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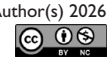

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Revisiting the gender gap in innovation: A qualitative comparative analysis of high-tech new ventures in China

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Abstract

Prevailing deficit logic suggests that women entrepreneurs underperform in innovation due to resource disadvantages; yet, growing evidence shows that gender does not consistently exert a statistically significant effect. We address this puzzle through a contextual–configurational approach, examining how entrepreneurs not only do gender but also do context in achieving a high innovation outcome. Using qualitative comparative analysis on a sample of high-tech new ventures in China, we identify three distinct innovation archetypes and make several key contributions. Thus, by integrating multiple theoretical perspectives, we develop a contextualised understanding of innovation in high-tech new ventures shaped by the interplay between gender, intangible resources and environmental dynamism. In addition, we reveal that the conjunction of women, gender and resource disadvantage can, under conditions of environmental turbulence, foster high levels of innovation, and finally, we reconcile the ongoing debate regarding the role of gender in innovation, offering a more holistic understanding of gender differences in entrepreneurship.

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Keywords
gender, innovation, context, high-tech, new ventures

Introduction

Innovation plays a vital role in new entrepreneurial ventures, particularly in the high-tech sector. It not only fosters legitimacy among key stakeholders – such as investors, suppliers and customers (Seigner et al., 2022) – but also reduces dependence on external resource providers and enhances market influence; thereby, improving venture performance (Damanpour et al., 2009). As entrepreneurship and innovation remain male-dominated domains (Biscione et al., 2022; Marlow and McAdam, 2012, 2015), the prevailing deficit logic suggests that the persistent resource constraints faced by women entrepreneurs render their ventures less innovative than those of their male counterparts (Strohmeyer et al., 2017; Tonoyan et al., 2020). However, recent empirical evidence indicates that despite these disadvantages, some women entrepreneurs are equally capable of achieving innovation on a par with men (Devine et al., 2019; Madison et al., 2022). This paradox raises a timely inquiry: if resource deficits are expected to constrain innovation, then how can we explain how and when women-led ventures are highly innovative?

To address this paradox, our study draws on a contextual perspective in response to calls from entrepreneurship scholars to account for context in advancing entrepreneurship theory and the literature of gender and innovation (Alsos et al., 2013; Welter, 2011, 2019). A contextual perspective posits that entrepreneurial phenomena are embedded within multiple and inter-dependent layers of contextual dimensions. In our study, context cuts across different levels of analysis and spans along three dimensions (Welter, 2011), including who (for example, women versus male entrepreneurs), where (for example, in male-dominant sectors, such as high-tech) and when (for example, resource-environment interplay). In alignment with a contextual perspective, we adopt a configurational thinking approach (Wiklund and Shepherd, 2005), enabling us to argue that innovation outcomes arise not from isolated conditions, but from the conjunctural effects of the entrepreneur's gender, intangible resources and environmental dynamism. Taken together, the contextual perspective and configurational thinking provide a coherent conceptual framework that guides our exploration into when and how women-led ventures achieve high levels of innovation despite resource disadvantages.

Our study examines two intangible resources – human capital (entrepreneurial experience) and social capital (networking ties with businesses and government officials; Davidsson and Honig, 2003; Wiklund and Shepherd, 2008) – and two environmental conditions, market and technological dynamism (Foss et al., 2022; Haefner et al., 2021; Wu et al., 2024). This focus is grounded in the resource-based view (RBV) of firm growth (Penrose, 1959; Barney, 1991, 2001) and the environmental dynamism perspective (Miller and Friesen, 1983). Prior work suggests that gender differences may exist in how entrepreneurs assemble and mobilise resource bundles (Devine et al., 2019); meanwhile, environmental dynamism shapes how entrepreneurs perceive and exploit opportunities (Tonoyan et al., 2020) and may differentially benefit women and men (Langowitz and Minniti, 2007; Wu et al., 2024). Guided by the contextual–configurational framework, we ask: Under what configurations of gender, intangible resources and environmental dynamism do new ventures achieve a high level of innovation, and how do these differ between women- and men-led ventures? To investigate this two-fold research question, we adopt a qualitative comparative analysis (QCA) method. Grounded in configurational thinking, QCA is well suited to uncover multiple

mechanisms underlying how women-led and men-led highly innovative ventures align their intangible resources with environmental dynamism (Wiklund and Shepherd, 2005). QCA, as an innovative analytical approach, is particularly helpful for addressing issues of data skewness, such as the underrepresentation of women entrepreneurs, and effectively addresses causal complexity (Bliese et al., 2024; Douglas et al., 2020; Furnari et al., 2020). As a case-based approach, QCA offers the ability for 'systematic cross-case comparisons' while simultaneously handling a high level of 'within-case complexity' (Rihoux and Lobe, 2009), enabling us to uncover new insights into gender differences in achieving the equifinality of innovation.

We analyse a sample of 62 high-tech new ventures drawn from a large-scale national random survey data collected from China (Dou et al., 2019). The high-tech sector offers a particularly enriched research setting: it is male-dominated (Marlow and McAdam, 2012; Tonoyan et al., 2020), innovation is critical for survival and growth and women entrepreneurs in this sector display a stronger propensity for risk-taking compared to their counterparts in non-high-tech sectors (Saeed et al., 2021). China provides a particular suitable context for this study for at least three reasons. First, although a communist ideology promotes gender equality, traditional norms remain deeply entrenched, sustaining strong stereotypes that portray women as less capable or less inclined toward entrepreneurship (Huang and Gamble, 2015; Zhao and Yang, 2020). Second, despite these stereotypes, research shows that women entrepreneurs in high-tech sectors in China are especially active in mobilising intangible resources, such as social networks (Burt and Burzynska, 2017). Third, high-tech sectors in China are marked by intense market and technological dynamism, especially during the reform era (Zhou, 2013).

Our research contributes to analyses of women's entrepreneurship, and the gender differences in the innovation literature, by moving beyond net-effects analyses toward a contextual–configurational perspective in which entrepreneurs not only do gender but also do context to achieve high innovation outcomes. Through this lens, we offer theoretical explanations and empirical evidence that challenge prevailing deficit logics. To develop these arguments, the article proceeds as follows. The next section introduces the three contextual dimensions – Who, Where and When – and articulates our rationale for adopting a contextual–configurational approach. This discussion also highlights the under-explored interdependencies between gender, intangible resources and environmental dynamism in shaping innovation outcomes. We then detail our QCA research design and present our findings, followed by a discussion and practical implications. The article then notes the limitations of the study, offers some avenues for future research and ends with conclusions summarising our key contributions.

