Volume 3, Issue 2, 2025

Print ISSN: 2960-0073

Online ISSN:2960-0081

World Journal of Economics and Business Research

World Journal of Economics and Business Research

Volume 3, Issue 2, 2025

Published by Upubscience Publisher

World Journal of Economics and Business Research
Print ISSN: 2960-0073 Online ISSN: 2960-0081
Email: info@upubscience.com
Website: http://www.upubscience.com/

Table of Content

THE RELATIONSHIP BETWEEN ENTERPRISE DIGITAL TRANSFORMATION AND ENTERPRISE PERFORMANCE BASED ON THE PERSPECTIVE OF DATA ELEMENTS 1-5
YiTong Liu

EXPLORING THE PERFORMANCE PRODUCTION OF SCI-TECH FINANCE POLICY: TYPICAL PATHS AND INNOVATIVE INSIGHTS FROM CHINA PROVINCES 6-15
YangFan Lu*, Yuan Mei

PRACTICAL VALUE, CHALLENGES AND OPTIMIZATION PATH OF FINANCIAL SHARING CENTER IN THE CONTEXT OF FINANCIAL DIGITAL TRANSFORMATION 16-19
XiaoYan Qiao

ASSESSING AND ENHANCING ANHUI PROVINCE'S INDUSTRIAL TRANSFER CAPACITY: A MULTIDIMENSIONAL APPROACH 20-32
AiYong Lin, YaJie Zhang*, Xue Wu

THE MECHANISM OF PROMOTING THE SOUND DEVELOPMENT OF THE DIGITAL ECONOMY THROUGH ICT STANDARD 33-36
XueQian Zhang*, Hong Zhang

AN EXPLORATION OF FOREIGN DIRECT INVESTMENT IN THAILAND 37-42
Xu Wang

DYNAMIC RISK ASSESSMENT IN THE INSURANCE INDUSTRY BASED ON A HIGH-RISK UNDERWRITING DECISION MODEL 43-49
BinHao Guo, ShuJie Shi*, GuoLiang Wen, XingPeng Zhuo

SMART HOME CONSUMER NEEDS BASED ON K-MEANS CLUSTERING AND KANO MODEL 50-53
NuoLin Yu

ANALYSIS OF INTEREST RELATIONSHIPS IN THE INDUSTRY-EDUCATION INTEGRATION COMMUNITY FOR FINANCIAL AND COMMERCIAL PROFESSIONAL GROUPS IN HIGHER VOCATIONAL COLLEGES 54-58
DeJun Zou

CROSS-BORDER E-COMMERCE POLICIES AND THE HIGH-QUALITY DEVELOPMENT OF URBAN ECONOMIES 59-69
JiaYao Zhou, HaiHui Wang*

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3039

THE RELATIONSHIP BETWEEN ENTERPRISE DIGITAL TRANSFORMATION AND ENTERPRISE PERFORMANCE BASED ON THE PERSPECTIVE OF DATA ELEMENTS

YiTong Liu
Department of Business, Accounting, Xi'an International Studies University, Xi'an 710128, Shaanxi, China.
Corresponding Email: 18991002666@163.com

Abstract: With the rapid development of information technology, the construction of digital government has become an important means to promote the modernization of national governance system and governance capacity. At the same time, the digital transformation of enterprises has also become a key way to enhance enterprise competitiveness and achieve sustainable development. Based on the perspective of data elements, this paper discusses the complex relationship between enterprise digital transformation and enterprise performance. The research results show that the digital transformation of enterprises has a significant positive impact on their performance. The digital transformation significantly improves the return on equity of enterprises by optimizing business processes, improving operating efficiency and innovation ability. Among them, digital transformation is particularly critical to the improvement of innovation ability, which is reflected in shortening the product time to market, promoting knowledge sharing and teamwork, and timely capturing market trends and customer needs. In addition, the study also examined the impact of financial leverage ratio, asset size and cash asset ratio on enterprise performance. Based on the research conclusion, this paper puts forward the corresponding policy suggestions, which provides the scientific basis and reference for the implementation of the digital transformation strategy of enterprises, and is of great significance for promoting the high-quality development of China's economy and society.
Keywords: Digital transformation of enterprises; Enterprise performance; Data elements; Regression analysis; Robustness test

1 INTRODUCTION

With the rapid development of information technology, the construction of digital government has become an important means to promote the modernization of national governance system and governance capacity. In the research field of discussing the digital transformation of enterprises and its impact on enterprise performance, many scholars have revealed the complexity and diversity of the digital transformation from different perspectives and methods. The construction of the theoretical model of the study of Wang Kaiyang et al. may be limited by the researchers' subjective cognition and assumptions[1,2], Leading to the universality and reliability of the conclusions are affected. Because the construction of theoretical models and the empirical test have certain subjectivity and limitations, it is difficult to fully and accurately reflect the actual process and effect of digital transformation. The disadvantage of this method is that the acquisition and processing of big data may be affected by many factors, leading to the accuracy and reliability of the conclusions. The acquisition and processing process of big data is relatively complex and easy to be influenced by many factors, while the fixed-effect model of panel data also has some limitations. In this paper, more accurate and comprehensive data sources and processing methods are adopted, which can more accurately reflect the actual impact of digital government construction on the digital transformation of enterprises. Although the study of Hu Jinyan et al. has discussed the impact of digital government construction on enterprise performance[3]. However, its disadvantage is that it mainly focuses on the single dimension of public data opening, and does not fully consider the diversity and complexity of digital transformation. Limitations may result from an incomplete understanding of the digital transformation process, leading to certain limitations on the application scope of the conclusions. In contrast, although the research of Wu Jie et al. starts from the two dimensions of digital depth and breadth[4], But relying on text mining methods for data acquisition and processing may be restricted by the subjectivity and completeness of text content.
In speaking, this paper combines a variety of data sources, the construction of more rigorous theoretical model and the introduction of more control variables to more accurately capture the dynamic and non-linear relationship in the process of enterprise digital transformation, so as to provide a more in-depth and reliable analysis conclusion for the research of enterprise digital transformation.

2 THE IMPACT OF ENTERPRISE DIGITAL TRANSFORMATION ON ENTERPRISE PERFORMANCE

2.1 Variable Interpretation

Refer to existing studies[5-8], This paper controls the factors that may affect the digital transformation of enterprises from the city level and the enterprise level. Enterprise level control variables include: leverage ratio, final total liabilities / total assets, cash ratio, the final cash and cash equivalent balance / total assets, enterprise age, with the observation year (2023) -IPO year, assets, measured by the end of the number of natural assets, equity nature (SOE), state-owned enterprises value of 1, non-state-owned enterprises value 0, audit opinions, if the company's current financial report is issued by the standard audit opinion, the opinion value is 1, otherwise 0, the board of directors (board), with the number of the board of directors. The control variables at the city level include: industrial structure, measured by the proportion of the tertiary industry in GDP (%), the level of opening to the outside world: measured by the actual foreign investment, and measured by the economic development level (lnGDPper) from the per capita GDP. The specific variables are shown in Table 1:

Table 1 Variable Declaration

Type Of Variable	Variable Symbol	Variable Name	Explain
Explained Variable	ROE	Enterprise Performance	Return On Total Assets
Explanatory Variable	Dt	Digital Transformation Of Enterprises	Digital Technology Application
	Lev	Leverage Ratio	Total Ending Liabilities / Total Assets
	Cash	Cash Ratio	Closing Balance Of Cash And Cash Equivalents / Total Assets
	Lnasset	Asset Size	Natural Logarithm Of The Total Assets At The End Of The Year
	Age	Enterprise Age	Years Of Listing = Observation Year (2023) -Ipo Year
	Soe	Nature Of Stock Rights	The Value Of State-Owned Enterprises Is 1, And That Of Non-State-Owned Enterprises Is 0
Controlled Variable	Opinion	Audit Opinion	For The Standard Audit Opinion, Then Opinion Assigns 1, Otherwise 0
	Board	Board Size	Number Of Board Members
	Struct	Industrial Structure	The Tertiary Industry Accounts For (%) In Gdp
	Trade	Open To The Outside World	Actual Foreign Investment
	Lngdpper	Economic Development Level	Per Capita Gdp

2.2 Data Source and Processing

In this paper, China's A-share listed enterprises from 2012 to 2023 are selected as empirical regression samples. The relevant data of the sample enterprises are from the database of China Tai'an (CSMAR) and the National Bureau of Statistics, and the government data are from the official website of the Chinese provincial government. In terms of basic data, this paper deleted the sample of enterprises with delisting, ST, finance (including banking, securities, insurance, etc.), listing less than 2 years after listing and seriously missing main variables in the sample period. In order to avoid the impact of extreme values, this paper conducts bilateral 1% tail reduction of continuous variables.

2.3 Model Building

In order to test the impact of enterprise digital transformation on enterprise performance, the following basic regression model is constructed:

$$ROE_{i,t} = \beta_0 + \beta_1 DT_{i,t} + \beta_2 Controls_{i.t} + \varepsilon_{i,t} \tag{1}$$

Among, i on behalf of the enterprise, t representative year， $ROE_{i,t}$ indicates return on total assets in year t,that is, enterprise performance. $\beta_1 DT_{i,t}$represents the degree of digital transformation of the i enterprise in year t. $Controls_{i,t}$ represents the above series of control variables. These control variables are designed to capture other factors that may have effects on business performance to ensure the accuracy of the study results. $\varepsilon_{i,t}$ for the random error term, to capture partial variation that is not explained in the model. β_1 reflects the causal relationship between digital government and enterprise performance. According to the above theoretical analysis, the estimated coefficient is expected to be significantly positive.

2.4 Relationship Between Enterprise Performance and Digital Transformation

Through the benchmark regression analysis of the panel data, the following conclusions, as shown in Table 2:

Table 2 Regression Analysis Table

Variable	**Return On Equity**
Digital Transformation	0.324***
/	(0.011)

Financial Leverage Ratio	-2.248***
/	(0.141)
Asset Size	0.188***
/	(0.035)
Cash Asset Ratio	0.745***
/	(0.177)
Company Age	-0.020***
/	(0.007)
Nature Of Stock Rights	0.130
/	(0.092)
Type Of Audit Opinion	0.913***
/	(0.084)
Board Size	-0.009
/	(0.015)
_Cons	-3.883***
/	(0.742)
Time Fixed Effect	Controlled
Enterprise Fixed Effect	Controlled
N	24738
R2	0.015

Note: Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

There is a significant positive correlation between the digital transformation of enterprises (represented by the variable of "digital transformation") and its performance (measured by the "ROE of return on equity"). This discovery means that digital transformation can not only directly affect enterprise performance by improving operational efficiency and reducing operating costs, but also bring more competitive advantages and value growth to enterprises through indirect ways such as innovating business models and improving customer experience. The coefficient of digital transformation is as high as 0.324 and is statistically significant ($p < 0.01$), which further strengthens its important role in the enterprise performance improvement.

In addition to the digital transformation, the regression model considers several other control variables, including financial leverage ratio, asset size, cash asset ratio, age of the company, nature of equity, type of audit opinion and size of the board. The coefficients and significance levels of these variables provide a more comprehensive perspective on the influencing factors of business performance. The negative correlation between financial leverage ratio and return on equity indicates that high debt level may have adverse effects on enterprise performance, while asset size, cash asset ratio and audit opinion type are positively correlated with enterprise performance, showing the positive effects of economies of scale, good cash flow and positive audit opinion on enterprise performance. Although the influence of equity nature on enterprise performance is not statistically significant, there may be differences in governance structure and decision-making efficiency, which may have some impact on the long-term development of the enterprise; the influence of board size on enterprise performance is not statistically significant. However, an efficient, professional board is essential for the strategic decisions, risk management and long-term development of the enterprise. Based on this, enterprises should pay attention to the professionalism and diversity of their members when building the board of directors to improve the decision quality and efficiency of the board of directors.

3 THE ROBUSTNESS TEST OF THE RELATIONSHIP BETWEEN ENTERPRISE DIGITAL TRANSFORMATION AND ENTERPRISE PERFORMANCE

3.1 Model Building

To verify the reliability of the benchmark regression results, the robustness test was conducted from the perspective of variable hysteresis. Enditary problems are common challenges in empirical research, especially there may be a two-way causal relationship between digital transformation (DT) and company performance: on the one hand, digital transformation may improve enterprise operational efficiency and improve performance; on the other hand, high-performance enterprises may have more resources to invest in digital transformation. To alleviate this endogeneity problem, this paper adopts the method of lagging phase one core explanatory variable to construct a model for testing.

In the robustness test, the core explanatory variable "digital transformation" was replaced with its lag phase one (l. digital transformation), and other control variables and fixed effects setting were consistent with the benchmark model. Through lagging processing, the mutual influence of digital transformation and performance can be partially eliminated, and the sustainability of digital transformation effect can be tested. If the lag variable is still significantly positive, it indicates that the improvement effect of digital transformation on performance has time continuity, and the benchmark results are not seriously endogenous interference.

3.2 Conclusion of the Robustness Test

The model results are shown in Table 3:

Table 3 Results Table for the Robustness Test

Variable	Return On Equity Robustness Test (Lag: 1 Period）
Digital Transformation (Lag: 1 Phase)	0.289***
/	（0.125）
Financial Leverage Ratio	-2.341***
/	(0.149)
Asset Size	0.186***
/	(0.037)
Cash Asset Ratio	0.853***
/	(0.187)
Company Age	-0.016**
/	(0.007)
Nature Of Stock Rights	0.135
/	(0.097)
Type Of Audit Opinion	0.908***
/	(0.086)
Board Size	-0.008
/	(0.016)
_Cons	-3.879***
/	(0.792)
Time Fixed Effect	Controlled
Enterprise Fixed Effect	Controlled
N	23623
R^2	0.016

Note: Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

From the model goodness of fit, the benchmark regression model and robustness test model adjustment r^2values were 0.015 and 0.016, respectively, little difference occurred, indicating that the robustness test did not significantly change the goodness of fit of the model. This demonstrates the robustness and reliability of the benchmark regression results. As can be seen from table 3, the coefficient of the lagging first-phase digital transition in the model is 0.289 (p <0.01), which is slightly lower than the 0.324 of the benchmark model, but still remains highly significant. This shows that the positive effect of digital transformation on return on equity (roea) is sustainable in the time dimension, and the core conclusion has not been substantially changed by the lagging adjustment of variables, that is, the previous digital transformation efforts will continue to have a positive impact on enterprise performance in the subsequent period.through the robustness test of the lag-phase variable method, this paper found that the coefficient direction and significance of the core explanatory variable "Digital transformation" Were consistent in the benchmark regression and the robustness test, and the direction and significance of the coefficients of most control variables also remained stable.this indicates that the benchmark regression results in this paper are robust and reliable, and that the digital transformation has a significant and robust positive impact on enterprise performance.

4 CONCLUSION

Based on the perspective of data elements, this paper deeply discusses the complex relationship between enterprise digital transformation and enterprise performance. Through the empirical analysis, the following main conclusions are drawn: the digital transformation of enterprises has a significant positive impact on their performance. Specifically, digital transformation has significantly improved the return on equity of enterprises by optimizing business processes, improving operational efficiency and innovation ability. The improvement of enterprise innovation ability by digital transformation is mainly reflected in the following aspects: first, by introducing advanced digital technologies and tools, enterprises can carry out research and development activities more efficiently and shorten the market time of products; second, digital technology promotes the internal knowledge sharing and communication and improves the innovation collaboration ability of the team; third, digital transformation helps enterprises to timely capture market trends and customer needs, so as to drive the continuous innovation of products and services. In addition, control variables such as financial leverage ratio, asset scale, cash asset ratio also have a significant impact on enterprise performance, further verifying the view that enterprise performance is affected by multiple factors.

