Industrial Security: China's New Development Framework

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Abstract

This paper explores how to construct an industrial security index construct with the new China's development framework. This paper first discusses the concept of industrial security, and then propose far groups of factors to construct industrial security index: demand regime, distribution regime, production scheme and internal and external factors. Twenty third-level indicators are chosen to construct the China's industrial security index. The analytic hierarchy process is used to empower the indicators, the quantitative indicators are standardized, and the entropy method and the efficacy analysis method are used to evaluate the relativity of the indicators and the measurement of industrial security, so as to achieve high-quality industrial development and sustainable and healthy economic development.

Keywords: new development framework; industrial security index; analytic hierarchy process; entropy method; analytic hierarchy process

JEL Classification Code: O33, Q55, L21, M14, G38

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1.Introduction

China is currently undergoing a transition to a new stage of "high-quality" development, which necessitates the establishment of an industrial security system tailored to the needs of this new era. Industrial security is a vital component of economic security, directly influencing the long-term development and stability of the nation's economy. This paper aims to analyze the concept and significance of industrial security through the lens of the new China's development strategy and to explore the necessity of constructing a comprehensive industrial security index.

China's industrial security system, while improving, still faces challenges in ensuring comprehensive security across all sectors. The country has made significant progress in enhancing the resilience of its industrial chain, especially in sectors such as technology and manufacturing. However, there remain vulnerabilities due to external dependencies, such as reliance on foreign technologies and raw materials, as well as the risks posed by global economic fluctuations. Efforts to modernize the industrial security framework are ongoing, but gaps exist in fully integrating technological advancements, energy efficiency, and risk management into a cohesive system that can safeguard the economy against future uncertainties.

Building on this context, the paper proposes for evaluating industrial security. It addresses key factors across four dimensions: demand, distribution, production, and internal and external factors. Using this structure, the paper proposes 20 third-level indicators for assessing China's industrial security, providing a comprehensive and nuanced approach to understanding the challenges and opportunities in industrial security.

This study advances knowledge by developing a comprehensive, data-driven framework that bridges the gap between traditional industrial security models and recent needs within China's evolving economic landscape. Guo, Y., & Feng, H. (2020) use hierarchical analysis, entropy methods, and efficacy analysis to offer a novel approach for evaluating and prioritizing critical factors affecting industrial security. Moreover, the study contributes to a deeper understanding of how technological innovation, energy efficiency, and supply chain resilience can be integrated into the industrial security system to support sustainable economic growth. These insights provide policymakers with a more informed basis for enhancing industrial security and ensuring long-term economic stability in China.

The methodological contributions of this study are equally significant. By applying the analytic hierarchy process, entropy method, and efficacy analysis, this paper develops a robust evaluation system for analyzing the relative importance of various indicators and assessing the level of industrial security. These techniques offer scientific, data-driven insights that support high-quality industrial development, enabling sustainable and secure economic growth. This comprehensive evaluation model serves as a valuable reference for policymakers and industry leaders in making informed decisions about industrial security and development strategies.

2. Literature Review

Jing (2006) emphasized the importance of designing systems with resilience and rapid recovery capabilities to protect critical infrastructure like water supplies, power grids, and transportation networks. This includes incorporating redundancy, robust materials, and adaptive intelligent design, such as decentralized power grids or multi-layered supply chains, to reduce reliance on single points of failure. Additionally, Jing advocated for proactive monitoring systems and real-time data analysis to detect risks early, minimizing damage and speeding up recovery. In the same year, Sun & Liu (2006) explored the risks of complex cyberattacks on industrial sectors, especially those involving critical infrastructure like power and transportation, highlighting the need for robust industrial security evaluation frameworks to handle advanced threats.

Yang Guoliang (2010) proposed that industrial security is determined by variables such as foreign-controlled industrial power, foreign industrial constraints, the government regulatory environment, and the industrial market environment. He developed a three-level industrial security evaluation index system based on industrial control power, industrial competitiveness, and industrial development environment, proposing 12 third-level indicators to measure China's industrial security.

He Weida and Du Pengjiao (2013), based on the characteristics of China's industrial sector and the principles for constructing industrial security indicators, selected 18 third-level indicators to evaluate China's industrial security, covering domestic industrial environment, international competitiveness, external dependence, and industrial relevance. In the same year, Zhu Jianmin & Wei Dapeng (2013) introduced the "five-factor model," an evaluation system encompassing industrial competitiveness generation capability, industrial control power, industrial ecological environment, industrial competitiveness, and industrial dependence, providing a comprehensive assessment of China's industrial security.

Martin Kenney & John Zysman (2016) examined the rise of the platform economy and its impact on industrial structures, arguing that governments must invest in technology, talent, and regulatory reforms to address risks posed by digital platforms like Amazon and Uber. Their research highlights the evolving nature of industrial economies amid technological disruption and the need for a dynamic policy environment to support industrial security in a global context.

Teigelkamp et al. (2017) highlight the importance of advanced modeling tools to assess vulnerabilities and strengthen system resilience.

Guo Yizhou & Feng Hua (2020) developed an evaluation system for China's internet industrial security, including the industrial development environment, industrial competitiveness, industrial control, and network security environment. Using hierarchical analysis and the entropy weight method, they assigned weights to internet industrial security indicators, supporting a systematic evaluation of China's internet industrial security.

Pochmara and Świetlicka (2023) stressed the need for adherence to international cybersecurity standards like ISA/IEC 62443 to enhance industrial cybersecurity. In the same year, Juan Vicente Barraza de la Paz and colleagues (2023) conducted a systematic review of security challenges in the Industry 4.0 era, arguing that traditional risk management frameworks must evolve to address cyber-physical threats in modern industrial systems. They highlighted the growing necessity of multi-layered protection systems to adapt to the rapidly changing threat landscape in industrial environments.

