

Pathways to High-Level Integrated Innovation Between Large Enterprises and SMEs: Evidence from Wenzhou Under the TOE Framework

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Abstract

Integrated innovation (in Chinese, rongtong chuangxin), namely the collaborative innovation of large, medium, small, and micro enterprises along and across industrial chains, has become a central instrument of China's innovation policy. Drawing on the technology–organization–environment (TOE) framework, this study examines how multiple conditions jointly configure to produce high-level integrated innovation among enterprises in Wenzhou, a city emblematic of China's private economy. Data were collected through a questionnaire survey of enterprises in Wenzhou conducted between May and August 2024, yielding 105 valid responses, supplemented by ten in-depth interviews. Descriptive statistics show that only 41.9% of the 105 surveyed firms—44 firms in total—had engaged in inter-firm innovation cooperation; among these 44 firms, talent shortage (61.4%), lack of cooperation platforms and channels (50.0%), and funding constraints (45.5%) are the most salient barriers. Using fuzzy-set qualitative comparative analysis (fsQCA) on the 44 firms engaged in integrated innovation, the study identifies three equifinal pathways to high-level integrated innovation: an R&D-driven path, a digital-technology-driven path, and an organization–environment composite path. Government policy support emerges as the only core condition common to all three configurations, while top management support and industry competitive pressure function as auxiliary conditions. The findings suggest that high-level integrated innovation is the outcome of conjoint technological, organizational, and environmental factors rather than of any single factor, and that differentiated strategies should be adopted by large enterprises, small and medium-sized enterprises (SMEs), and the government.

Keywords

Integrated Innovation; Collaborative Innovation; TOE framework; fsQCA; Large Enterprises and SMEs; Wenzhou

1. Introduction

Against the backdrop of accelerating globalization and technological change, the

pace of product and technology iteration has reached unprecedented speed, posing severe challenges to manufacturing enterprises. Constrained by knowledge accumulation, talent, funding, and firm size, innovating alone is increasingly difficult to sustain, pushing enterprises toward broad-based collaboration. In 2017, the concept of integrated innovation between large, medium, and small enterprises (in Chinese policy discourse, *rongtong chuangxin*) was advocated at the State Council executive meeting and the Summer Davos Forum. It aims to activate the innovation engine of large enterprises and unleash the innovation potential of small and medium-sized enterprises (SMEs), linking the upper and lower reaches of industrial chains, promoting resource sharing and risk sharing, and enhancing the resilience of industrial and supply chains.

Since then, governments at all levels have issued a cascade of supporting policies, from the 14th Five-Year Plan for Promoting the Development of Small and Medium-sized Enterprises (2021) and the Hand-in-Hand Action notice (2022) to the Opinions on Promoting the Development and Growth of the Private Economy (2023), with corresponding policies in Zhejiang Province and Wenzhou, including the Regulations of Wenzhou Municipality on Promoting Scientific and Technological Innovation of Private Enterprises (April 2024).

Wenzhou provides a particularly meaningful setting for studying this phenomenon. The city rose to prosperity on its private economy—the share of private enterprises in enterprise number, GDP, industrial value added, employment, and tax revenue all exceeds 90%—yet many of its traditional industries face arduous transformation challenges. In 2023, Wenzhou built 67 high-level innovation platforms, introduced 21 new R&D institutions, and supported more than 2,300 enterprise R&D institutions at the municipal level or above. Given the difficulty of independent innovation for small and micro enterprises, cooperative innovation has become a preferred route.

Although scholars have paid increasing attention to cooperative and, more recently, integrated innovation, few studies have examined integrated innovation through the lens of the technology–organization–environment (TOE) framework, and fewer still have adopted a configurational approach recognizing the joint, non-additive effects of multiple conditions. Addressing this gap, this study investigates (1) the current status of, and barriers to, integrated innovation in Wenzhou and (2) the configurational pathways to high-level integrated innovation, using fuzzy-set qualitative comparative analysis (fsQCA) on original survey data and deriving differentiated recommendations for large enterprises, SMEs, and the government.

2. Literature Review and Theoretical Framework

2.1. From Cooperative Innovation to Integrated Innovation

The theoretical roots of integrated innovation lie in research on cooperative innovation: Fusfeld and Haklisch [1] first proposed that cooperative innovation is a

contractual arrangement formed when two or more firms each invest resources to achieve common R&D goals; D'Aspremont and Jacquemin [2] showed that cooperative R&D saves costs, raises innovation output, and mitigates spillovers; Williamson [3] argued that such relationships build inter-firm trust; Miotti and Sachwald [4] emphasized that partner selection depends on complementary resources; Nieto and Santamaría [5] found technological cooperation especially critical for small firms; and Giovannetti and Piga [6] and Liu et al. [7] analyzed how active cooperation within local networks and concerted stakeholder action support innovation and risk control.

