



Evaluation System and Group Path Analysis of High-Quality Development of China's Civil-Military Integration Industry

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Abstract. The high-quality development of China's civil-military integration (CMI) industry is vital for advancing national modernization. Rooted in the defense technology sector, the CMI industry faces challenges in achieving high-quality growth. This study explores key factors and configuration paths for this development.

Through a literature review, theoretical analysis, and the construction of an evaluation system, the study assesses the CMI industry's development across Chinese provinces. Using the fsQCA method, it identifies regional differences and temporal trends, revealing the importance of innovation, industrial structure, and marketization.

Findings highlight significant regional disparities, with the eastern region leading in development. Innovation and industrial structure are key factors, with marketization as a consistent influence over time. The study offers targeted strategies to enhance CMI industry growth.

Keywords: Civil-Military Integration, High-Quality Development, fsQCA, Evaluation System, Configuration Pathways.

1 Introduction

1.1 Research Background

Since the 21st century, technological revolution and industrial transformation have reshaped the global innovation landscape, driving deep integration between military and civilian technologies and intensifying international competition. As a global technological powerhouse, China has made significant strides across various sectors. However, in critical high-tech areas like semiconductors, China faces substantial challenges, including blockades and suppression from Western countries, particularly the United States. This escalating competition underscores the urgency for China to achieve technological self-reliance and strengthen its civil-military integration (CMI) industry.

The 20th National Congress of the Communist Party of China emphasized high-quality development as a core requirement for Chinese modernization, stressing the need to build a modern industrial system and enhance the real economy. The CMI

industry, deeply rooted in defense technology, plays a vital role in the modernization of national defense. Since 2009, with strong industrial policy support, China has established 32 national-level CMI industry bases across 22 provinces, driving rapid industry growth. The output value of China's CMI industry rose from approximately 1.25 trillion yuan in 2013 to about 4.59 trillion yuan by 2022.

While extensive research exists on high-quality industrial development and the growth of the CMI industry, critical gaps remain. Jin Bei (2018) and Shi Dan (2019) explored the multi-dimensional characteristics of high-quality development but did not address how these integrate with the unique nature of the CMI industry^[1,2]. Similarly, the evaluation metrics established by Li Qiaohua (2019) and Ma Zongguo & Liu Guoxin (2020) often overlook the dual attributes of the CMI industry, which balances national defense and economic development^[3,4]. Fu Chenyu et al. (2019) developed multi-dimensional evaluation systems, but these may not fully capture the CMI industry's specific demands and complexities^[5]. Additionally, while Zhao Aiyong et al. (2020) and Li Qiuxiang et al. (2021) emphasized market demand and innovation, the role of the CMI industry within broader innovation strategies is underexplored^[6,7]. Du Renhuai (2021) investigated the integration of national defense and civilian industries, but practical applications within the CMI industry need further empirical support^[8].

Given these gaps, this study aims to explore high-quality development within China's CMI industry by analyzing publicly listed companies in the sector. The research focuses on three aspects: (1) theoretical analysis of the mechanisms and characteristics of high-quality development in the CMI industry; (2) construction and evaluation of a system for high-quality development; and (3) analysis of configuration paths and key factors, considering spatial and temporal differences, with corresponding countermeasures. The goal is to provide new insights and methodologies for achieving high-quality development in China's CMI industry.

1.2 Research Objectives and Significance

• Research Objectives.

The primary objective of this study is to construct and analyze an evaluation system that measures the high-quality development of China's civil-military integration (CMI) industry. The study aims to:

1. Develop a comprehensive evaluation framework tailored to the CMI industry that assesses its development across various regions in China.
2. Apply the fsQCA method to identify and analyze the group pathways and key configurations that influence the high-quality development of the CMI industry.
3. Provide empirical insights into the differences in development patterns across regions and propose targeted strategies to enhance the industry's overall performance.

• Theoretical Significance.

This study contributes to the theoretical understanding of the CMI industry's high-quality development by creating a scientifically grounded evaluation system. This system not only captures the unique characteristics of the CMI industry but also provides a

structured approach to assess its development. By utilizing the fsQCA method, the research introduces a novel analytical perspective that explores the complex interplay of factors influencing the industry's growth. This theoretical framework expands the current body of knowledge and offers a new methodological approach for studying the CMI industry's development pathways.