This paper not only confirms the key role of digital transformation in improving enterprise performance, but also provides a useful reference for policy makers and business practitioners. With the continuous development of information technology, enterprises should actively embrace digital transformation, enhance competitiveness through technological innovation, and achieve sustainable development. In the future, the government should also step up efforts to promote the construction of digital government, provide a good policy environment and support system for the digital transformation of enterprises, and jointly promote the high-quality development of the economy and society.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Wang Kaiyang, Sun Zhuo, Chen Pengcheng. The impact of digital transformation on enterprise financial performance: the intermediary role and regulating role of enterprise dynamic ability. Management Review, 2024, 36(12): 249-262.

[2] Li Jianpei, Shi Jie, Gu Naihua. Research on the spillover effect of digital government construction on the digital transformation of enterprises — Evidence from the big data of government procurement contracts. Southern Economy, 2025, (02): 1-25.

[3] Hu Jinyan, Yu Lu, Liu Yinwei. Does digital government building improve corporate performance?—An open perspective based on data elements. Dongyue Theory Cong, 2024, 45(06): 109-122.

[4] Wu Jie, Zhou Shengdi, Wang Gaiyin. Research on the impact of digital transformation on enterprise performance —Empirical analysis based on the depth and breadth of digitalization. Economic Research in Shanghai, 2024, (09): 49-59.

[5] Ge Yuanqin, He Yang, Zhao Ruitong. Digital transformation and green technology innovation of enterprises under the background of new quality productivity—The "U" -shaped regulation effect based on redundant resources. Eco-economy, 2025, 1-30.

[6] Lun Xiaobo, Liu Yan. Digital Government and Enterprise Digital Transformation: the Road to Digital China. Economic Management, 2024, 46(08): 5-25.

[7] Meng Yuan, Yang Rong. Government governance in the era of big data: digital government and enterprise research and development manipulation. The World Economy, 2024, 47(01): 118-149.

[8] Xia TangBing. Digital government construction and Enterprise Performance improvement: the Perspective of institutional Environment of digital Economy. Business Economics Research, 2023, (02): 103-107.

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3040

EXPLORING THE PERFORMANCE PRODUCTION OF SCI-TECH FINANCE POLICY: TYPICAL PATHS AND INNOVATIVE INSIGHTS FROM CHINA PROVINCES

YangFan Lu*, Yuan Mei
School of Public Administration, South China University of Technology, Guangzhou 510640, Guangdong, China.
Corresponging Author: YangFan Lu, Email: yfanlu@scut.edu.cn

Abstract: This paper focuses on "how differentiated policy configurations lead to industrial development". It proposes the performance production as a novel perspective for policy management, utilizing China's provincial policies for sci-tech finance development as a case for operational observation. Qualitative data was converted into a quantifiable format using structured calibration procedures, and then three typical paths of system management were simulated via the fsQCA method. The 'limited adaptation' path involves selecting policy objectives and targeted investment of public resources through industrial basis analysis, corresponding to provinces with bright spots in the underdeveloped tier. The 'motivated action' path entails setting policy objectives to drive task arrangement and resource allocation, aligning with provinces demonstrating evident progress in the backward tier. The 'systematic improvement' path signifies that policies are derived through specific, successive steps, corresponding to leading provinces with developed industries. This study constructs a bridge between industrial policy analysis and performance evaluation, emphasizing the mutual guidance of multi-dimensional policy contents and their combined output mechanism. It offers practical and innovative implications for designing and implementing industrial policies across different regions.
Keywords: Industrial policy; Performance production; Configuration path; Sci-tech finance development

1 INTRODUCTION

Industrial policy, as a significant type of public policy, focuses on sci-tech finance, which plays a strategic role in national economic development and exhibits an emerging scale alongside forward-looking technology. Therefore, government cultivation is deemed essential [1]. Existing literature on emerging industry policies primarily adopts two perspectives: one is policy science analysis, which delves into the policy structure or process [2-3]; the other is policy performance evaluation, which examines the effectiveness of specific policy instruments [4-5]. However, these two perspectives are largely independent, leading to fragmented understanding of the intermediate principles from policy allocation to industrial progress, creating "missing links." The consequences of this lack are twofold: firstly, diagnosing problems in industrial policy lacks practical evidence from policy effectiveness, confining discussions to policy itself; secondly, evaluated industrial performance is difficult to attribute to specific policy elements, hindering direct implications for policy improvement. Furthermore, current policy performance evaluation predominantly uses traditional methods like regression models to test the impact of a single content dimension, failing to examine the combined effect of multi-dimensional policy content. This approach diverges from the real logic of policy action, rendering industrial policy performance analysis too abstract and detached from ontology, separating fact measurement from value judgment, and thus unable to assist policy system design through interactive guidance of policy elements.

This paper proposes a novel perspective of the performance production, bridging the gap between policy composition and industrial performance. What does the term "performance production" entail? Essentially, it refers to the process by which relevant subjects of a specific policy gradually create policy performance through their "actionable" behavior within the constraints of environmental conditions [6]. Policy performance production research differs from the evaluation of policy implementation or policy performance. Policy implementation evaluation presupposes established policy objectives, clarity in policy subjects, their responsibilities, and policy procedures, focusing on comparing the consistency of policy implementation paths with expectations [7]. Policy performance evaluation, on the other hand, assesses policy design and implementation from an epistemological perspective, emphasizing value evaluation, outcome evaluation, and incremental evaluation, but with inadequate attention to policy ontology and process [8]. Policy performance production constitutes an associative mechanism from ontology (policy content) to epistemology (policy effect), encompassing the internal structure of the policy system and the behavioral logic of policy subjects, which can be described through paths such as "(policy) demand-goal-responsibility-evaluation" or "(subject) motivation-resource-behavior-result." Thus, policy performance production may partially complement the functions of the aforementioned two types of research.

To analyze industrial policy from the perspective of the performance production, it is imperative to focus on its decision-making basis, goal setting, responsibility division, subject relationships, and implementation processes. These elements are commonly encompassed within industrial policies and are pivotal factors influencing policy performance production. They are interconnected and guide each other, but their interplay requires further interpretation. We aim to refactor the three-dimensional situation of policy management, with the objective of elucidating the following two levels of problems:

Q1: How can we systematically dissect the policy system of a specific region and effectively guide and integrate various policy contents?
Q2: How do implementing actors take rational actions within policy frameworks to achieve their goals? Specifically, how do different policy schemes lead to disparate outcomes in industrial development?
Given the institutional system, China's industrial policy is primarily planned and organized at the local level under the unified guidance of the central government. Its specific implementation exhibits characteristics of content integration and diversified forms [9]. This study systematically collected data on policies related to sci-tech finance issued in 31 provinces in mainland China. We referred to the structural procedure developed by Basurto and Speer [10] to convert qualitative information into scientifically calibrated conditions and outcome variables. Additionally, fuzzy-set Qualitative Comparative Analysis (fsQCA) was applied to simulate various paths of policy performance production, providing a reference for optimizing industrial policy design and implementation across different regions.

2 MATERIALS AND METHODS

2.1 Case Selection and Data Collection

Considering the timeliness of research and data availability, this paper collected policy documents during the period of the “13th Five-Year Plan”. This period was chosen because, in October 2011, 8 National Ministries and Commissions of China issued "Several Opinions on Promoting the Integration of Science and Technology with Finance" as a unified action plan. Subsequently, provinces responded by proposing personalized policy deployments based on local conditions. We adopted a holistic approach by attempting to find all sci-tech finance policy documents available through open channels and compiling them into a regional policy system for research.
We searched for policy data through the following three channels, striving for comprehensiveness and forming a “triangular mutual proof”. Firstly, we searched for keywords related to sci-tech finance on the official websites of provincial governments and their functional departments, primarily in the “Policy Release” section. Secondly, we searched for the same keywords in the well-known policy database “Pkulaw” (http://www.pkulaw.cn). Thirdly, we searched for “province name + sci-tech finance (or specific industry name)” in mainstream search engines such as Baidu and Sohu. The results from this search were used for review, comparison, and supplementation.
Provinces included as cases for analysis met three criteria: firstly, at the provincial level, at least one sci-tech finance policy was officially issued during the 13th Five-Year Plan period; secondly, at least one of the leading industries was included in the statistical catalog of sci-tech finance industries; and thirdly, the core index data reflecting industrial development in the corresponding years were fully disclosed. Fortunately, all 31 provinces (municipalities and autonomous regions) in Mainland China met these criteria. We compiled 140 policy documents found by province (averaging 4.5 per province) to establish the database for fsQCA.

2.2 The fsQCA Method

This paper used fsQCA to examine the influence of industrial policy deployment on sci-tech finance development. As a method to explore the causation of certain social phenomena, QCA has the following advantages. Firstly, it focuses on the effect of condition configurations rather than individual factors. Secondly, the fuzzy-set calculation helps to reduce multi-collinearity interference. Thirdly, different fitted condition configurations are considered equivalent, breaking the optimal solution thinking. Fourthly, it is suitable for small and medium sample sizes [11]. Since the contents of the sci-tech finance policy system are difficult to measure simply, dividing them into several membership levels between 0 and 1 is more in line with reality [12].
Referring to similar literature, fsQCA should be conducted in six steps [13]. It is necessary to specify some key parameters here to ensure the reliability of the analysis. The first is consistency. For fuzzy sets, the consistency of sufficient conditions refers to the ratio of the intersection of the condition variable membership set (X) and the outcome variable membership set (Y) to X, while the consistency of necessary conditions can be expressed as the ratio of the intersection of X and Y to Y. The closer the consistency is to 1, the better it is. The consistency of sufficient conditions is generally required to be above 0.75 or 0.8, and was set to 0.8 in this study. The threshold for necessary condition consistency was relatively uniform and was set to 0.9 [14]. Secondly, coverage is used to assess how well the condition membership set X physically covers the outcome membership set Y. When fsQCA obtains the solution, it displays three coverage indicators: raw coverage, unique coverage, and overall solution coverage [15]. There is no clear minimum standard for coverage; it is mainly used to demonstrate differences in the explanatory power of several equivalent solutions for the outcome. Moreover, there are two parameters associated with coverage. One is the minimum frequency of the cases. The analysis requires that the number of cases resulting from each conditional configuration should not be too small; this is used as a premise to determine the effective solution. Usually, 1 or 2 is considered in small sample research, and this study sets it as 1. The other is the proportional reduction in inconsistency (PRI). To avoid the situation where all conditional configurations lead to the same outcome with no simple solutions, we manually adjust the truth table row with PRI < 0.7 to 0 after filtering according to the minimum case frequency [16].

3 VARIABLES AND CALIBRATION

3.1 Constructing and Calibrating the Conditions

QCA typically employs four mainstream strategies for condition selection: obtaining guidance from theoretical knowledge, considering the real meaning of condition combinations, using measurement techniques to exclude certain conditions, and comprehensive inclusion [17]. This study integrates the first two strategies and aims to establish a verified analytical model for the policy performance production. On one hand, literature indicates that industrial policy content exhibits complex characteristics. For instance, the policy context perspective necessitates superimposing static and dynamic elements to derive key analytical dimensions, namely, the appeal of industrial development to policy and its response, demand-oriented policy goal setting and decomposition, goal-based key task allocation, responsibility division and coordination, and resource guarantee mechanisms. On the other hand, are these factors indeed considered in real policy design and practice? By conducting a preliminary analysis and induction of the collected policy data's text content, we can find empirical evidence demonstrating the common existence of the aforementioned points.

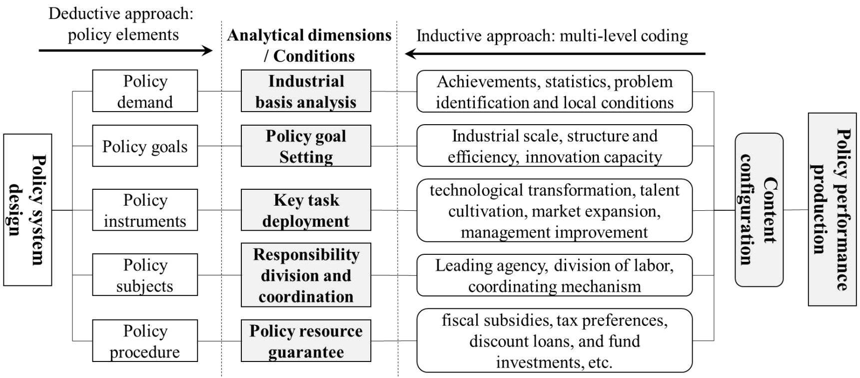


Figure 1 The Analytical Framework of Industrial Policy Performance Production

Both inductive and deductive paths unanimously confirm that the performance production of sci-tech finance policy comprises five conditions, as depicted in Figure 1: industrial basis analysis, policy goal setting, key task deployment, responsibility division and coordination, and policy resource guarantee. The subsequent step is to calibrate each variable. To date, most studies employing Qualitative Comparative Analysis (QCA) have utilized the direct or indirect calibration method proposed by Rihoux and Ragin [18], which presupposes the availability of quantitative measurements for each variable. Basurto and Speer developed a structured calibration procedure tailored for qualitative information, capable of transforming text data into fuzzy sets for QCA while ensuring systematicness and transparency, thereby overcoming the defects of fuzzy measurement and untestability of such variables in previous studies. We drew inspiration from this procedure but noted that it was originally exemplified using interview data. Since our original data consist of policy documents, designing an interview outline for variable measurement is unnecessary. The transformation process can be simplified into the following three steps.

3.1.1 Developing preliminary measures and qualitative anchors of the conditions

The first step is constructing an initial measurement scheme for the conditions and selecting qualitative anchors. This part is purely based on theoretical knowledge and the researchers' operational understanding of the concept. We needed to develop not only a preliminary list of measures for each condition but also the content for observation under each measure and their relative importance. This is akin to the process of making a code book in content analysis. It may be adjusted when we enter the sample.

Industrial basis analysis (IBA) refers to the review and summary of the current or past development of the industry within local policies, which is the accordance for policy formulation and future industrial development [19]. The most valuable elements of policy performance production in industrial basis analysis are as follows. The first is summarizing the highlights of industrial development in previous periods, in terms of dimensions such as industrial scale, layout structure, major projects, and innovation capacity to guide the selection of policy goals. The second is embedding relevant statistical data, providing information on key indicators, quantitative data, directions of changes, and comparison of strengths and weaknesses, as a future reference for goal values. The third is identifying the existing problems of the industry in aspects such as core technologies, value levels, production factors, and industrial linkage, to suggest the deployment of policy tasks and resource investment [20]. To measure this condition, we established a preliminary scheme consisting of the above three measure points and their subordinate 16 observation contents (4 contents per measure point). Although the probability of each observation content appearing in the policy is not completely random, any content can be the most important for the industrial basis analysis of a specific region. We balance the situation and assigned equal weight to each observation content. During calibration, that each measure point covers all observation contents was initially set to be the anchor of full in the "in-depth analysis of industrial basis" set, that no observation content is covered was set to be the anchor of full out of this conditional set, and that half observation contents are covered was set to be the crossover.

Policy goal setting (PGS) refers to the requirements of the policy that industrial development should achieve in the future. According to the need of matching industry statistics, three aspects (i.e., industry scale, structural benefit, innovation capacity) of quantitative goals are usually set by provincial industrial policies. Specifically, the industry scale has requirements for the value added, growth rates, and shares of certain industries; the structural benefit has requirements for the proportions of industries, industrial clusters, and leading industries or enterprises; the innovation capacity has requirements for R&D input, the number of high-tech enterprises and R&D platforms. A measurement scheme consisting of the above three measure points with 14 observation contents could be established for this condition, and equal weights were taken in accordance with the previous condition. During calibration, that each measure point covers all observation contents, that half of the observation contents are covered, and that no observation contents is covered were initially set as the anchors of full in crossover, and full out, respectively.