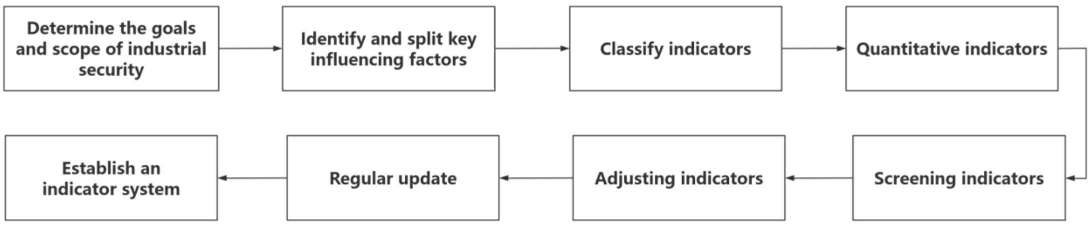
3. Research Framework

3.1 Principles of indicator construction

The construction of industrial security indicators should adhere to the following principles: (1) Goal-oriented: Indicator design should align with overall security management objectives, ensuring effective resource allocation and decision-making (Shaikh et al., 2021). (2) Economic effectiveness: Design should be economical and practical, using data that is easily obtained, collected, and analyzed. Indicators must provide valuable information, aiding management in identifying potential risks and optimizing resource allocation. (3) Operability: Indicators should clearly reflect factors that management can control, offering actionable suggestions and guiding necessary actions (IntechOpen, 2020). (4) Standardization: Consistent methods and definitions should be used in collecting data and calculating indicators to ensure comparability and reliability across different units, departments, and regions (Guo Yizhou & Feng Hua, 2020). (5) Security: Indicator design must consider security and privacy, ensuring data protection to prevent information leakage and comply with relevant laws and standards. (6) Sustainability: Indicators should be continuously evaluated and updated to reflect the latest management concerns, supporting long-term security risk management and performance improvement.

3.2 Indicator construction method

To create an effective industrial security evaluation system, one must define its goals and scope to cover all supply chain aspects for comprehensive risk management, considering relevant policies and standards. Key influencing factors are identified and broken down into operational, measurable indicators, which are then logically classified into a systematic structure. Quantitative indicators are developed using data sources such as surveys and expert evaluations to assess current and future trends. Representative indicators are selected to avoid redundancy, and adjustments are made based on each industry's specific characteristics. The system must be dynamic, regularly updated, and continuously refined to accurately reflect industrial security factors and guide decision-makers. The specific system indicator construction process is shown in Figure 1



Source: Author
Figure 1. industrial security assessment system indicator construction process

3.3 Indicator construction

Based on the new development framework, this paper divides the industriay security indicators into four categories: demand regime, distribution scheme, production side and internal and external factors. Each first-level indicator can be further divided into several second-level sub-indicators, and there are several third-level indicators under the second-level indicators, as shown in Table 1.

Table 1. China's industrial security evaluation index system

First-level indicators	**Second-level indicators**	**Third-level indicators**	**Quantitative indicators**	**Data Source**
Demand regime	Consumption demand dynamics	National consumption capacity	Residents' consumption level (index, 1978=100)	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
	Internal and external demand dynamics	Domestic market demand	Contribution rate of final consumption expenditure to GDP growth	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
		Foreign market demand	Contribution rate of import and export of goods and services to GDP growth	General Administration of Customs of the People's Republic of China.(n.d.). http://www.customs.gov.cn/
	Demand growth dynamics	Domestic demand growth rate	National per capital consumption expenditure index	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
Distribution regime	Domestic competitiveness	Profit rate	Cost-profit rate	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
		Industry contribution rate	Ratio of industrial added value increment to GDP increment	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/

		Labor productivity	Ratio of industrial GDP to total employment	China Economic Information Network. (n.d.). https://www.cei.cn/
Production scheme	Independent innovation capability of industry	Technological innovation capability	Major scientific and technological achievements/R&D expenditure	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/ China Economic Information Network. (n.d.). https://www.cei.cn/
		Innovation transformation capability	Annual growth rate of technology market transaction volume	State Intellectual Property Office. (n.d.). https://www.cnipa.gov.cn/
	Industry resilience	R&D investment	R&D expenditure as a percentage of industrial GDP	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
		Technology absorption and learning capability	Full-time equivalent growth rate of R&D personnel	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
	Industrial resources and environment	Energy utilization rate	Energy consumption per unit of GDP	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
	Industry risk diversification capability	Current asset turnover rate	Current asset turnover times (times/year)	China Securities Regulatory Commission. (n.d.). http://www.csrc.gov.cn/
		Residents' consumption	Consumer Price Index	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/

		capacity		
Internal and External factors	Industry external dependence	Industry export external dependence	Ratio of total export trade to GDP	General Administration of Customs of the People's Republic of China.(n.d.). http://www.customs.gov.cn/ National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
		Industry import external dependence	Ratio of total import trade to GDP	General Administration of Customs of the People's Republic of China.(n.d.). http://www.customs.gov.cn/
		Industry capital external dependence	Ratio of actual foreign investment to total output value of the year	National Bureau of Statistics. (n.d.). https://www.stats.gov.cn/
	Industry international competitiveness	Industry international market share(IMS)	(Export value)/(Total world export value)	Ministry of Commerce of the People's Republic of China. (n.d.). https://www.mofcom.gov.cn/
		Industry trade competitiveness index(TC)	(Export value-Import value)/(Export value+Import value)	Ministry of Commerce of the People's Republic of China. (n.d.). https://www.mofcom.gov.cn/ UN comtrade. (n.d.). https://comtradeplus.un.org/

3.3.1. Construction of demand regime indicators

The demand regime refers to market demand for products and services. In the new China's development framework, building an industrial security system requires meeting market demand, upgrading consumption, and optimizing the consumption structure. Changes in the demand cause the adjustments in industrial structure. Enterprises must adjust supply and production structures to meet consumer needs and enhance competitiveness to ensure industrial security (He Weida & Du Pengjiao, 2013).

3.3.2. Construction of distribution regime indicators

The distribution regime refers to how resources are allocated. Building an industrial security system requires improving resource allocation, promoting efficient and fair distribution, establishing a sound industrial structure, and stabilizing industrial and supply chains. Changes in the distribution regime affect enterprise development and, consequently, industrial security. A well-functioning distribution regime enables better allocation of resources, allowing enterprises to access funds, talent, markets, and policy support, thus fostering innovation and competitiveness, ensuring industrial security (Wang Wei & Li Minghua, 2020).

