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A Configurational Study on the Impact of Business Environment on Innovation in Private Enterprises

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Abstract: Business environment plays a pivotal role in fostering private enterprise innovation, yet prior research has often neglected the intricate and synergistic interactions among its constituent elements. This study addresses this theoretical gap through the application of Necessary Condition Analysis (NCA) and Qualitative Comparative Analysis (QCA) to investigate the multidimensional configurations enhancing private enterprise innovation. The NCA results identified the market environment as a necessary yet insufficient condition when considered in isolation. The QCA modeling further reveals three distinct synergistic pathways leading to high levels of innovation, which are consistently centered on a core combination of the governance environment, market environment, and technological investment. This study provides targeted policy implications for optimizing business environment configurations that foster robust innovation ecosystems.

Keywords: Business environment; Innovation; Fuzzy set qualitative comparative analysis (fsQCA)

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1. Introduction

Private enterprises (PEs) constitute a cornerstone of China's economic development, functioning as primary engines of employment generation, technological advancement, and overall growth. In recognition of their strategic importance, the optimization of the business environment (BE) has been elevated to a central policy objective aimed at sustaining private sector vitality. Despite these policy efforts, PEs continue to be constrained by multifaceted challenges rooted in both global trade volatility and domestic structural pressures. Extant studies, however, have predominantly examined individual BE components in isolation, thereby failing to capture the multidimensional and synergistic effects embedded within their interactions. To bridge this gap, this study employs Necessary Condition Analysis (NCA) and fuzzy-set Qualitative Comparative Analysis (fsQCA) to uncover the configurational pathways through which the BE shapes innovation in Chinese private enterprises. The results are expected to advance the understanding of BE-innovation dynamics and to provide empirically grounded implications for policy optimization and enterprise-level strategy formulation.

2. Research significance

2.1. Theoretical significance

The impact of the business environment on private enterprise innovation (PEI) is investigated through a configurational lens, providing novel theoretical insights. Traditional linear models have frequently failed to account for the complex, multidimensional interactions among environmental factors. This study contributes to configuration theory by demonstrating how particular combinations of political, economic, social, and technological elements synergistically generate innovation outcomes. Furthermore, multiple pathways, rather than a single optimal condition, are revealed for fostering PEI, thereby offering a more nuanced theoretical foundation for innovation policy and advancing the conceptual understanding of innovation ecosystems.

2.2. Practical significance

Conventional approaches to BE optimization often emphasize individual factors, potentially yielding limited effectiveness due to unaddressed interactions. This study identifies actionable configurations of environmental elements that effectively stimulate PEI. The findings provide an empirical basis for policymakers to develop targeted, context-specific interventions, moving beyond "one-size-fits-all" strategies. Additionally, comprehension of these configurations offers practical guidance for enterprises in formulating innovation strategies aligned with the specific environmental conditions they encounter, ultimately enhancing their competitiveness and contribution to high-quality economic development.

3. Research review

3.1. International research status

Globally, extensive research has explored how the business environment shapes enterprise innovation. Most studies employ regression-based methods to assess linear effects of institutional quality, competition, or regulation on innovation [1,2]. However, such single-factor analyses overlook the systemic nature of BE. Recent configurational studies emphasize that innovation outcomes arise from synergistic interactions among institutional, market, and policy dimensions, offering a more comprehensive understanding of innovation dynamics across diverse contexts [3–5].

3.2. Domestic research status

In China, BE-innovation research has accelerated under national reforms promoting entrepreneurship and private-sector vitality. Empirical studies highlight the effects of tax incentives, administrative simplification, and financing constraints on private enterprises' innovation [6]. Yet, most adopt linear frameworks, neglecting complex interdependencies among policy, institutions, and market forces. Recent evidence calls for configurational analyses to reveal how multiple BE components jointly foster PEs' innovative performance.

4. Data and variables

4.1. Research sample

In accordance with Qualitative Comparative Analysis (QCA) principles, which emphasize both homogeneity and maximum heterogeneity, a sample of 48 prefecture-level cities in mainland China was selected based on their private enterprise innovation levels in 2023. Homogeneity was ensured as all selected cities exhibited

relatively high innovation performance among private enterprises. Maximum heterogeneity was achieved through the inclusion of diverse administrative levels (e.g., municipalities, provincial capitals, sub-provincial cities) and extensive geographic coverage across 16 provincial-level regions. The sample size aligns with standard requirements for fsQCA studies. Data for antecedent variables were collected for 2022, whereas outcome variable data correspond to 2023, incorporating a one-year lag to account for temporal effects and ensure analytical rigor.