Key task deployment (KTD) refer to the work that needs to be implemented to promote the development of local industries for a period in the future. In the current theory, the development of sci-tech finance mainly relies on four factors: technology, talent, market and management, and the combination becomes a benign ecology that drives the healthy growth of the industry [21]. Among them: technological tasks generally involve network infrastructure, industrial robots, and digital and intelligent technology development and application; talent-oriented tasks require cultivating top talents, incubating innovation and entrepreneurial teams, and continuously improving personnel quality and industry-university-research collaboration; market-oriented tasks boost demand by establishing brands and benchmarks, accelerating the transfer and diffusion of scienctific & technical (S&T) achievements, and enhancing industrial public services as well as international cooperation; managerial tasks require improving the governance structure and enhancing the effectiveness of assessments, incentives, administrative approval, and intellectual property protection. On this basis, a measurement scheme consisting of four measure points with 16 observation contents was established, and equal weights were assigned to each observation content. Likewise, that each measure point covers all observation contents, that it covers half of the observation contents, and that it covers no observation content were set as the anchors of full in, crossover, and full out, respectively.

Responsibility division and coordination (RDC) refers to various aspects proposed by local policies such as how to organize and implement all or part of the work to develop the industry, who leads the coordination, what departments are responsible for which policy tasks, and how departments communicate with each other. Under this condition, an established leading and coordinating agency, a clear division of responsibilities between departments, and a normative mechanism for communication and coordination were the three measure points. In addition, there were 8 observation contents with equal weights, and the qualitative anchors for calibrating each measure point were initially selected according to the aforementioned logic.

Policy resource guarantee (PGS) refers to the methods and means of public financial resources stated in the policy to support industrial development. Drawing on the classification of mainstream industrial policy tools, we used four types of resource inputs, namely fiscal subsidies, tax preferences, financial support, and market investment as the measure points for this condition. Specifically, fiscal subsidies include the approaches such as setting up special funds, increasing inputs, centralized procurement, and asset allocation; tax preferences include tax deductions and additional deductions for specific market players; financial support includes granting discount loans and exclusive credit products to enterprises; market investment includes cooperation between the government and social capital, setting up investment funds and fiscal equity investment. Based on this, a measurement scheme consisting of four measure points with 11 observation contents was established (with equal weights assigned), and the anchors of calibration were selected according to the aforementioned logic.

3.1.2 Policy coding and summarizing the data for adjustment of measures

The second step is to enter the empirical field of data collected and to revise the measurement scheme through coding the policy text and summarising its classifications. This step consists of three parts. Firstly, Review the occurrence of each initial code (observation content) from all cases and decide whether to delete or adjust the code based on the variation, reliability, and sufficiency of information. Secondly, identify information and its divergence in categories that appears in multiple cases but cannot be covered by existing codes. Thirdly, summarize new information across cases (categories) and add it as a new code.

After this process, the following adjustments were made to the original measurement scheme for the five conditions. First of all, in measure point 1 “using fiscal subsidies”of PRG, the observation content of “asset allocation” was deleted because no provincial policy had mentioned such information (with measured value unchanged across all cases). Additionally, in measure point 2 “a clear division of responsibilities between departments” under the condition of RDC, the last two observation contents were combined into “lead unit or co-organizer” because most policy tasks or key projects are under the responsibility of only one unit, without any co-organizers (the measured value only slightly varied). Besides, one measure point was added in PGS and KTD, respectively. Taking the former as an example, quantitative indicators proposed in some provincial policies, such as “introducing high-level talents/teams”, “obtaining breaking through technologies”, and “building demonstration areas for technique/product use”, could not be classified into the preset three measure points, namely the industry scale, the structural benefit, and the innovation capacity. Based on the summary of the meanings of these indicators, a new measure point “quantifying goals on element cultivation” was added. Moreover, observation content was accordingly added to measure points of other conditions. For example, in terms of measure point 3 “identifying the existing problems of the industry” under IBA, several provincial policies had mentioned “a large gap between advanced countries and regions”, which could not be categorized into the four preset codes such as core technologies, so “regional gap” was added as the fifth observation content. As these adjustments caused changes in the value range of measures for each variable, the anchor points for calibration needed to be reconsidered.

To ensure the accuracy of the categorization for observation contents and measure points, we conducted reliability and validity tests in two ways. Firstly, we randomly selected 20 policy samples, which were independently coded by two researchers. Secondly, after an interval of 15 days, any selected policy sample was repeatedly coded by a same researcher. The consistency of the coding systems by two people (times) was above 90%, indicating that the adjusted measurement scheme was robust.

3.1.3 Determining the fuzzy sets (scales & anchors) and assigning case memberships

The third step is obtaining the memberships of the cases by determining the fuzzy set scale and qualitative anchors of each condition based on the adjusted measurement scheme. On the one hand, the precision of the fuzzy set, three-value, four-value, or other scales, was dependent on the details provided by the data. We took into account the number of observation contents at each measure point and selected a three-value fuzzy set for measure points with two observation contents and a four-value fuzzy set for measure points with three observation contents. For those with more than four observation contents, we further analyzed their interrelationship because observation contents may occur at the same time. For example, although the measure point “embedding indicators and statistical data” included four observation contents, it is almost impossible for the other three contents to appear in the case when the “key indicators” was ignored. Five-value fuzzy sets and ones with larger scales are rarely used in existing studies. Among the 19 measure points under the five conditions of this paper, eight had four to five observation contents, where a four-value fuzzy set could be applied, and only two measure points with more than six observation contents required five-value fuzzy sets. Because of the preset equal weight of each observation content, different anchors could take values according to the setting of average interval.

On the other hand, Basurto and Speer pointed out that the theoretical concept should be adapted based on the sociocultural context of a case located. We can construct an imaginary perfect or very poor case that just fits the sample experience so that the anchor values of full in and full out not are not necessarily equal to the maximum and minimum values of the measure point. In this study, there are three measure points of which the selection of the full-in anchors is deviated from the maximum number of the observation contents. For example, under “quantifying goals on structural benefit”, “industrial clusters” and “leading industries or enterprises” required industrial concentration at the macro and micro levels, respectively, and most provinces only considered one of them. Therefore, the full-in anchor only required “quantifying at least 5 goals”. “Including one observation content or below” was selected for the anchors of full nonmembership of three measure points because: on one hand, very few cases that “do not contain any observation content”, it was necessary to avoid the “right skewed” distribution of variables that may affect the analysis; on the one hand, policy performance production has higher requirements for certain measure points, so only cases with “higher levels” could be given a same membership as compared to other measure points. Seen from “deploying tasks on technological transformation”, almost all provinces made great efforts in this regard as technological improvement is the lifeline of sci-tech finance, therefore “deploying only one task” is viewed as a poor performance. The gradient distribution of values on other anchors (the number of observation contents) was similarly adjusted in a scientific manner.

Here, we obtained the fuzzy membership of each case at each measure point by selecting their closest qualitative anchor for calibration based on the number of observation contents that is found in the coding process of policy texts. And afterward, values of the conditions were aggregated according to the memberships of the measure points. As the measure points within the conditions have basically horizontal, parallel, and equal relationships, we calculated the arithmetic mean for aggregation and then complete the data conversion.

3.2 Constructing and Calibrating the Outcome

The purpose of the outcome is to quantify the development performance of sci-tech finance in each province during the “13th Five-Year Plan” period. However, the current national and local statistical yearbooks lack readily accessible data of this specific nature. A more credible strategy lies in sourcing relevant research findings from reputable institutions. Among the most prominent are: firstly, the "China FinTech Innovation and Development Index" crafted by the Central University of Finance and Economics, encompassing four dimensional quantitative metrics that assess financial technology endowment, business progression, social perception, and core competencies; secondly, the "China Urban Sci-Tech Finance Development Index" introduced by Zero2IPO Research Center, which delves into dimensions such as policy frameworks, innovation dynamism, financial services, and developmental achievements. While the former has been annually published since 2018, the latter has joined the fray since 2020, both utilizing cities as their evaluation units, encompassing over 200 cities spanning all provinces in China. Given the alignment of the measurement period with the conditional variables in our study, we opted to consult the former. Our methodology involved: firstly, sourcing data based on its core indicators and evaluation framework to extrapolate results for 2015, employing estimated values to fill in gaps for missing indicators; secondly, aggregating the city-level indices within each province using a weighted approach, thereby utilizing the outcomes as a proxy for the development level of sci-tech finance within that province.

Based on this, we calculated the growth ratio of the sci-tech finance development index from 2015 to 2020 for 31 provinces, resulting in an interval variable ranging from 17.5% (the minimum) to 132.4% (the maximum). Then the direct calibration method was employed, with the key step being the selection of qualitative anchors. Theoretically, defining any five-year growth rate of sci-tech finance as a “high growth rate” is challenging due to the absence of a fixed standard. Rihoux and Ragin proposed referencing larger data sets to ensure calibration is based on “substantive knowledge” beyond the sample. Some studies determine the level by comparing its growth rate with that of the service industry, which constitutes a larger data set. For instance, a growth rate of sci-tech finance exceeding that of service industrial by more than three times as “rapid growth” and one 30% lower as “stagnation” [22]. According to this principle, we set the full membership anchor at the point where the growth rate of sci-tech finance exceeds that of the service industry by three times during the 13th Five-Year Plan period, and the full nonmembership anchor at the point where it is 30% lower. The crossover point is where the two growth rates are equal. Thus, a five-value fuzzy set was used to measure the outcome, assigning a membership of 1 to cases above the full-in point, 0 to cases below the full-out point, and 0.25 and 0.75 to cases between the full-out and crossover points and between the crossover and full-in points, respectively.

4 RESULTS AND FINDINGS

4.1 Necessary Conditions Analysis

The first step of the fsQCA is to test the necessity of the presence or absence of a single condition. The analysis results using the fsQCA3.0 software are outlined in Table 1. The consistency of PGS is 0.9237, and the consistency of PRG is 0.9142. Both reached a set consistency ≧0.9 threshold. That is, policy goal setting and policy resource guarantee alone may constitute a necessary condition for the high performance of provincial sci-tech finance. The consistency of the presence and absence of other conditions are all lower than 0.9, which is not necessary to achieve high industrial performance.

Table 1 Necessary Conditions Analysis.

Conditions	Consistency	Coverage	Conditions	Consistency	Coverage
IBA	0.6494	0.6347	~IBA	0.6620	0.5659
PGS	0.9237	0.6606	~PGS	0.2941	0.7067
KTD	0.8775	0.5692	~KTD	0.5219	0.6423
RDC	0.3913	0.6836	~RDC	0.8430	0.5556
PRG	0.9142	0.6693	~PRG	0.3107	0.5243

Note: '~' and '*' are the basic symbols of the Boolean calculation. The former means that the corresponding condition variable is missing, and the latter means "and".

As PGS and PRG are both necessary conditions, the empirical relevance between the two needs to be evaluated. A necessary condition X is trivial if its size exceeds the outcome Y, or if both X and Y are very large (close to being constants). We choose to judge their relevance or triviality by calculating the coverage of Y for X [23]. The coverage for PGS is 0.5642 and that for PRG is 0.5738, which implies that neither of these two conditions is trivial for the outcome. Comparing the set sizes in which the two conditions exceed the result, policy goal setting is slightly larger. That is, the condition of policy resource guarantee is more relevant to the outcome –high industrial performance.

4.2 Sufficiency Analyses for Condition Configurations

Second, to examine the sufficiency of different conditional configurations in generating the result. Three types of solutions can be obtained through the standardised analysis, namely a complex solution not including any logical remainders, an intermediate solution that only includes the logical remainders meeting theoretical expectations and empirical evidence and a concise solution that included all logical remainders without assessing their rationality. We considering that the conditions appearing in both the concise and intermediate solutions are the core conditions, the conditions that only appear in the intermediate solution are the marginal conditions and the necessary conditions are regarded as the core conditions to be included.

Table 2 summarises the valid condition configurations in an easy-to-read format, and shows their core conditions, marginal conditions, consistency and coverage. According to the differences in the core conditions, these solutions formed three typical paths for provincial policy performance production. Solution 1 (SI) can be expressed as "IBA * PGS * ~ KTD * ~ RDC * PRG". It provides a model wherein provinces select and set limited policy goals based on an in-depth analysis of the industrial basis, and then guides the inclined investment of public resources, thus is called a "limited adaptation" path of policy performance production. S2 can be expressed as "~ IBA * PGS * KTD * ~ RDC * PRG". It provides a model wherein provinces autonomously set policy goals, deploy key tasks around the goals and focus resource investments on the tasks, thus is called a "motivated action" path of policy performance production. S3 can be expressed as "IBA * PGS * KTD * RDC * PRG". It provides a model wherein provinces set policy goals based on an in-depth analysis of the industry basis, deploy key tasks, clarify the responsibility and coordination mechanisms and input resources according to the goals. This solution demonstrates how their industrial policy contents are derived by steps and how they are connected and implemented successively; thus, it is called a "systematic improvement" path of policy performance production.

Table 2 The Condition Configurations of Provincial Sci-tech finance "High Performance".

Conditions	Solutions		
	S1: IBA+PGS+PRG	S2: PGS+KTD+PRG	S3: IBA+PGS+KTD+RDC+PRG
IBA	●	△	●
PGS	●	●	●

KTD	○	▲	▲
RDC	△	△	▲
PRG	▲	●	●
Consistency	0.8620	0.8643	0.8073
Raw coverage	0.3072	0.4700	0.2821
Unique coverage	0.1320	0.1831	0.1133
Overall solution consistency		0.8135	
Overall solution coverage		0.6718	

Note: ● = Core condition exists; ○ = Core condition is missing; ▲ = Marginal condition exists; △ = Marginal condition is missing.

The above configurations prove the multiple causalities of policy performance production for provincial sci-tech finance; that is, fsQCA deepens the understanding of the link between policy content and industrial development. On the one hand, the consistency of each solution is relatively high, reaching the requirement of consistency for sufficient conditions, signifying that they have strong explanatory power. Among them, the unique coverage of S2 is the largest (0.1831), denoting that S2 has the strongest explanatory power. On the other hand, the overall solution consistency is 0.8135, highlighting that among all cases that met the three configurations of conditions, 81.35% of provinces have achieved high performance in sci-tech finance development. The overall solution coverage rate was 0.6718, which means that combining the three solutions can generally explain 67.18% of the provincial cases.

It is worth noting that PGS and PRG coexist in S1–S3, whether as a core condition or a marginal condition. This point shows that to obtain high industrial performance, the two factors must work together and complement each other [24]. From the relationship between the five conditions, it can be seen that under the limitation of policy resources and the attention of policy executors, the deployment of key tasks often depends on the goals that have been set, and the division of responsibilities is determined according to the needs of the tasks. Finally, the tasks and division of responsibilities clarified the ways and directions of public resource input. Fundamentally, the resource allocation of industrial policies is determined by policy goals, which also ensure the realisation of policy goals. These two factors are indispensable for policy performance. Even if the deployment of key tasks or division of responsibilities is absent, policy resources can still be selectively allocated directly according to the goals.

4.3 Robustness Tests

This study adopts two schemes for the robustness test. The first is to make counterfactual inferences by constructing "non-high performance" and "low performance" results for provincial industrial development, which helps to further verify the existing conditional configurations. According to the principle of "causal asymmetry", X→Y does not necessarily lead to ~X→~Y (Barbara & Jan, 2016). We explored the conditional configurations for cases with high and "non-high performance" and "low performance" based on the calibration settings. The "non-high performance" group has two typical solutions. In the absence of IBA, PGS and RDC (even if there are KTD and PRG), or in the absence of PGS, RDC and PRG (even if there are IBA and KTD), it is impossible for provincial policies to achieve high performance. The core and marginal conditions of these two solutions are different from those of the "high-performance" group, which also shows that the necessary and sufficient conditions analysed above are reliable. The constructed "low performance" group cannot obtain identifiable solutions due to too few cases, and the consistency of its condition configurations is much lower than 0.8.

