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Configurational Analysis of Critical Factors for Globalization of Manufacturing Industrial Chains in Guangdong Province: fsQCA Approach

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Abstract

Against the backdrop of economic globalization and the complex and volatile trade environment, the expansion of overseas markets by Guangdong's man- facturing industry is facing new challenges and opportunities. This study, from the perspective of the regional industrial innovation system, comprehensively uses methods such as literature research, case analysis, and fuzzy-set qualitative comparative analysis (fsQCA) to deeply analyze the configurations of key fac-tors contributing to the success of Guangdong's manufacturing industry chains in overseas markets.The research finds that elements within the regional indus-trial innovation system—including innovation subject factors, innovation en-vironment factors, and innovation interaction factors—influence the overseas performance of manufacturing industry chains through different configurational forms. Some successful cases demonstrate a configurational model where core subjects' innovation resource input and capabilities are closely integrated with industrial chain network collaboration, enabling precise alignment with inter-national market demands under policy support.

Keywords

Manufacturing Industry Chain; Configuration Research; Qualitative Comparative Analysis

1. Introduction

Against the backdrop of deepening global economic integration, manufacturing, as the core component of the real economy, plays a decisive role in determining regional economic competitiveness and global industrial chain status. As a leading manufacturing province in China, Guangdong has long held a pivotal position in foreign trade due to its open policy environment, comprehensive industrial supporting facilities, and large market scale, serving as a key gateway for "Made in China" to enter the global market. However, in recent years, the effects of rising international trade protectionism, intensified geopolitical conflicts, and global supply chain restructuring have posed numerous new chal-

lenges to the overseas expansion of Guangdong's manufacturing industry chains, including increased trade barriers, rising production costs, fluctuating market demand, and intensified technological competition. How to seize opportunities and address challenges in the complex and volatile international environment to achieve sustained and stable development of manufacturing industry chains in overseas markets has become an urgent issue to be resolved. Based on this, this paper takes the overseas markets of Guangdong's manufacturing industry chains as the research object. Drawing on the theory of regional industrial innovation systems, and using methods such as literature research, case analysis, and qualitative comparative analysis, it deeply explores the configurations of key factors contributing to their success in overseas markets. The study aims to enrich the application of regional industrial innovation system theory in the field of manufacturing internationalization, while providing theoretical basis and practical guidance for Guangdong's manufacturing enterprises and relevant departments to formulate scientific and reasonable overseas market expansion strategies. This will help Guangdong's manufacturing industry chains achieve value upgrading in the global industrial chain division of labor, enhance international competitiveness, and promote high-quality regional economic development.

2. Research Design and Data Measurement

2.1. Research Methods and Hypotheses

Qualitative Comparative Analysis (QCA) is a research method based on set theory and Boolean algebra, positioned between qualitative and quantitative approaches, suitable for small-to-medium sample sizes.[1]It primarily explores the combinatorial relationships of multiple antecedent conditions (collectively referred to as "configurations") that lead to the occurrence or non-occurrence of outcomes. This study employs QCA to investigate the key factor configurations for the overseas market success of Guangdong's manufacturing industry chains for the following reasons:First, the success of industry chains in overseas markets is not the result of a single factor. QCA can uncover combinations of multiple antecedent conditions leading to the explained outcomes, i.e., it can identify complex non-linear relationships among factors. Second, this study involves 19 case samples. QCA is applicable to both small case studies (fewer than 15 samples) and medium-sized samples (15 – 50 cases). [2]Third, the diverse development paths and converging outcomes of overseas market success indicate equifinal causal chains where different configurations lead to the same result.[3]Crisp-set Qualitative Comparative Analysis (csQCA) and Fuzzy-set Qualitative Comparative Analysis (fsQCA) are the most commonly used configurational analysis methods. csQCA uses dichotomous values (0, 1) to describe variables, addressing "either-or" problems, while fsQCA allows variables to take any value between 0 and 1, handling issues of variable degree and partial membership.[4]Since variables in this chapter, such as the intensity of innovation resource input and capabilities of core innovation subjects, are primarily derived from qualitative data, the variables exhibit continuity to a certain extent rather than simple binary relationships.[5]Therefore, this chapter employs Fuzzy-set Qualitative Comparative Analysis

(fsQCA) to examine the configurational relationships of elements contributing to the overseas market success of industry chains.

