of entrepreneurs have become a key reason for the decreasing number of female entrepreneurs (Gupta et al. 2008). This asymmetry of gender roles becomes institutionalized in a particular civilization and a particular context (Kenny 2007). In the context of entrepreneurship, gender role asymmetry undermines the capabilities and priorities of female entrepreneurs and their perceptions of work (Thébaud 2015).

In countries where gender inequality is prevalent and the female perspective is undervalued, business performance is lacking when implemented (Cowden and Karami 2023). According to the Ewing Marion Kauffman Foundation (2015), women entrepreneurs, influenced by the cultural context of gender roles, receive almost half of the start-up capital of male entrepreneurs when it comes to equity financing and have difficulty finding financial resources compared to their male counterparts. The performance of female entrepreneurs is highest in areas with lower levels of gender role inequality (Cowden and Karami 2023). In summary, we make the following proposition:

Proposition 5: *GS has a negative effect on EP.*

The mediating role of opportunity development (OD). The emergence of digital technologies, platforms, and infrastructure has provided opportunities for entrepreneurs to create new businesses and for existing business branches to move from offline to online environments (Cenamor et al. 2019; Jafari-Sadeghi et al. 2020). Individuals' access to external knowledge through digital networks is essential to develop the ability to identify new business opportunities, which will positively affect the financial performance of enterprises (Ghanbarpour and Gustafsson 2021). Information asymmetry allows individuals to capture information using digital capabilities to recognize opportunities (Ramos-Rodríguez et al. 2010). Therefore, it is reasonable to assume that digital technologies and its capabilities provide a range of opportunities for entrepreneurial action. In the process of OD, potential entrepreneurs seek, identify, and evaluate information to improve products or services and exploit specific markets to improve business performance (Shu et al. 2018).

Exploiting opportunities, skills, and capabilities is critical to corporate performance (Sariol and Abebe 2017; Uotila 2017). Exploration can yield positive performance outcomes as it allows for the discovery of new opportunities, the acquisition of key markets or technical knowledge, the development of new unique capabilities, and the expansion of customer base (Lubatkin et al. 2006). Chen and Liu (2020) found that the mediating factor between the relationship of digital competence and entrepreneurial performance in female entrepreneurs is opportunity exploitation. Taken together, we argue that female entrepreneurs' digital ability enhance their OD capabilities, which further positively affects their EP. Thus, we propose the following hypothesis:

Proposition 6: *OD mediates the relationship betweenDA and EP.*

Female entrepreneurs have limited access to resources and social networks during the start-up phase, whereas co-working spaces provide open workplaces, collaborative opportunities, and a sense of community, creating opportunities for female entrepreneurs to build new businesses (Luo and Chan 2021). The gender-aware framework's emphasis on social embeddedness supports the idea that team diversity impacts opportunity development (Brush et al. 2009). A diverse and heterogeneous entrepreneurial team is more sensitive to changes in the complex competitive environment and has a wider range of sources and access to information, which helps entrepreneurs to capture opportunities and allocate resources rationally, thus helping to improve their entrepreneurial performance (Huang et al. 2022a; Rovelli et al. 2020). Teams with highly heterogeneous industry experience are better able to gain insight into changes and developments in related industries and quickly identify key resource supporters, which helps entrepreneurs integrate relevant entrepreneurial resources and improve their OD and problem-solving abilities (Jin et al. 2017). By developing opportunities, entrepreneurs can effectively allocate internal and external resources to accomplish their entrepreneurial tasks, which can help them maintain a competitive advantage in a highly competitive environment and improve their EP (Benitez et al. 2018). Evidently, the greater the heterogeneity of an entrepreneurial team, the more it improves the ability of female entrepreneurs to exploit opportunities, which promotes EP. Therefore, we propose the following hypothesis:

Proposition 7: *OD mediates between ETH and EP.*

Methodology

Sample and procedures. This study employed a survey methodology to investigate female entrepreneurship across China. A survey approach was chosen for its ability to gather a wide range of data from a geographically diverse sample, allowing us to capture the nuances of female entrepreneurship across different regional economic contexts in China. This method enables a more holistic understanding of the factors influencing entrepreneurial performance. The survey was designed to sample female entrepreneurs (business founders, co-founders, and CEOs) from three regional categories in China: developed, more developed, and less-developed digital economies. This stratified sampling approach ensures representation across diverse economic landscapes, providing a comprehensive view of female entrepreneurship in China. To mitigate the impact of COVID-19, data was collected through a combination of online and offline methods, ensuring broad geographic coverage and higher response rates.