Second, we recalibrate the variables or adjust some of the parameters. As the conditions in this study are all qualitative variables, their policy text coding is highly structural and difficult to reset, we only chose the outcome for recalibration. The three anchors of full in, crossover point and full out are adjusted to 400%, 100% and 10% respectively, referring to the growth rate of sci-tech finance to service industrial added value. The same solutions could still be identified after repeated analysis, with an overall consistency of 0.8246 and an overall coverage of 0.6487. We also draw on the idea of Schneider and Wagemann to raise the consistency threshold for sufficient conditions from 0.80 to 0.83 and 0.85, or raise the frequency threshold from 1 to 2 (less than 10% of cases were excluded); the solutions acquired are still basically the same. Overall, the aforementioned fitted performance production paths are robust.

4.4 Interpreting The Policy Performance Production Paths

4.4.1 The "limited adaptation" path

The key to this path is to choose and set limited policy goals according to the analysis of the industrial basis and then guide the inclined investment of public resources. Some provinces have achieved success in the development of sci-tech finance, which mainly benefits from their highlights of the three major aspects of industrial basis analysis, goal setting, and resource guarantee in the policy system. Their policy goals are not "targetless" but based on the scientific analysis of the province's industrial basis to seek breakthroughs of key points, such as weak links of the industry and key challenges; then, they should be set as the goals. Meanwhile, with the guidance of the rigid assessment mechanism and quantitative index, the corresponding resource input to the industrial policy is naturally inclined based on the goal, or even the extreme situation of "doing less or none without the restraint of goal". In fact, the industrial development goal of a region is systematic (e.g. it can be divided into multiple dimensions of scale, distribution and innovation, which contain multiple measurement indicators). However, considering the boundary of government powers and responsibilities, the lack of policy information and the limited total amount of resources, it is particularly important to select a few goals and concentrate on the actions, which is more conducive to policy performance production. Researchers have gained extensive experience in goal management and attention distribution theory.

The "limited adaptation" path is represented by provinces and cities such as Hubei and Chongqing. They are areas with "bright spots" in the sub-developed echelons of sci-tech finance, and the industrial scale is at the upper-middle level. The advantages of the two indicators are prominent (even surpassing the leading provinces) in Hubei: industrial agglomeration and the gap between industries. The industrial innovation efficiency measured by input-output in Chongqing is nearly double that of the provinces at the same level. Over time, it may be foreseen that these provinces and cities will drive sci-tech finance with comparative advantages to achieve rapid development. Analysing its provincial-level industrial policy documents, it did not carry out comprehensive task deployment around the four elements of technology, talent, market and management. However, based on an in-depth analysis of the industrial basis, Hubei focused on industrial distribution, and Chongqing focused on industrial innovation; the coordination and responsibility division is more general than it is in other provinces. This type of provincial experience provides a model for fully relying on industrial-basis analysis to guide goal setting and resource input under the conditions of lacking key tasks and responsibility division in policies (or relatively weakened), as they can also derive good policy performance production.

4.4.2 The "motivated action" path

The key to this path is to set provincial policy goals autonomously, deploy the key tasks around the goals and invest resources in the tasks. Some provincial policies do not have an analysis of the advantages and disadvantages of past industrial development, but directly set performance goals based on an objective logic (e.g. the logic of goal integrity, the logic of highlighting key points, the logic of adapting to local conditions, etc.), and then deploy several special tasks under the guidance of the goal, giving targeted resource input to achieve success in policy performance. Target management theory treats each policy subject as rational. They set performance goals as needed, automatically guide performance-producing behaviors and raise corresponding resources. Accordingly, policy task selection and resource allocation around the performance goal can be regarded as the purposeful process of relationship and behavior adaptation within the performance production (inter-subjects). For provinces that conform to this path, their industrial policies often lack responsibility division and coordination, which may be included in the "key tasks", or according to the aforementioned principles, the responsibility division and coordination mechanism presents a "rational and self-conscious" attribute.

The path of "motivated action" is represented by Sichuan, Gansu and other provinces and cities. These belong to the underdeveloped echelons of sci-tech finance. Their early industrial basis can be described as "all-around weak", including industrial scale, agglomeration and innovation efficiency. However, during the "13th Five-Year Plan" period, Gansu's Sci-tech finance averaged an annual growth rate of 13% and Sichuan's annual growth rate reached 22%. Obviously, its growth engine has been "fully activated". From the perspective of its provincial-level industrial policies, it has not been analysed too much. The foundation of local sci-tech finance (or the analysis is simple and general) and the development goal setting has not fully covered the three areas of industrial scale, distribution and innovation. However, two provincial governments have placed accelerating industrial development ("to be larger and then stronger") in a prominent position, such as setting quantitative assessment indicators for scale and growth, and key policy tasks and resource inputs are also deployed around this main line. Their focus on the key points to make efforts is distinctive. Objectively, this type of provincial policy system and goal setting requires neither reference nor special concerns. Therefore, acting boldly according to actual conditions is available. They provide basic backward areas to consolidate their comparative advantages and achieve catch-up experiences through goal selection and resource orientation.

4.4.3 The "systematic improvement" path

The key to this path is that provinces set policy goals based on a comprehensive analysis of the industry, deploy key tasks according to the goals and then clarify responsibility division and coordination mechanisms, as well as input resources corresponding to the tasks. Its experience comes mainly from several advanced provinces in terms of industrial development. From a comparative perspective, the contents of each module of their policy system corresponding to the five condition variables are relatively comprehensive; that is, policy deployment has "overall advantages" compared to other provinces. Although, in terms of condition configuration, goal setting and resource guarantee are still the core elements of supporting policy performance production, the industrial basis, key tasks, coordination and responsibility division have also played important guiding and cohesive functions. At the holistic level, the provincial policies that conform to this path present the characteristics of "gradual deduction", wherein the industrial basis is used to stimulate goal setting, key tasks are arranged around goal indicators and the division of labour and resource input is clearly defined according to the tasks. This kind of policy is undoubtedly logical, basic and scientific.

The "systematic improvement" path is represented by the two provinces of Guangdong and Shanghai, which belong to the "head" echelon of Sci-tech finance development. Except for specific aspects (such as unsteady growth), the performance of these industries is almost fully ahead, and the fields are relatively balanced. In contrast, Guangdong's advantages are more prominent. Analysing the industrial policies of the two provinces, it is obvious that the two sets of documents are both complete in structure and content (i.e. the length is several times longer than similar policies in other provinces). Each part is discussed sequentially and pertinently according to the previous part, ranging from the industrial basis to goal setting, key tasks, coordination and responsibility division and resource guarantee. These provincial experiences can provide a model for all parts of the country to guide the performance and output of sci-tech finance through policy design.

5 CONCLUSIONS AND IMPLICATIONS

This paper centers on the inquiry "How do differentiated policy configurations lead to industrial development" and introduces the performance production as a novel perspective. To empirically observe this concept, we gathered policy texts from 31 Chinese provinces during the "13th Five Year Plan" period. We transformed qualitative data into variable measurements using structured calibration procedures and then simulated three typical paths of policy performance production using the fsQCA method. The "limited adaptation" path entails guiding the selection of policy objectives and targeted investment of public resources through an analysis of the industrial base. The "motivated action" path involves setting industry policy objectives to drive policy task arrangement and resource allocation. The "systematic improvement" path signifies that industrial policies are derived step by step and connected successively.

This research contributes to bridging the gap between policy context/implementation analysis and policy (performance) evaluation. It initiates the diagnosis of policy problems based on policy performance, aiding in bridging the divide between factual descriptions and value judgments of policies. In terms of methodology, apart from applying fsQCA to explore the combined impact of multidimensional policy contents—which surpasses traditional regression analysis by focusing on a single policy element and requiring a large sample—this study also deduces the calibration procedure for qualitative data from policy texts and provides reliable examples. At the practical level, by sorting the interaction between industrial policy contents and their performance production paths, it offers a demonstration for differentiated policy design and implementation across various regions.

As previously mentioned, existing related literature does not directly address the policy performance production mechanism but mainly focuses on policy performance management. From the perspective of policy goal management, they largely discuss the impact of different forms of goal setting on policy effectiveness. Our analysis further reveals how it affects, such as arranging key tasks around quantitative goals and preferential allocation of resources (the "motivated action" path). Research on policy element synergy largely explains the possibility of synergy between elements or measures the level of synergy, but this paper further presents a realistic mechanism for different elements to guide and synergize with each other, such as selecting policy goals and investing public resources according to industrial base analysis (the "limited adaptation" path). Regarding policy implementation deviation, scholars generally identify its reasons through policy executors, the institutional environment, or information resources. Our study supplements the analysis from the perspective of the internal interaction between policy and implementation systems. For instance, connecting policy contents sequentially and clarifying the mechanism of responsibility division and coordination are more conducive to achieving high performance in industrial development (the "systematic improvement" path).

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

ACKNOWLEDGMENT

The author acknowledges the Guangdong Provincial Science and Technology Planning Project (No. 2024A1010050001) and Guangzhou Science and Technology Planning Project (No. 2024A04J3844) for Covering the research and publication expenses of this article.

REFERENCES

[1] Tausif B, Philip S, Paul M. Industrial policy initiatives in manufacturing: Examining cross-country interventions through an evolutionary typology of technology systems. Science and Public Policy, 2024, 51(5): 823-825. DOI: 10.1093/scipol/scae026.

[2] Shen H, Xiong P, Yang L, et al. Quantitative evaluation of science and technology financial policies based on the PMC-AE index model: A case study of China's science and technology financial policies since the 13th five-year plan. Pos One, 2024, 19(8): 1-28. DOI: 10.1371/journal.pone.0307529.

[3] Huang C, Yue X, Yang M. A quantitative study on the diffusion of public policy in China: evidence form the s&t finance sector. Journal of Chinese Governance, 2018, 3(2): 235-254. Doi: 10.1080/23812346.2017.1342381.

[4] Lin Junda. Analysis of the effect of financial subsidy on China's new energy vehicle industry R & D. activities. Modern Economy, 2019, 10(1): 96-107. DOI: 10.4236/me.2019.101007.

[5] Su T. Investigating Science and Technology Finance and Its Implications on Real Economy Development: A Performance Evaluation in Chinese Provinces. Journal of the Knowledge Economy, 2023, 11: 1-28. DOI: 10.1007/s13132-023-01502-7.

[6] Brix J, Krogstrup H, Mortensen N. Evaluating the outcomes of co-production in local government. Local Government Studies, 2020, 46(2): 169-185. DOI: 10.1016/j.jclepro.2020.122381.

[7] Nahm, Jonas. Exploiting the Implementation Gap: Policy Divergence and Industrial Upgrading in China's Wind and Solar Sectors. The China Quarterly, 2017: 1-23. DOI: 10.1017/s030574101700090x.

[8] Omrani H, Oveysi Z, Emrouznejad A. A mixed-integer network DEA with shared inputs and undesirable outputs for performance evaluation: Efficiency measurement of bank branches. The Journal of the Operational Research Society, 2023, 74(4):1150-1165. DOI: 10.1080/01605682.2022.2064783.

[9] Tian R, Xu B. China's Science and Technology Finance and Economic Corridor Development: A Coupling Relationship Analysis. International Journal of Advanced Computer Science and Applications, 2024, 15(2): 39-48.
[10] Basurto, X and Speer J. Structuring the Calibration of Qualitative Data as Sets for Qualitative Comparative Analysis (QCA). Field Methods, 2010, 24(2): 155-174. DOI: 10.2139/ssrn.1831606.
[11] Manuel Fernández-Esquinas, María Isabel Sánchez-Rodríguez, José Antonio Pedraza-Rodríguez, et al. The use of QCA in science, technology and innovation studies: a review of the literature and an empirical application to knowledge transfer. Scientometrics, 2021, 126: 6349-6382. DOI:10.1007/s11192-021-04012-y.
[12] Hans-Jütirgen Z. Fuzzy Set Theory and its Applications (4th edition), Kluwer Academic Publishers Group, Dordreeht. The Netherlands, 2001.
[13] Zhang M, Du Y. Qualitative Comparative Analysis(QCA) in management and organization research: position, tactics, and directions. Chinese Journal of Management, 2019, 16(9): 1312-1323.
[14] Cheng C, Yang Z, He Y, et al. How configuration theory explains performance growth and decline after Chinese firms cross-border M&A: using the fsQCA approach. Asia Pacific Business Review, 2021, 555-578. DOI: 10.1080/13602381.2021.1910900.
[15] Schneider, C Q, Wagemann, C. Set-Theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis, Cambridge. Cambridge University Press, 2012. DOI: 10.1017/CBO9781139004244.
[16] Du Y, Kim P. One size does not fit all: Strategy configurations, complex environments, and new venture performance in emerging economies. Journal of Business Research, 2021, 124: 272-285. DOI: 10.1016/j.jbusres.2020.11.059.
[17] Ragin C. The Comparative Method: Moving beyond Qualitative and Quantitative Strategies. Berkeley: University of California Press, 2014.
[18] Rihoux B, Ragin C. Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques, Thousand Oaks CA. Sage Publications, 2009.
[19] Meckling J. Making Industrial Policy Work for Decarbonization. Global Environmental Politics, 2021, 21(4): 134–147. DOI: 10.1162/glep_a_00624.
[20] Maloney W, Nayyar G. Industrial policy, information, and government capacity. The World Bank Research Observer, 2018, 33(2): 189-217. DOI: 10.1596/1813-9450-8056.
[21] Pauliuk S, Arvesen A, Stadler K. Industrial ecology in integrated assessment models. Nature Climate Change, 2017, 7(1): 13-20. DOI: 10.1038/nclimate3148.
[22] Jovanovic J, Morschett D. Under which conditions do manufacturing companies choose FDI for service provision in foreign markets? An investigation using fsQCA. Industrial marketing management, 2022(Jul.): 104.
[23] Schneider M, Schulze-Bentrop C, Paunescu M. Mapping the Institutional Capital of High-Tech Firms: A Fuzzy-Set Analysis of Capitalist Variety and Export Performance. Journal of International Business Studies, 2010, 41(2): 246-266. DOI: 10.1057/jibs.2009.36.
[24] Vilmos F Misangyi, Abhijith G Acharya. Substitutes or Complements? A Configurational Examination of Corporate Governance Mechanisms. Academy of Management Journal, 2014, 57(6): 1681-1705. DOI: 10.5465/amj.2012.0728.