- **Practical Significance.**

The practical significance of this research lies in its potential to guide the strategic planning and policy-making processes within the CMI industry. By identifying and analyzing the key factors and pathways that contribute to the industry's high-quality development, the study offers actionable insights that can improve decision-making at both the governmental and enterprise levels. The evaluation system provides a tool for monitoring and benchmarking the industry's progress, while the analysis of group pathways offers a deeper understanding of the regional disparities and potential areas for improvement. This research ultimately aims to support the sustainable and balanced growth of the CMI industry, aligning it with national goals for economic and defense development.

2 Evaluation System for High-Quality Development

In the previous article, we explored in detail the background, objectives and theoretical basis for the high-quality development of the civil-military integration industry. In order to further promote the development of the civil-military integration industry, it is necessary to construct a scientific and systematic evaluation system so as to accurately assess and analyse the level of high-quality development of the civil-military integration industry in each province (city).

2.1 Principles of Evaluation System Construction

Before discussing the construction principles of the evaluation system in depth, it is necessary to briefly review the basic features of the high-quality development of the civil-military integration industry, so as to lay a theoretical foundation for the construction of the evaluation system.

The high-quality development of civil-military integration industry is mainly reflected in the following aspects:

Expansion of industrial scale. The development of the civil-military integration industry is not only reflected in the rapid expansion of the industrial scale, but also in the gradual improvement and maturity of its industrial chain. With the continuous expansion of the industrial scale, the market influence and competitiveness of the civil-military integration industry have been significantly enhanced.

Improvement of economic efficiency. An important sign of high-quality development is the continuous improvement of economic efficiency. By improving total factor productivity and optimising resource allocation, the civil-military integration industry has gradually shifted from a growth mode relying on factor inputs to a growth mode

centred on efficiency enhancement, thus realising a significant increase in economic efficiency.

Enhancement of innovation ability. Innovation drive is the core driving force for the high-quality development of civil-military integration industry. Through technological innovation and industrial co-innovation, the civil-military integration industry has continuously made breakthroughs in key technological fields and maintained the industry's technological leadership and market competitiveness.

The deepening of the degree of integration. The high-quality development of the military-civilian integration industry is also manifested in the deep integration of military and civilian technologies and resources. This integration not only promotes the two-way transfer of technology and the optimal allocation of resources, but also promotes close collaboration between enterprises upstream and downstream of the industrial chain, and enhances the overall competitiveness of the industry.

The realisation of shared development. Shared development is one of the important elements of high-quality development. The development of the military-civilian integration industry not only enhances regional economic and social benefits, but also realises the sharing of development fruits by increasing employment and raising income, thus enhancing social harmony and stability.

Understanding the basic characteristics of high-quality development in the civil-military integration industry provides essential theoretical support and a practical foundation for constructing an effective evaluation system. The evaluation system should comprehensively capture and reflect these key features, ensuring it not only highlights the unique aspects of the civil-military integration industry but also aligns with modern development needs. By combining various indicators, respecting historical context, and incorporating contemporary development concepts, the system can offer scientific guidance for promoting the sustainable and healthy growth of the industry.

The construction of the evaluation system for the civil-military integration industry must adhere to several key principles. First, the principle of scientificity ensures that the selected indicators are based on solid theoretical foundations and accurately reflect the industry's high-quality development. The system must also be systematic, capturing the industry's holistic and hierarchical nature through interrelated and complementary indicators. Additionally, the principle of typicality requires that the indicators represent the industry's core characteristics, particularly its unique integration aspect, while remaining adaptable across regions and development stages. Lastly, the principle of operability ensures the system's practical application by relying on objective, real data from authoritative sources, making it both easy to implement and credible in its results.

2.2 Selection and Design of Evaluation Indicators

When studying the level of high-quality development of industries, academics usually construct an indicator system covering multiple dimensions. Based on the qualities of high-quality development of civil-military integration industry, this paper fully draws on the research results of previous scholars on the high-quality development of industry, and combines the unique development characteristics of the civil-military integration industry to construct the evaluation structure of high-quality development of civil-

military integration with "one system and five dimensions". The "one system" is the evaluation index system of high-quality development level of civil-military integration industry; the "five dimensions" include industry scale, economic benefits, innovation ability, integration degree and sharing level, which are composed of 18 specific indicators. The details are shown in Table 1.

Table 1. Evaluation index system for high-quality development of civil-military integration industry.