The data collection period spanned eight months, from May to December 2021. A total of 600 questionnaires were distributed, out of which 580 were returned, yielding a high return rate of 96.67%. After excluding 22 invalid responses based on the following criteria: (1) unspecified option selections; (2) excessively short response times; (3) over 90% identical answers; and (4) more than one-third of questions unanswered, 558 valid questionnaires remained, resulting in a valid recovery rate of 96.21%. The respondents predominantly fell within the 21–40 age group (66.85%). Marital status distribution included 53.05% married and 38.89% unmarried individuals. Additionally, 56.81% of the respondents had children, while 43.19% did not.

Measure. All variables were assessed using a 5-point Likert scale, with response options ranging from 1 (strongly disagree) to 5 (strongly agree). Established or modified scales with proven reliability and validity were employed for all variables to ensure the accuracy and credibility of the measurements.

DA. This study refers to Ilomäki et al.'s (2014) elaboration of the connotation of digital competence and innovatively designed a scale for measuring digital competence, including "fragmented learning," "rapid learning," and "lifelong learning."

OD. Entrepreneurial OD used a scale developed by Chen and Liu (2020), which includes three questions, for example, "I have a channel to quickly gather information about entrepreneurial opportunities."

ETH. We draw on Zimmerman's (2008) top management team heterogeneity scale to measure ETH, specifically "skill heterogeneity," "educational heterogeneity," and "professional experience heterogeneity."

EFC. We adapted Netemeyer et al.'s (1996) work on the Work-Family Conflict Measurement Scale, including six questions, for example, "The ability to balance work and family has a very strong impact on my mood and state of mind."

GS. Based on Liñán et al.'s (2020) elaboration of the connotation of GS, we modified the GEM measurement items to include three questions, such as "Women have equal opportunities to start a business compared to men."

EP. We used subjective measures to measure EP (Gao et al. 2018), including four indicators such as sales growth rate and market share.

Statistical approach. PLS-SEM was used to test the hypothesis, which was considered particularly appropriate for this study (Hair et al. 2011; Hair et al. 2019) for the following reasons: in terms of research objectives, this study was based on a gender-awareness framework to explore the facilitating and hindering factors of FEP as an extension of existing structural theories; regarding the sample size requirements, we were able to meet both criteria for the 580 responses we received. The first requirement states that the sample size should be up to 10 times the formation metric used to measure a specific dimension. The second requirement suggests a sample size of up to 10 times the number of structural paths in the structural model for a given potential construct. In both cases, our sample size of 580 responses exceeded the necessary thresholds. In addition, PLS does not require the assumption that the data conform to a normal distribution, and it is a prediction-oriented approach that gives optimal prediction accuracy.

We used fsQCA to determine the synergistic effect of DA, OD, ETH, EFC, and GS on the high EP of female entrepreneurs. This analytical approach is based on the configuration theory paradigm, allowing us to explore the intricate and nonlinear relationships between variables (Fiss 2011). By utilizing fsQCA, we could effectively uncover the complex connections that emerged between the independent and dependent variables.

Therefore, considering the complexity of the factors influencing female entrepreneurial performance, we used two complementary analytical methods, PLS-SEM and fsQCA. PLS-SEM is suitable to explore complex relationships among latent variables, while fsQCA is able to reveal multiple combinations of conditions that lead to high entrepreneurial performance. The combination of these two approaches allowed us to comprehensively analyze the key factors influencing female entrepreneurial performance and their interactions.

Common method bias. We addressed common method bias in two ways. First, during the survey, participants were assured of complete anonymity and were informed that the data collected would be used solely for research purposes at an aggregate level (Kaya et al. 2020). This prompted the respondents to provide honest and unbiased responses. Next, we conducted Harman's Single-Factor Test (Harman 1961) as a post hoc control measure for common method variance. This test involved performing an unrotated principal component analysis on all the study's question items. The results indicated that the first principal component explained only 25.53% of the variance, falling below the threshold of 50%. This finding suggests that a single factor cannot explain the majority of the variance, indicating that common method variance in our study is not a significant concern.

Pls-sem analysis and results

Measurement model. We performed a measurement model assessment using PLS-SEM to assess the dimensions of the study constructs. Our analysis primarily examined the reliability of internal consistency, as well as the convergent and discriminant validity of the constructs. In Table 1, we provide the indicators that displayed item factor loadings above 0.5 and reached statistical significance at $p < 0.05$. indicating the reliability of each indicator (Sarstedt et al. 2021). Additionally, Cronbach's alpha, Rho coefficient (Rho), and composite reliability (CR) values for our constructs were all above 0.7, indicating high internal consistency. Additionally, the average variance extracted (AVE) values exceeded 0.5, These findings suggest good convergent validity (Hair et al. 2019). Furthermore, Table 2 demonstrates that the square root of each conformational AVE was higher than the corresponding correlation coefficient, as proposed by Fornell

and Larcker (1981). Moreover, the correlation coefficients' heteroscedasticity ratio (HTMT) was below the threshold of 0.85, providing further evidence supporting the discriminant validity of the constructs.