3.3.3. Construction of production scheme indicators

The production scheme refers to the mode and organization of production. In the new development framework, building an industrial security system requires promoting industrial upgrades, driving innovation, improving efficiency, and achieving high-quality development. Changes in production schemes influence industrial structure adjustments and enterprise transformation, impacting industry security.

Enterprises must adopt advanced technologies, enhance efficiency, and ensure competitiveness (Guo Yizhou & Feng Hua, 2020). Over-reliance on foreign inputs, especially in high-tech industries, poses risks to industrial security. Sectors like instrumentation, medical equipment, and electronics are heavily dependent on imports (Zhu Jianmin & Wei Dapeng, 2013). In order to cope with these challenges, it is particularly important to establish an index system of internal and external factors to comprehensively evaluate technology application, resource dependence and production fit, so as to enhance industrial safety

3.3.4. Construction of internal and external factors indicators

Internal and external factors refer to the domestic economic environment and international trade patterns. Building an industrial security system requires strengthening international trade cooperation, fostering innovation, and monitoring domestic economic changes to reduce risks and improve resilience. These factors impact the market environment and competitive landscape, with globalization increasing competition and affecting industrial security. Failure to adapt can lead to loss of market share and competitiveness. Additionally, changes in these factors influence industrial chain integration. Global cooperation is essential to optimize efficiency and maintain security (Tian Ye, Wang Yueying & Chen Xiao, 2023). China, as a production-oriented importer, especially in high-tech sectors, relies heavily on imports. A stable economic cycle depends on maintaining a high export-import balance and integrating closely with the global economy (Huang Xiaofeng & Zhang Zhigan, 2023)

4. Data and Methodology

4.1 Industrial security evaluation index system (Analytic hierarchy process)

This paper mainly uses the analytic hierarchy process (AHP) to obtain the weights of indicators at all levels for the weight setting of China's industrial industry evaluation indicators, and then uses the entropy weight method to correct the weights, as follows:

$$S = \alpha B_1 + \beta B_2 + \gamma B_3 + \delta B_4$$

$$B_1 = \sum a_i b_{1i}$$

$$B_2 = \sum a_j b_{2j} \qquad \alpha + \beta + \gamma + \delta = 1$$

$$B_3 = \sum a_k b_{3k} \qquad \sum a_i = \sum a_j = \sum a_k = \sum a_m = 1$$

$$B_4 = \sum a_m b_{4m} \qquad (i、j、k、m = 1,2,\ldots,n)$$

1.Establish a hierarchical model. To construct a hierarchical structure for the industrial security evaluation system, it is essential to clearly define the logical relationships between the overarching goal, the target layer, and the specific indicators. This structure should reflect a systematic approach, where the overall goal is aligned with strategic objectives at the target layer, and each objective is subsequently represented by specific, measurable indicators. When comparing the relative importance of each element, adopt a functional framework that highlights their respective contributions to achieving the overarching goal of industrial security evaluation:

Wherein, S is the industrial security level of China, B1 is the demand regime, B2 is the allocation pattern, B3 is the allocation pattern, and B4 is the internal and external factors. α, β, γ, δ are the first-level indicator coefficients of B1, B2, B3, and B4, respectively, b1i, b2j, b3k, and b4m are the second-level indicators under the first-level indicators, and a_i、a_j、a_k、a_m are the weights of the second-level indicators.

2. Construct the weight in the hierarchy $A = (a_{ij})_{n \times n}$. Suppose there are n factors in a certain layer, $X = \{x_1, x_2, \ldots, x_n\}$, and the weight of each criterion for the target is determined by mutual comparison. Let a_{ij} represent the comparison result of the i-th factor relative to the j-th factor, then $a_{ij} = 1/a_{ij}$, $A = (a_{ij})_{n \times n}$ and A is called a pairwise comparison matrix.

3. Calculation of the weight coefficient of the evaluation system indicators. The root method is used in AHP to calculate the weight coefficient of the Internet industry security evaluation indicators. First, calculate the product of each element in each row of the matrix:

$$M_i = \prod_{j-1}^{n} a_{ij} \qquad (i = 1,2,\ldots,n)$$

Then calculate the nth root of the M rows: $\overline{W_i} = \sqrt[n]{M_i}$, normalize the vector, and standardize $W = (W_1, W_2, \ldots, W_n)^T$, then the weight value calculation result is:

$$W_i = \overline{W_i} / \sum_{i=1}^{n} \overline{W_i}$$

4. Consistency test. Generally, the indicator CR is used for judgment, and the calculation formula is: CR=CI/RI, and CI must satisfy the function formula: $CI = (\lambda_{\max - n} - n)/(n-1)$. When CR<0.10, the consistency of the matrix can be judged, otherwise the judgment matrix needs to be adjusted appropriately. Using the above steps, the weights of indicators at all levels of China's industrial security evaluation indicator system are calculated and determined (see Table 2).

Table 2. China's industrial security evaluation index system

First-level indicators (evaluation aspects)	**Second-level indicators (Weighted factors)**	**Third-level indicators (Weighted factors)**
B1 Demand regime (0.130)	**b11** Consumption demand dynamics(0.195)	National consumption capacity(0.195)
	b12 Internal and external demand dynamics(0.414)	Domestic market demand(0.276)
		Foreign market demand(0.138)
	b13 Demand growth dynamics(0.391)	Domestic demand growth rate(0.391)
B2 Distribution regime(0.295)	**b21** Domestic competitiveness(1.000)	Profit rate(0.311)
		Industry contribution rate(0.196)
		Labor productivity(0.493)
B3 Production scheme(0.483)	**b31** Independent innovation capability of industry(0.372)	Technological innovation capability(0.240)
		Innovation transformation capability(0.132)
	b32 Industry resilience(0.358)	R&D investment(0.161)
		Technology absorption and learning capability(0.197)
	b33 Industrial resources and environment(0.073)	Energy utilization rate(0.073)
	b34 Industry risk diversification capability(0.197)	Current asset turnover rate(0.089)
		Residents' consumption capacity(0.108)
B4 Internal and external factors(0.092)	**b41** Industry external dependence(0.432)	Industry export external dependence(0.107)
		Industry import external dependence(0.140)
		Industry capital external dependence(0.185)
	b42 Industry international competitiveness(0.568)	Industry international market share(0.245)
		Industry trade competitiveness index(0.323)