Theoretical background

Who and where – Contextual dimensions: Women entrepreneurs in high-tech

Context is critical for understanding when, how and why women-led ventures can achieve a high level of innovation. According to Welter (2011), entrepreneurial action is embedded within specific institutional and industry settings. We focus on high-tech sector as it is deeply rooted in masculine norms, thereby amplifying the constraints and barriers that women entrepreneurs typically encounter (Callerstig et al., 2024). At the same time, high tech sectors are characterised by intense innovation imperatives (Marlow and McAdam, 2012), which makes them a salient setting for examining how women-led new ventures navigate constraints to achieve a high level of innovation. Prior studies provide some counterevidence that women entrepreneurs can attain innovation outcomes comparable to their male counterparts (Yousafzai et al., 2019), while others suggest that women entrepreneurs can mitigate structural disadvantages by strategically adopting masculine behaviours

in high-tech sectors (Marlow and McAdam, 2012, 2015). In what follows, we will first elaborate on the dominant deficit logic that positions women-led ventures as less innovative than their male-led counterparts, before presenting counterevidence from the high-tech sector that complicates this narrative.

The dominant narratives attribute the under-performance of women-led ventures to gender stereotypes, which frame women as lacking the traits traditionally associated with entrepreneurial pursuits such as innovation. Drawing on gender role congruity theory (GRCT), gender is understood as a socially constructed concept that shapes expectations about the roles of men and women (Eagly and Karau, 2002). Men are often ascribed traits such as agency, risk-taking, and assertiveness, which are commonly viewed as positively contributing to innovation, whereas women are stereotypically perceived as risk-averse, relational and communal – traits assumed to hinder innovation (Eagly and Karau, 2002; Yang et al., 2020). These stereotypes not only prescribe how all entrepreneurs are expected to behave but also shape external perceptions of their legitimacy. For example, resource providers often regard women-led firms as less innovative and less profitable (Anglin et al., 2022; Zhao and Yang, 2020), creating distinct barriers for them in establishing legitimacy and accessing resources critical for innovation (Alsos et al., 2013; Jennings et al., 2023). Over time, repeated exposure to gender stereotypes can lead women to internalise these biases, undervalue their entrepreneurial capabilities, and reduce their engagement in entrepreneurial activities (Thébaud, 2010; Zhao and Yang, 2020).

Nevertheless, emerging literature increasingly documents the non-significant relationship between gender and innovation, leaving the field divided on the extent to which the gender of an entrepreneur shapes innovation outcomes (Brush et al., 2022; Tm and Joseph, 2020). In particular, women entrepreneurs in male-dominated sectors, such as high tech, diverge in important respects from those in other sectors, such that the deficit logic, where systemic disadvantages such as resource constraints, rooted in gender stereotypes, are presumed to lead to under-performance, does not uniformly apply. Saeed et al. (2021), for example, find that women entrepreneurs in high-tech sectors, compared to other sectors, exhibit a heightened propensity for risk-taking. Strikingly, some women entrepreneurs strategically adopt traits aligned with entrepreneurial role expectations – including, at times, masculine behaviours – to enhance legitimacy and secure resources (Marlow and McAdam, 2012, 2015; Zhao and Yang, 2020). In a similar vein, women entrepreneurs may engage in counter-stereotypical behaviours – such as pursuing innovation – that, rather than being penalised, can be legitimised and even rewarded in contexts where such entrepreneurial pursuit is socially valued (Seigner et al., 2022). High-tech sectors exemplify such contexts, as they are infused with strong cultural imperatives for innovation (Marlow and McAdam, 2012). Yet, research remains scarce on the contextual mechanisms that enable a high level of innovation in women-led firms within high tech sectors.

When – Contextual dimension: Resource-environment conjunction

In order to develop a contextualising theory of innovation in high tech sectors through a gender lens, one must acknowledge the 'situational and temporal boundaries' that shape how and why innovation happens, that is, the When-contextual dimension (Welter, 2011, p.174). Regarding this dimension, we focus on the interplay of intangible resources and environmental dynamism in new ventures. Intangible resources inherent to the owner–entrepreneur, particularly human and social capital, can be understood as contextual conditions insofar as they shape the temporal dynamics of resource mobilisation – how entrepreneurs manage resources in dynamic environments for value creation (Devine et al., 2019; Sirmon et al., 2007). In this regard, gendered differences in resource endowments and mobilisation (Manolova et al., 2007) indicate that intangible resources act as

temporal enablers or constraints, shaping a venture's innovation outcomes differently for men and women. Environmental dynamism also embodies temporality, as it reflects both the pace and unpredictability of change in markets and technologies (Calantone et al., 2003). From this perspective, the external environment in which a new venture operates substantially influences its ability to access and control critical resources necessary for developing and commercialising innovative products or services (Sirmon et al., 2007). While these insights suggest that the interplay between intangible resources and environmental dynamism partially contextualises the pathways through which innovation emerges, research on their interdependencies with the gender of entrepreneur remains limited and scattered. In the sections that follow, we examine the existing literature on the interdependencies between gender and intangible resources, and between gender and environmental dynamism, in order to highlight how these partial insights inform, yet fall short of fully explaining, the joint effects of gender, resources and environmental conditions on innovation.

Intangible resources: Human capital and social capital. According to the RBV of the firm growth (Barney, 1991, 2001; Penrose, 1959), human capital and social capital are considered valuable, rare, inimitable and non-substitutable resources that help firms sustain their competitive advantage. In terms of human capital, prior entrepreneurial experience has been identified as one of the most significant and stable predictors of entrepreneurial success (Davidsson and Honig, 2003) and specifically of innovation (Westhead et al., 2003). Experience enhances innovation by strengthening cognitive capabilities and absorptive capacity, enabling entrepreneurs to process information efficiently and recognise opportunities (Symeonidou and Nicolaou, 2018). Specialised knowledge and skills accumulated through prior ventures facilitate pattern recognition in complex situations, fostering innovative ideas (Pindado et al., 2023). Moreover, experience enriches entrepreneurial learning, allowing lessons from past critical events to inform opportunity evaluation based on available resources (Kor et al., 2007). It also supports efficient resource mobilisation and helps establish a reputation, securing business orders and leveraging contacts for innovation (Hernández-Carrión et al., 2017).