Structural model. The structural model was evaluated and tested using a bias-corrected bootstrap technique based on 5000 resample bootstrap runs. As suggested by Chin (1998), an acceptable value of R2 must be > 0.1 or 0. According to the coefficient of determination R2, the structural model's 24.7% variance in FEP is explained by numerical competence, OD, ETH, WFC, and GS, and 36.6% variance in OD is explained by numerical competence and ETH. The importance of Q2 must be greater than 0 (Hair et al. 2011), and the values of R2 and Q2 in this study met the criteria (Table 3); therefore, the model is predictive.

The results obtained from the PLS-SEM analysis (Table 3, Fig. 2) indicate that digital ability have a positive effect on entrepreneurial performance, but this effect is not statistically significant ($\beta = 0.077$; $t = 1.701$; $\rho > 0.05$), thus H1 is not supported. Meanwhile, opportunity development has a significant positive effect on entrepreneurial performance ($\beta = 0.216$; $t = 4.532$; $\rho < 0.001$), supporting H2. Similarly, entrepreneurial team heterogeneity has a significant positive effect on entrepreneurial performance ($\beta = 0.298$; $t = 6.949$; $\rho < 0.001$), supporting H3. Furthermore, work (entrepreneurship)-family conflict has a significant negative effect on entrepreneurial performance ($\beta = -0.119$; $t = 2.804$; $\rho < 0.01$), confirming H4. However, gender stereotypes exhibit a negative effect on entrepreneurial performance, but this effect is not statistically significant ($\beta = -0.018$; $t = 0.391$; $\rho > 0.05$); thus, H5 is not supported.

We also examined the mediating role of OD in the relationships between DA, ETH, and EP. The results in Table 3 indicate that the mediating effect of DA → OD → EP is 0.107 ($t = 4.096$; $\rho < 0.001$), which is consistent with the prediction; therefore, H6 is supported empirically; the mediating effect of ETH → OD → EP is 0.042 ($t = 3.521$; $\rho < 0.001$), indicating that H7 holds.

Fuzzy-set qualitative comparative analysis (fsqca)

The first step in the fsQCA was calibration, which is the process of assigning an affiliation to a specific set of conditions for a case. The affiliation set after calibration ranges from zero to one (Huang et al. 2022b). This study used the most used direct calibration method (Ragin 2008) to calibrate all conditional and outcome variables with three limiting values: 0.05 set for complete non-affiliation, 0.50 set for crossover point, and 0.95 set for complete affiliation. The calibration anchor points and descriptive statistics for each variable are presented in Table 4.

In the second step, we conducted a necessity analysis to determine the proportion of fuzzy set scores in each condition that are less than or equal to the corresponding score of the outcome (Amara et al. 2020). A condition was deemed necessary if the consistency score exceeded 0.9 (Ragin 2008). By referring to the results presented in Table 5, we can conclude that no conditions were found to be necessary for attaining high levels of FEP.

To analyze the configuration of groupings that lead to high female entrepreneurial performance (FEP), we employed the fsQCA software (version 3.0). Following the recommendation of Fiss (2011), we set the original consistency threshold at 0.8, the PRI consistency threshold at 0.75, and the case frequency threshold at 2 (Ragin 2006). The results (Table 6) showed that two groupings (S1 and S2) received high scores for FEP, and the solution demonstrated a consistency of 0.94, indicating that these two configurations, which covered the majority of cases, were adequate in promoting high FEP. Furthermore,the coverage of the solution was 0.48, indicating that the two configurations explained 48% of the high FEP. According to Configuration S1, 17% of the cases showed that when both facilitators—OD and ETH—and neither of the barriers—EFC and GS—were present, they could contribute to high FEP. According to Configuration S2, 12% of the cases showed that when DA, OD, and ETH facilitators were present, even though EFC and GS barriers were also present, they contributed to high scores in the EP of female entrepreneurs. The consistency indicator is 0.95, which is consistent with the adequacy assertion.

Discussion

Drawing on a gender-aware framework for women (Brush et al. 2009) and social role theory (Eagly 1987), this study explores the facilitating and hindering factors that influence FEP and the mediating role of OD in DA, ETH and FEP in contributing to understanding the mechanisms of action affecting FEP. In addition to the PLS-SEM analysis method, we used fsQCA to analyze the anthems that contributed to the high EP of female entrepreneurs.