Source: Author's calculations

Table 3: Entropy weight calculation results

Entropy weight method			
Item	**Information entropy value e**	**Information utility value d**	**Weight (%)**
National consumption capacity	0.886	0.114	7.758
Domestic market demand	0.981	0.019	1.276
Foreign market demand	0.976	0.024	1.632
Domestic demand growth rate	0.902	0.098	6.647
Profit margin	0.966	0.034	2.296
Industry contribution rate	0.936	0.064	4.364
Labor productivity	0.901	0.099	6.745
Technological innovation capability	0.774	0.226	15.338
Innovation transformation capability	0.908	0.092	6.232
R&D investment	0.907	0.093	6.285
Technology absorption and learning capability	0.939	0.061	4.141
Energy utilization rate	0.897	0.103	6.992
Current asset turnover rate	0.93	0.07	4.766
Resident consumption capacity	0.939	0.061	4.123
Industry export external dependence	0.943	0.057	3.885
Industry import external dependence	0.921	0.079	5.344
Industry capital external dependence	0.968	0.032	2.188
Industry international market share	0.944	0.056	3.778
Industry trade competitiveness index	0.908	0.092	6.209

Source: Author's calculations

5. Use the entropy weight method to correct the calculation process of the weight value. In order to solve the problem that the hierarchical analysis method is affected by subjective factors to a certain extent, the article further uses the entropy weight method to correct the weights of each indicator obtained by the hierarchical analysis method after determining the weight. The entropy weight method is further used to correct the weights of each indicator obtained by the hierarchical analysis method. The entropy weight method is used to determine the weights of each secondary indicator. There are four specific steps:

Assume that there are m security evaluation indicators and n years of data sources, forming a data matrix $X = (x_{ij})_{n \times m}$. The information entropy calculation method in information theory is:

$$H(x) = -\sum_{i=1}^{n} f(x_i) \ln f(x_i)$$

①Define f_{ij} as the weight of the index value of the i-th evaluated object under the j-th index of matrix X, then

②Let e_j be the entropy value of the j-th index, there is (where $k = 1/\ln n$):

$$e_j = -k\sum_{i=1}^{n} f_{ij} \times \ln f_{ij}$$

③ Calculate the weight of each index by the following formula: $w_j = (1-e_j)/\sum_{j=1}^{m}(1-e_j)$

When w_j is larger, the index is more important.

④ Determine the final weight w_j of each index.

Calculate the comprehensive weight and w of the quantifiable index in the weight obtained by the hierarchical analysis method, then $W_i = w_i \times w$ is the comprehensive modified weight of the i-th quantitative index. See Table 3.

Table 2 and Table 3 show significant differences in weight allocation for industrial security indicators using the analytic hierarchy process (AHP) and the entropy weight method. Table 2 employs the AHP method, utilizing data analysis and historical information to assign relative importance to indicators (Qiu, L. 2023).

Conversely, Table 3 uses the entropy weight method, which determines weights based on the information entropy and utility of each indicator, emphasizing data objectivity and minimizing subjective bias. Thus, the weights in Table 3 more accurately reflect each indicator's data variability and actual impact on industrial security.

Specifically, the technological innovation capability in Table 3 receives a higher weight (15.338%) compared to 0.240% in Table 2, indicating its greater influence on industrial security from a data-driven perspective due to higher volatility. In contrast, while the AHP method assigns a weight of 0.276% to domestic market demand, reflecting expert emphasis, its weight in Table 3 is only 1.276%, suggesting limited impact on overall safety.

These differences underscore the distinct focuses of the two methods in assessing industrial security. Combining AHP with the entropy weight method could create a more comprehensive evaluation system, enhancing decision-making's scientific nature and adaptability to complex industrial changes.

4.2. Industrial security risk warning (The efficacy coefficient method)

4.2.1 Calculation method for mapping indicator values to safety status scores

Based on the connotation of commonly used indicators for measuring industrial security and drawing on the research results of Zhu Jianmin (2013), the variables are defined. Use the data to find the data of the same indicator in representative countries, find out the highest and lowest values, and then use the range standardization method to standardize the original data:

$$S_i = \begin{cases} (X_i - X_{\min})/(X_{\max} - X_{\min}) & (1) \\ 1 - (X_i - X_{\min})/(X_{\max} - X_{\min}) & (2) \\ \dfrac{1}{1 + |\partial - X_i|} & (3) \end{cases}$$

The greater the index value, the greater the impact on industrial security, the formula (1) is used, and the opposite meaning is used. Formula (2) is used. If an indicator belongs to a moderation indicator, formula (3) is used for standardization. Where Xi is the original value of the data taken by a certain indicator, $X_{\max}$ is the maximum value of the data taken by a certain indicator, $X_{\min}$ is the minimum value of the data taken by a certain indicator, S_i is the standardized value obtained by a certain indicator, and ∂ is the ideal value of a certain indicator. When the value of this indicator is ∂, it has the greatest impact on industrial safety.

4.2.2 Calculation of the comprehensive efficacy coefficient method

1. Specific calculation method

The efficacy coefficient method is also called the efficacy function method. It is based on the principle of multi-objective planning. It determines a satisfactory value and an unacceptable value for each evaluation indicator. The satisfactory value is the upper limit and the unacceptable value is the lower limit. The degree to which each indicator achieves the satisfactory value is calculated, and the score of each indicator is determined accordingly. Then, the weighted geometric average is used for synthesis to evaluate the comprehensive status of the object under study.