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3041

PRACTICAL VALUE, CHALLENGES AND OPTIMIZATION PATH OF FINANCIAL SHARING CENTER IN THE CONTEXT OF FINANCIAL DIGITAL TRANSFORMATION

XiaoYan Qiao
China Railway Construction Engineering Group Co. Ltd., Beijing 110070, China.
Corresponding Email: 1579057428@qq.com

Abstract: The author, through comprehensive research on the digital transformation practices of financial shared service centers (FSSC) in the digital economy, their challenges, and optimization measures, found that FSSC can help achieve financial efficiency improvements, cost reduction through financial effectiveness, data management empowerment, and support for corporate strategic decision-making. However, it also faces difficulties such as the lack of technical interfaces with existing systems, the inability to establish new institutional models, and mastering key capabilities in shared center data management while avoiding data security risks. By analyzing relevant literature and practical issues in enterprises, the author proposes optimization strategies for the transition of FSSC to cloud platforms, providing direction for the digitalization of enterprise financial management.
Keywords: Financial shared center; Digital transformation; Data governance; Cloud platform; Optimization path

1 INTRODUCTION

In the wave of digital economy and new productive forces, data elements have become one of the most important factors in the digital and intelligent transformation of enterprises. The finance department is the core data department of an enterprise, serving as its internal data hub and "brain nerve," with vast amounts of operational data and even data for management decisions; however, due to its functional positioning and corporate organizational model, it faces issues such as organizational fragmentation, separation of business and finance, and information silos, which result in the financial department's weaker contribution to the overall value of the enterprise in the digital wave. As an innovative financial management model, the financial shared service center is a critical component in building a world-class corporate financial management system. For enterprises, it is essential to recognize the strategic value of constructing a financial shared service center. This article discusses key issues in the current construction of financial shared service centers from three aspects: corporate digital transformation, challenges faced, and optimization paths, and provides a systematic solution for better advancing the digital and intelligent transformation of corporate finance for reference[1-3]. As an innovative financial management model, the financial shared service center (FSSC) is a critical component in building a world-class corporate financial management system. The FSSC integrates financial resources, improves business processes, and enhances service quality, thereby adding value to enterprises. In the digital economy era, the construction and optimization of the FSSC have become particularly important. By centralizing financial affairs, the FSSC avoids the waste of resources and communication costs caused by decentralized management, reduces operating costs, and enhances the market competitiveness of the enterprise[4-6].

2 PRACTICAL VALUE OF DIGITAL TRANSFORMATION OF FINANCIAL SHARING CENTER

2.1 Improve Financial Management Efficiency and Reduce Operating Costs

A financial shared service center can reduce the complexity of financial operations by automating processes and using intelligent invocation structures to lower financial management costs. Traditional financial management processes and systems are often developed based on fixed reports and procedures. However, due to the inability to customize these fixed programs to change report flows, they lack flexibility, making it difficult for financial staff to quickly adjust processes according to business and demand changes. The digital financial shared service center achieves centralized and standardized handling of financial accounting tasks through technologies such as Robotic Process Automation (RPA) and artificial intelligence. This enables the centralized implementation of financial accounting tasks like accounts payable, accounts receivable, general ledger, and fixed assets by the financial shared service center, enhancing both efficiency and accuracy in business processing. Practical experience shows that implementing a financial shared service center can optimize financial functions and reduce the number of financial personnel, standardize management processes, and lower corporate financial operating costs. This cost-saving advantage is particularly evident when the financial shared service center is located in new locations with low salaries and labor costs. The digital financial shared service center realizes the core financial capabilities of the enterprise through a "sharing + reuse" model, making financial business capabilities modular, standardized, and achieving economies of scale. In terms of efficiency improvement, the financial shared service center will promote standardized operations within each subsidiary, eliminating redundant and cumbersome tasks, integrating financial functions, and enabling centralized analysis of financial data.

2.2 Enhance Data Governance Capabilities and Decision Support Functions

Through the construction of information systems, the financial shared service center has gradually transformed from a traditional financial shared center into an enterprise data center, significantly enhancing the company's data governance capabilities. Under the traditional financial information model, financial data relying on physical storage and manual backups is at risk of loss, leakage, errors, and security vulnerabilities, severely limiting the efficiency of financial work. In contrast, a digital financial shared service center, by establishing a comprehensive data management system, ensures the integrity, accuracy, and consistency of financial data, providing effective data for corporate management decisions.

The quality of data is the foundation of decision-making and also the basis for the implementation of financial shared services. All financial activities are realized with the support of data. Digital transformation constructs unified, standardized, and real-time data, enhancing the accuracy of financial analysis and the rationality of budget preparation, laying a theoretical foundation for corporate strategic decisions. At the same time, the digital financial shared service center improves data security mechanisms, ensuring that the company's financial data is not leaked or misused, reducing the possibility of core interests being compromised.

2.3 Promote the Integration of Business and Finance and Empower Enterprise Strategy

The financial shared service center helps enterprises achieve true integration of business and finance. Under the traditional financial management model, there is a clear boundary between the finance department and the business department, often preventing the finance department from timely obtaining accurate and complete financial data. However, a digital financial shared service center can leverage technologies such as the Internet of Things and blockchain to achieve integration of business and finance. This means combining the company's business flow, cash flow, and information flow, integrating financial management activities with corporate development, thereby enhancing operational efficiency and service quality.

From the perspective of "integration of business and finance," achieving a digital financial shared service center can better serve operational decision-making and support business development goals. Timely and effective data sharing facilitates the financial shared service center in assisting business departments with timely and accurate financial analysis, meeting the company's needs to adapt to market changes. Additionally, a digital financial shared service center allows management to focus less on non-core financial matters and more on core operations, thereby enhancing the company's operational efficiency.

3 MAIN CHALLENGES FACED BY THE DIGITAL TRANSFORMATION OF FINANCIAL SHARING CENTER

3.1 Technical Integration and System Compatibility

The financial shared service center serves group enterprises, featuring not only comprehensive coordination and centralized control at headquarters but also the unique situation of each subsidiary operating independently. This poses a significant challenge for data integration across the entire enterprise group within information systems. In reality, many group enterprises 'financial shared platforms fail to achieve seamless integration and interoperability with ERP systems, business management systems, and other platforms, leading to issues such as poor data communication and inflexible system integration. Additionally, the storage and security performance, as well as speed of the information platform, can also affect the effectiveness of the financial shared service center's functions.

For multinational corporate groups, the financial system data standards of subsidiaries in different regions vary, which objectively increases the technical difficulty of implementing a financial shared service center. Data silos weaken the ability to share and integrate financial data in real-time across systems, making it harder to fully realize the expected outcomes of digital transformation in finance. Moreover, the frequent updates of new technologies require the financial shared service center to have high technical update capabilities, imposing higher demands on the company's information infrastructure and personnel reserves.

3.2 Organizational Change and Employee Resistance to Adaptation

Digital transformation means a "radical organizational restructuring" of financial systems. Traditional finance professionals have long been accustomed to decentralized, manual financial operations and face difficulties in adopting the new approach of systematic, centralized, automated, and intelligent financial shared centers. Research has found that during the transition from traditional financial management models to digital financial shared centers, less than 40% of issues stem from technical challenges, while most problems arise from changes in the mindset of finance personnel and shifts in organizational structure.

The establishment of a financial shared service center enables the realization of an integrated financial strategy within enterprises. The separation of financial accounting and management accounting processes, along with the transformation of financial personnel from mere bookkeepers to partners in business operations and value creators, presents significant management challenges in the digital transformation of corporate finance. At the same time, the centralized financial shared service center model also alters the role positioning of financial departments within subsidiaries, potentially leading to conflicts such as re-balancing authority and organizational culture changes, which must be addressed through change management and communication strategies.

3.3 Data Security and Compliance Risks

Finally, the data security and compliance risks of financial shared service centers, which hold massive amounts of data, have increased. Corporate financial information includes details about the company's finances, operations, and cash status. If such information is illegally disclosed or misused, it could result in incalculable asset losses and severely damage the company's reputation. Especially when international data is transferred, the financial shared service center must comply with data regulations in different countries and regions, such as the EU's General Data Protection Regulation (GDPR) and China's Personal Information Protection Law, making the compliance of digital transformation more complex.

The lack of a unified data management process, standards, quality assurance mechanisms, and access control procedures, or the inability to identify and define corporate data, can affect the quality of financial reports and decision-making due to issues such as data quality and data synchronization. The challenge of how to effectively address data risks presented in new scenarios like cloud computing and artificial intelligence also poses ongoing updates and transformations for financial shared service centers.

4 OPTIMIZATION PATH OF FINANCIAL SHARING CENTER

4.1 Build a Cloud-Based Digital Platform to Upgrade the Technical Architecture

In the context of new productive forces, data elements have become the most valuable production factors for enterprises after digital transformation. Financial shared service centers should actively explore paths to transition to cloud-based digital platforms, building elastic and scalable technical architectures through cloud computing technology. Cloud-based digital platforms can aggregate various financial data resources of the enterprise, expanding from accounting sharing to shared services across multiple domains, ultimately transforming into enterprise-level data centers.

The specific manifestations include: rearchitecting the existing financial shared service center application system into a microservices architecture, decoupling and flexibly assembling functional modules; introducing an AI-based data analysis engine to perform real-time computations on large volumes of financial data; setting up open API interfaces for relevant data to achieve seamless integration with external systems such as supply chains and sales markets.

4.2 Improve the Data Governance System and Release the Value of Data Elements

Improving data governance capabilities is the primary direction for optimizing and transforming financial shared service centers. Companies should focus on data governance to establish a comprehensive governance framework covering data standards, data quality, data security, and data value. In terms of data standards, unify the coding, naming, and interface requirements of financial data to ensure consistency and coherence; in terms of data quality, establish a data quality assessment model and a data issue traceability system to quantify and continuously monitor data quality. In terms of data security,

The financial shared service center must establish multi-dimensional security safeguards: physical data protection, network-level security measures (including firewalls, anti-malware and vulnerability scanners, network intrusion detection systems), application-level access control and identity authentication, as well as data-level encryption and secure transmission. Additionally, it should develop a data classification and protection strategy for critical financial information to enhance the security of financial data.

4.3 Promote the Construction of Organizational Capacity and Cultivate Digital Financial Talents

Organizational capability is a necessary guarantee for the optimization and transformation of financial shared service centers. The company can strengthen organizational capabilities in three aspects: First, optimize the organizational structure of the financial shared service center by setting up functional teams such as process management, data analysis, and technical support based on digital operation requirements, establishing a flexible and efficient organizational model; Second, establish a performance management mechanism that matches digital transformation, setting performance indicators related to data quality, process efficiency, and user experience; Third, build a data-driven corporate culture, advocating that employees form a work culture of "speaking with data, making decisions with data."

From the perspective of development direction, the financial shared service center should cultivate three types of digital finance talents: first, compound talents familiar with both finance and technology, who are solution experts responsible for designing and implementing digital finance solutions; second, financial data analysis experts, who are tasked with mining financial data and deriving insights; third, change management experts, who drive organizational and personnel changes during the digital transformation process.

4.4 Expand the Service Boundary and Build a Value-Creating Financial Sharing Center

The future financial shared service center should not be content with providing the simplest financial services but should actively seek to expand its boundaries and become a value creation hub. First, it should extend upstream in the financial value chain, offering value-added services such as financial forecasting, financial risk management, and investment decision support. Second, it should expand into other shared business areas like human resources and procurement, forming a scale advantage through multi-functional sharing.

A more forward-looking exploration is to export the capabilities of the financial sharing center to the external market and create new profit growth points through commercial operation.

5 CONCLUSION AND DISCUSSION

This paper comprehensively explores the practical significance, opportunities, and challenges of financial shared service centers in the context of corporate financial digital transformation, as well as optimization recommendations. The conclusion points out that financial shared service centers can significantly enhance financial management levels, reduce financial management costs, improve data management capabilities, and support corporate strategic decision-making, making them an effective path to building world-class financial management systems. However, during their construction and transformation, they face challenges such as technological integration, organizational change, data management, and data security. Companies need to consider these aspects comprehensively from the perspectives of technical infrastructure, data architecture, organizational capability, and service model, and fully promote coordinated advancement[7-8].

Intelligent, platform-based, and ecosystem-oriented development will be the future trend for financial shared service centers. Under the conditions of technological innovation and application such as artificial intelligence and blockchain, these centers may evolve into more intelligent and platform-based systems. They will exhibit future accounting forms based on artificial intelligence and blockchain, as well as predictive analytics. Financial shared service centers will also transform from internal service functions to financial service platforms that link internal and external resources, thereby exerting greater leverage on the value of industrial ecosystems[9-10].

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Henriette E, Feki M, Boughzala I. 11 digital transformation challenges and how to overcome them. Journal of Business Research, 2016, 78(2): 123–135.

[2] Jeleel-Ojuade A. The role of information silos: An analysis of how the categorization of information creates silos within financial institutions. SSRN, 2024.

[3] Hu Anqin, Kong Qingjing, Han Sufen. Research on the Digital Transformation of Finance under the Sharing Concept. Qinghai Daily, 2023(12): 1-3.

[4] Yin H. Research on the optimization of financial shared service center of enterprise group. 2019.

[5] Zhang Q, Zhang L. Research on the transformation path of financial shared service center to cloud digital platform. Business Accounting, 2024, (10): 10–14.

[6] Li C, Zhu Xianjun. Analysis and Research on the Financial Shared Service Center Model. Manager Journal, 2009(24): 1.

[7] Zhang Q. Advantages and limitations of financial shared service center. 2024(6).

[8] Smith J, Johnson L. Financial data management in the digital economy. In: Handbook of Digital Transformation. Springer, 2023: 234–256.

[9] Brown A, Ryan M. Breaking down data silos: Strategies for financial institutions. Journal of Financial Technology, 2023, 15(3): 45–60.

[10] White L, Green S. Digital transformation in finance: Overcoming the silo mentality. International Journal of Business and Economics, 2024, 22(1): 78–92.

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3042

ASSESSING AND ENHANCING ANHUI PROVINCE'S INDUSTRIAL TRANSFER CAPACITY: A MULTIDIMENSIONAL APPROACH

AiYong Lin, YaJie Zhang*, Xue Wu
Business School, Suzhou University, Suzhou 234000, Jiangsu, China.
Corresponding Author: YaJie Zhang, Email: zhangyj@ahszu.edu.cn

Abstract: The scientific assessment of regional industrial transfer capacity and the identification of its key determinants are crucial for fostering high-quality regional coordination and facilitating a smooth domestic economic cycle. This study proposes a data-driven framework for the comprehensive evaluation of regional industrial transfer capacity and the systematic identification of its influencing factors. Methodologically, we construct an evaluation index system based on three dimensions: industrial attraction, industrial support, and industrial development. The entropy-weighted TOPSIS model is employed to assess the development level of regional industrial transfer and analyze its evolutionary trends. Furthermore, an obstacle degree model is applied to pinpoint the key constraints hindering industrial transfer capacity, enabling the formulation of targeted policy recommendations. Empirically, we examine industrial transfer succession across cities in Anhui Province from 2015 to 2023. The results reveal a spatially heterogeneous pattern characterized by "one core with multiple nodes." Key obstacles include inefficiencies in sci-tech innovation input-output and suboptimal levels of openness to foreign markets. This study contributes a robust analytical tool for regional industrial transfer decision-making, offering both theoretical insights and practical guidance for industrial structure upgrading and agglomeration development.
Keywords: Industrial transfer; Anhui province; Entropy weight TOPSIS model; Obstacle degree model

1 INTRODUCTION

China's vast territorial expanse exhibits pronounced regional heterogeneity, with significant disparities in economic development, social progress, and resource endowments across its eastern, central, and western regions. These imbalances manifest in several critical dimensions: The eastern region demonstrates markedly faster structural adjustment and superior development quality compared to its western counterparts, while northern regions—particularly the northeast—grapple with insufficient developmental vitality, exacerbated by population outflow and accelerated aging. Furthermore, the current industrial spatial distribution remains suboptimal, lacking systematically differentiated regional industrial policies.

To address these challenges and realize the strategic objective of coordinated regional development, it is imperative to fully leverage the comparative advantages arising from the heterogeneity of regional resource endowments and development gradients. Industrial transfer—a phenomenon driven by interregional comparative advantage differentials or sectoral factor demand variations at specific developmental stages—constitutes an inherent mechanism of market economy evolution [1]. Enhancing regional industrial transfer capacity necessitates two foundational efforts: rigorous identification of key influencing factors, and scientific quantification of transfer potential. This demands the construction of a dynamic evaluation framework that integrates regional economic, social, and environmental dimensions. Such an approach holds dual significance: it not only facilitates the smoothing of domestic economic circulation but also serves as a critical enabler for achieving high-quality spatially integrated development.