First, at the micro-level, we used OD and DA as predictors of FEP. These findings indicate that OD has a significant positive effect on FEP, suggesting that OD facilitates FEP, which corresponds to the findings of previous studies (Huang et al. 2022a). The impact of DA on FEP was explored to serve as a response to the quantitative research that Nambisan (2017) argued was lacking in the digital entrepreneurial ecosystem. DA had a positive but insignificant impact on FEP; however, OD partially mediates the role of DA and FEP. The reasons why DA is not significant for FEP may include the limitations of digital tools in promoting female entrepreneurship (Oggero et al. 2020). Wiig et al. (2024) points out that women with more powerful digital skills and advanced training can make more effective use of digital technology to create and discover new business opportunities, compared to the other women. In addition, in the context of the traditional Chinese patriarchal society, the social positioning of the role of women limits the ability of female entrepreneurs to obtain resources to some extent. The inequality of social resources is also replicated in the Internet field, weakening the positive impact of digital power on women's entrepreneurial performance, which supports the conclusion of Dy et al. (2017). Thus, while digital power can theoretically improve women's entrepreneurial performance, in practical application, its effect is constrained by multiple social and structural factors.

Second, at the meso level, we used ETH as a predictor of FEP. Our findings align with previous research (Xing et al. 2020) and suggest that ETH positively influences FEP, suggesting that ETH is a facilitator of FEP; in addition, we confirmed the mediating role of OD in ETH and FEP, which is consistent with previous studies (Ostmeier and Strobel 2022; Lubatkin et al. 2006). At the macro level, we used EFC and GS as predictors of FEP, and our results indicated that EFC negatively affects FEP, which is consistent with the findings of Basco (2015); GS had a negative effect on FEP, but the effect was not significant. This finding contradicts previous studies that identified GS as a significant obstacle to female entrepreneurship (Martiarena 2022). Group characteristics may affect entrepreneurial performance (Marx et al. 2013). Based on this, the reason why GS is not significant to FEP may be that within the female entrepreneurs, female entrepreneurial role models play an important role in reducing the negative effects of stereotypes (BarNir 2021). Within-group role models provide evidence for realistic social comparisons, thus reducing the perceived threat from stereotypes (Von Hippel et al. 2011). Especially in settings where gender stereotypes are common, exposure to female role models may enhance the confidence and self-efficacy

of female entrepreneurs (BarNir 2021). In addition, entrepreneurial characteristics are closely related to entrepreneurial performance. While initiative and risk-taking are often associated with men, flexibility, adaptability and passivity are more associated with women (Wilson and Tagg 2010). Given that entrepreneurial activities often occur in uncertain environments, adaptability and flexibility are particularly important (Perez-Quintana et al. 2017). Therefore, from the perspective of personality traits, female entrepreneurs are in some ways more suitable for entrepreneurship than men, which can also be used as an explanation for the insignificance of gender stereotypes on female entrepreneurial performance. These results suggest that as society progresses and women's education levels improve, women's gender consciousness is gradually strengthened.

Finally, we applied fsQCA to measure the combinatorial conditions under which DA, OD, ETH, EFC, and GS interacted to predict high FEP. The fsQCA analysis revealed two histotypic paths that promoted FEP: first, when two facilitators, OD and ETH, were present and two barriers, EFC and GS, were absent concurrently, they could promote the high performance of female entrepreneurs. The ETH has a significant positive impact on FEP, which is consistent with the findings of Xing et al.(2020), but is different from the study of Díaz-Fernández et al. (2015). This is because companies led by female entrepreneurs often have more innovative environments and better survival prospects than male entrepreneurs (Ughetto et al. 2020). In addition, when women do not need to balance the conflict between family and work, and gender stereotypes hinder their access to resources to less, their entrepreneurial performance is significantly improved. These findings show that supporting female entrepreneurs to optimize their team structure and resource acquisition environment is of great significance to improving their entrepreneurial performance. Moreover, DA, OD and ETH as core conditions can significantly offset the adverse effects of WFC and GS on female entrepreneurs and produce high FEP. Therefore, the analysis results of the fsQCA largely support the findings of PLS-SEM, while they also show that only the synergistic effect of various factors can better explain the EP of female entrepreneurs. The combined effect of these factors can more effectively elucidate the synergies on FEP.