Referring to Bian Jihong (2010)'s method of using the efficacy coefficient method to comprehensively evaluate the performance of industrial clusters, the single efficacy coefficient is determined according to the characteristics of the specific indicator data at the third level: the larger the indicator value (actual value), the better, and it is defined as an extremely large variable, such as the cost-profit ratio, the annual growth rate of technology market transaction volume, etc.; the smaller the indicator value, the better, and it is defined as an extremely small variable, such as the consumer price index, energy consumption per unit of GDP, etc.

(1) For extremely large indicators, the scores of individual indicators are:

$$z_1 = \begin{cases} 0 & x_{ij} < m_j \\ \dfrac{x_{ij} - m_j}{M_j - m_j} \times 40 + 60 & x_{ij} \in [m_j, M_j) \\ 100 & x_{ij} \geq M_j \end{cases}$$

(2) For very small indicators, the scores of individual indicators are:

$$z_2 = \begin{cases} 100 & x_{ij} < m_j \\ \dfrac{M_j - x_{ij}}{M_j - m_j} \times 40 + 60 & x_{ij} \in [m_j, M_j) \\ 0 & x_{ij} \geq M_j \end{cases}$$

Among them, indicator x_{ij} is the actual value, and $M_j, m_j (0 \leq m_j \leq M_j)$ is the maximum and minimum value of each level of indicator x_{ij}. According to the aforementioned AHP method, the weight of each measurement indicator is determined, and the weighted geometric mean method is used to calculate the comprehensive efficacy coefficient Z, that is, the comprehensive efficacy coefficient Z = ∑ single efficacy coefficient × the weight of the indicator / total weight.

2. Determination of warning interval

The quantitative results of industrial security evaluation status are graded into five types of results, namely very safe, relatively safe, critical, unsafe, and crisis. The mapped security levels are set as A, B, C, and D, and the corresponding score ranges are: [90, 100], [80, 90), [70, 80), [60, 70). The smaller the score, the greater the danger.

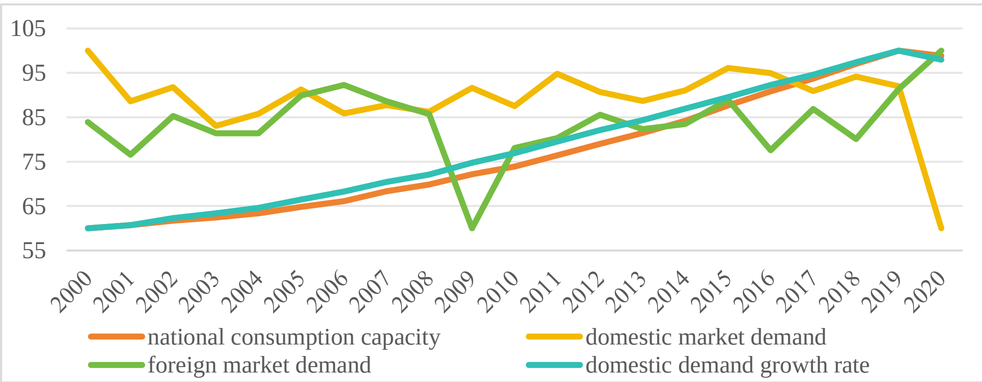
Table 4. Security levels and corresponding scores

Security Level	Range	Level Description
A	［90，100］	Security
B	［80，90］	Relative security
C	［70，80］	Critical state
D	［60，70］	Crisis

Source: Adapted from Guo, Y., & Feng, H. (2020)

5. Result Analysis

Based on the above theoretical research, the hierarchical analysis method and the efficacy coefficient method are used to evaluate and analyze the security status of China's industrial industry. Using relevant data, the specific measurement results are shown.

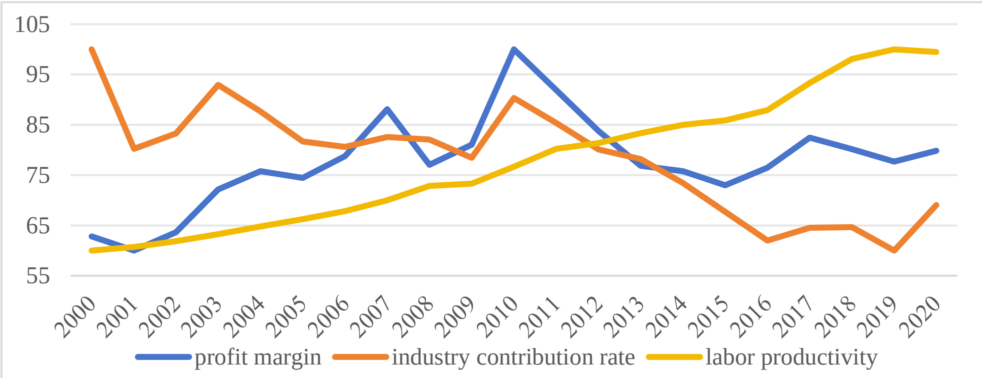


Source: Author's estimations

Figure 2. Changes in China's Industrial security Level 3 Indicators of the demand regime

Figure 2 analyzes the impact of China's demand regime on industrial trade security, focusing on national consumption capacity, domestic market demand, foreign market demand, and domestic demand growth rate. A stronger national consumption capacity enhances industrial security by stabilizing the market; from 2000 to 2020, the security score rose from 60 to 100 due to economic growth, though it slightly dropped to 98.85 in 2020.