Under the strategic imperative of fostering coordinated and high-quality regional development, industrial transfer has emerged as a critical focus in contemporary academic inquiry. Existing scholarship, as evidenced by key literature, primarily concentrates on three core dimensions: the systematic construction of evaluation index system, the methodological selection for capacity assessment, and the identification of critical influencing factors.

For the construction of regional industrial undertaking professional evaluation index system, scholars mostly build their comprehensive evaluation index system from different perspectives based on the theory of industrial transfer. For example, Zhang et al. used cloud theory and correlation function to build a potential measurement model of rural undertaking urban industrial transfer from the perspective of industrial attraction, industrial undertaking, industrial selection and industrial development capacity [2]; Liang et al. built an evaluation index system of industrial transfer capacity from seven aspects: economic development level, industrial structure level, opening-up level, technological innovation level, industrial supporting capacity, market development potential and labor cost [3]; Liu et al. built an index evaluation system for the ability of the western region to undertake manufacturing transfer from three aspects: Industrial attraction, industrial support and industrial development potential [4]; Xu et al. built an evaluation index system of industrial undertaking potential in the poverty belt from the five dimensions of industrial ecological carrying capacity, industrial attraction, industrial support, industrial development and industrial selection [5]. Wang and Liu built an improved "thrust pull resistance" interregional industrial transfer force system, and systematically analyzed the industrial transfer forces of industrial transfer out areas and industrial undertaking areas from the three dimensions of thrust factor, pull factor and resistance factor [6].

Scholarly research has employed diverse quantitative methodologies to assess regional industrial transfer capacity, reflecting varying theoretical perspectives and analytical objectives: Liu et al. applied shift-share analysis to decompose industrial transfer into three components: structural, competitive, and deviation effects, enabling comprehensive tracking of industrial relocation trends [7]. Yuan and He developed dual indices of industrial agglomeration and attraction intensity to delineate transfer patterns and identify potential receiving regions [8]. Peng et al. combined Euclidean distance measurement of geo-economic relations with industrial order degree modeling to quantify interregional structural complementarity [9]. Contemporary studies have advanced methodological sophistication through: Factor analysis [3]，Entropy-weighted TOPSIS [7]，Social network analysis [10]，Hybrid entropy-time series weighting [11]. This methodological evolution demonstrates a progression from unidimensional metrics toward integrated frameworks that capture the complex spatial, structural, and temporal dimensions of industrial transfer processes.

Further, in order to improve the level of regional industrial transfer, scholars carried out research on its driving factors. The specific research results are as follows: Wang and Jia believe that the comparative advantage and competitive advantage of the undertaking area are important factors affecting the industrial transfer of enterprises [12]; Yuan and He believe that the ability to undertake industrial transfer is determined by the investment environment, natural resources, convenient transportation, technological innovation, labor costs [8]; Qiu et al. believed that the investment environment, industrial clusters, independent innovation of enterprises, and industrial undertaking policies had an important impact on undertaking industrial transfer [13]. Zhang and Xue believe that the internal driving force of rural undertaking industrial transfer is mainly driven by economic capital benefits, resource and environmental benefits, and network system construction [2]; Sorodan et al. believed that the regional development level, scientific and technological innovation ability and market potential had the most significant impact on the industrial undertaking capacity [14]; Sun and Zhao believe that technological innovation ability, business environment quality and intellectual property protection are the key to enhance the attractiveness of industrial transfer [15]; Yue and Miao the best area to undertake resource intensive, labor-intensive, capital intensive and technology intensive industries is to undertake environmental advantages, labor, investment, scientific and technological innovation and other factors [16]; Wei et al. established a gravity model and believed that labor factors, trade environment, innovation ability and policy environment were the key factors affecting industrial transfer [17]. Wang et al. believed that the level of infrastructure, market size, industrial agglomeration and the cumulative effect of FDI had a significant promoting effect on the international industrial transfer in the region, while human capital had a significant negative inhibitory effect [18].

Based on the above literature, this paper attempts to expand the existing articles from the following three aspects:

(1) Industrial transfer is a complex support attraction development composite system, which involves a multi-dimensional and multi-level dynamic interaction process, but the internal relationship between them has not yet been clearly identified quantitatively. Therefore, it is necessary to consider the selection of key indicators of the support, attractiveness and development of regional industrial transfer and reduce the impact of subjective factors on the indicators.

(2) In the evaluation method of industrial transfer succession, a single method is often used, but there are many factors affecting industrial transfer succession, and the evaluation results obtained by different methods are different. Therefore, it is necessary to build a data-driven measurement and evaluation method of regional industrial transfer succession, so as to objectively and truly predict the dynamic changes and trends of regional industrial transfer succession.

(3) Due to the differences among regions, the practicability of relevant research results needs to be improved, and the support for regional decision-making is limited. Therefore, using the data-driven method to accurately and quantitatively evaluate the regional industrial transfer succession can form the whole process and dynamic monitoring for different regions, so as to form differentiated and appropriate accurate countermeasures for different regions.

To address the aforementioned challenges, this paper uses the research ideas of Lin et al [19]. For reference, proposes a data-driven comprehensive evaluation method of regional industrial transfer succession, and observes the evolution trend of regional industrial transfer succession, so as to realize the upgrading of regional industrial structure, promote industrial agglomeration, and achieve the goal of leapfrog economic development.

In order to achieve the above research objectives, the second part of the paper is the method, the third part is the case analysis, and the fourth part is the conclusion.

2 METHODS

This part is a comprehensive introduction to the measurement, evaluation and identification methods, including the method process, data collection, data processing, and data model.

2.1 Method Processes

Due to the significant gap between the East and west of China's economic development, the urban-rural dual structure is obvious, and the regional development imbalance exists for a long time. At the same time, the cost of land and labor in the eastern region continues to rise, the resource and environmental constraints continue to upgrade, and the industry needs to upgrade to high-tech and high-end, forcing the industry to transfer to the central and western regions. Therefore, it is necessary to scientifically evaluate the mutual constraints of regional industrial support, attraction and development, and quantify the level of industrial transfer inheritance, which is also the motivation of this paper.

However, industrial transfer is a complex support attraction development complex system, involving multi-dimensional, multi-level dynamic interaction process. However, there is no clear quantitative understanding of the internal relationship between them. There are regional differences in influencing factors. There are significant differences in the establishment of data sets and the selection of evaluation methods in different regions. Therefore, it is a challenge for researchers to build a universal evaluation index system to accurately measure the development trend and dynamic evolution of industrial transfer inheritance.

To address these challenges, this paper establishes a data-driven comprehensive evaluation method of regional industrial transfer, which measures, evaluates and identifies the regional ecological carrying capacity. Data driven applications mainly include: data collection mainly constructs indicators from the perspective of industrial undertaking, industrial attraction and industrial development; The data processing includes dimensionless standardization processing by normalization method and determination of index weight by entropy method; Data modeling is to build the TOPSIS Model of regional ecological carrying capacity respectively. Data analysis is based on TOPSIS to scientifically evaluate the dynamic evolution trend of regional industrial transfer succession, and put forward targeted methods to improve regional industrial transfer succession in practice. It can be seen that data driven is applied to build a more universal comprehensive method for measuring, evaluating, analyzing and optimizing the identification of regional industrial transfer inheritance. Therefore, this method can provide support for the evaluation and improvement of industrial transfer in different regions, and can also provide support for the management decision-makers in different regions who are based on resource endowment to realize the upgrading of industrial structure and industrial agglomeration in the industrial undertaking areas.

2.2 Data Collection

The inheritance of industrial transfer is a comprehensive ability to effectively attract and undertake external transferred industries through the construction of systematic ability to promote the upgrading and development of industries in the region [20]. It is the result of the synergy of industrial attraction, industrial support and industrial development. Among them, industrial attraction includes market potential, consumption potential, income potential, labor attraction, land and capital attraction, etc. Industrial support includes infrastructure, resources and environment, and institutional support. Industrial development power includes the development level of industrial scale, the development level of scientific and technological innovation and the development level of opening to the outside world [21]. See table 1 for specific index construction

Table 1 Evaluation Index System of Industrial Transfer Relay

	Rule Layer	Indicatorlayer	Interpretation
Industrial Transfer Relay	Industry Attractiveness(Y1)	Per Capita GDP (yuan)(X1)	market potential
		Retail Sales of Consumer Goods (in billions of yuan)(X2)	consumption potential
		Per Capita Disposable Income of Urban Residents (yuan)(X3)	Earning Potential
		Number of People Aged 15-59 (in 10000)(X4)	Attracting labor force
		Average Salary of on-the-job Employees (yuan)(X5)	
		Per Capita Years of Education (years)(X6)	
		Average Selling Price of Houses (yuan/square meter)(X7)	Land attraction
		Proportion of Domestic and Foreign Currency Loan Balance of Financial Institutions to GDP(%)(X8)	Attracting funds
		Number of Industrial Enterprises above Designated Size (units)(X9)	Industrial attraction
		Proportion of Secondary and Tertiary Industries(%)(X10)	
	Industrial Supporting Capacity(Y2)	Highway Density (km/square kilometer)(X11)	Facility support
		Freight Turnover (10000 ton kilometers)(X12)	
		Industrial Water Consumption (100 million cubic meters)(X13)	Resource and environmental support
		Industrial Electricity Consumption (100 million kilowatt hours)(X14)	
		Urban Green Space Coverage Rate(%)(X15)	
		Days with Good Air Quality(%)(X16)	
		Comprehensive Utilization Rate of Industrial Solid Waste(%)(X17)	
		Total Fixed Assets Investment (100 million yuan)(X18)	Institutional guarantee support
		Administrative Fees and Confiscation Fees as a Percentage of GDP(%)(X19)	
	Industrial Development Potential(Y3)	Total Output Value of Industrial Enterprises above Designated Size (in billions of yuan)(X20)	Industrial scale development
		Total Industrial Profit (in billions of yuan)(X21)	
		Number of Patent Applications Authorized (units)(X22)	Technological

R&D Budget (in billions of yuan)(X23)	innovation and development
Number of High-tech Enterprises(X24)	
Proportion of Total Import and Export Volume to GDP(%)(X25)	Development of level of opening-up to the outside world
Actual Utilization of Foreign Capital Total (in billions of US dollars)(X26)	

2.3 Data Sources and Processing

2.3.1 Data sources

The research collected and sorted out the data reflecting the industrial attraction, industrial support and industrial development of regional industrial transfer. The data mainly came from the statistical yearbook of Anhui Province, the statistical yearbook of China's environment, the statistical yearbook and statistical bulletin of various cities in Anhui Province, the relevant data published by the ecological and environmental protection departments of Anhui Province and various cities, as well as the field survey data, etc.

2.3.2 Data processing

In order to scientifically quantify the importance difference of each evaluation index, first normalize the original data to eliminate the dimensional influence, and then use the information entropy theory to objectively determine the weight of each index. The specific implementation steps are as follows

(1) Construction of standardized evaluation matrix for regional industrial transfer

Suppose the original evaluation index matrix of regional industrial transfer succession is:

$$X=\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \tag{1}$$

x_{ij} is the original value of the research object i and index j,

In view of the dimensional heterogeneity and inconsistent direction of the evaluation index system of industrial transfer undertaking (positive indicators are positively correlated with undertaking capacity, and negative indicators are negatively correlated), in order to achieve the comparability and aggregation of multi index data, the normalization method is used for dimensionless processing. Among them, the positive indicator is treated according to formula (2) and the negative indicator is treated according to formula (3) to obtain the standardized matrix R (formula 4)

$$r_{ij}=\frac{x_{ij}-\min(x_{ij})}{\max(x_{ij})-\min(x_{ij})} \tag{2}$$

$$r_{ij}=\frac{\max(x_{ij})-x_{ij}}{\max(x_{ij})-\min(x_{ij})} \tag{3}$$

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \tag{4}$$

r_{ij} refers to the standardized value of the research object i and index $j, i=1,2,\cdots,m$; $j=1,2,\cdots,n$.

(2) Determination of Index Weight

In order to objectively quantify the relative importance of each evaluation index of industrial transfer, the entropy method is used to allocate the weight. The specific method is as follows: first determine the information entropy H_j (see formula 5). The greater the value $1-H_j$, the higher the information utility value of the index, and the greater its weight in the evaluation of industrial transfer succession; Then use formula 7 to determine the weight of each index.

$$H_j=-\frac{1}{\ln m}\sum_{i=1}^{m} f_{ij}\ln f_{ij} \tag{5}$$

$$f_{ij}=\frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \tag{6}$$

$$w_j = \frac{1-H_j}{\sum_{j=1}^{n}(1-H_j)} \tag{7}$$

2.4 Data Model

2.4.1 Entropy weight TOPSIS method

Scholars' comprehensive evaluation of industrial transfer succession mainly includes principal component analysis, analytic hierarchy process, fuzzy comprehensive evaluation, entropy method and entropy weight TOPSIS method. However, the principal component analysis method is not accurate enough in explaining the succession of industrial transfer, and needs a large sample size; Analytic hierarchy process and fuzzy comprehensive evaluation method are significantly affected by subjective judgment in the process of weight determination; The entropy method is not enough to express the gap between the actual bearing capacity and the ideal state of the region. The entropy weight TOPSIS method has the advantage of objective weighting of entropy method. By improving the calculation of the proximity between the evaluation object and the positive and negative ideal solution, the authenticity of the evaluation results is significantly improved. Therefore, this paper uses the entropy weight TOPSIS method to comprehensively evaluate the regional industrial transfer undertaking [22].

(1) Construction of weighted decision matrix

In order to enhance the objectivity of the results and fully reflect the differences between the evaluation indexes, the weighted idea is introduced in the evaluation of industrial transfer inheritance. The weight of each index w_j determined by the entropy weight method, and then the weighted standardized decision matrix is constructed, as shown in formula (8).

$$V = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} = \begin{bmatrix} z_{11}.w_1 & z_{12}.w_2 & \cdots & z_{1n}.w_n \\ z_{21}.w_1 & z_{22}.w_2 & \cdots & z_{2n}.w_n \\ \vdots & \vdots & \vdots & \vdots \\ z_{m1}.w_1 & z_{m2}.w_2 & \cdots & z_{mn}.w_n \end{bmatrix} \tag{8}$$

(2) Determining positive and negative ideal solutions

Let V^+ represent the maximum value of the index j in the weighted evaluation data in the object i, that is, the best scheme, as the rational solution; V^- Represents the minimum value of the jth index in the ith object in the weighted evaluation data, that is, the most unsatisfactory scheme, as the negative ideal solution. See formulas (9) and (10) for specific calculation

$$V^+ = \{\max v_{ij} \,|\, i = 1,2,\cdots,m\} \tag{9}$$

$$V^- = \{\min v_{ij} \,|\, i = 1,2,\cdots,m\} \tag{10}$$

(3) Calculate the Euclidean distance from the positive (negative) ideal solution

Let the distances from each evaluation object vector to the positive and negative ideal solutions be D_i^+ and D_i^-, respectively, as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(V_{ij} - V_j^+)^2} \qquad (i = 1,2,\cdots,m) \tag{11}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n}(V_{ij} - V_j^-)^2} \qquad (i = 1,2,\cdots,m) \tag{12}$$

(4) Calculate closeness C_i

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \tag{13}$$

Closeness C_i represents the relative closeness between the evaluation object and the rational solution, and its value range is [0,1]. When $C_i \rightarrow 1$, it indicates that the industrial transfer inheritance of the object approaches the optimal water; On the contrary, when $C_i \rightarrow 0$, it reflects its weak carrying capacity. The ranking analysis based on the pasting progress value can realize the quantitative comparison and grading of the carrying capacity of different research objects, and provide a scientific basis for the decision-making of industrial transfer.