First-level indicators	Second-level indicators	Third-level indicators
Index of high-quality development of civil-military integration industry	Scale of industry	Total annual business income of listed companies of civil-military integration
		Annual Total Assets of Listed Civil-Military Integration Companies
		Total Annual Tax Payment of Listed Civil-Military Integration Companies
	Economic Benefits	Average Operating Profit of Civil-Military Integration Listed Companies
		Labour Productivity of All Staff of Listed Civil-Military Integration Companies
		Operating Profit of Listed Civil-Military Integration Companies as a Percentage of Operating Revenue
	Innovation Capacity	Ratio of Profit to Total Assets of Civil-Military Integration Listed Companies
		Number of Invention Patents of Civil-Military Integration Listed Companies per Year
		Number of R&D Personnel of Civil-Military Integration Listed Companies
		Annual R&D Expenditure of Civil-Military Integration Listed Companies as a Percentage of Total Operating Revenue
		Per capita R&D expenditure of R&D personnel of civil-military integration listed companies
		Share of R&D Personnel of Civil-Military Integration Listed Companies in the Company's Personnel
		Ratio of Total Operating Income of Civil-Military Integration Listed Companies to Regional GDP
		Ratio of Number of Employees of Civil-Military Integration Listed Companies to the Number of Employed Persons in the Region
		Ratio of total tax revenue of civil-military integration listed companies to regional general public budget revenue
	Degree of Integration	

	Number of Employees of Civil-Military Integration Listed Companies
Sharing Level	Compensation of workers of civil-military integration listed companies as a proportion of operating income
	Ratio of average annual salary of personnel of civil-military integration listed companies to average annual salary of regional employees

- Key Dimensions and Indicators

(1) Industry Scale

Industry scale is the foundation for the high-quality development of civil-military integration industry. This paper measures the industry scale through three indicators: total annual operating revenue^[9], total assets and total tax payment of listed companies in civil-military integration, which reflect the overall development capability and growth potential of the industry.

(2) Economic Benefits

Economic efficiency is an important reflection of the quality of industrial development, mainly reflecting the profitability and operational efficiency of the industry. This paper selects the indicators of average operating profit, full labour productivity, operating profit as a percentage of operating revenue and return on assets to assess the economic efficiency of the civil-military integration industry^[10].

(3) Innovation Capacity

Innovation is the endogenous driving force for high-quality development. This paper assesses the innovation capacity of the civil-military integration industry through indicators such as the number of annual invention patents, the number of R&D personnel, and the proportion of R&D expenditure to operating income, which reflect the strength of the industry in technological innovation and knowledge creation^[9].

(4) Degree of integration

The degree of integration is an important characteristic of the civil-military integration industry that distinguishes it from other industries. This paper measures the degree of integration through indicators such as the ratio of total business revenue to regional GDP, the ratio of the number of employees to regional employment^[11], and the ratio of total tax payment to regional general public budget revenue, which can effectively assess the degree of integration between civil-military integration industries and the regional economy^[12].

(5) Level of Sharing

Shared development is the ultimate goal of high-quality development. This paper selects indicators such as the number of employees of listed companies of civil-military integration, the proportion of labour compensation to operating income, and the ratio of the average annual salary of personnel to the average annual salary of regional employees to measure the sharing level of the industry, so as to assess the social contribution of the industry's development and the breadth of sharing of results^[13,14].

2.3 Evaluation Methods and Data Sources

- Data standardisation

In the process of data processing, taking into account the different units of measurement of each indicator, this paper adopts the extreme value method to standardise the data to ensure the comparability between different indicators. The formula is as follows:

$$x_{ijt} = \frac{x_{ijt} - \min(x_{ijt})}{\max(x_{ijt}) - \min(x_{ijt})} \quad (1)$$

Where i denotes the year, j denotes the specific indicator, t denotes the specific province, and x_{ijt} denotes the standardised data.