Theoretical implications. This research makes substantial theoretical advancements by introducing an integrated model based on the Gender Awareness Framework and social role theory. This innovative approach not only enriches the existing theoretical landscape but also sheds light on the interplay of factors influencing female entrepreneurial performance (FEP) from a gender-sensitive lens. The study's exploration into the dynamics of digital ability (DA), opportunity development (OD), team heterogeneity (ETH), work-family conflict (EFC), and gender stereotypes (GS) provides a comprehensive understanding of their individual and collective impacts on FEP. Notably, the investigation into OD's mediating role in the relationship between DA, ETH, and FEP significantly deepens our theoretical comprehension of female entrepreneurship.

Firstly, the research advances our understanding of digital ability among female entrepreneurs. Despite the growing importance of digital technology in entrepreneurship, the research in this area is still nascent, with limited insights into how digital abilities support female entrepreneurship (Ughetto et al. 2020). Specifically, there is a scarcity of studies on how female entrepreneurs effectively utilize digital technology (Wiig et al. 2024). This study introduces DA as a key variable and revealing its influencing role in female entrepreneurial performance (FEP), thus providing a more nuanced understanding of the digital dimension in female entrepreneurship.

Secondly, the research confirms the positive impact of team heterogeneity on female entrepreneurial performance. Although findings on team heterogeneity have been mixed (Díaz-Fernández et al. 2015), this study empirically validates, through PLS-SEM and fsQCA analyses, that diversity in gender and professional background within teams fosters resource integration and innovation, thereby enhancing business performance. This not only supports existing research (Guo et al. 2023) but also provides a theoretical basis for team management practices.

Methodologically, this study pioneers in employing Partial Least Squares Structural Equation Modeling (PLS-SEM) alongside Fuzzy Set Qualitative Comparative Analysis (fsQCA), thus offering a methodological innovation in examining complex variable interactions within female entrepreneurship. The concordance of fsQCA's asymmetric results with PLS-SEM findings not only corroborates the robustness of the analytical approach but also adds a novel dimension to the empirical literature. This dual-method analysis culminates in a richer, more holistic theoretical contribution, enhancing our understanding of the multifaceted nature of female entrepreneurship and paving the way for future scholarly explorations in this vibrant field.

Managerial implications. This study has several practical implications. From a micro perspective, to improve the digital abilities of female entrepreneurs, it is recommended that government and relevant institutions design and implement specialized digital ability training programs. These programs should cover modules such as e-commerce operations, social media marketing, and big data analysis. A blended approach combining online and offline training will allow female entrepreneurs to participate flexibly, enhancing their proficiency with digital tools. From a meso perspective, ETH is an important factor for female entrepreneurs to achieve high EP. Therefore, managers must recognize the importance of diversity within the entrepreneurial team. When female entrepreneurs form entrepreneurial teams, they focus on complementary skills and diverse backgrounds, and strengthen this diversity in gender, age, vocational skills and educational experience to ensure that the team has comprehensive capabilities in technology, management and marketing.

From a macro perspective, the dual role of women in motherhood and society causes female entrepreneurs to take on "dual responsibility." They must balance the roles of family and entrepreneurship in order to minimize conflict. Therefore, to support them in balancing family and entrepreneurship, it is essential to develop tailored work-life balance initiatives. Companies and policymakers should offer flexible work arrangements, such as flexible hours and remote work options. Additionally, providing in-house childcare services or partnerships with childcare facilities can alleviate family burdens. Promoting mental health support and time management training will further assist female entrepreneurs in managing stress and achieving work-life harmony.

In addition, society should create a relaxed and equal gender role environment, vigorously promote successful female entrepreneurship, set up entrepreneurial role models for women, and reduce the over-exaggeration of the traditional gender roles of women to stimulate female entrepreneurial energy. The government should implement policies favorable to female entrepreneurship, such as tax incentives, startup subsidies, and low-interest loans. Establishing dedicated financing channels for female entrepreneurs and lowering financing barriers will ensure they receive adequate financial support, enhancing their self-efficacy and team cohesion.

Conclusion

This study aims to explore the key factors affecting the entrepreneurial performance of Chinese women in the digital economy,