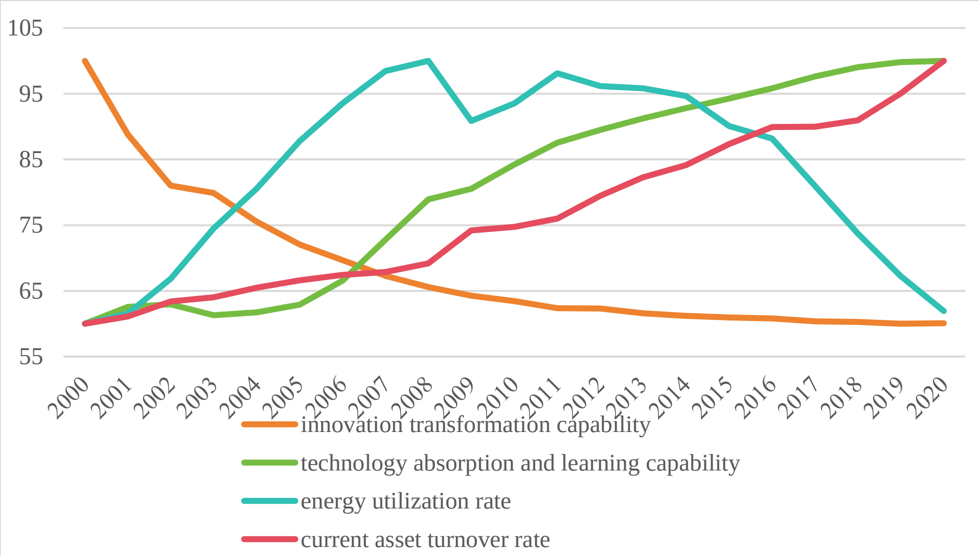
Domestic market demand is vital, with its security score fluctuating from 100 in 2000 to 60 in 2020 and peaking at 96.11 in 2015, emphasizing the need to adapt to consumer preferences. Foreign market demand varied, starting at 83.9 in 2000, falling to 60 in 2009 due to the financial crisis, and recovering to 100 in 2020, highlighting the importance of diversifying export markets. Finally, the domestic demand growth rate saw a steady increase in the security score from 60 to 100 in 2019, slightly dropping to 97.98 in 2020, underlining the necessity of stable growth for long-term industrial security in China.



Source: Author's estimations

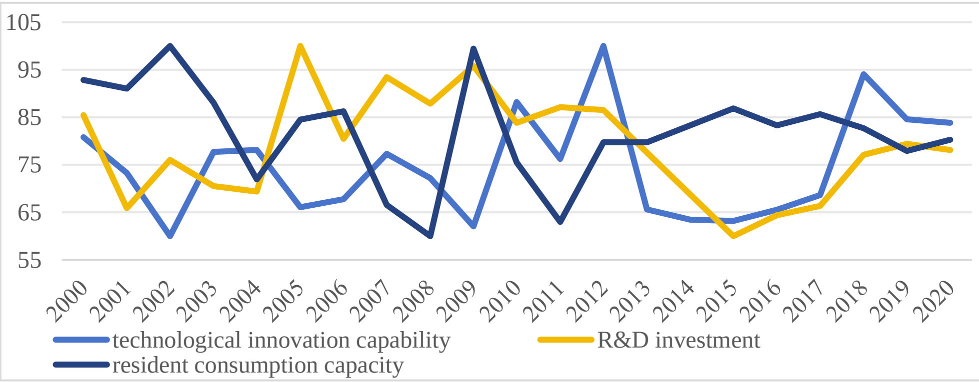
Figure 3. Changes in China's Industrial security Level 3 Indicators of the distribution regime

Figure 3 analyzes the impact of China's distribution regime on industrial trade security, focusing on profit margin, industry contribution rate, and labor productivity. The profit margin assessment indicates that higher scores reflect industries effectively managing profitability while ensuring stability; from 2000 to 2020, the score fluctuated, starting at 62.84, peaking at 100 in 2010, and declining to 77.7 in 2019, which suggests challenges in balancing profit generation with security investments, although it slightly recovered to 79.86 by 2020. The industry contribution rate, vital for industrial security, peaked at 100 in 2000 but declined to 67.71 in 2015, indicating increased vulnerability among key industries like energy and chemicals, with scores only improving slightly from 2016 to 2020, highlighting the need for stronger management and policy support. Meanwhile, the labor productivity score increased from 60 in 2000 to 99.49 in 2020, underscoring its growing importance in enhancing production efficiency and competitiveness, making its steady improvement crucial for ensuring long-term security and stability in China's industry.



Source: Author's estimations

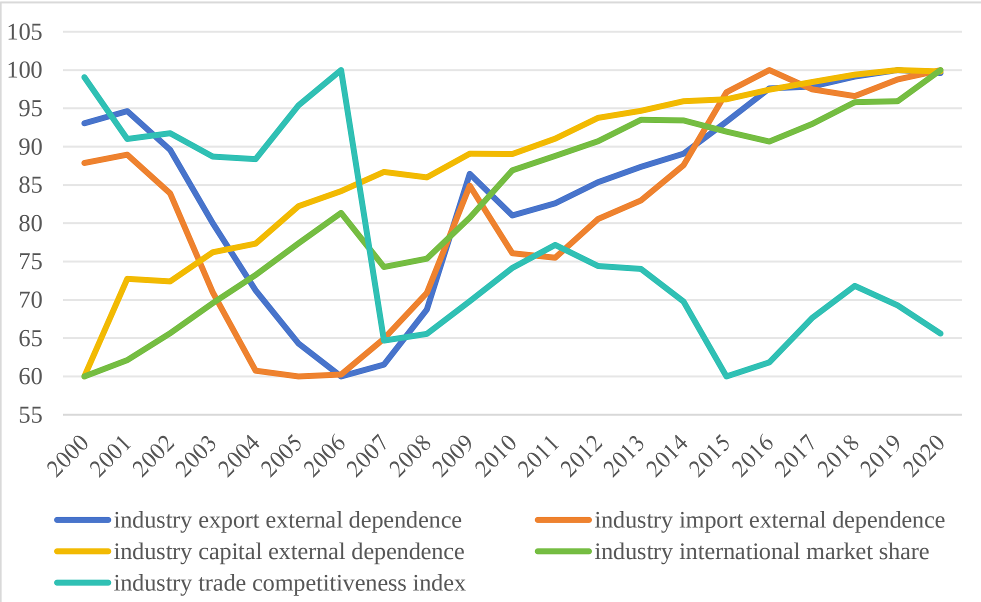
Figure 4. Changes in China's Industrial security Level 3 Indicators of the production regime