- Entropy value method weight determination

In order to ensure the scientific and objective nature of the indicator system, this paper adopts the entropy value method to calculate the weight of each indicator. This method determines the degree of discrete by measuring the information entropy of each indicator, thus determining the weight of each indicator and finally arriving at the comprehensive score. The specific steps are as follows:

1. Indicator ratio:

$$p_{ijt} = \frac{x_{ijt}}{\sum_{i=1}^n x_{ijt}} \quad (2)$$

2. Entropy calculation:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^n p_{ijt} \ln(p_{ijt}) \quad (3)$$

3. Coefficient of variation:

$$d_j = 1 - e_j \quad (4)$$

4. Weighting calculation:

$$w_j = \frac{d_j}{\sum_{j=1}^m d_j} \quad (5)$$

- Comprehensive Score Calculation

After determining the weights of each indicator, the comprehensive score is calculated based on the actual data of each province to arrive at the high-quality development index of the civil-military integration industry.

$$S_i = \sum_{j=1}^m w_j \times x_{ijt} \quad (6)$$

Through the above steps, the indicator system constructed in this paper can scientifically and systematically reflect the high-quality development level of civil-military integration industry in each province, and provide reliable data support for relevant policy formulation and industrial development.

- Data sources

The sample of listed companies includes listed companies under the ten major military industrial groups and listed companies in the military industrial sector (or the concept of military-civilian integration), totalling 474 companies. The data of these companies are mainly obtained through the websites of the groups, securities networks and financial websites. Companies whose main business is real estate and financial investment were excluded, as well as Hong Kong, Macao and Taiwan and provinces with fewer military-civil integration listed companies. The time span of the study is from 2016 to 2022. Data sources The data related to listed companies are obtained from the Cathay Pacific database, and other data are obtained from various statistical yearbooks.

2.4 Analysis of the Level of High-Quality Development Index of the Civil-Military Integration Industry

- Overall Evaluation Analysis

In the previous section, this paper preliminarily constructed the evaluation index system for the high-quality development of the civil-military integration industry. In this section, the entropy value method will be used to briefly analyze the index of high-quality development of the civil-military integration industry across relevant provinces in the country during the period from 2016 to 2022, as well as to conduct an overall evaluation and regional analysis to show the status of high-quality development of the civil-military integration industry in each region of the country.

The results of the high-quality development index calculated according to the entropy method show that the high-quality development index of the civil-military integration industry in most provinces showed an upward trend during the period from 2016 to 2022, although there were some fluctuations in individual provinces. This indicates that regions across the country have generally made positive progress in the high-quality development of the civil-military integration industry, but there are still significant differences in the level of development among different provinces. This can be seen specifically in Figure 1.

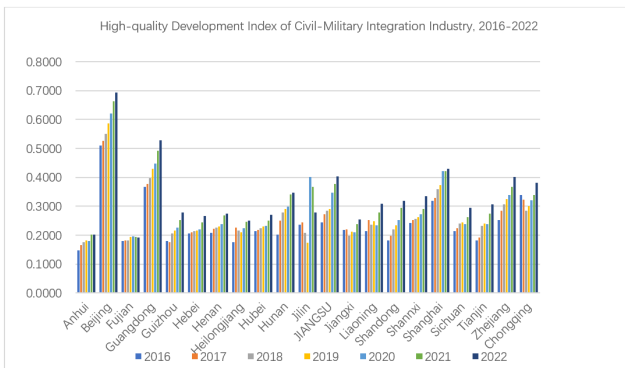


Fig. 1. High-quality Development Index of Civil-Military Integration Industry, 2016-2022.

Among all provinces, Beijing, Guangdong and Shanghai rank among the top three in terms of the level of high-quality development of the civil-military integration industry, representing the core regions of the three economic zones of Beijing-Tianjin-Hebei, the Pearl River Delta and the Yangtze River Delta, respectively. Beijing, in particular, has a significantly higher innovation capacity and development level of civil-military integration industries than other regions due to its rich scientific and educational resources, concentrated high-tech industries, and the layout of the headquarters of military-industrial groups. In contrast, the development level in the central and western regions is generally lower, reflecting the shortcomings of these regions in terms of industrial foundation, innovation capability and policy support.

- Sub-regional evaluation analysis

From a sub-regional perspective, the high-quality development index of the civil-military integration industry in the eastern region is clearly ahead of other regions, showing steady growth. The western region (e.g., Chongqing, Sichuan, Shaanxi, Guizhou) has the next highest level of development, and although its growth rate is relatively stable, the overall level is still lower than that of the eastern region. The civil-military integration industry in the northeastern region gradually recovered after experiencing a certain degree of decline during 2018 and 2019, while the central region lagged behind in its overall level of development. Specifically, this can be seen in Figure 2.