4.2. Variable definition and measurement

Data for this study were primarily obtained from official statistical yearbooks, authoritative national databases, and established research reports. All raw indicators were subsequently calibrated into fuzzy-set membership scores ranging from 0 to 1 for fsQCA analysis as outlined:

(1) Innovation Level of Private Enterprises (ILPE): The outcome variable was operationalized as the natural logarithm of (1 + total patent applications) filed by all A-share listed private enterprises within each city in 2023, with data aggregated from the CSMAR database, the CNRDS database, and official intellectual property sources;

(2) Antecedent Variables (Business Environment, 2022): Measurements were primarily adapted from the 2022 Report on China's Urban Business Environment and supplemented with official statistical data. The Political Environment was assessed using Administrative Environment (AE; e.g., government expenditure, government-business relations) and Rule of Law Environment (RE; e.g., social security provisions, judicial services). The Economic Environment comprised Financial Environment (FE; e.g., finance sector employment, financing efficiency) and Market Environment (ME; e.g., economic performance, import/export activity, enterprise scale). The Social Environment included Public Service (PS; e.g., utility provision, medical services) and Human Resources (HR; e.g., talent reserves, labor costs). The Technological Environment was measured using Information Services (IS; mobile phone and broadband internet user counts) and Science & Technology Expenditure (SE; total government fiscal spending on science and technology), with data obtained from the CNKI database and respective city statistical yearbooks.

5. Research results

5.1. Calibration of variables

Prior to analysis, raw data for the eight antecedent conditions (AE, RE, FE, ME, PS, HR, IS, and SE for 2022) and the outcome variable (ILPE for 2023) were calibrated into fuzzy-set membership scores ranging between 0 and 1. The direct calibration method was applied, with the 75th percentile, median (50th percentile), and 25th percentile of each variable's distribution serving as thresholds for full membership (fuzzy score > 0.95), the crossover point (fuzzy score = 0.5), and full non-membership (fuzzy score < 0.05), respectively. To prevent ambiguity for scores exactly equal to 0.5, a small constant of 0.001 was added.

5.2. Analysis of necessary conditions

Necessary conditions were analyzed using both fsQCA and Necessary Condition Analysis (NCA). The fsQCA results indicated that no individual antecedent condition reached the conventional consistency threshold of 0.9 for being considered necessary for either high ILPE or its absence (~ILPE), suggesting that no single business environment factor alone is indispensable for achieving high private enterprise innovation.

NCA further quantified necessity effect sizes (d), revealing that only the Market Environment (ME) exhibited a significant necessary effect for high ILPE (d = 0.179, Ceiling Regression, $P < 0.001$), whereas other conditions displayed non-significant effects ($P > 0.05$) or very small effect sizes (d < 0.1). Bottleneck analysis indicated that attaining higher ILPE levels requires progressively higher minimum ME levels; for instance, achieving 80% of the observed ILPE range necessitates at least 44.3% of the observed ME range. These findings underscore the critical, albeit insufficient, role of the market environment.

5.3. Analysis of sufficient conditions (configurations)

Truth tables were constructed for high ILPE and non-high ILPE (~ILPE), applying a frequency threshold of 1 and a consistency cutoff of 0.8. Intermediate solutions were produced, identifying configurations sufficient for the outcomes. As shown in **Table 1**, this study identifies three distinct configurations as sufficient pathways for achieving high private enterprise innovation (Overall Solution Consistency: 0.848; Overall Solution Coverage: 0.579):

(1) C01 (Policy-Market Driven Tech Innovator): Characterized by the presence of AE, RE, ME, and SE, along with the absence of FE, PS, and IS (Raw Coverage: 0.119; Unique Coverage: 0.045; Consistency: 0.938);

(2) C02 (Comprehensive Resource Synergy): Involves all core (AE, RE, ME, SE) and peripheral (FE, PS, IS) conditions, exhibiting the highest empirical relevance (Raw Coverage: 0.504; Unique Coverage: 0.416; Consistency: 0.834);

(3) C03 (S&T Expenditure & Gov-Market Synergy Driven): Defined by AE, ME, and SE with peripheral conditions FE, PS, and HR, but marked by the absence of RE and IS (Raw Coverage: 0.105; Unique Coverage: 0.030; Consistency: 0.953).

Across all pathways, strong AE, vibrant ME, and substantial SE consistently emerged as core conditions for high innovation.

Table 1. Configurations of predictor variables in the fsQCA analysis

Predictor variable	C01	C02	C03
AE (Administrative environment)	Present	Present	Present
RE (Rule of law environment)	Present	Present	Absent
FE (Financial services)	Absent	Partial	Partial
ME (Market environment)	Present	Present	Present
PS (Public services)	Absent	Partial	Partial
HR (Human resources)	-	-	Partial
IS (Information infrastructure services)	Absent	Partial	Absent
SE (Science & technology expenditure)	Present	Present	Present
Consistency	0.938	0.834	0.953
Raw coverage	0.119	0.504	0.105
Unique coverage	0.045	0.416	0.030
Solution consistency	0.848	-	-
Solution coverage	0.579	-	-

6. Conclusion

This study examined the complex relationship between the urban business environment and private enterprise innovation using a configurational approach applied to data from 48 Chinese cities. NCA and fsQCA were employed. The analyses revealed that, although a conducive ME constitutes a necessary condition for high innovation, no single environmental factor is sufficient by itself. Three distinct configurations, comprising combinations of AE, RE, FE, ME, PS, HR, IS, and SE, were identified as sufficient for attaining high innovation levels. Across these pathways, a robust AE, a dynamic ME, and substantial SE consistently emerged as core conditions. These empirically derived configurations provide guidance for targeted policy interventions aimed at enhancing innovation ecosystems and promoting sustainable economic growth.

Disclosure statement

The author declares no conflict of interest.

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