Similarly, social capital, in terms of business networks and links with government support agencies (Wiklund and Shepherd, 2008), is crucial for innovation in new ventures (Opper et al., 2017; Peng and Luo, 2000; Shu et al., 2012). Networking enhances legitimacy for innovative initiatives, facilitates resource mobilisation through ties with reputable actors and provides access to complementary resources at lower costs (Drees and Heugens, 2013; Gulati and Gargiulo, 1999). Strong ties also foster trust, cooperation and joint problem-solving, generating further opportunities for innovation (Uzzi, 1997). Embeddedness in social networks enriches knowledge exchange, reduces uncertainty and increases the likelihood of innovation success, while also enabling more efficient resource mobilisation through social comparison among firms (Shu et al., 2012).

Although fragmented, prior literature highlights the interdependencies between gender and resources, showing that women entrepreneurs are systematically disadvantaged in resource endowments compared to their male counterparts, which in turn drives gendered differences in resource mobilisation. In particular, women entrepreneurs often start ventures with less entrepreneurial experience, particularly in high-tech sectors (Strohmeyer et al., 2017). This reflects the fact that social gender-role expectations and institutional arrangements around work–family balance limit the participation of women in entrepreneurship and thereby, constrain their opportunities to accumulate entrepreneurial experience (Thébaud, 2010). Women are also less likely to occupy leadership positions (Eagly and Karau, 2002; Tonoyan et al., 2020), further reducing their entrepreneurial intentions and the likelihood of venture creation (GEM, 2022). Similarly, in terms of social capital, women entrepreneurs are disadvantaged by smaller business and political networks (Manolova et al., 2007; Nguyen, 2021), lower centrality in professional networks (Burt,

2019; Tonoyan et al., 2020) and a greater reliance on personal ties – such as family and friends – for resource bootstrapping (Jennings and Brush, 2013), and less engagement with professional networks compared to their male counterparts (Fang et al., 2022).

Given gender differences in resource endowments, existing studies highlight differentiated – but sometimes equally effective – resource mobilisation strategies among women and men entrepreneurs. For example, Devine et al. (2019) show that women entrepreneurs may hold relative advantages in mobilising resources, as their stronger relational orientation and diligence enhance their ability to attract additional resources critical for innovation. Similarly, Jayawarna et al. (2015) demonstrate that women and men engage in distinct informal resourcing strategies, which can be equally effective in supporting venture survival and growth. More recent empirical evidence suggests that some women entrepreneurs are able to mitigate systemic disadvantages and adapt effectively to changes in external environments (Manolova et al., 2020). However, the contextual resource-environment conditions that enable such adaptive capacity remained underexplored.

Environmental dynamism. Following Calantone et al. (2003); McKelvie et al. (2018), we focus on two dimensions of environmental dynamism, market and technological dynamism. Market dynamism, or turbulence, refers to the degree of change and unpredictability in a market, particularly in competitor and customer behaviour (Li and Atuahene-Gima, 2001). High turbulence compels firms to abandon established routines and intensify their entrepreneurial pursuit of innovation (Covin and Slevin, 1989). Innovation not only enables new ventures to address shifting customer requirements but also to capture new market niches, and ultimately 'neutralise threats and exploit opportunities in turbulent markets' (Calantone et al., 2003; Tsai and Yang, 2013, p. 1282). Meanwhile, technological dynamism denotes the velocity of technological transformations within the industry (McKelvie et al., 2018). Rapid technological advances heighten the urgency of innovation in order to upgrade existing offerings and develop new products and services (Damanpour et al., 2009). The effects of technological dynamism are especially pronounced in high-tech sectors, where technological progress reshapes access to and deployment of critical resources for technology-driven ventures (Marlow and McAdam, 2012). Although environmental dynamism is widely recognised as a critical contextual condition in innovation studies, its intersection with the gender of entrepreneurs is much less explored. Existing research has largely examined related contexts beyond owner-entrepreneurs, such as women managers (Foss et al., 2022) or gendered CEO succession issues (Wu et al., 2024). This body of works show that women and men perceive and interpret external environments differently (Foss et al., 2022), and consequently, entrepreneurial responses to environmental dynamism – including both market and technological turbulence – can be understood as gendered (Wu et al., 2024). These insights suggest the existence of gender nuances in how entrepreneurs mobilise and deploy intangible resources for innovation.

In sum, we have identified several underexplored areas in the women, entrepreneurship, gender and innovation literature. First, prior research has offered limited contextual understanding of how gendered joint resource-environmental contextual conditions differentially enable or constrain the pursuit of innovation. The extant literature remains fragmented with respect to the interdependencies between the gender of the entrepreneur, intangible resources and environmental dynamism in shaping innovation outcomes. Second, the prevailing deficit-based logic, often grounded in GRCT, reinforces the assumption that women entrepreneurs are structurally disadvantaged and thus, more likely to under-perform in innovation. Third, there is a persistent debate concerning the role of gender in innovation. However, much of this debate tends to focus on whether men or women are more innovative, rather than examining how each gender relates to context and related effectiveness in achieving the same innovation outcome.

As Welter (2019) suggests that entrepreneurs not only 'do gender' but also 'do context', our study posits that ventures led by those who are capable of leveraging context by strategically aligning intangible resources and environmental dynamism are more likely to achieve a high level of innovation. Ventures are temporarily embedded in a specific period – defined by the extent of resources under their control and by how entrepreneurs perceive uncertainty and unpredictability in the external environment. This implies that what enables innovation in one particular contextual setting, represented by three dimensions – who (women vs. men entrepreneurs), where (in male-dominant sectors, such as high-tech) and when (resource-environment interplay) – may not necessarily hold in others. Since entrepreneurial phenomena such as innovation are embedded within multiple and inter-dependent layers of contextual dimensions, our study adopts a configurational thinking approach to examine how these conjunctural conditions combine to shape innovation outcomes. This configurational perspective recognises that innovation emerges not as the outcome of one isolated condition but through the synergies generated by the interplay of gender, intangible resources and environmental dynamism (Furnari et al., 2020). In the following section, we outline the QCA approach used to systematically investigate how gender interplays with intangible resources and environmental conditions to produce innovation outcomes.

Methodology

Qualitative comparative analysis

Guided by a configurational thinking (Greckhamer et al., 2008; Ragin, 2008), our exploratory study adopts QCA as an analytical approach (Furnari et al., 2020) for several reasons.

First, a configurational approach allows for a deeper understanding of the causal complexity of high innovation (Wiklund & Shepherd, 2005). From an analytical perspective, QCA applies Boolean algebra to reduce complex realities into calibrated sets and identify multiple sufficient configurations of conditions that produce the same outcome (Ragin, 2008). This logic of causal conjunction uncovers equifinal pathways to innovation shaped by gender, intangible resources and environmental dynamism (Douglas et al., 2020; Haefner et al., 2021).