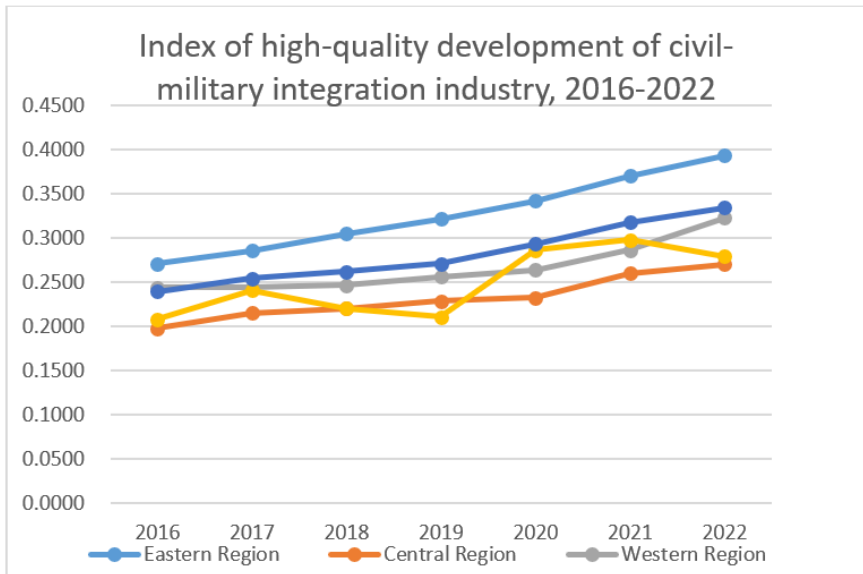


Fig. 2. High-quality Development Index of Civil-Military Integration Industry in Four Major Regions, 2016-2022.

According to the analysis of data from 2016 to 2022, the eastern region has clear development advantages, leading in industrial scale and economic benefits, while also

demonstrating significant competitiveness in innovation ability and integration level. The western region, although performing well in terms of sharing levels, still has room for improvement in industrial innovation and integration. In contrast, the northeastern and central regions need to further enhance their overall development levels to narrow the gap with the eastern and western regions.

3 Configurational Pathways Analysis

This study adopts the method of group state analysis to explore the path of high-quality development of the civil-military integration industry in various regions of China. The cluster analysis method, especially fuzzy set qualitative comparative analysis (fsQCA), can analyse how different combinations of factors work together to contribute to a particular outcome, which in this study is the high-quality development of the civil-military integration industry^[15].

3.1 Key Analytical Processes and Methodology Overview

- Variable selection

In the variable selection process, this paper selected the conditional variables from 2016 to 2022 for descriptive statistical analysis (see Table 2). In the data collection, a small amount of missing data was found in the civil-military integration multivariate data, accounting for less than 10% of the total data. In order to ensure the accuracy and reliability of the data analysis, this paper analyses these missing values in detail and confirms that they do not have a significant bias or abnormal impact on the overall dataset. In response to the fact that the data on the degree of marketisation only goes up to 2019, this paper uses linear interpolation to estimate the data for 2020 and beyond, ensuring the continuity and consistency of the data series.

Table 2. Descriptive statistics for variables.

Variable name	Maximum value	Minimum value	Mean value	Standard deviation
Average GDP (AVGDP)	19.0313	3.3291	7.7084	3.5032
Technological Innovation Capability (QY) ^[16]	65.4900	17.8500	32.3800	11.3311
Marketization Level (SC) ^[17]	8.9760	4.6000	6.7151	0.9670
Financial Development Level (JR) ^[18]	0.8528	0.0617	0.2315	0.1507
Industrial Structure (CY) ^[19]	2.8380	2.2280	2.4512	0.1282
Government Support (ZF)	0.3997	0.1050	0.2134	0.0645
High-Quality Development Index of Civil-Military Integration Industry (JMR)	0.6943	0.1483	0.2817	0.1006

Relevant data are from local statistical yearbooks, the 2016-2020 Report on China's Regional Innovation Capacity, the China Financial Statistics Yearbook, and relevant statistics.

- Data calibration

In order to apply the fsQCA methodology, the data need to be calibrated into fuzzy sets. This process involves transforming the raw data into values between 0 and 1, with each value representing the degree of conformity of a particular case (e.g., a province) under specific conditions. The data calibration process ensures that the data are suitable for histogram analysis. The calibration results are shown in Table 3.

Table 3. Calibration anchor points for each variable.