Source: Author's estimations

Figure 5. Changes in China's Industrial security Level 3 Indicators of the production regime

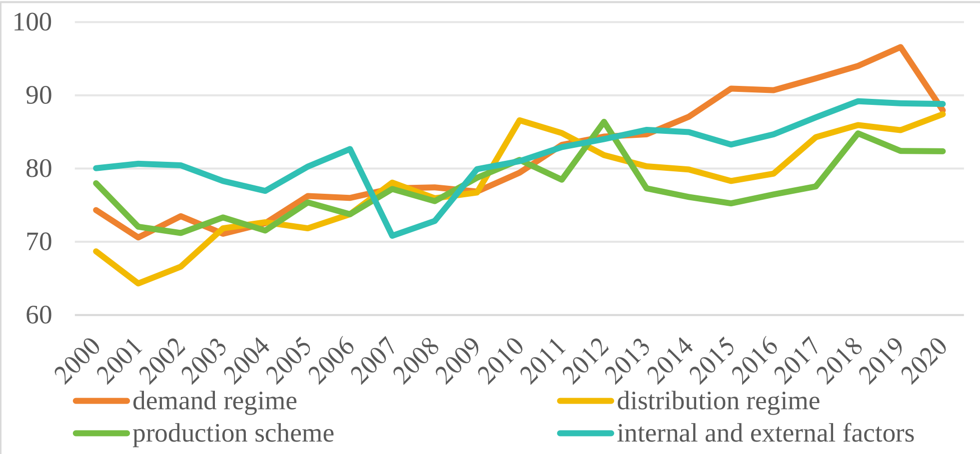
Figure 4 analyzes the impact of China's production scheme on industrial trade security, focusing on seven aspects: technological innovation capability, innovation transformation capability, R&D investment, technology absorption and learning capability, energy utilization rate, current asset turnover rate, and residents' consumption capacity. From 2000 to 2020, the technological innovation score fluctuated, starting at 80.84, peaking at 100 in 2012, and ending at 83.83 in 2020, indicating both progress and challenges in sustaining innovation. The innovation transformation capability score declined from 100 to 60.05, highlighting difficulties in translating R&D into industrial improvements. R&D investment started at 85.44, fell to 60 in 2015, and recovered to 78.13 by 2020, emphasizing the need for consistent long-term strategies. The technology absorption score rose from 60 to 100, reflecting improved integration of advanced technologies, while energy utilization peaked at 100 in 2008 but dropped to 61.9 in 2020, indicating vulnerabilities in energy management. The current asset turnover rate increased steadily from 60 to 100, demonstrating enhanced financial management. Finally, residents' consumption capacity fluctuated, peaking at 100 in 2002 and stabilizing at 80.3 by 2020, underscoring the importance of strong purchasing power for industrial security. Overall, continuous investment and adaptation are crucial for maintaining resilience and stability in China's industrial sector.



Source: Author's estimations

Figure 6. Changes in China's Industrial security Level 3 Indicators of the internal and external factors

Figure 5 analyzes the impact of internal and external factors on China's industrial trade security, focusing on five aspects: industrial export dependence, industrial import dependence, external dependence on industrial capital, international market share, and the industrial trade competitiveness index. From 2000 to 2020, industrial export dependence fluctuated, peaking at 100 in 2019, indicating strong resilience against external market risks. Industrial import dependence dropped from 87.87 in 2000 to 60 in 2005, then improved to 100 in 2016, reflecting enhanced domestic production capacity. Similarly, external dependence on industrial capital increased from 60 to 100 over the same period, demonstrating reduced reliance on foreign capital. China's international market share rose steadily to 100 by 2020, showcasing improved competitiveness and product quality. The industrial trade competitiveness index, however, fluctuated significantly, starting at 99.06 in 2000 and falling to 60 in 2015 before recovering to 65.58 in 2020, highlighting ongoing challenges in maintaining global competitiveness. To ensure long-term stability and security, China must continue promoting innovation, diversify markets, and strengthen domestic production capabilities.



Source: Author's estimations

Figure 7 Changes in China's Industrial security Level 1 Indicator

The overall evaluation of China's industrial security from 2000 to 2020 examines four dimensions: demand, distribution, production, and internal/external factors.

Demand Regime: The safety score increased from a low "C" level in 2000, indicating unsafe demand conditions, to "A" after 2015, highlighting improved industrial security. This shift suggests a rise in domestic demand and a reduced dependence on external markets. In 2020, the score slightly declined to 87.95 but still maintained a relatively high "B" level.

Distribution Regime: The distribution regime saw significant fluctuations. From 2000 to 2006, it scored low at "D," reflecting vulnerabilities in the distribution system. However, improvements began in 2007, with the score reaching "B" after 2010 and stabilizing at 87.42 in 2020, indicating more reasonable in the distribution system.

Production Scheme: The production level exhibited relatively stable scores between 70 and 80, indicating that safety improvements were minimal over the years, primarily remaining in the "C" level. Although scores briefly improved to "B" in 2010 and 2012 due to enhanced productivity, challenges in ensuring industrial security remain, particularly regarding responsiveness to external shocks.

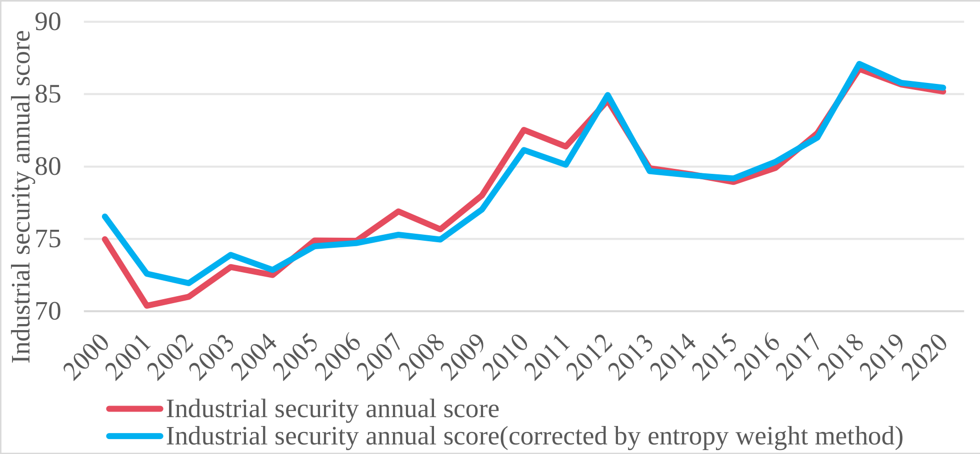
Internal and External Factors: The safety score for internal and external factors remained high, increasing from 80.05 in 2000 to 88.81 in 2020, consistently maintaining a "B" level. This reflects China's strong ability to manage internal and external challenges, bolstered by enhanced internal management and responsive strategies amidst globalization and competitive market pressures.