2.4.2 Obstacle model

In order to further identify and quantify the key obstacle factors of industrial transfer inheritance, the paper calculates the obstacle degree of each factor to the promotion of industrial transfer inheritance based on the index deviation degree, so as to determine the main limiting factors, and provide the basis for optimizing the regional industrial transfer inheritance [23]. The specific steps are as follows:

(1) Calculate index deviation

$$D_j = 1 - r_{ij} \tag{14}$$

The greater the deviation degree of the indicator, the farther the indicator deviates from the optimal state, and the stronger the barrier effect.

(2) Calculate obstacle degree

The deviation degree and weight are integrated to calculate the obstacle degree of each factor.

$$O_j = \frac{D_j \bullet w_j}{\sum_{j=1}^{n}(D_j \bullet w_j)} \tag{15}$$

The larger the O_j value, the stronger the impediment of this factor to the promotion of industrial transfer.

3 CASE STUDY

Using the above research methods, this paper focuses on the inheritance of industrial transfer in 16 cities of Anhui Province. At the theoretical construction level, firstly, based on the three dimensions of industrial attraction, industrial support level and industrial development potential, this paper constructs a comprehensive evaluation index system of industrial transfer inheritance. At the method application level, Entropy TOPSIS method and obstacle degree model are integrated to accurately and quantitatively evaluate the level and spatio-temporal dynamic evolution trend of regional industrial transfer inheritance, and identify and quantify the key obstacle factors of industrial transfer inheritance. At the level of policy system, this paper designs policy recommendations for various regions in Anhui Province to promote industrial upgrading and achieve high-quality development of economic integration by means of industrial transfer, and summarizes management enlightenment.

3.1 Case Study Background

Anhui Province is an important member of the Yangtze River Delta region and a key province in the rise of central China, and also an important destination for domestic industrial gradient transfer. Anhui Province is close to provinces such as Shanghai, Jiangsu and Zhejiang, which are important industrial transfer out areas of the country. It has successively set up demonstration zones for undertaking industrial transfer in the Wanjiang City belt and Anhui pilot free trade zone. It has clearly focused on emerging industries and promoted the transformation and upgrading of traditional industries in the "14th five year plan" of Anhui Province. It also has the advantage of developed transportation network and is competitive in land, labor and energy costs, attracting a large number of manufacturing enterprises to migrate. Automobile industry clusters have been formed in Hefei and other places, labor-intensive industries have been formed in Northern Anhui, and green industries have been formed in southern Anhui. Under the strategy of "integration of the Yangtze River Delta" to promote the coordinated development of industries, it has become the "bridgehead" for the transfer of industries from Shanghai, Jiangsu, Zhejiang and other provinces to the central and western regions. However, there are still some problems, such as unbalanced regional development, insufficient industrial supporting facilities, intensified competition, especially the environmental pressure caused by the transfer of traditional manufacturing industry. Therefore, it is typical to study the inheritance level of industrial transfer in 16 cities of Anhui Province to achieve high-quality economic development, which can also be used as a reference for other provinces.

3.2 Results

The Entropy TOPSIS method is used to comprehensively evaluate the level of regional industrial transfer and the spatio-temporal dynamic evolution trend of its subsystems; Further, with the help of obstacle degree model, the key driving factors of regional industrial transfer succession are identified. The specific results are as follows:

3.2.1 Analysis on the evolution law of comprehensive evaluation of industrial transfer succession in various regions of Anhui province

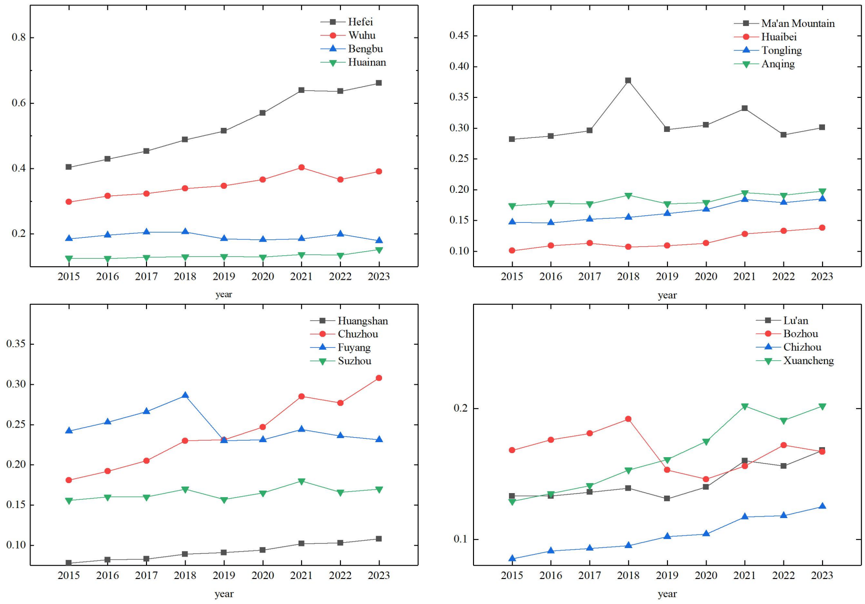


Figure 1 Comprehensive Evaluation Results of Industrial Transfer Relay

As shown in figure 1, according to the comprehensive evaluation results of industrial transfer undertaking in 16 cities of Anhui Province from 2015 to 2023, it can be seen that the comprehensive evaluation results of Hefei, Chuzhou, Wuhu, Xuancheng and other cities showed a significant upward trend, especially Hefei, which increased from 0.404 in 2015 to 0.661 in 2023, with the fastest growth rate and ranking first in the province; Ma'anshan, Fuyang and other cities showed fluctuating growth, but the overall trend was upward; However, Huaibei, Chizhou, Huangshan and other cities have a low base and slow annual growth rate. The reason is that Hefei has abundant scientific and technological innovation resources and the capital dividend, Chuzhou claims to be adjacent to Jiangsu, Zhejiang and Wuhu with complete industrial system, but Huaibei, Chizhou, Huangshan and other places have problems such as single industry, insufficient innovation investment and population outflow. The results of comprehensive evaluation in southern Anhui are generally higher than those in Northern Anhui, and the growth rate of Chuzhou, Xuancheng and other central cities is significant. The main reason is that southern Anhui has more regional advantages, forming a high-end industrial cluster, while northern Anhui has a high proportion of agriculture, slow industrialization, and prominent infrastructure and talent shortages.

3.2.2 Analysis on the evolution law of industrial attraction evaluation in various regions of Anhui province

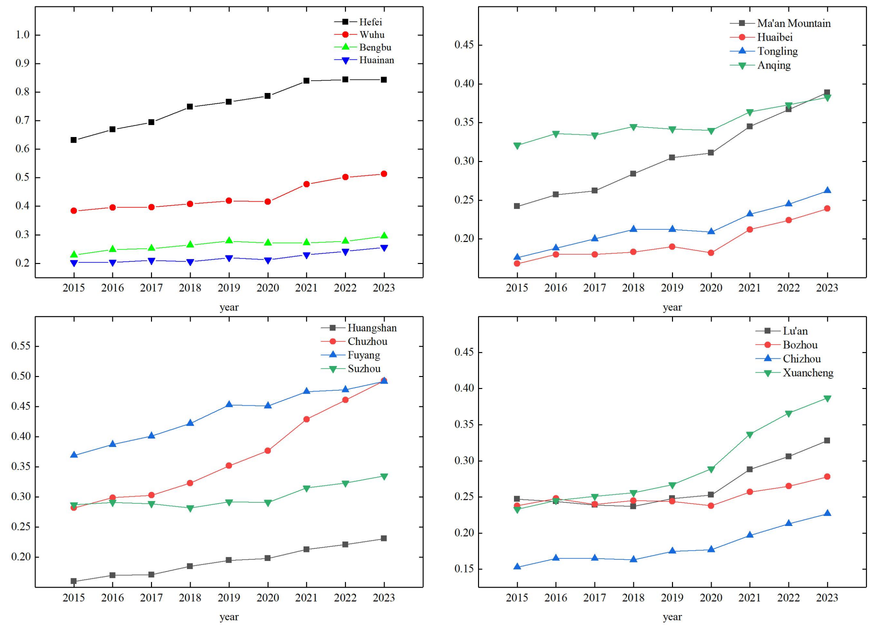


Figure 2 Comprehensive Evaluation Results of lndustrial Attraction

In figure 2, the evaluation results of the attractiveness of industrial transfer in Anhui Province from 2015 to 2023 show that the attractiveness of various cities is on the rise, but the growth rate is dissimilated, and the overall performance is characterized by "core leading and gradient dissimilation". As the core of the province, Hefei has a long-term leading attraction index (0.843 in 2023), followed by Wuhu, Chuzhou, Fuyang and other cities, forming a secondary growth pole; The attractiveness of Huaibei, Chizhou, Huangshan and other cities is relatively weak (less than 0.3 in 2023). The reason is that Hefei has formed a strong agglomeration effect by virtue of scientific and technological innovation and high-end manufacturing industry, and Wuhu and Chuzhou have benefited from the integration of the Yangtze River Delta and enhanced their ability to undertake industrial transfer. At the same time, the attraction of cities along the Yangtze River) and cities adjacent to the Yangtze River Delta has increased rapidly due to convenient transportation and complete supporting facilities. However, traditional resource-based cities such as Huaibei and Huainan have limited attractive growth due to their single industrial structure and slow transformation.

3.2.3 Analysis on the evolution law of industrial support level evaluation in various regions of Anhui province

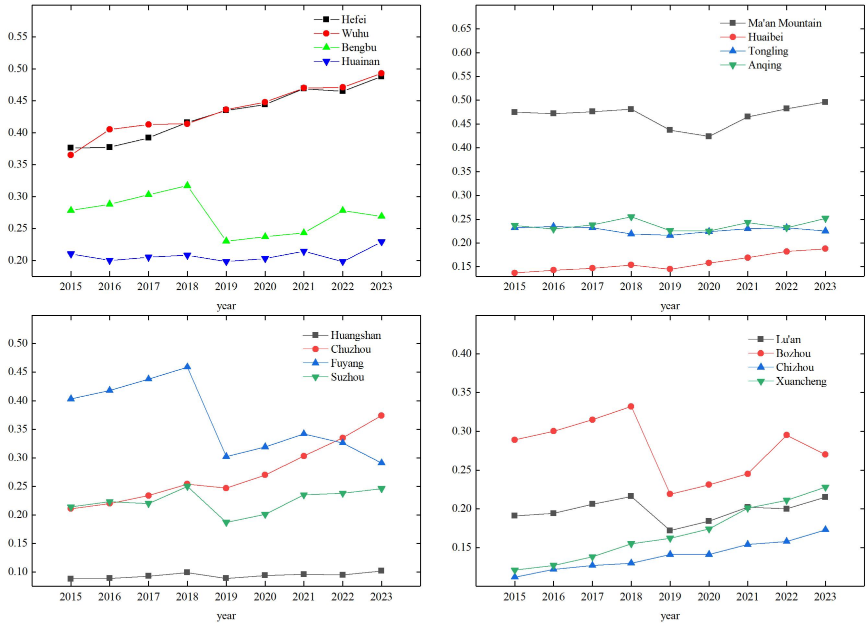


Figure 3 Comprehensive Evaluation Results of Industrial Support Level

According to figure 3, it can be seen that there are significant differences in the evaluation results of industrial transfer support among cities in Anhui Province from 2015 to 2023, and they show different trends over time, with a pattern of "strong in the South and weak in the north, high in the East and low in the West". Specifically, Ma'anshan, Hefei, Wuhu and other cities have strong support (0.496, 0.488, 0.493 in 2023), while Huangshan, Chizhou, Xuancheng and other places have weak support (0.102, 0.173, 0.228 in 2023), reflecting the imbalance of economic foundation and policy resources between Wanjiang City belt and Northern and southern Anhui. From the perspective of change trend, Hefei, Wuhu and other central cities have maintained a steady rise relying on scientific and technological innovation and industrial agglomeration; Chuzhou increased from 0.211 in 2015 to 0.374 in 2023, with a significant increase in support; The peak values of Fuyang and Bozhou both appeared in 2018, showing certain volatility. The main reason is that Chuzhou, Wuhu and other cities close to the Yangtze River Delta benefit from the regional collaborative policy, and the industrial undertaking capacity is enhanced; Some cities in Northern Anhui are restricted by infrastructure and industrial chain support, and the transformation is slow. At the same time, the industrial base also shows differences. Hefei, Ma'anshan and other industrial bases are strong and have strong support; Huangshan and Chizhou are dominated by tourism and have weak anti risk ability. For short-term fluctuations, Fuyang, Bozhou and other places were more significantly impacted by the epidemic, leading to a decline in support.

3.2.4 Analysis on evolution law of industrial development potential evaluation in various regions of Anhui province

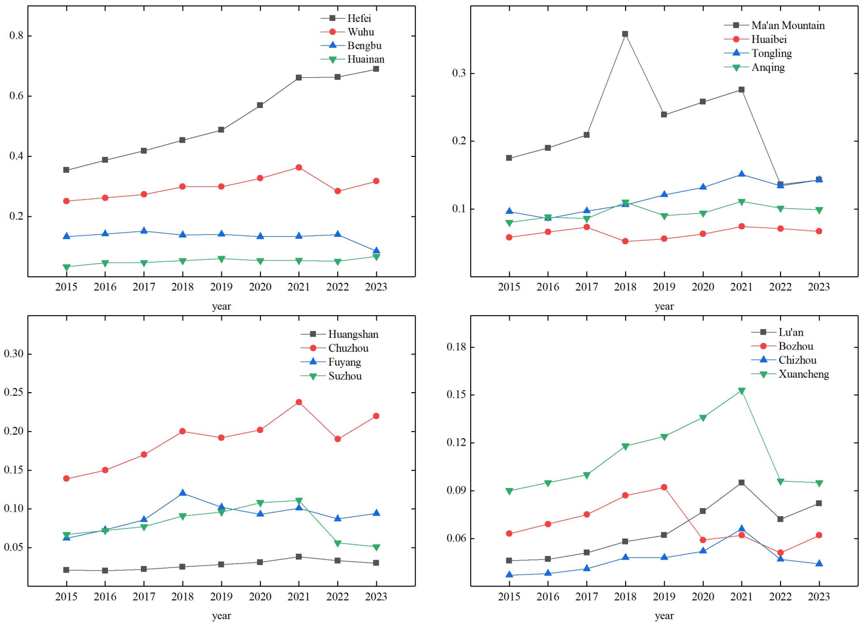


Figure 4 Comprehensive Evaluation Results of Industrial Development Capacity

According to figure 4, it can be seen that there are significant differences in the evaluation results of industrial transfer development ability among cities in Anhui Province from 2015 to 2023. The industrial development ability presents a pattern of "Hefei is one pole, Wuhu and Chuzhou are two points". The driving effect of core cities is obvious, but the regional balance needs to be strengthened. Specifically, Hefei, Wuhu, Chuzhou and other cities have strong development capacity, while Huangshan, Chizhou, Huainan and other places have weak development capacity. Hefei's development capacity continues to lead, growing from 0.354 in 2015 to 0.689 in 2023, showing a steady upward trend; Wuhu and Chuzhou followed, but Chuzhou fluctuated after reaching a peak of 0.238 in 2021. In contrast, the development capacity of Huangshan has always been at a low level, only 0.03 in 2023. As the provincial capital city, Hefei enjoys the advantages of policy, resources and technology, and the effects of scientific and technological innovation and industrial agglomeration are significant; Wuhu and Chuzhou are close to the Yangtze River Delta and have strong ability to undertake industrial transfer. At the same time, Hefei, Wuhu and other cities have received more policy support and infrastructure investment. However, due to the high proportion of traditional industries in Northern Anhui and the lack of transformation power, Huangshan, Chizhou and other places are limited by the requirements of ecological protection and the single industrial structure, and the growth is slow.