Variable Classification	Variable Name	Calibration Anchor		
		Full affiliation (95%)	Midpoint (50%)	Completely unaffiliated (5%)
Conditional Variables	Average GDP(AVGDP)	15.26	6.60	4.02
	Technological Innovation Capability (QY)	55.42	28.70	19.80
	Marketization Level (SC)	8.17	6.60	5.18
	Financial Development Level (JR)	0.46	0.18	0.10
	Industrial Structure (CY)	2.74	2.42	2.27
	Government Support (ZF)	0.34	0.21	0.13
Outcome variable	High-Quality Development Index of Civil-Military Integration Industry (JMR)	0.50	0.25	0.18

- Individual Conditional Necessity Analysis

In qualitative comparative analysis (QCA), individual conditional necessity analysis is a key step in assessing whether each independent conditional variable is necessary to achieve a particular outcome^[20]. By calculating two metrics, consistency and coverage, we can determine the extent to which a given condition variable is correlated with the outcome variable. This study found that although some of the conditions (e.g., industrial structure and scientific and technological innovation capacity) showed high consistency and coverage, none of them reached the critical value of 0.9, and therefore could not be considered necessary conditions for the outcome. This suggests that the high-quality development of the civil-military integration industry is influenced by a combination of multiple factors rather than being dominated by a single condition.

- Construction of the truth table

After completing the data calibration, this study constructed a truth table to analyse the impact of different combinations of conditions on the results. The truth table identifies which combinations have a significant impact on the high-quality development of the civil-military integration industry by assessing the frequency and consistency of different combinations of conditions. In this paper, the consistency threshold is set at 0.8 and the number of cases threshold at 1, so as to filter out the condition combinations that have a significant impact on the results. This approach provides a solid data foundation for subsequent path analyses and helps to understand the joint effects of multiple conditions.

3.2 Regional Configurational Pathways Analysis

Through group state analysis, this study adopts the level of economic development, scientific and technological innovation capacity, degree of marketisation, government support, level of financial development and industrial structure as key condition variables, and explores how the combinations of these conditions jointly affect the high-quality development of the civil-military integration industry. The results of the analysis show that the combinations of conditions have different influences and modes of action in different regions and stages of development.

- Results of overall high-quality development group state analysis

Table 4 summarises nine main grouping types, each of which represents a specific set of condition combinations reflecting unique paths to promote the high-quality development of civil-military integration industries in different regional contexts. The consistency of the single solution for each of the groupings is above 0.75, indicating that these groupings are sufficient conditions for promoting the high-quality development of the civil-military integration industry, and the overall level of consistency of the solution is 0.845, showing that under these combinations of conditions, 84.5 per cent of the cases have achieved a high level of development.

Table 4. High-quality development cluster analysis results.

Conditional Configuration	Config 1	Config 2	Config 3	Config 4	Config 5	Config 6	Config 7	Config 8	Config 9
AVGDP	●	●	•	⊗		⊗		●	⊗
QY	●	●		●	⊗	⊗	•	●	⊗
SC		•	•	⊗	●		•		⊗
JR			●	⊗	⊗	●	●	●	⊗
CY	●		●		⊗	●	●	●	●
ZF	⊗	⊗		●	•	•	⊗	•	⊗
Consistency	0.829	0.850	0.856	0.822	0.812	0.839	0.894	0.899	0.818

Original Coverage	0.417	0.616	0.597	0.303	0.309	0.298	0.538	0.337	0.356
Unique Coverage	0.007	0.029	0.036	0.009	0.005	0.027	0.004	0.004	0.012
Solution Consistency					0.763				
Solution Coverage					0.845				

Note: ● means that the core condition appears, • means that the edge condition appears, ⊗ means that the core condition does not appear, and ○ means that the auxiliary condition does not appear. A blank space indicates that the presence or absence of this variable has no effect.

• Deconstructive Analysis of Southern Region Grouping

In the analysis of the southern region (including 12 provinces such as Anhui, Fujian and Guangdong), industrial structure, scientific and technological innovation capacity, degree of marketisation, level of financial development and level of economic development are identified as core conditions.

Table 5. Results of spatial grouping analyses - Southern region.