Overall, the assessment indicates that while the demand and distribution levels have seen significant progress, the production level has improved slowly and still faces challenges. China's industrial sector demonstrates a robust capacity to navigate internal and external factors, but future efforts must focus on strengthening coordination and improvement across all levels to ensure long-term security and stability in the industry.

Table 5 Results of China's industrial security calculations from 2000 to 2020

	Analytic hierarchy process		Entropy weight method	
Year	**Industrial security annual score**	**Industrial security level**	**Industrial security annual score**	**Industrial security level**
2000	74.97	C	76.55	C
2001	70.38	C	72.59	C
2002	70.99	C	71.94	C
2003	73.06	C	73.89	C
2004	72.5	C	72.85	C
2005	74.89	C	74.48	C
2006	74.87	C	74.7	C
2007	76.89	C	75.28	C
2008	75.67	C	74.95	C
2009	78.01	C	77.04	C
2010	82.54	B	81.14	B
2011	81.39	B	80.13	B
2012	84.57	B	84.93	B
2013	79.89	C	79.69	C
2014	79.46	C	79.39	C
2015	78.92	C	79.18	C
2016	79.91	C	80.32	B
2017	82.32	B	81.99	B
2018	86.74	B	87.09	B
2019	85.67	B	85.78	B
2020	85.17	B	85.44	B

Source: Author's estimations



Source: Author's estimations

Figure 8 Changes in Annual Scores of Industrial security in China

Tables 5 and 6 illustrate the annual scores and grades of China's industrial security from 2000 to 2020, with the main distinction being the use of the entropy weight method for correction in Table 6. In general, the corrected scores in Table 6 are slightly higher, particularly in the years after 2017, reflecting that the entropy weight method more precisely captures the improvements in China's industrial security. For example, 2017 was rated as "C" in Table 5 but was upgraded to "B" in Table 6 after correction, indicating that the corrected method offers a more nuanced understanding of the progress made. Despite the similar overall trends in both tables, which indicate a steady improvement in China's industrial security during this period, Table 8 provides a more detailed and accurate assessment. It highlights the steady increase in China's resilience against external risks and challenges, marking progress in securing its industrial sector.

Despite the positive trends shown in the data, China's industrial security remains in a relatively critical state. The chart indicates a gradual upward trend in industrial security from 2003, with notable improvements between 2010 and 2018. However, the slight decline after 2018 suggests that external pressures continue to pose risks. While the overall scores reflect progress, the country still faces substantial vulnerabilities due to external factors, such as the "double-end squeeze" from developed nations and the "catch-up squeeze" from emerging economies. These pressures place significant strain on China's industrial sector, which, despite improving, remains exposed to global shocks. The slight dip in security scores post-2018 highlights the impact of these external threats, underlining the need for cautious management and continued efforts to strengthen industrial security for long-term stability.

In particular, China's reliance on foreign technology and global supply chains, as indicated by the recent plateau in scores, emphasizes the ongoing risks. To maintain and further enhance industrial security, China must focus on reducing external dependencies and bolstering its domestic capabilities to withstand these challenges.

6. Contribution

This paper enhances the understanding of industrial security in China's new development framework by proposing a multidimensional evaluation system that includes demand regime, distribution regime, production scheme, and internal and external factors. It introduces 20 tailored third-level indicators and employs innovative methods like the analytic hierarchy process and entropy method for data-driven analysis. This framework improves the assessment of industrial resilience and offers actionable insights for policymakers, promoting strategies that integrate technological innovation and supply chain resilience for sustainable economic growth.

7.Conclusion

This paper has examined the construction of China's industrial security evaluation index system within the new development framework, focusing on demand regimes, distribution regimes, production schemes, and internal and external factors. Utilizing the analytic hierarchy process, entropy method, and efficacy analysis, we developed a comprehensive evaluation model that captures the multidimensional nature of industrial security.

The analysis reveals that while China's industrial security is improving, challenges persist, particularly due to global economic fluctuations and external pressures from both developed and emerging economies. For instance, the assessment of the demand regime showed significant fluctuations in domestic market demand, emphasizing the need for adaptability to consumer preferences. The distribution regime's analysis indicated vulnerabilities in key industries, necessitating stronger management and policy support. Additionally, the production scheme highlighted the need for continuous investment in technological innovation and energy efficiency, as well as improvements in current asset turnover rates.

The findings stress the importance of reducing external dependencies in trade and capital flows to enhance resilience. The observed decline in the industrial trade competitiveness index suggests ongoing challenges in maintaining a competitive edge in the global market, underscoring the necessity for policymakers to address these vulnerabilities.

Looking ahead, this research offers several important implications for policy and future studies. Policymakers should prioritize strengthening the resilience of China's industrial supply chain, promoting domestic market growth, and enhancing industry capabilities to adapt to technological changes. Furthermore, future research should explore how these industrial security systems can be refined to address emerging risks, particularly in the digital economy and in the context of climate change.

Comparing this research with existing studies reveals that our approach provides a more comprehensive framework by integrating economic, environmental, and technological factors. Future work could expand this model to specific industrial sectors or regions within China, offering more detailed insights into their respective security challenges. By doing so, we can develop targeted strategies that bolster the overall stability and resilience of China's industrial sector in an increasingly complex global landscape.

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