Second, QCA enables a holistic examination of the role of gender in innovation. It is increasingly recommended for contexts marked by data skewness – such as the under-representation of women entrepreneurs – while addressing causal complexity (Bliese et al., 2024; Douglas et al., 2020). By combining the strengths of qualitative and quantitative research, QCA facilitates replication and generalisation in small-sample studies (Arellano et al., 2021; Greckhamer et al., 2008), and systematic cross-case comparisons with high within-case complexity (Rihoux and Lobe, 2009). This allows us to uncover subtle nuances in contextual configurations that shape innovation outcomes.

Third, unlike correlation-based methods, QCA accommodates high-order interdependencies beyond three-way interactions (Furnari et al., 2020). Our configurational model incorporates five conditions – gender, entrepreneurial experience, networking frequency, and market and technological dynamism – highlighting synergistic rather than additive effects. Finally, because QCA does not assume distributions or estimate coefficients for individual variables, it is less vulnerable to outliers and omitted variable bias than regression analysis (Witt et al., 2021).

Data and sample

Given the urgent need to contextualise innovation by women-led ventures in non-Western settings (Ogundana et al., 2021), we draw on survey data from China, the world's largest non-Western economy. Chinese women entrepreneurs have become pivotal actors in both social and economic development, contributing not only to national growth but also to global markets.

Their significance is reflected in their rapid expansion and notable achievements; for instance, they represented 44.6% of Forbes's 2022 list of self-made women billionaires (Jiang et al., 2024). Although communist ideology officially endorses gender equality, deeply ingrained cultural norms continue to reinforce stereotypes that portray women as less capable or less entrepreneurial than men (Huang and Gamble, 2015; Zhao and Yang, 2020). Yet, existing studies demonstrate that Chinese women entrepreneurs, particularly in high-tech sectors, actively leverage intangible resources such as social networks to counter these barriers (Burt and Burzynska, 2017). High-tech sectors in China are also characterised by pronounced market and technological dynamism, conditions that have intensified during the reform era (Zhou, 2013). These dynamics make China a compelling and theoretically rich setting for examining how gender, resources and environmental conditions jointly shape innovation.

Our dataset comes from the 2015 wave of the biennial National Survey of Private Enterprises in China, administered by the All-China Federation of Industry and Commerce (ACFIC) in partnership with the Family Business Research Centre at Zhejiang University. The survey employed stratified sampling and was distributed through ACFIC's provincial and local branches across the country. This dataset has been widely used in management and entrepreneurship research demonstrating its reliability and scholarly relevance (Junkang et al., 2021; Zhao and Yang, 2020).

The survey data include a total of 1294 firms. We constructed our sample using three criteria: (1) firm age, (2) high-tech sector, and (3) the dual role of the business owner as chair. Following Uzuegbunam et al. (2021), we included only high-tech new ventures with a firm age of eight years or less. Following Post and Byron (2015), we further restricted the sample to firms in which the business owner also serves as chair of the board of directors, thereby ensuring that they are key decision-makers. After excluding cases with missing data, the final sample comprised 62 firms, 10 of which are led by women. The proportion of women entrepreneurs aligns with prior research and reflects the broader underrepresentation of women in entrepreneurship (Brush et al., 2022; GEM, 2023).

We applied different restriction criteria, which produced samples of varying sizes. Nevertheless, the results – combinations of gender, intangible resources and environmental dynamism leading to innovation – remained highly consistent across samples (see Supplemental Appendices). The results reported here ($n = 62$) correspond to the sample with the highest coverage scores. Somewhat analogous to R^2, the coverage score refers to the proportion of the outcome that is explained by each configuration or by the entire solution (with multiple configurations leading to the outcome). The QCA literature recommends prioritising results with higher coverage scores, as they indicate greater empirical relevance and effectiveness of both individual configurations and the overall solution in explaining the outcome (Rutten, 2020).

We conducted analyses of variance (ANOVAs) to check whether significant differences existed in demographic characteristics between our analytical sample and the firms excluded due to missing data on key variables. First, we removed the firms with incomplete information on the key variables. Ultimately, we had a total of 724 complete cases, representing 55.95% of the original sample. Second, an ANOVA comparing these retained firms with those excluded showed no significant differences across major firm and owner attributes, including total sales, total assets, advertising expenditure, employee training investment, (all measured in 2013), founder's sex taken as a proxy for gender, owner's education experiences and owner's political ties (see Supplemental Appendix 1 for details). Finally, we compared the final working sample of 62 firms with the remaining 662 firms among the 724 complete cases. Again, no significant differences were detected across these key variables (Supplemental Appendix 2). These results suggest that, although the final sample is relatively small, it remains broadly representative of the overall surveyed sample.

To minimise common method bias, questions related to business owner perceptions of firm innovation, their entrepreneurial experience, and networking frequency were completed by the owner, while information about environmental dynamism conditions was provided by the financial manager of each firm. We conducted Harman's one-factor test (Podsakoff et al., 2003) to further check whether common method bias is a potential problem in our study. The results show that the largest factor accounts for only 26.88% of the total variance, suggesting that common method bias is not a major issue in our study.

Measurement

All measurements for the selected variables in our study, drawn from the ACFIC dataset, are based on prior literature.

Innovation is measured as the average of three items, following Miller and Friesen (1982). Business owners rated their organisational strategic posture toward innovation (item 1) and product innovation outcomes (items 2 and 3) on a seven-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Social capital, operationalised as the strength of networking ties measured through networking frequency reported by business owners, is assessed following Peng and Luo (2000). This construct comprises seven items rated on a seven-point Likert scale, which are averaged to derive an overall score. These items are designed to capture the intensity of networking activities between the focal organisation and main stakeholders, including top executives, clients, suppliers, distributors, competitors and government officials. Top management ties are particularly relevant to firms in a transition country like China (Peng and Luo, 2000). Two environmental conditions – market dynamism and technological dynamism – are measured following McKelvie et al. (2018). Market dynamism is assessed using two items, and technological dynamism using four items, all rated on a seven-point Likert scale. The averages of the Likert scale items were then calculated to form single measures for innovation, network ties, market dynamism and technological dynamism.

Table 1 lists all items used to measure the aforementioned constructs. Cronbach's alpha and composite reliability of all multiple-item scale variables were substantially above the threshold of 0.70. Their average variance extracted figures are above the threshold of 0.50, while all factor loadings are also above 0.50. Together, these figures demonstrate strong construct reliability and validity (Hair et al., 2018).

Finally, both the business owner's gender and entrepreneurial experience are binary variables. Gender is 1 for male; 0 otherwise. Entrepreneurial experience is 1 if the entrepreneur has prior experience in setting up a business before the current company; 0 otherwise.