Conditional Configuration	Config 1	Config 2	Config 3	Config 4	Config 5	Config 6
AVGDP	•	⊗	●	⊗	●	⊗
QY			●	●	•	●
SC	•	⊗	•		●	⊗
JR		⊗	⊗	●	●	●
CY	●	●		●	●	⊗
ZF	⊗	•	⊗	⊗		•
Consistency	0.894	0.821	0.819	0.869	0.919	0.832
Original Coverage	0.619	0.309	0.373	0.320	0.594	0.224
Unique Coverage	0.012	0.059	0.006	0.005	0.070	0.224
Solution Consistency					0.839	
Solution Coverage					0.786	

Note: ● means that the core condition appears, • means that the edge condition appears, ⊗ means that the core condition does not appear, and ○ means that the auxiliary condition does not appear. A blank space indicates that the presence or absence of this variable has no effect.

Among the multiple groupings in the Southern region, industrial structure usually plays a key role as a core condition. Especially in economically developed regions such as Guangdong, Jiangsu, and Zhejiang, the combination of the level of economic development, the degree of marketisation, and the industrial structure has driven the rapid development of the civil-military integration industry. In contrast, Anhui and other provinces have gradually realised the high-quality development of the civil-military integration industry in recent years by adjusting the industrial structure, strengthening scientific and technological innovation and financial support.

According to the analysis of group state in Table 5, the development path of civil-military integration industry in the southern region is diversified and flexible. For example, in Shanghai, the combination of economic development, marketisation and financial development, supplemented by scientific and technological innovation, has jointly promoted the steady improvement of the civil-military integration industry; while in Sichuan, scientific and technological innovation and financial development have become the core conditions for promoting the civil-military integration industry, showing the important role of the local government in policy guidance and industrial support.

• Deconstructive Analysis of Grouping in the Northern Region

The results of the group state analysis in the northern region (including nine provinces, including Beijing, Hebei and Henan) show that scientific and technological innovation capacity and industrial structure are the core conditions for promoting the high-quality development of the civil-military integration industry. In addition, the degree of marketisation, the level of financial development and government support also play a positive role in the development of the industry under different circumstances.

Table 6. Results of spatial grouping analyses - northern region.

Conditional Configuration	Config 1	Config 2	Config 3	Config 4	Config 5	Config 6
AVGDP	•	⊗			⊗	⊗
QY		⊗	●	●	⊗	⊗
SC	•		•	⊗	⊗	⊗
JR		⊗	⊗	⊗	●	
CY	●	⊗	⊗	⊗		●
ZF	⊗	⊗	⊗	•	•	•
Consistency	0.907	0.802	0.881	0.959	0.870	0.838
Original Coverage	0.588	0.476	0.376	0.330	0.378	0.384
Unique Coverage	0.017	0.007	0.006	0.006	0.035	0.001
Solution	0.768					

Consistency	
Solution	0.887
Coverage	

Note: ● means that the core condition appears, • means that the edge condition appears, ⊗ means that the core condition does not appear, and ○ means that the auxiliary condition does not appear. A blank space indicates that the presence or absence of this variable has no effect.

According to Table 6, in regions such as Beijing, Liaoning and Shandong, the combination of industrial structure and level of economic development significantly promoted the development of civil-military fusion industry, especially in the fields of manufacturing and defence industry, which have developed strong competitiveness and innovation capacity through reforms and market-oriented promotion.

In contrast, in Hebei and Henan, the degree of marketisation and scientific and technological innovation capacity have played a more significant role in the development of the civil-military integration industry, especially in promoting technological innovation and resource allocation within the region. Although government support plays a role in some of the groupings, on the whole, the market and scientific and technological innovation capacity have a more significant impact on the civil-military integration industry in the northern region.

In summary, the northern and southern regions show obvious differences in the path of high-quality development of civil-military integration industry. The southern region relies more on the combination of economic development, the degree of marketisation and industrial structure, while the northern region places more emphasis on the central role of scientific and technological innovation capability and industrial structure. These findings provide important empirical evidence for the further formulation of regional development strategies.

3.3 Configurational Pathways Analysis Over Time

• Overall Time Evolution Grouping Analysis

By analysing the groupings of civil-military integration industry development from 2016 to 2022, this study finds that the consistency of the grouping solutions for each year is above 0.75, indicating that these groupings are sufficient conditions to promote the high-quality development of the civil-military integration industry. The consistency of the overall solution is above 0.8, implying that a larger proportion of cases achieve a higher level of development under the corresponding condition groupings.

Table 7. Results of the spatial and temporal evolution grouping analyses.