with the theoretical perspective of gender consciousness framework and social role theory, through the mixed method of structural equation model (PLS-SEM) and fuzzy set qualitative comparative analysis (fsQCA), to analyse the mechanism of high EP and barriers in female entrepreneurs. The PLS-SEM analysis effectively addressed RQ1. The PLS-SEM results show that at the micro level, OD was found to have a significant positive influence on FEP, in agreement with the results of the Huang et al. (2022a), while the effect of DA on FEP was positive but not significant, supporting the limitation of digital ability on FEP (Oggero et al. 2020). However, OD plays a mediating role in DA and FEP. At the meso level, ETH significantly and positively impacts FEP. Additionally, OD plays a mediating role between ETH and FEP. At the macro level, we observed a significant negative impact of EFC on FEP, while the effect of GS on FEP was negative but not insignificant, supporting the BarNir (2021) view that female entrepreneurial role models can reduce the negative impact of stereotypes. In response to RQ2, the fsQCA results identified two distinct pathways that lead to high FEP, partially corroborating the PLS-SEM findings. The analysis revealed that when female entrepreneurs are not hindered by WFC and GS, the combination of OD and ETH fosters high FEP. Additionally, DA, OD, and ETH emerge as crucial factors that mitigate the adverse effects of WFC and GS, thereby promoting FEP. Therefore, this study makes several important contributions. First, it extends the existing literature by integrating micro-, meso-, and macro-level factors into a comprehensive framework for understanding female entrepreneurial performance in the digital economy context. Second, it employs the application of a mixed-method approach combining PLS-SEM and fsQCA to investigate female entrepreneurship in China, providing both variable-centered and configuration-centered insights. Last, it underscores the mediating role of OD in linking DA, ETH, and FEP and identifies resilience pathways in overcoming GS and WFC. These findings advance theoretical understanding of female entrepreneurship and offer practical implications for policymakers and practitioners seeking to promote women's entrepreneurship in China's digital economy.

Limitations and future research

Several limitations should be taken into account in our study. First, the data were collected from China, and the single-country sample limited our capacity to come to general conclusions. Therefore, future studies should expand the sample size, covering different cultural backgrounds and regions, to enrich our findings in other cultural settings and regions and verify the generalizability of the study conclusions. Second, the factors that promote and hinder the EP of female entrepreneurs vary in different entrepreneurial stages, and this study does not describe the entrepreneurial stage they occupy, ignoring the dynamic changes of influencing factors in different stages. Therefore, future research can rationalize the division of the entrepreneurial stages in which the enterprise is located, and cross-verify the applicability of the model in different contexts and in different entrepreneurial stages, so as to provide more detailed insights.

Data availability

The datasets used and analyzed during the present study are available from the Corresponding author upon reasonable request.

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Appendix

Figures 1 and 2

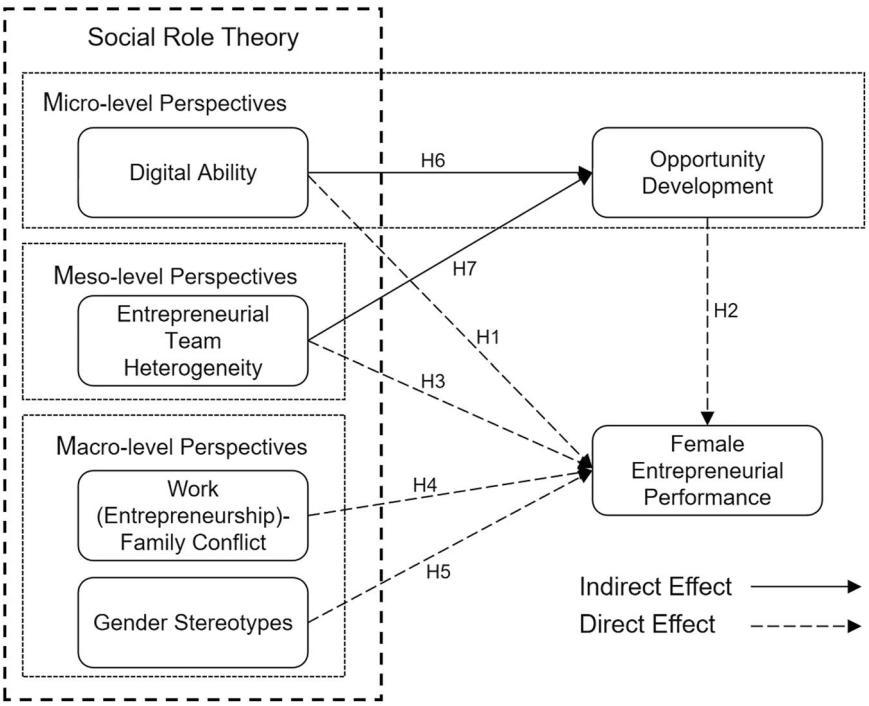

Fig. 1 Theoretical Framework.