Calibration

Calibration refers to the transformation of raw data into set membership. There are two distinct types of sets: crisp and fuzzy. Membership in a crisp set can only take the value of 0 or 1, whereas membership in a fuzzy set can take values between 0 and 1. We rely on existing literature and substantive case knowledge to establish all calibration thresholds.

Due to the binary nature of our gender and entrepreneurial experience variables, they are coded into crisp set membership. For the outcome variable and the other remaining antecedent variables, we applied a direct calibration method to transform them into continuous fuzzy sets (Ragin, 2008; Schneider and Wagemann, 2012). We use fsQCA software (Ragin, 2018) to compute set membership scores (Ragin, 2008). We set 2, 4 and 6, respectively, for three anchor

Table 1. Construct measures.

Construct measures	FL
Innovation ($\alpha = .83$, CR = 0.88, AVE = 0.71)	
1. The company values product or service research and development, technology leadership and innovation	0.85
2. In the past 5 years, the company has launched many new products or services	0.89
3. In the past 5 years, the company has made significant changes to its products or services	0.73
Networking frequency ($\alpha = .93$, CR = 0.94, AVE = 0.69)	
1. Senior management of the client company	0.72
2. Executives of supplier companies	0.76
3. Executives of competing companies	0.76
4. Executives of distributors or marketing companies	0.70
5. Government leaders at all levels	0.88
6. Industry department officials	0.87
7. Supervising and supporting department officials (such as tax bureau, state-owned bank, industrial and commercial bureau)	0.89
Market turbulence ($\alpha = .87$, CR = 0.82, AVE = 0.7)	
1. It is difficult to predict customer needs and changes in product demand	0.85
2. The market behaviour of competitors is difficult to predict	0.88
Technological dynamism ($\alpha = .88$, CR = 0.86, AVE = 0.61)	
1. Technological breakthroughs in the industry have made a large number of new product ideas possible	0.87
2. Technological changes are very rapid	0.83
3. The technology development trend in the next few years is difficult to predict	0.71
4. Technological changes provide us with a lot of opportunities	0.85
Gender of business owner cum chair of the directors	
A dummy variable taking the value of 1 if the entrepreneur is male, and 0 otherwise.	
Entrepreneurial experience	
A dummy variable, taking the value of 1 if the entrepreneur has entrepreneurial experience before, and 0 otherwise.	

Note. Kaiser–Meyer–Olkin Measure of Sampling Adequacy KMO = 0.698.
$N = 62$. AVE is average variance extracted. CR is composite reliability.

points, namely full non-membership, cross-over point and full membership, following previous studies that use Likert scale data such as Haefner et al. (2021). Cases with a value of six or higher are fully in the target set, whereas cases with a value of two or lower are fully out of the target set. The crossover point of four represents the values 'where there is maximum ambiguity as to whether a case is more in or more out of the target set' (Ragin, 2008, p. 90). Cases with a value between four and six are more in than out of the target set, whereas cases with a value between two and four are more out than in the target set. Table 2 summarises the measurement and calibration of all variables, including descriptive statistics from a comparable sample of new ventures across all industries, following the QCA practice (Dwivedi et al., 2018). This has shown that the mean of the comparable sample is close to our crossover threshold and lower than the full-in threshold in our calibration.

To avoid dropping any cases with the exact score of 0.5, which is the cross-over membership score, we add a constant of 0.001 to all scores below full membership score, that is 1, following (Fiss, 2011).

Table 2. Set membership calibration and descriptive statistics.

		Calibration			Measure descriptives*			
Variable	Measure	Fully in	Crossover	Fully out	Mean	*SD*	Min	Max
Innovation	Average score from seven-point Likert scales	6	4	2	5.696	1.221	1	7
Gender	A dummy variable, taking the value of 1 if entrepreneur is male, and 0 otherwise.	1		0	0.857	0.351	0	1
Entrepreneurial experience	A dummy variable, taking the value of 1 if entrepreneur has entrepreneurial experience before, and 0 otherwise	1		0	0.696	0.461	0	1
Networking frequency	Average score from 7 seven-point Likert scales	6	4	2	4.186	1.490	1	7
Market turbulence	Average score from 2 seven-point Likert scale questions	6	4	2	4.857	1.456	1	7
Technological dynamics	Average score from 4 seven-point Likert scale questions	6	4	2	5.228	1.253	1	7

Note. We set 2, 4 and 6, respectively, for three anchor points, namely full non-membership, cross-over point and full membership, following previous studies that use Likert scale data such as Haefner et al. (2021).
*Following Dwivedi et al., (2018), we include the measure descriptives for a larger sample (n = 230, firm age is equal or less than 8 years old, all industries) extracted from the same database for comparative purposes.

Analysis and findings

Necessity analysis

We ran a necessity analysis before the sufficiency analysis in order to identify any necessary conditions for a high level of innovation to occur. Table 3 presents the results of the necessity analysis with all conditions and their negations. To determine a necessary condition, we rely on a consistency score threshold of 0.9 (Schneider and Wagemann, 2012), which reflects the high reliability of how an antecedent associates with the outcome (Witt et al., 2021). The results suggest that there are no prerequisite conditions for high innovation. However, there are two antecedents with notably high consistency scores, namely male gender (0.839) and a high level of technological dynamism (0.890).

Sufficiency analysis

With calibrated data, we then constructed a truth table (see Supplemental Appendices), in preparation for the sufficiency analysis. The truth table presents all configurations made from our five antecedent conditions. Therefore, we have 32 ($=2^5$) rows in total. This study sets the frequency cut-off point at 1, as suggested by Greckhamer et al. (2018). This means that only rows with at least one empirical observation are retained for the analysis. For each row, we utilise two thresholds to determine the value of the outcome: (1) raw consistency must be higher than 0.99, and (2) proportional reduction in inconsistency (PRI) consistency must be higher than 0.99. A high PRI consistency means a low possibility that the same configuration would occur in both the outcome and its absence (Greckhamer et al., 2018). Setting these thresholds much higher than generally accepted thresholds in the literature, that is, 0.8 for raw consistency and 0.7 for PRI consistency, allows us

Table 3. Necessity analysis.

Conditions	Consistency	Coverage
Male	0.839	0.896
Female	0.161	0.891
With entrepreneurial experience	0.712	0.878
No entrepreneurial experience	0.288	0.940
High level of market turbulence	0.759	0.961
Low level of market turbulence	0.315	0.965
High level of technological dynamics	0.890	0.958
Low level of technological dynamics	0.184	0.978
High level of networking frequency	0.564	0.954
Low level of networking frequency	0.512	0.973

Note. Necessity consistency threshold = 0.9.

to discover prevalent combinations of attributes leading to innovation (Greckhamer et al., 2018; Schneider and Wagemann, 2012). Those rows satisfying the two thresholds receive a value of 1 for the outcome, and 0 otherwise.