Chinese scholars have developed the concept in the context of large enterprise–SME collaboration: Fang et al. [8] showed that excess returns promote, whereas rising costs suppress, cooperative strategies; Chen and Yang [9] proposed an institution–actor–element–organization framework for chokepoint technology breakthroughs; Huang et al. [10] found that advantageous supply network positions enhance collaborative innovation capability; and Li [11] and Li and Zhang [12] showed that the digital economy and digital transformation promote integrated innovation by reducing operational risk and information asymmetry.

2.2. The TOE Framework

The TOE framework holds that an organization's adoption of new technologies or innovation behaviors is jointly shaped by the technological (T), organizational (O), and environmental (E) contexts, and it is widely applied in combination with fsQCA. Gu et al. [13] analyzed the configurational antecedents of user participation in product innovation; Zeng et al. [14] identified five configurational paths to high original innovation, with elements across the three dimensions exhibiting complementary and substitution relationships; and Wu and Zhang [15] found that single-factor-led, dual-factor-driven, and all-dimensional synergy modes can all achieve high-level green innovation performance—yet few have studied integrated innovation under this framework.

2.3. Analytical Framework

Following the TOE logic, this study includes two conditions per dimension: enterprise R&D investment and digital technology application in the technological dimension (the internal supporting force), organizational strategic flexibility and top management team support in the organizational dimension (the internal driving force), and government policy support and industry competitive pressure in the environmental dimension (the external pushing force). Consistent with the literature, the outcome—integrated innovation performance—is conceptualized along two dimensions: breadth (the diversity of cooperation forms and the number of innovation partners) and depth (the frequency of exchange and the depth of trust with partners).

3. Research Design and Methodology

3.1. Data and Sample

Data were collected through a questionnaire survey and field interviews of large, medium, small, and micro enterprises in the Wenzhou area, focusing on representative enterprises in Wenzhou's "5+5" industries (the five traditional pillar and five strategic emerging industries emphasized in local industrial policy). Entrepreneurs and managers completed the questionnaire via WeChat or telephone and were informed that the survey was for academic research only. The survey ran from May to August 2024: of 111 questionnaires returned, 6 with missing entries or obvious errors were removed, leaving 105 valid responses (94.6% effective recovery rate). Ten in-depth interviews were also conducted with executives and experts of key enterprises. The sample is dominated by small and micro enterprises—about 79% of respondents employ 300 or fewer staff, consistent with their more than 90% share of Wenzhou's private economy—with manufacturing accounting for the highest share (39.1%).

3.2. Variables and Calibration

The outcome variable, the integrated innovation level, combines a breadth and a depth dimension. Breadth is reflected in the diversity of cooperation forms and the number of partners: the questionnaire recorded each firm's cooperation forms (nine options) and its number of partners (five ordered categories). Depth is reflected in the frequency of exchange and the depth of trust with partners; the two items were measured on five-point Likert scales and reverse-coded before aggregation, so that higher scores consistently indicate more frequent exchange and deeper trust. The breadth score averages the number of cooperation forms and the partner-count score, the depth score averages the two reverse-coded items, and the index weights the two dimensions at 50% each. As the number of cooperation forms ranges from 1 to 8 in the sample (theoretical maximum 9), this raw count was used without rescaling, giving the breadth component a somewhat wider effective range than the depth component—a choice acknowledged as a limitation in Section 7. The six condition variables follow Section 2.3—R&D investment, digital technology application, organizational strategic flexibility, top management team support, government policy support, and industry competitive pressure—all measured on five-point scales. Following the direct calibration method [16], raw scores were transformed into membership scores between 0 and 1, with the three qualitative anchors set on the basis of the theoretical range and the observed distribution of each variable's scores, the scale midpoint serving as the crossover point (membership 0.5). All analyses used the fsQCA 3.0 software.

3.3. The fsQCA Method

fsQCA, a branch of qualitative comparative analysis, combines case and variable

orientations through fuzzy-set theory and, unlike regression-based methods that estimate net effects, is particularly suitable for identifying how multiple conditions jointly configure to produce an outcome—precisely the question posed by the TOE framework.

The configurational analysis covers the 44 firms that had engaged in integrated innovation (41.9% of the valid sample). The consistency threshold for retaining a configuration was set at 0.75—slightly below the commonly recommended 0.8 in view of the small number of cases—and the frequency threshold at 1, following common practice in small-N studies [17]. Logical remainders were addressed through counterfactual analysis based on the theoretical expectation that each condition contributes positively to integrated innovation, yielding the intermediate solution; PRI consistency was examined at the truth-table stage to guard against configurations sufficient for both the outcome and its negation. Following standard notation, ● denotes a core condition present, ○ a peripheral condition present, ⊗ a condition absent, and a blank a condition playing no substantive role; a condition is classified as core when it appears in both the intermediate and parsimonious solutions and as peripheral when it appears only in the intermediate solution.