Conditional Configuration	2016		2017		2018		2019		2020		2021		2022	
	Config H1	Config H2a	Config H2a	Config H1b	Config H1b	Config H3	Config H2a	Config H2b	Config H1b	Config H3	Config H3	Config H2b	Config H2b	Config H2
AVGDP	●	•			●		⊗				●	●	•	•
QY	•	⊗	⊗	●		⊗	•	⊗						•

SC	●	●	●		⊗		●	●	●	•	●	●	•	•
JR		⊗	•	●		⊗			•	●	⊗	•		•
CY	⊗		•		•	•	●		●		●	●	●	●
ZF		⊗		•	•	●	•	⊗	⊗		⊗	•	⊗	⊗
Consistency	0.719	0.764	0.846	0.794	0.791	0.849	0.813	0.764	0.867	0.785	0.827	0.888	0.905	0.892
Original Coverage	0.674	0.643	0.428	0.617	0.493	0.347	0.371	0.219	0.273	0.392	0.325	0.351	0.571	0.538
Unique Coverage	0.197	0.184	0.162	0.243	0.343	0.368	0.476	0.431	0.424	0.375	0.011	0.027	0.052	0.019
Solution Consistency		0.807		0.879		0.816		0.876		0.843		0.847		0.880
Solution Coverage		0.748		0.744		0.824		0.855		0.721		0.666		0.652

Note: ● means that the core condition appears, • means that the edge condition appears, ⊗ means that the core condition does not appear, and ○ means that the auxiliary condition does not appear. A blank space indicates that the presence or absence of this variable has no effect.

Table 7 summarises the results of the analysis of the grouping states in different years. The analysis shows that the degree of marketisation is a key factor that consistently influences the development of the civil-military integration industry throughout the period analysed. Nevertheless, its influence varied across years and regions, reflecting the fact that the degree of marketisation was not a core or decisive condition in all cases.

• Analysis of trends in time evolution

In 2016, 2018 and 2021, the level of economic development was seen as a core condition for the development of the civil-military integration industry, emphasising the key role of the general level of the economy and the purchasing power of the population in driving the growth of this industry. As per capita GDP rises, market demand for high-tech and high value-added products increases, creating a favourable external environment for the civil-military integration industry.

From 2019 to 2022, the optimisation and upgrading of the industrial structure gradually becomes the core driving force for the development of the civil-military integration industry. This trend shows that over time, the growing demand for establishing a solid industrial foundation and strengthening high-tech industries has become a key element in promoting the deep development of civil-military integration. Optimising the industrial structure not only promotes the transformation of scientific and technological achievements and the application of new technologies, but also promotes the formation of industrial clusters, providing a new impetus for the sustainable development of the civil-military integration industry.

In summary, the degree of marketisation, as a consistent and important condition, highlights the key role of building an efficient market in the development of civil-military integration industry. Meanwhile, the upgrading of the level of economic development and the optimisation of industrial structure play a central role in the development of civil-military integration industry at different stages.

4 Conclusions

This study summarises the following basic conclusions through an in-depth discussion of the high-quality development of China's civil-military integration industry:

1. Good overall development trend, but significant regional differences

By constructing a comprehensive evaluation index system, this paper finds that China's civil-military integration industry in general presents a steadily improving development trend, especially in the eastern region, where the industrial scale and technological innovation capacity far exceed those in other regions by virtue of its economic foundation and advantages in innovation resources. However, there are significant regional differences, and there is still much room for improvement in the central and western regions. The eastern region should give full play to its radiation role to drive the balanced development of the national civil-military integration industry.

2. Regional innovation capacity and industrial structure upgrading is the core key

Research shows that regional technological innovation capacity and industrial structure optimisation and upgrading are the core conditions for promoting the high-quality development of civil-military integration industry. Technological innovation and industrial upgrading not only enhance industrial competitiveness, but also promote the development of high-tech and high value-added fields. While these factors are key, other auxiliary conditions such as government support and financial development also play an important role in specific situations, emphasising the relevance and flexibility of policy formulation.

3. Contextual differences in time and space reveal development patterns

The study further reveals the impact of spatial and temporal factors on the development of the civil-military integration industry. Northern provinces rely on the optimisation of industrial structure and the enhancement of scientific and technological innovation capabilities, while southern provinces focus more on economic development and financial support. In the time dimension, economic development is the main driver from 2016 to 2018, while industrial structure optimisation becomes the core driver from 2019 to 2022. The degree of marketisation is present throughout, indicating that a sound market mechanism is crucial for industrial development.

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