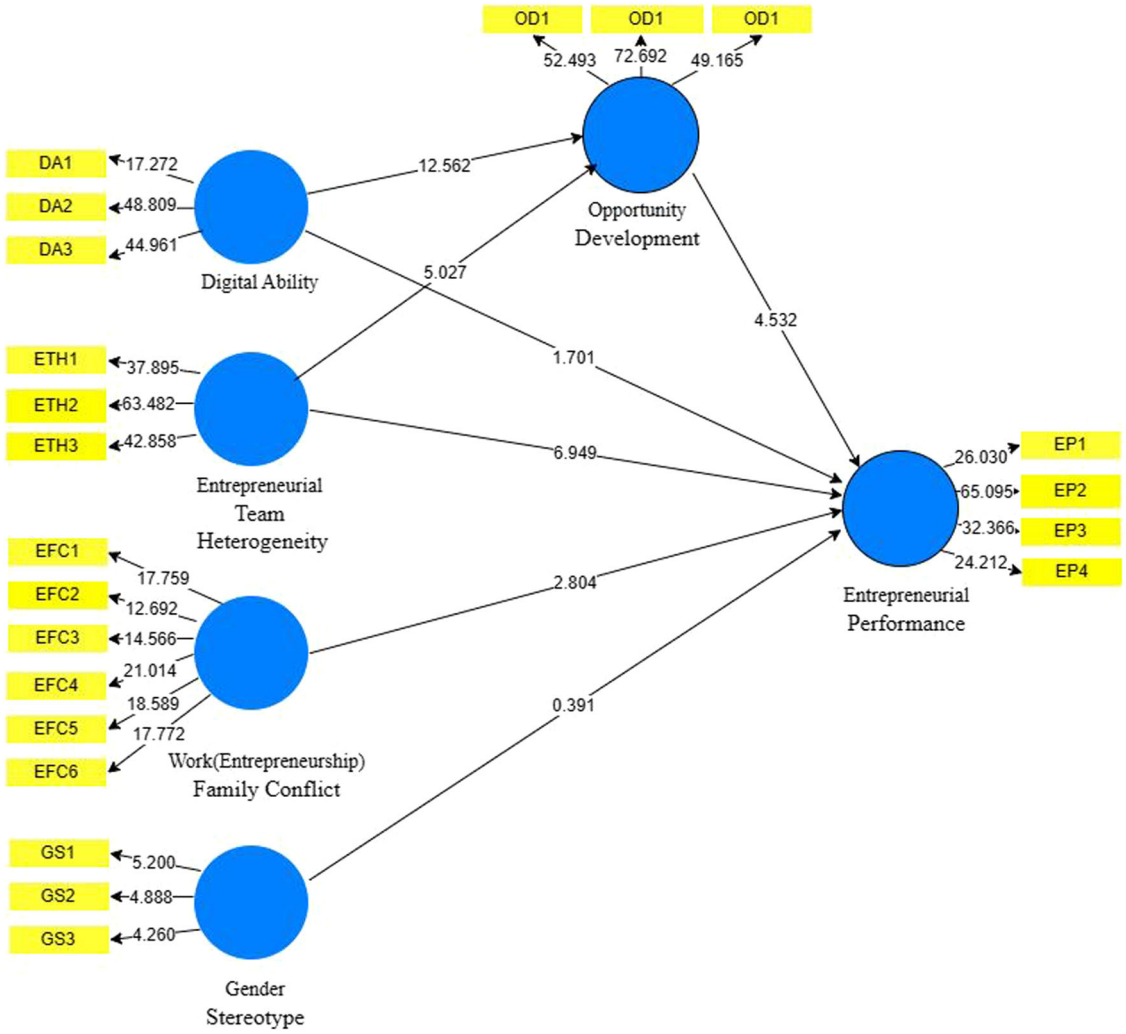

Fig. 2 Structural Model.

Tables 1–6

Table 1 Reliability and convergent validity.

Construct	factor loading	T value	α	Rho	CR	AVE
DA1	0.795	17.272***	0.778	0.790	0.870	0.691
DA2	0.862	48.809***				
DA3	0.836	44.961***				
OD1	0.863	52.493***	0.849	0.852	0.909	0.768
OD2	0.897	72.692***				
OD3	0.869	49.165***				
ETH1	0.858	37.895***	0.820	0.823	0.893	0.735
ETH2	0.886	63.482***				
ETH3	0.827	42.858***				
EFC1	0.856	17.759***	0.922	0.938	0.938	0.717
EFC2	0.805	12.692***				
EFC3	0.840	14.566***				
EFC4	0.880	21.014***				
EFC5	0.868	18.589***				
EFC6	0.828	17.772***				
GS1	0.892	5.200***	0.868	0.887	0.918	0.789
GS2	0.901	4.999***				
GS3	0.872	4.260***				
EP1	0.769	26.030***	0.811	0.823	0.876	0.640
EP2	0.880	65.095***				
EP3	0.815	32.366***				
EP4	0.728	24.212***				

***$p < 0.001$, α alpha, *CR* Composite reliability, *AVE* average variance extracted.

Table 2 Correlations and discriminant validity.