4. Results

4.1. The Current Status of Integrated Innovation in Wenzhou

Innovation input. In total, 38.1% of the respondent enterprises invest less than RMB 0.5 million per year in innovation and only 29.5% more than RMB 1 million. Larger firms invest more: 24.1% of firms with 300 or fewer employees invest more than RMB 1 million annually, versus 50.0% of larger firms—a gap attributable to conservative orientations, short-term profit motives, and resource constraints.

Participation. In total, 41.9% of the respondent enterprises—44 firms in total—have carried out innovation cooperation with other enterprises. Among the 61 firms that had not, the main reasons were the lack of opportunities and channels (45.9%), perceived low innovation intensity (45.9%), concerns about rising costs (36.1%), insufficient government policy support (18.0%), worries about leakage of intellectual property and corporate secrets (11.5%), confidence in the firm's own R&D strength (9.8%), and other reasons (9.8%).

Forms and depth. Among the 44 firms engaged in integrated innovation, patent technology licensing and transfer (56.8%), innovation cooperation platforms (52.3%), and joint patent applications (38.6%) are the most common forms; 56.8% have fewer than five partners, 86.4% maintain frequent exchange and cooperation, and 75.0% report deep trust and strong ties—indicating relatively high levels of both breadth and depth.

4.2. Analysis of Single Conditions

As shown in Table 1, the consistency of the top management team condition (0.908)

marginally exceeds the conventional benchmark of 0.9, but its coverage is comparatively low (0.685), and the consistency of the remaining five conditions ranges from 0.62 to 0.81. Thus, no single condition constitutes a necessary condition: top management support comes close to being necessary but is far from sufficient on its own, so it is necessary to proceed to the analysis of sufficient configurations.

Table 1. Analysis of necessary conditions for high-level integrated innovation

Condition	Consistency	Coverage
R&D investment	0.754	0.642
~R&D investment	0.521	0.636
Digital technology application	0.751	0.727
~Digital technology application	0.496	0.518
Top management team	0.908	0.685
~Top management team	0.357	0.536
Organizational strategic flexibility	0.622	0.790
~Organizational strategic flexibility	0.640	0.531
Government policy support	0.812	0.776
~Government policy support	0.451	0.477
Industry competitive pressure	0.796	0.759
~Industry competitive pressure	0.475	0.504

Note: ~ denotes the logical operation of negation.

4.3. Configuration Analysis

The analysis produced three configurations for high-level integrated innovation, H1–H3, reported in Table 2. The consistency of each configuration and of the overall solution meets the retention threshold of 0.75 specified in Section 3.3; all three configurations in fact exceed 0.8. The overall solution consistency is 0.889—88.9% of the firms satisfying the configurations achieved high-level integrated innovation—and the overall coverage is 0.591. Since the sum of the unique coverage values (0.154) is much smaller than the overall coverage, the three pathways represent partly overlapping routes to the same outcome rather than mutually exclusive segments of the sample.

Table 2. Configurations for high-level integrated innovation

Condition	H1	H2	H3
R&D investment	●		⊗
Digital technology application		●	⊗
Top management team	○	○	○
Organizational strategic flexibility	●	●	⊗
Government policy support	●	●	●
Industry competitive pressure	○	○	○
Consistency	0.905	0.876	0.981
Raw coverage	0.455	0.504	0.233
Unique coverage	0.025	0.067	0.062
Overall solution consistency	0.889		
Overall solution coverage	0.591		

Note: ● = presence of a core condition; ○ = presence of a peripheral condition; ⊗ = absence of the condition; blank = the condition plays no substantive role in the configuration. Core and peripheral conditions are distinguished by comparing the intermediate solution with the parsimonious solution.

4.4. Interpretation of the Three Pathways

Across the three configurations, government policy support is the only condition that serves as a core condition in all three, while industry competitive pressure and the top management team function as auxiliary conditions throughout: whatever pathway a firm follows, high-level integrated innovation is consistently accompanied by supportive policy, a competitive industry environment, and top management attention.

Configuration H1 (R&D-driven path). In H1, digital technology application plays no substantive role, while R&D investment and organizational strategic flexibility serve as core conditions, alongside government policy support and the auxiliary conditions of top management support and industry competitive pressure. Firms on this path rely primarily on substantial R&D investment, reinforced by flexible organizational arrangements—typical of resource-rich larger enterprises.

Configuration H2 (digital-technology-driven path). In H2, R&D investment plays no substantive role, while digital technology application and organizational strategic flexibility serve as core conditions, again combined with government policy support and the two auxiliary conditions. Firms on this path rely mainly on digital technologies, which lower communication costs, reduce information asymmetry, and widen cooperation channels, corroborating recent evidence that digital transformation promotes integrated innovation [11, 12].