The next step is the logical minimisation process, which aims to generate parsimonious causal regularities of a high level of innovation. Depending on how logical reminders – configurations in the truth table with no empirical observations – are treated, it results in three types of solutions. The (most) complex solution relies solely on empirically observed data, disregarding any logical reminders, whereas the (most) parsimonious solution incorporates any logical reminders to achieve greater parsimony; therefore, these solutions may fail to adequately explain the outcome (Rutten, 2021). The intermediate solution is favoured for striking a balance between parsimony and complexity while also relying on easy counterfactuals in compliance with theoretical and empirical literature (Ragin, 2008; Schneider & Wagemann, 2012).

Table 4 provides a summary of five configurations in the intermediate solution for a high level of innovation. Five configurations explain 30.4% of the firms with a high level of innovation in the sample. Of the 62 firms in our sample, 10 are led by women, and our solution covers eight of them, demonstrating high empirical relevance.

The consistency score of the overall intermediate solution is 0.994, while the consistency scores of the five configurations range between 0.993 and 1. These numbers are substantially greater than the suggested threshold of 0.75 from the literature, thus validating the reliability of the results (Schneider and Wagemann, 2012). In addition, all five configurations are empirically non-trivial as raw coverage scores range between 0.033 and 0.22. Coverage demonstrates the explanatory power of each configuration to the outcome, and the recommended threshold for raw coverage is 0.02 (Douglas et al., 2020). These five configurations illustrate three archetypes of high innovation in high-tech new ventures. While these archetypes share a paucity of intangible resources, they can be distinguished by the conjunction of gender and environmental conditions.

Archetype 1: Genderless in highly dynamic environments. With the highest empirical relevance, that is, explaining 22% of all highly innovative ventures in the sample, archetype 1 shows that regardless of the gender of an owner-entrepreneur, high-tech new ventures managed by novice entrepreneurs pursue high levels of innovation in extremely turbulent environments. This environmental hostility, characterised by a high degree of market turbulence and technological dynamism, fosters high levels of innovation and obscures any gender disparities among novice entrepreneurs.

Table 4. Intermediate solution for high innovation.

	Genderless in highly dynamic environments	Male-led in stable markets	Women-led in dynamic environments		
Antecedents	1	2	3a	3b	3c
Gender		●	⊗	⊗	⊗
Entrepreneurial experience	⊗	⊗	●	●	⊗
Networking frequency		⊗	⊗	⊗	●
Market turbulence	●	⊗	●		
Technological dynamics	●			●	●
Model coefficient					
Raw coverage	0.220	0.046	0.033	0.055	0.065
Unique coverage	0.135	0.018	0.002	0.024	0.009
Consistency	0.993	1	1	0.996	1
Number of cases with greater than 0.5 membership	14	2	2	3	4
Solution coverage	**0.304**				
Solution consistency	**0.994**				

Notes. Frequency cut-off: 1, raw consistency cut-off: 0.99, PRI consistency cut-off: 0.99.
We use the following symbols according to (Fiss, 2011): ● = present (or male gender); ⊗ = absent (or women gender); blank space = either present or absent (don't care). Larger symbols are core, smaller symbols are peripheral.

Archetype 2: Male-led in stable markets. This second archetype accounts for the lowest proportion of highly innovative ventures, that is, with a raw coverage of 0.046. Compared to other ventures in the remaining archetypes, highly innovative ventures in this archetype are deprived of intangible resources. Their highly innovative approach also adheres to social expectations of their leader's gender. Strikingly, only this archetype demonstrates a viable route to a highly innovative outcome in a benign environment, that is, under a stable market where market demand and competitor behaviour is more predictable.

Archetype 3: Women-led in dynamic environments. With the second-highest empirical relevance, three configurations (3a, 3b, 3c) describe when women-led firms exhibit high levels of innovation, despite this being contrary to the socially expected gender role of women. Compared to the preceding archetype (i.e. Male-led in Stable Markets), highly innovative ventures in this archetype have relatively more intangible resources and operate in a more unstable environment. However, compared to Archetype 1 (i.e. Genderless in Highly Dynamic Environments), the environment in this archetype is less hostile. It only requires a high level of either market uncertainty or technological dynamism to trigger highly innovative behaviour in the presence of one intangible resource condition.

Configurations 3a and 3b are almost identical except for the two substituting environmental conditions. In the absence of established networks with relevant stakeholders, the highly innovative outcome in new ventures led by experienced women entrepreneurs is driven by an unpredictable market or rapidly changing technology.

Configuration 3c has the highest raw coverage score (=0.065) in this archetype. New ventures led by novice women entrepreneurs are highly innovative when technologies are undergoing rapid change, but only if they are able to leverage the resources embedded in their networks with businesses and government agencies.

Robustness tests

To evaluate the robustness of our findings, we performed multiple sufficiency analyses using larger samples by relaxing various selection criteria. While the results remained robust, both solution coverage and raw coverage scores were significantly reduced, as noted earlier in the sample construction process. This indicates that the configurations derived from these larger samples explain a smaller proportion of innovative women-led ventures (see Supplemental Appendices).

Following Arellano et al. (2021) and Rutten (2020), we implement four additional robustness tests grouped into three categories: 'lenient', 'conservative', and 'alternative' to examine the stability of the reported solution. As shown in Table 5, most reported configurations remain identical when we either lower the consistency cut-off (Lenient test), increase the consistency cut-off (Conservative test) or use alternative calibration thresholds (Alternative tests). Only one configuration does not appear in three out of four tests, which belongs to the third archetype. However, with the two remaining configurations consistently remaining identical in all four robustness tests, this does not affect the overall robustness of our archetypes.

Discussion

Entrepreneurship and innovation research remains male-dominated areas, which reinforce the prevailing deficit logic that undermines the innovation performance of women-led firms, especially those with resource disadvantages. Given that entrepreneurial phenomena such as innovation are embedded within multiple and interdependent contextual layers, there is a timely need to examine the innovation performance of women-led firms beyond the net effects of the entrepreneur's gender upon innovation. Our study advances the women, entrepreneurship and gender debate in the innovation literature by adopting a contextual–configurational approach to unveil multiple equally effective configurations of who (women versus men entrepreneurs), where (in male-dominant sectors, such as high-tech) and when (resource-environment interplay) that underpin innovation outcomes (Figure 1).