QCA methods emphasize "multiple concurrent causal relationships" across cases, where combinations of different antecedent conditions may lead to the same outcome. Based on the principles of QCA analysis, the following assumptions form the foundation for the subsequent analysis:First, the success of Guangdong's manufacturing industry chains in overseas markets is the result of the joint action of three aspects: innovation subject factors, innovation environment factors, and innovation interaction factors.Second, the key elements for the overseas market success of Guangdong's manufacturing industry chains can achieve high industrial innovation performance in overseas markets through combinations of different constituent elements.Third, the impact of each element on industrial innovation performance depends on its interaction with other elements.

2.2. Selection of Research Samples

The sample industries in this study were screened based on the following principles:the principle of typicality. When selecting samples, this study primarily focused on manufacturing industries within the top ten pillar industrial clusters, which are more representative.the principle of data availability. The 19 cases have abundant public information and relatively authentic data, and researchers have the opportunity to directly obtain relevant information through field investigations and online data collection.

Table 1. Sample selected

Case	Type	Industrial Cluster
1	Chain-lead Enterprise	Electronic Information Industry Cluster
2	Supporting Enterprise	Electronic Information Industry Cluster
3	SME with Innovative Focus	Electronic Information Industry Cluster
4	Chain-lead Enterprise	Ultra-clear Video Display Industry Cluster
5	Supporting Enterprise	Ultra-clear Video Display Industry Cluster
6	SME with Innovative Focus	Ultra-clear Video Display Industry Cluster
7	Chain-lead Enterprise	Smart Home Appliance Industry Cluster
8	Supporting Enterprise	Smart Home Appliance Industry Cluster
9	SME with Innovative Focus	Smart Home Appliance Industry Cluster
10	Chain-lead Enterprise	Automotive Industry Cluster
11	Supporting Enterprise	Automotive Industry Cluster
12	Supporting Enterprise	Automotive Industry Cluster
13	SME with Innovative Focus	Automotive Industry Cluster
14	Chain-lead Enterprise	Modern Light Industry and Textile Industry Cluster
15	Supporting Enterprise	Modern Light Industry and Textile Industry Cluster
16	SME with Innovative Focus	Modern Light Industry and Textile Industry Cluste
17	Chain-lead Enterprise	Advanced Materials Industry Cluster

Case	Type	Industrial Cluster
18	Supporting Enterprise	Advanced Materials Industry Cluster
19	SME with Innovative Focus	Advanced Materials Industry Cluster

3. Fuzzy Set Valuation and Performance Measurement

Ragin pointed out that researchers should decide which fuzzy set method to use for valuation. After reviewing relevant literature, this study argues that the four-value method can more delicately reflect gaps in sample data. Thus, it employs the classic four-value method (0, 0.33, 0.67, 1) for variable valuation, where:"0" represents full non-membership;"0.33" represents more non-membership;"0.67" represents more membership;"1" represents full membership.[6]

For overseas industrial performance, most studies commonly use overseas operating income as a measure, including revenue from business operations formed by establishing sales networks, service systems, and production bases overseas through various forms such as greenfield investment, cross-border M&A cooperation, and setting up overseas offices. This is the most direct reflection of overseas markets. However, measuring overseas market success solely by overseas operating income is insufficient, as the achievements of industrial chains in overseas markets are integrated across multiple regional target markets. Therefore, this study adopts an independent scoring strategy to evaluate five dimensions: market performance, customer stickiness, value creation, technological discourse power, and risk resistance. Each dimension is scored from 0 to 5 (with 5 indicating the highest performance), and the sum of scores across the five dimensions yields the comprehensive score of overseas market performance (ranging from 0 to 25).[7]

Table 2. Assignment Criteria for Innovation Resource Input and Capabilities of Core Entities

Score	Configuration Valuation Criteria(CICE)
1	R&D investment is significant; or a brand-new technical paradigm is defined, achieving industry-level technological breakthroughs; business technologies create new product categories in the industry market or replace existing solutions.
0.67	R&D investment is substantial; or major technological iterations are achieved; business technologies significantly alter the industry market landscape, becoming disruptive to leading enterprises.
0.33	R&D investment is moderate; or partial technological optimizations are completed; business technologies achieve partial market penetration or are adopted by part of the market.
0	All the above capabilities are weak.