Configuration H3 (organization–environment composite path). In H3, R&D investment, digital technology application, and organizational strategic flexibility are all absent—that is, firms display low membership in these conditions rather than a literal absence of R&D activity or digitalization; the top management team must attach great importance to integrated innovation under government support and competitive pressure to succeed. The label reflects that the path joins an organizational condition (top management commitment) with environmental conditions (policy support and competitive pressure), and it is characteristic of resource-constrained SMEs whose top management commitment substitutes for technological and organizational resources.

4.5. Barriers to Integrated Innovation

Among the 44 firms engaged in integrated innovation, the most serious problems are the lack of talent (61.4%), the lack of platforms and channels for cooperation (50.0%), and the lack of funding (45.5%), alongside insufficient government support, inter-firm trust deficits, and uneven distribution of interests. Interviewees reported that firms interested in digital transformation lack the managers and technical staff able to implement projects; that SMEs with limited brand influence cannot attract large enterprises' attention or identify suitable partners; and that funding constraints have forced some projects to be postponed amid the unfavorable economic situation. Policy implementation also falls short—one respondent

reported that subsidies of 30%–50% promised for digitalization projects have frequently failed to materialize—and internal resistance, cultural differences, and fears of core knowledge leakage further hinder cooperation.

5. Discussion

First, the findings validate the applicability of the TOE framework to inter-firm integrated innovation: each configuration combines conditions from all three dimensions, confirming that integrated innovation is driven by the conjunction of technological, organizational, and environmental factors rather than any single dimension, extending prior TOE-based research on user participation in product innovation [13], original innovation [14], and green innovation [15] to large enterprise–SME collaboration.

Second, the results demonstrate equifinality: R&D investment, digital technology application, and organizational strategic flexibility can substitute for one another as the technological–organizational underpinning of cooperation, yet none is individually necessary. This resonates with the configurational logic of prior TOE studies [14] and cautions against one-size-fits-all policy prescriptions.

Third, the prominence of government policy support as the only core condition common to all three configurations highlights the institutional embeddedness of integrated innovation in China, while the barrier analysis shows that the effect of policy depends on implementation—subsidies announced but not delivered undermine the very support that, according to the configurational results, is decisive. The auxiliary roles of top management support and competitive pressure further indicate that integrated innovation requires both internal commitment and external incentives [3, 4]. Finally, the organization–environment composite path (H3) is essentially the pathway available to resource-constrained SMEs [5], for whom the policy implication is not simply more funding but reliable platforms and channels—precisely the barrier reported by 50.0% of the firms engaged in integrated innovation.

6. Conclusions and Recommendations

Based on a survey of 105 enterprises in Wenzhou and an fsQCA analysis of the 44 firms engaged in integrated innovation (41.9% of the sample), this study concludes that: participation in integrated innovation in Wenzhou remains limited, with fewer than half of the firms cooperating in innovation and small firms' innovation investment markedly lower than that of larger firms; high-level integrated innovation is achieved through three equifinal pathways—an R&D-driven path, a digital-technology-driven path, and an organization–environment composite path—with government policy support as the only core condition common to all three configurations and top management support and industry competitive pressure as auxiliary conditions; and the main barriers are talent shortage, the lack

of cooperation platforms and channels, funding constraints, insufficient policy implementation, internal resistance, and inter-firm trust deficits.

For large enterprises (H1 or H2), the priorities are to share and cultivate talent through exchange platforms and training centers serving SMEs; to open up cooperation platforms that give SMEs opportunities to display their strengths; to provide financial support and co-investment through special or venture funds; and to promote cultural integration and trust building, including confidentiality agreements.

For SMEs (H3), the priorities are to enhance talent attractiveness through compensation and incentive mechanisms; to seek cooperation actively through industry associations, chambers of commerce, and digital platforms; to adopt diversified financing strategies beyond bank loans; and to strengthen internal management and cultivate an open, innovative culture.

For the government, the priorities are to increase policy support—raising subsidy proportions, simplifying procedures, and strengthening supervision of implementation; to build cross-industry and cross-regional cooperation platforms for partner matching; to improve the financing service system for SMEs; and to promote trust building through communication activities and stronger intellectual property protection.

7. Limitations and Future Research

This study has several limitations. The data were collected in a single region through the researchers' contacts, so the findings may be affected by sample selection, regional concentration, and subjective attitudes, and generalizability requires caution. The configurational analysis covers only 44 firms—an acceptable but modest sample for fsQCA—and describes set relationships rather than causal effects. All variables were self-reported, so common-method variance cannot be excluded, and the breadth component of the outcome index may over-weight formal diversity. Future research could exploit longitudinal data to examine the evolution of cooperation networks and the performance consequences of different configurations, and test the external validity of the three pathways in other regions with dense private enterprise economies.

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