Interdependencies of gender, intangible resources and environmental dynamism

This study contributes to the contextualisation of entrepreneurship by integrating multiple theoretical perspectives to show that innovation in high-tech new ventures is a contextualised phenomenon shaped by the interplay between gender, intangible resources and environmental dynamism. While there are a growing number of entrepreneurship studies examining the intersection of context and gender, they mainly focus on non-innovation outcomes (Yousafzai et al., 2019), such as Wheadon and Duval-Couetil (2019) who investigate entry rates in technology entrepreneurship. Only a handful of studies, such as Madison et al. (2022), mention context when examining the effects of gender of entrepreneur on innovation. However, their contextualisation is largely methodological, focusing on the spatial–institutional setting of data collection rather than engaging with substantive context – that is theorising innovation itself as a contextualised phenomenon (Welter, 2011). To date, a conceptual model that frames innovation through the lens of gender as one contextual dimension ('who') and situates it alongside substantive contexts such as the resource–environment conjuncture, as in our study, is absent.

By providing a conceptualisation of innovation across gender, intangible resources and environmental dynamism, we consolidate otherwise fragmented literatures by theorising the interdependencies among these dimensions. Prior research has, for instance, suggested that gender shapes how entrepreneurs mobilise resource bundles (Devine et al., 2019), while others indicate that

Table 5. Robustness check summary.

Reported configurations							
No.			1	2a	3a	3b	3c
Label			Genderless in highly dynamic environments	Male-led in stable markets	Women-led in dynamic environments		
Robustness tests							
Test no.	Test type	Test category					
1	Lower consistency cut-off: Raw consistency cut-off: 0.97 PRI consistency cut-off: 0.95	Lenient	Identical	Identical	Identical	Does not appear	Identical
2	Increase consistency cut-off to 1	Conservative	Identical	Identical	Identical	Does not appear	Identical
3	Use adjusted Likert scale points (1-4-7) for three qualitative anchors	Alternative	Identical	Identical	Identical	Does not appear	Identical
4	Use adjusted Likert scale points (3-4-5) for three qualitative anchors	Alternative	Identical	Identical	Identical	Identical	Identical

Note. We follow Arellano et al. (2021); Rutten (2020) to evaluate changes in the robustness tests in comparison with our results as follows: (1) 'Identical' indicates the configuration remains identical. (2) 'Very similar' indicates change in only one condition, such as the addition of one condition or the substitution of another condition. (3) 'Similar' indicates change in more than one condition, but there is no significant change in the core conditions. (4) 'Does not appear' indicates that the reported configuration does not appear in the robustness test.

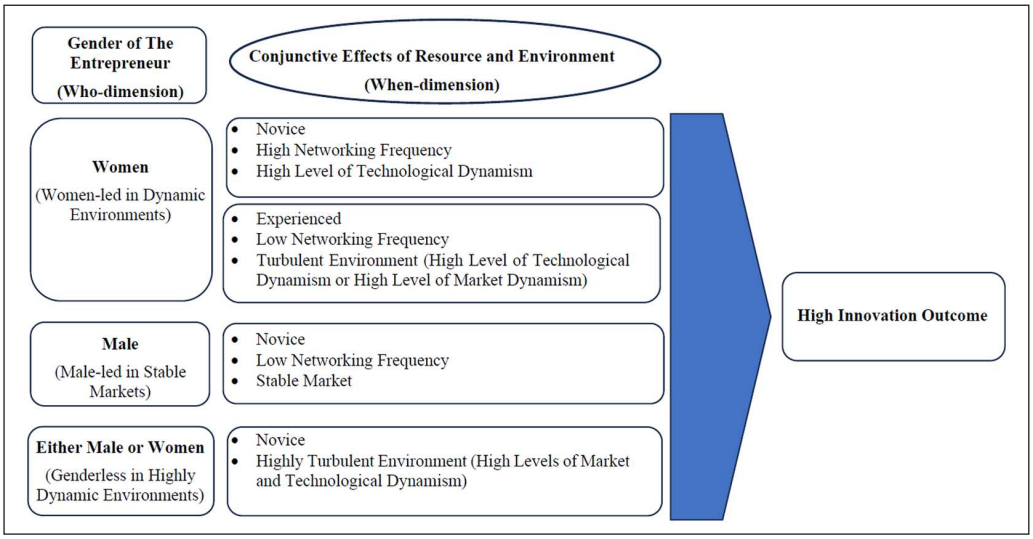

Figure 1. Three archetypes of high innovation in high-tech new ventures.

environmental dynamism would influence how entrepreneurs perceive and exploit opportunities (Tonoyan et al., 2020) with potential differential implications for women and men (Langowitz and Minniti, 2007; Wu et al., 2024). Our study unpacks how gendered patterns of resource mobilisation for achieving innovation are contingent upon environmental dynamism. Specifically, we show that under conditions of extreme environmental turbulence, gender differences are attenuated among novice entrepreneurs, suggesting that when high levels of market and technological dynamism co-occur, they suppress the salience of gendered resource mobilisation. Furthermore, we illustrate that the same resource –environment conjunction – does not necessarily produce an equivalent innovation outcome across the genders reflecting the causal asymmetry inherent in contextualised entrepreneurial processes (Douglas et al., 2020). For instance, highly turbulent environments – whether characterised by a high level of market or technological dynamism – can incentivise women entrepreneurs to leverage limited resources in ways that challenge socially prescribed gender roles in association with GRCT. Conversely, under stable market conditions, male entrepreneurs tend to conform to expected gender norms by pursuing innovation despite resource constraints – an outcome that appears counterintuitive from the environmental dynamism perspective (Covin and Slevin, 1989).

Revisiting deficit logics in women entrepreneurship

Our research advances the women's entrepreneurship literature by showing that the confluence of women, gender and resource disadvantage, typically framed within the prevailing deficit logics as constrained performance, may instead foster high innovation when situated in turbulent environments. While recent studies document how women entrepreneurs adapt to environmental turbulence by for instance, pivoting their business models during the COVID-19 pandemic (Manolova et al., 2020), our study advances this line of enquiry by elucidating the joint environmental and resource conditions that enable disadvantaged women-led new ventures to achieve a high level of innovation. We argue that turbulent environments exert pressure on women entrepreneurs to strategically

reconfigure scarce resources for innovation. Simultaneously, the legitimacy constraints imposed by gender stereotypes can compel women entrepreneurs to exert greater effort in innovation, particularly in male-dominated sectors such as high-tech (Foss et al., 2022). These contexts make counter-stereotypical behaviours, such as innovation, socially acceptable and valued (Saeed et al., 2021; Seigner et al., 2022). We also found that women entrepreneurs who have prior start-up experience, or well-established networks with business and political leaders, are better positioned to leverage of the pressures of turbulent environments. These intangible resources enable women to effectively reinforce and legitimise the venture's innovation initiatives internally, even when gender roles remain incongruent with societal expectations of leadership (Foss et al., 2022). This illustrates the non-substitutable role of intangible resources in enabling women-led ventures to navigate and adapt to dynamic external environments (Davidsson and Honig, 2003; Manolova et al., 2020).