	DA	OD	ETH	EFC	GS	EP
DA	**0.831**	0.562**	0.366**	0.014	−0.005	0.301**
OD	0.693	**0.876**	0.375**	−0.077	−0.044	0.374**
ETH	0.459	0.450	**0.857**	−0.002	0.022	0.403**
EFC	0.051	0.087	0.029	**0.847**	0.422**	−0.135**
GS	0.075	0.056	0.088	0.472	**0.888**	−0.072
EP	0.377	0.452	0.493	0.156	0.090	**0.800**

Coefficients below the diagonal are heterozygosity-monotrait ratios (HTMT); coefficients above the diagonal are inter-construct correlations; bolded coefficients are square root values of each construct AVE; **significantly correlated at the 0.01 level (two-sided).

Table 3 Hypothesis test results.

Effects	Relationships	Beta	t-value	Decision
Direct				
H1	DA → EP	0.077	1.701	Not Supported
H2	OD → EP	0.216	4.532***	Supported
H3	ETH → EP	0.298	6.949***	Supported
H4	EFC → EP	−0.119	2.804**	Supported
H5	GS → EP	−0.018	0.391	Not Supported
Mediating				
H6	DA → OD → EP	0.107	4.096***	Supported
H7	ETH → OD → EP	0.042	3.521***	Supported
$R^2_{EP} = 0.247$				
$R^2_{OD} = 0.366$				
$Q^2_{EP} = 0.149$				
$Q^2_{OD} = 0.149$				

***$p < 0.001$, **$p < 0.01$, R^2 determination of coefficient, Q^2 predictive relevance.

Table 4 Calibrations and Descriptive Statistics of the Research Variables.

Conditions	Calibration criteria			Descriptive statistics			
	Fully-in	Cross-over	Fully-out	Mean	S. D	Min	Max
DA	5.00	4.00	2.67	3.82	0.80	1.00	5.00
OD	5.00	3.67	2.31	3.56	0.80	1.00	5.00
ETH	5.00	3.67	2.33	3.67	0.76	1.00	5.00
EFC	5.00	3.17	2.00	3.31	0.90	1.00	5.00
GS	5.00	3.00	1.67	3.19	0.94	1.00	5.00
EP	4.50	3.00	2.00	3.19	0.66	1.00	5.00

Table 5 Necessity test for a single condition.

Entrepreneurial Performance

Conditions	Consistency	Coverage
ZDA	0.653	0.789
~ZDA	0.652	0.660
ZOD	0.679	0.811
~ZOD	0.642	0.657
ZETH	0.738	0.809
~ZETH	0.601	0.665
ZEFC	0.641	0.700
~ZEFC	0.689	0.767
ZGS	0.682	0.718
~ZGS	0.662	0.765

Table 6 Configurations for achieving high Entrepreneurial Performance.

Configurations	raw coverage	unique coverage	consistency	solution coverage	solution consistency
S1: ~f(OD*ETH* ~ EFC* ~ GS)	0.37	0.17	0.95	0.48	0.94
S2: ~f(DA*OD* ETH*EFC*GS)	0.31	0.12	0.94		

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Author contributions

Yangjie Huang: Acquired funding, administrated project, and supervised process and wrote the paper. Yue Yuan: Clarified the conceptual logic, wrote the paper and further content supplementation, modification, and language refinement for the paper. Shijia Yu, Yunlei Shou: Data analysis and language refinement for the paper. Jing Wang: Draf the initial version.

Competing interests

The authors declare no competing interests.

Ethical approval

The process and procedures used in this study adhere to the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) at the Institute of China Innovation and Entrepreneurship Education, Hangzhou Normal University, Hangzhou, China. The ethical approval protocol number is 2021-01. This approval encompasses all aspects of the study, including data collection, analysis, participant recruitment, informed consent procedures, and confidentiality measures, as outlined in the approved protocol. The research was conducted strictly in line with the ethical framework approved by the IRB.

Informed consent

The data collection process adhered strictly to ethical standards, with written informed consent obtained from all respondents at the beginning of each session, conducted by the research team starting on January 15, 2021. Participants received a consent form detailing the study's purpose, their role, data use solely for research, and assurances of confidentiality. Consent covered participation, data use, and publication of anonymized results. All participants were informed that personal identifiers, including names, would

be anonymized, ensuring their anonymity. As the study was non-interventional (survey-based), participants were informed of the research's purpose, data use, and the lack of risks involved. The study sample included undergraduate students over 18, with no vulnerable populations; therefore, no parental or guardian consent was required. No payments or incentives were provided for participation. A copy of the consent form is available upon request.

Additional information

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