Table 3. Assignment Criteria for the Perfection Degree of Innovation Entities

Score	Configuration Valuation Criteria(PDIE)
1	The industry has a large number of upstream and downstream enterprises and research institutions;Collaborates with numerous research-oriented and applied universities;Financial and service institutions are of large scale, with financial institutions able to provide abundant funds and discount interest support, as well as numerous high-end technology services; Industry associations are

Score	Configuration Valuation Criteria(PDIE)
0.67	well-developed and frequently participate in international standards-setting meetings. The industry has a certain number of upstream and downstream enterprises and research institutions;Collaborates with a certain number of research-oriented and applied universities;Financial and service institutions are of relatively large scale, with financial institutions able to provide certain funds and discount interest support, as well as a certain number of high-end technology services; Industry associations are stable and participate in international standards-setting meetings to a certain extent.
0.33	The industry has a small number of upstream and downstream enterprises and research institutions;Collaborates with a small number of research-oriented and applied universities; Financial and service institutions are of moderate scale, with financial institutions able to provide limited funds and discount interest support, as well as limited high-end technology services;Industry associations are of moderate scale and participate in international standards-setting meetings to a limited extent.
0	All the above capabilities are weak.

Table 4. Assignment Criteria for Infrastructure Completeness

Score	Configuration Valuation Criteria(IC)
1	Possesses overseas investment infrastructure with strong externality, significant investment scale, and long construction period;Exhibits remarkable resource endowment in the industry or target market;Is located in a well-developed supporting industrial cluster and is capable of dominating the cluster.
0.67	Possesses overseas investment infrastructure with certain externality, relatively large investment scale, and long construction period;Has strong resourceendowment in the industry, enabling long-term lock-in of resource supply;Is located in an industrial cluster and can be deeply embedded in it.
0.33	Possesses overseas investment infrastructure with moderate externality, moderate investment scale, and moderate construction period;Has moderate resource endowment, enabling regional resource cooperation;Can engage in partial cluster collaboration.
0	All the above capabilities are weak.

Table 5. Assignment Criteria for Industrial Chain Collaborative Network Density

Score	Configuration Valuation Criteria(ICCND)
1	Engages in high-frequency collaboration, establishing transnational industry-university-research innovation alliances with remarkable technology output capabilities;Possesses a global strategic alliance network involving multiple countries/regions and industrial sectors, leading the construction of industrial collaborative ecosystems;Builds a digital supply chain platform, enabling real-time data interconnection with overseas partners, featuring short order response time and high inventory turnover rate.
0.67	Conducts regular collaboration covering core technical fields, establishing stable overseas R&D hubs;Achieves cross-linkage alliances covering R&D, production, and sales, forming regional industrial synergy;Exhibits relatively short order response time and high inventory turnover rate.
0.33	Engages in sporadic collaboration mainly focused on short-term technical improvements, without forming a systematic technological collaboration network;Establishes cooperation with a few key customers/suppliers, with collaboration limited to local links;Has moderate order response time and inventory turnover rate.
0	All the above capabilities are weak.

Table 6. Assignment Criteria for Institutional Incentives

Score	Configuration Valuation Criteria(II)
1	High-level policy incentives with strategic-level support;The target country designates the industry as a priority development sector, providing customized policy packages;Policies are long-term stable and forward-looking, incorporated into national development strategies;Risk protection mechanisms are provided.
0.67	Moderate policy incentives with practical support effects;The target country provides systematic policy support, land/plant preferential policies, tariff reductions, etc.;Policies have high transparency, and foreign investment service agencies are established to assist enterprise landing; Intellectual property protection, data security, and other regulations are relatively complete, with moderate enforcement intensity and controllable enterprise compliance risks.
0.33	The target country provides a basic policy framework, but with limited incentive intensity;Policy stability is general, with local sectoral restrictions;There are basic compliance requirements such as labor laws and environmental protection laws, but enforcement is lenient, and enterprises need to bear high compliance costs independently.
0	All the above capabilities are weak.