Gendered pathways of doing context

Our research engages with the inconclusive debate on gender differences in the innovation literature and responds to calls for deeper insights into the role of gender in entrepreneurship, particularly in resource-constrained contexts (Brush et al., 2022; Jennings et al., 2023) by showing how gender influences how entrepreneurs 'do context' – constructing and navigating contextual conditions to achieve equally effective innovation outcomes differently. Previous studies on gender differences have typically sought linear best-fit solutions to measure the statistical significance of gender (Baron and Tang, 2011; Guzman and Kacperczyk, 2019; Strohmeyer et al., 2017; Tonoyan et al., 2020). This approach often generates causal predictions about which gender is correlated with superior forms of innovation thereby, reinforcing the deficit logic that positions women-led ventures as less innovative. However, such correlational approaches may encounter difficulties in adequately addressing the skewness of gender data and the complexity of the innovation phenomenon, as noted by Bliese et al. (2024) and Douglas et al. (2020). In contrast, a contextual–configurational approach, as used in our study, shifts the analytical focus from linear statistical correlations to conjunctive interactions, revealing distinct configurations of gender, intangible resources and environmental dynamism, each of which contributes equally to achieving higher levels of innovation. By examining how entrepreneurs not only 'do gender' but also 'do context' (Marlow and Martinez Dy, 2018), our study offers a more holistic understanding of how both women and men-led new ventures can equally and effectively achieve a high innovation outcome.

The evidence generated also has several practical implications for entrepreneurs in the high-tech sector suggesting various pathways through which women-owned and women-led firms can transform adversity into advantage and so, achieving heightened innovation outcomes in dynamic environments. In such environments, characterised by unpredictable market demands, competitive behaviour and rapidly evolving technologies, novice women owner-entrepreneurs should commit robustly to innovation to seize new entrepreneurial opportunities. Such commitment might involve increased investment in research and development and commercialisation, facilitating the introduction of new products or services. In less dynamic situations, wherein technological changes are the primary concern, new ventures led by novice women entrepreneurs can be more innovative by effectively leveraging complementary resources derived from strong networks with key stakeholders. Moreover, in cases where a women-owned and women-led new venture lacks a well-established network with key stakeholders, possibly due to a combination of the liability of newness and gender stereotypes prevalent in high-tech industries, reliance on the entrepreneur's prior start-up experience becomes crucial. This experience aids in navigating unstable periods, particularly when market demand is challenging to predict or technology is undergoing rapid evolution.

Limitations and future research

While our study makes important contributions, it has several limitations that point to potential directions for future research. First, our study employed a relatively small cross-sectional sample, with a limited number of women-led firms. This partially constrains generalisability and introduces the possibility of selection bias. ANOVAs, as reported in the Methodology section, suggest that the working sample is broadly comparable with the firms excluded from the dataset. This indicates that potential bias due to case selection is likely limited. In addition, it is important to note that QCA is specifically designed to accommodate small sample sizes (Ragin, 2008; Rihoux and Lobe, 2009), and its Boolean algorithm and minimisation logic enhance robustness by identifying consistent configurations and enabling replication (Douglas et al., 2020). Future research could build on our findings by examining larger samples to assess how gendered configurations evolve over time and across different entrepreneurial contexts. Such efforts would help to validate and extend our findings while addressing potential sample biases inherent in small-N studies.

Second, we focus on innovation in the high-tech sector, given its central role in the survival and growth of high-tech ventures. Future research could examine other contexts where innovation is highly valued, such as crowdfunding, where innovative behaviour is critical for accessing financial resources (Seigner et al., 2022). Moreover, our findings are situated in China's reform-era context, marked by relative gender egalitarianism and a dynamic market environment (Huang and Gamble, 2015). Comparative studies across diverse economies – developed and developing – would further test the validity and boundary conditions of our results.

Third, this study examines how two conditions – intangible resources and environmental dynamism – combine to influence the role of gender in achieving high innovation outcomes. These conditions were selected for their theoretical relevance to innovation from the RBV and environmental dynamism perspectives, as well as prior evidence on their interaction with gender. Future research is encouraged to incorporate additional conditions from other theoretical lenses to further explore the gender gap in innovation. Moreover, due to data limitations, entrepreneurial experience was coded as a binary variable. Given that the level of entrepreneurial experience (e.g. number of prior businesses founded) may also shape innovation outcomes, future studies could employ more fine-grained measures to capture this nuance.

Conclusion

Although deficit logic suggests that women entrepreneurs underperform in innovation due to resource disadvantages, recent evidence shows that some women-led firms can achieve innovation outcomes similar to those of men (Devine et al., 2019; Madison et al., 2022). To explain these ostensibly paradoxical outcomes, we adopt a contextual–configurational approach to investigate the configurations of gender, intangible resources and environmental dynamism under which new ventures achieve high levels of innovation, and how these differ between women- and men-led firms. Drawing on GRCT, the RBV and the environmental dynamism perspective, we conducted a QCA using survey data from high-tech new ventures in China. Our findings identify three distinct archetypes of innovation (Figure 1), representing multiple equifinal pathways to achieving a high innovation outcome. Notably, gender is neither a necessary nor sufficient condition for high levels of innovation. Instead, its influence emerges through the conjunctive effect of intangible resources and environmental dynamism.

Our research makes three important contributions to analyses of gendered differences regarding innovation. First, by integrating multiple theoretical perspectives, this study advances a contextualised understanding of innovation in high-tech new ventures showing how it is shaped by the

interplay between gender, intangible resources and environmental dynamism. This integration consolidates otherwise fragmented insights regarding the interdependencies amongst these conditions. Second, we address prevailing deficit narratives in the literature by demonstrating that the confluence of women, gender and resource disadvantages can, under conditions of environmental turbulence, foster higher levels of innovation. Third, we reconcile debates on the role of gender in innovation by moving beyond linear statistical correlations toward a contextual–configurational approach; this uncovers multiple pathways to more innovative behaviour. By examining how entrepreneurs not only do gender, but also context, regarding innovation outcomes, we provide a more holistic understanding of this debate.

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Supplemental material

Supplemental material for this article is available online.

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