Table 7. Assignment Criteria for Market Localization Embedding

Score	Configuration Valuation Criteria(MLE)
1	All supply chain, R&D, production, sales, and service links are deeply rooted in the target market;The brand is perceived as a "local enterprise," with leading consumer awareness and loyalty;The enterprise's values are deeply integrated with the local social responsibility system, making it a benchmark case for local policies and eligible for tax incentives or government cooperation projects;
0.67	A localization system is established across multiple dimensions (supply chain, sales, R&D, compliance), complying with local policies and regulations and establishing a compliance management system;Products are integrated with local cultural customs, and brand marketing strategies align with local values; The enterprise occupies a certain market share in the target market, forming differentiated competition with local rivals;
0.33	A preliminary localization system is constructed, complying with local policies and regulations and establishing a basic management system;Tentative layouts are only made in certain links;Products are adjusted for superficial attributes such as language and packaging, but core functions or service models are not optimized for local needs;
0	All the above capabilities are weak.

After coding the 19 samples, the following sample numerical coding table was obtained.

Table 8. Sample Numerical Coding Table

CASE	CICE	PDIE	IC	II	ICCND	MLE	OMIP
1	1	1	1	1	1	1	24
2	0.67	0.33	0.33	0.33	0.33	0.33	11
3	0.67	0.33	0	0.67	0.67	0.33	14
4	0.67	0.67	0.67	0.67	0.67	0.67	23
5	1	0.33	0.33	0.67	0.67	0.33	14
6	0.67	0.67	0.33	0.67	0.33	0.33	12
7	0.67	1	0.67	0.67	0.67	0.67	15
8	1	0.67	0.33	0.67	0.67	0.33	18
CASE	CICE	PDIE	IC	II	ICCND	MLE	OMIP
9	1	0.67	0.67	0.33	0.67	0.67	6
10	0.67	1	0.67	0.67	0.67	0.67	17
11	0.67	0.67	0.67	0.33	0.67	0.67	13

12	1	0.33	0.33	0.67	0.33	0.67	18
13	1	1	0.67	0.67	0.67	0.67	22
14	0.33	0.67	0.33	0.33	0.33	0.67	17
15	0.33	0.33	0.33	0.33	0.67	0.67	13
16	0.33	0.33	0.33	0.33	0.67	0.67	10
17	0.67	0.67	0.33	0.33	0.67	0.33	12
18	0.67	0.33	1	0.33	0.33	0.67	19
19	0.67	0.33	0.33	0.67	0.33	0.67	7

This study uses fsQCA 3.0 software developed by Charles C. Ragin for data processing. Before software operation, the data from the coding table are first imported into an Excel spreadsheet, where sample serial numbers and variable names (English letter codes) are set up. The Excel file is then saved in ".csv" format. Subsequently, fsQCA 3.0 is launched, and the Excel data are directly imported to start constructing the truth table, which serves as the foundation for deriving factor combinations and subsequent result discussions. The specific operational procedures are as follows:

Continuous values in the data coding table are converted into set membership values to facilitate truth table construction. Since the degree of overseas market success in the coding table are all continuous values, the Calibrate function in fsQCA 3.0 is used for conversion. The functional formula operation is: Y-fz = Calibrate(X, n1, n2, n3), where n1, n2, and n3 are the predefined thresholds) for valuation.[8]

Table 9. Critical Value of Innovation performance

Variable	Full Membership Threshold	Cross-over Point	Full Non-membership Threshold
Overseas Market Industrial Performance	17.1	11	6

4. Configurational Analysis Results

4.1. Necessity test results of conditional variables

For qualitative comparative analysis, the truth table essentially conducts sufficiency analysis. Therefore, to ensure that all independent variables are causes of changes in the outcome variable, a necessary condition analysis must be performed to confirm that all independent variables are subsets of the outcome variable (i.e., the consistency value is less than 1); otherwise, they need to be removed. According to the regulations of fsQCA (fuzzy-set Qualitative Comparative Analysis), the consistency of necessary condition analysis can be evaluated using the following formula:

$$\text{Consistency}(Y_i \le X_i) = \sum[\min(X_i, Y_i)] / \sum Y_i \tag{4.1}$$

The necessary condition test results for each independent variable in this study are shown in the following table.

Table 10. Necessity test results of conditional variables

Conditions	OMIP	
	Consistency	Coverage
CICE	0.903543	0.670562
~CICE	0.401575	0.768362
PDIE	0.818898	0.734334
~PDIE	0.503937	0.667536
IC	0.738189	0.804721
~IC	0.602362	0.632231
II	0.813976	0.799807
~II	0.574803	0.674365
ICCND	0.794291	0.732305
~ICCND	0.594488	0.756892
MLE	0.827756	0.763158
~MLE	0.561024	0.714286

It can be seen from the above table that the consistency values of the six factors are all less than 1[9], indicating that they are all sufficient rather than necessary conditions for causing the success or failure of overseas markets, and can all be included in fsQCA for further calculation.

4.2. Intermediate Solution Results

The data from the truth table were directly imported into fsQCA 3.0, and the "Fuzzy Truth Table Algorithm" program was run for calculation. The calculation yields three types of solutions: complex solution, intermediate solution, and parsimonious solution.In presenting the solution results, referring to Ragin and Fiss (2008), "●" denotes the presence of a causal condition, a blank space denotes absence, and empty cells "⊗" indicate the condition is irrelevant to the outcome.[10] The statistical results and analysis of factor combinations derived from fsQCA are detailed in the following section.

Table 11. Statistical results of intermediate solutions

Model：OMIP = f (PDIE, CICE, IC, II, ICCND, MLE)			
Frequency Threshold	1		
Consistency Threshold	0.814516		
Configuration Type	Raw Coverage	Unique Coverage	Consistency
PDIE*~IC*~II*~ICCND*MLE	0.495079	0.0334646	0.845378
CICE*~PDIE*IC*~II*~ICCND*MLE	0.397638	0.0334646	0.814516
CICE*PDIE*~IC*II*ICCND*~MLE	0.495079	0.0334646	0.845378
CICE*PDIE*IC*II*ICCND*MLE	0.681102	0.219488	0.868256

Table 12. Table type styles (Table caption is indispensable).

Variable Factors	Path1	Path2	Path3	Path4

Innovative Subject Factors	CICE		●	●	●
	PDIE	●	⊗	●	●
Innovative Environment Factors	IC	⊗	●	⊗	●
	II	⊗	⊗	●	●
Innovative Interaction Factors	ICCID	⊗	⊗	●	●
	MLE	●	●	⊗	●
Raw Coverage		0.495079	0.397638	0.495079	0.681102
Unique Coverage		0.0334646	0.0334646	0.0334646	0.219488
Consistency		0.845378	0.814516	0.845378	0.868256
Solution Coverage		0.813976			
Solution Consistency		0.887339			

(1) PDIE * ~IC * ~II * ~ICCID * MLE:Leading enterprises leverage technological advantages to penetrate overseas markets. Even with insufficient overseas infrastructure, institutional support, and industrial chain collaboration, success is achieved through "technical premium + localized channels".

(2) CICE * ~PDIE * IC * ~II * ~ICCID * MLE: Core enterprises compensate for insufficient subject innovation capabilities through large-scale overseas infrastructure investment, forming competitive barriers via "hardware scale + local channels". Here, IC (infrastructure completeness) substitutes for PDIE (subject innovation), suitable for capital-intensive industries.

(3) CICE * PDIE * ~IC * II * ICCID * ~MLE: "Dual Innovation-Driven + Institutional Incentives + Industrial Chain Collaboration" Ecological Type.Core enterprises form innovation synergy with other industrial chain entities. Overlaying policy support and industrial chain cluster effects, they occupy overseas markets through "technical standard output + industrial chain integration" even with low localization embedding.

(4) CICE * PDIE * IC * II * ICCID * MLE: "All-Factor Synergy" Ideal Type. Integrating six positive factors (innovation resources, subject capabilities, infrastructure, institutions, industrial chain, and localization), this configuration is mostly suitable for leading enterprises' high-end layout in developed markets. It requires simultaneous technical leadership, complete infrastructure, policy compliance, and local ecosystem integration.

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