3.2.5 Analysis on the obstacle factors of industrial transfer inheritance in Anhui province

Through the above analysis, it can be found that the overall level of industrial transfer inheritance in various cities in Anhui Province is good, but there are still significant differences. Therefore, this paper introduces the obstacle degree model to further reveal the key factors that hinder the improvement of the level of industrial transfer in various cities of Anhui Province, and specifically analyzes them from the two levels of criteria and indicators.

(1) Obstacle factor analysis of criterion layer

Based on Figure 5, we can see the obstacle degree results of the standard layer of industrial transfer in 16 cities of Anhui Province from 2015 to 2023. It can be seen that the order of the obstacle degree of the criterion layer from large to small is industrial development potential, industrial attraction and industrial support. The average obstacle degree was 0.63, 0.215, 0.155. This shows that the industrial development potential is the key factor restricting the promotion of regional industrial transfer, and the obstacle level of this factor shows an upward trend. It can be seen that although all cities in Anhui Province have increased investment in scientific and technological innovation, continuously increased the level of foreign capital utilization, and increased the proportion of foreign exports, due to significant regional differences and the impact of the epidemic, the industrial development in Anhui Province is unbalanced, so that the industrial development potential is still the first factor restricting the undertaking of industrial transfer. At the same time, the industrial attraction and industrial support have declined to varying degrees, which also shows that the attraction of industrial factors in Anhui Province has been rising, the market potential has been continuously improving, the infrastructure has been significantly improved, the effectiveness of resource and environmental protection has been outstanding, and the system security system has been continuously improved, which has become a strong guarantee for undertaking industrial transfer.

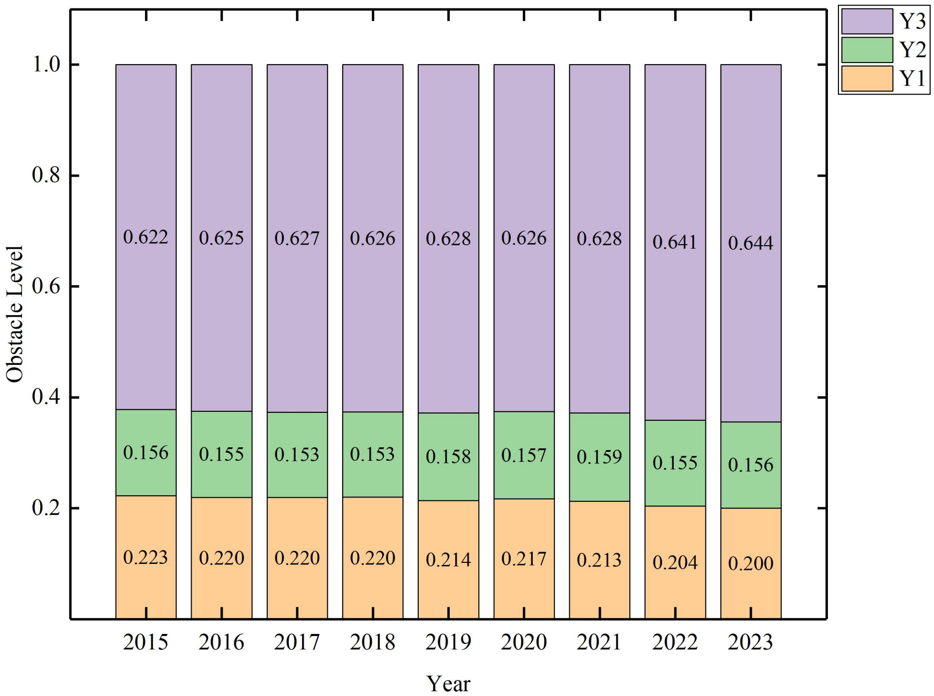


Figure 5 Obstacle Level of Anhui Industrial Transfer Inheritance Criteria (2015-2023)

(2) Obstacle factor analysis of index layer

Because there are many subdivision types of the indicator layer and the research time span is large, in order to facilitate the research, this paper selects 2015 and 2023, and selects the top five obstacle factors and discusses them according to the obstacle degree of the indicator layer. See Table 2 for details.

Table 2 shows that the main obstacle factors of the succession of industrial transfer in Anhui Province show strong stability in both time and space dimensions. Among them, the investment in scientific research and innovation (x23), the number of high-tech enterprises (x24), the proportion of total imports and exports in GDP (X25), the number of patent applications (X25) and the actual amount of foreign capital utilized (x26) are the core obstacle factors with the highest frequency. In addition, the turnover of goods (X12) and retail sales of social consumer goods (x2) also constitute constraints on the undertaking of industrial transfer in some regions.

Table 2 Obstacle Degree of Anhui Industrial Transfer Inheritance Index Layer (2015-2023)

Year	Hefei	Wuhu	Bengbu	Huainan	Ma'an Mountain	Huaibei	Tongling	Anqing
	X24(0.17)	X24(0.142)	X23(0.132)	X23(0.124)	X23(0.13)	X23(0.125)	X23(0.123)	X23(0.132)
	X25(0.151)	X23(0.137)	X24(0.129)	X24(0.119)	X24(0.129)	X24(0.119)	X24(0.12)	X24(0.126)
2015	X23(0.135)	X25(0.12)	X25(0.11)	X25(0.108)	X25(0.11)	X25(0.106)	X22(0.1)	X25(0.108)
	X22(0.117)	X22(0.107)	X22(0.105)	X22(0.096)	X22(0.104)	X22(0.1)	X25(0.081)	X22(0.102)
	X12(0.09)	X12(0.086)	X2(0.069)	X26(0.073)	X12(0.079)	X2(0.067)	X26(0.084)	X26(0.078)
	X25(0.36)	X24(0.136)	X23(0.127)	X23(0.126)	X24(0.127)	X23(0.127)	X23(0.129)	X23(0.135)
	X12(0.219)	X25(0.136)	X24(0.12)	X24(0.122)	X23(0.126)	X24(0.122)	X24(0.124)	X24(0.124)
2023	X26(0.218)	X23(0.113)	X25(0.116)	X25(0.11)	X25(0.119)	X25(0.11)	X22(0.106)	X25(0.115)
	X5(0.051)	X22(0.111)	X22(0.104)	X22(0.1)	X22(0.107)	X22(0.102)	X26(0.084)	X22(0.104)
	X21(0.045)	X26(0.106)	X26(0.085)	X26(0.079)	X26(0.086)	X26(0.08)	X25(0.072)	X26(0.086)
Year	Huangshan	Chuzhou	Fuyang	Suzhou	Lu'an	Bozhou	Chizhou	Xuancheng
	X23(0.121)	X23(0.133)	X23(0.139)	X23(0.131)	X23(0.128)	X23(0.131)	X23(0.121)	X23(0.127)
	X24(0.114)	X24(0.129)	X24(0.133)	X24(0.125)	X24(0.121)	X24(0.124)	X24(0.115)	X24(0.121)
2015	X25(0.1)	X25(0.114)	X25(0.116)	X25(0.111)	X25(0.109)	X25(0.111)	X25(0.101)	X25(0.104)
	X22(0.096)	X22(0.105)	X22(0.099)	X22(0.103)	X22(0.099)	X22(0.103)	X22(0.095)	X22(0.101)
	X26(0.071)	X2(0.068)	X26(0.081)	X2(0.068)	X26(0.071)	X26(0.066)	X12(0.069)	X12(0.069)
	X23(0.123)	X23(0.139)	X23(0.139)	X23(0.134)	X23(0.131)	X23(0.132)	X23(0.123)	X23(0.128)
	X24(0.114)	X25(0.137)	X24(0.13)	X24(0.125)	X24(0.122)	X24(0.124)	X24(0.117)	X24(0.124)
2023	X25(0.103)	X24(0.135)	X25(0.126)	X25(0.118)	X25(0.117)	X25(0.117)	X25(0.103)	X25(0.115)
	X22(0.097)	X22(0.114)	X22(0.109)	X22(0.104)	X22(0.1)	X22(0.105)	X22(0.099)	X22(0.103)
	X26(0.076)	X26(0.098)	X26(0.089)	X26(0.084)	X26(0.084)	X26(0.083)	X26(0.078)	X26(0.086)

Further analysis shows that although Anhui province continues to increase investment in scientific and technological innovation, there is still a significant gap in R&D intensity compared with developed provinces in the Yangtze River Delta. The uneven spatial distribution of innovation resources is prominent. High tech enterprises are highly concentrated in core cities such as Hefei and Wuhu, while the innovation foundation in northern and Western Anhui is weak, resulting in the imbalance of regional innovation factor allocation. This pattern makes the process of industrial upgrading slow in some cities, and it is difficult to effectively undertake the transfer of high value-added industries.

From the perspective of innovation output, although the number of patents shows a rapid growth trend, there are structural weaknesses: the proportion of high-quality invention patents is relatively low, the efficiency of technology transformation is insufficient, and the supporting effect of innovation achievements on industrial upgrading is limited, which directly restricts the carrying capacity of high-end manufacturing industry. In terms of the development of export-oriented economy, Anhui's dependence on foreign trade is lower than the national average, and the use of foreign capital is still dominated by the low-end links of the manufacturing industry, resulting in the weak ability to undertake international industrial transfer, which makes it difficult to deeply integrate into the high-end of the global value chain.

In terms of infrastructure, although the comprehensive transportation network has been continuously improved, the efficiency of the multimodal transport system is low, and the space for logistics cost optimization is large, which affects the stability of the supply chain and reduces the transfer willingness of enterprises to cost sensitive industries. The development of the consumer market shows the characteristics of regional differentiation. Core cities such as Hefei and Wuhu have contributed the main increment, but the overall consumption demand is insufficient, which restricts the carrying capacity of labor-intensive industries such as light industry and service industry.

4 CONCLUSIONS AND POLICY SUGGESTION

4.1 Conclusions

According to the research analysis and discussion, this paper draws the following conclusions: (1) from a comprehensive point of view, the industrial transfer succession in Anhui Province from 2015 to 2023 shows a "one pole and many points" trend, among which Hefei has the strongest industrial transfer succession, Wuhu, Chuzhou, Ma'anshan and Fuyang have the highest carrying capacity, while other cities have weak carrying capacity. (2) According to the analysis of the three subsystems, the industrial attraction is characterized by "core leading and gradient alienation". Hefei's attraction index has been leading for a long time, followed by Wuhu, Chuzhou, Fuyang and other cities, while Huaibei, Chizhou, Huangshan and other cities are relatively weak. The support of industrial transfer is characterized by "strong in the South and weak in the north, high in the East and low in the west". The support of Ma'anshan, Hefei, Wuhu and other cities is strong, while the support of Huangshan, Chizhou, Xuancheng and other places is weak. The industrial development capacity presents a pattern of "one pole and two points". Hefei, Wuhu, Chuzhou and other cities have strong development capacity, while Huangshan, Chizhou, Huainan and other places have weak development capacity. (3) By analyzing the obstacle factors, it can be seen that the biggest obstacle in the criteria layer is the industrial development potential, while the input-output of scientific and technological innovation and the development level of opening-up in the indicator layer are the core obstacle factors with the highest frequency. In addition, the turnover of goods (X12) and retail sales of social consumer goods (x2) also constitute the constraints of industrial transfer in some regions.

4.2 Policy Suggestion

Based on the research conclusion and the actual situation of cities in Anhui Province, this paper puts forward some policy suggestions to promote the continuous improvement of industrial transfer capacity of cities in Anhui Province

(1) Coordinated development of various regions and undertaking the transfer of industries according to local conditions

Based on their own resource endowment, industrial base and regional advantages, cities in Anhui should form complementary synergy with other cities in the Yangtze River Delta and the province, avoid homogeneous competition, and form differentiated industrial transfer strategies. Relying on the advantages of technological innovation, industrial clusters and Yangtze River port, Wanjiang City Belt cities focus on undertaking advanced manufacturing. With the advantages of human capital, agriculture and coal resources, Northern Anhui focuses on undertaking labor-intensive industries and building green agricultural product supply bases and new energy bases such as photovoltaic and energy storage. Taking advantage of ecological advantages, Southern Anhui can undertake the transfer of green industries such as ecological industry, culture, tourism, health and oxygen, and characteristic agriculture. With differentiated positioning and collaborative linkage, Anhui can form a new industrial undertaking pattern of "science and innovation leading the Wanjiang River, manufacturing upgrading Northern Anhui, and ecological empowerment Southern Anhui".

(2) Optimize the allocation of regional innovation resources and promote the deep integration of "science and innovation+industry"

Innovating the talent evaluation mechanism and establishing the flexible flow mechanism of talents in various regions of Anhui Province; Accelerate the construction of Anhui Science and technology market and promote the transformation of scientific and technological achievements; Set up innovation funds to promote industrial transfer, and strengthen the coordination of Finance and technology, industry, and fiscal and tax policies in various regions. Thus, the optimal allocation of innovation elements such as talents, technology and capital in various regions of Anhui Province can be realized, and the short board of unbalanced regional scientific and technological innovation can be solved. At the same time, based on regional innovation differences, the pattern of the core innovation circle centered on Hefei, the entrepreneurial innovation circle centered on Wuhu, Ma'anshan and Bengbu, and the application innovation circle represented by cities in southern and Northern Anhui has been formed. Realize the development potential of science and technology innovation driven industries in various regions, and continue to improve the level of industrial transfer in Anhui Province.

(3) Enhance the supporting capacity of the industrial chain to attract high-quality foreign investment and enhance the development potential of industrial transfer

Anhui Province should take the key industries such as new energy vehicles, integrated circuits and artificial intelligence as the guide, sort out the key links in the upstream and downstream, establish the strategy of "lack of chain and supplement of chain, weak chain and strong chain", strengthen the precise investment attraction of the industrial chain, enhance the attraction of foreign investment in key fields, encourage foreign-invested enterprises to increase capital and shares, and set up investment companies and regional headquarters. We will carry out "investment in Anhui" in depth, build institutionalized platforms such as "Huidong global" sea going activities and seafaring round tables, and strengthen docking and cooperation with internationally renowned investment institutions and international funds. Give play to the investment attraction function of Anhui pilot Free Trade Zone, national development zones, provincial international cooperation industrial parks and other open platforms, attract overseas top 500 companies and leading multinational companies to invest and cooperate in Anhui, and improve the quality and level of foreign capital utilization in Anhui Province. Promote the upgrading from production base to R&D center and regional headquarters, enhance the added value and competitiveness of traditional industries, and create a good industrial foundation for industrial transfer [24].

(4) Build an efficient logistics network, tap the county consumption potential, and enhance the comprehensive support of industrial undertaking

Through infrastructure upgrading and county logistics sinking, build an efficient logistics network and open the aorta of industrial undertaking. Lay out secondary distribution centers, form a three-level network of "hubs+nodes+terminals", build regional logistics hubs, and connect the Yangtze River Delta logistics corridor. Promote the seamless connection between the ports of the Yangtze River and the Huaihe River and railways and highways, and reduce the cost of bulk logistics. With the help of expansion and demand industry linkage, tap the county consumption potential. Support the construction of cold chain warehousing in northern and Western Anhui, and meet the high-end market demand in Shanghai, Jiangsu and Zhejiang. Use the urban and rural public transport network for express delivery to reduce the rural terminal distribution cost. Build a township business center, introduce the combination of chain brands and local characteristics, and promote live e-commerce into the county. Anhui Province can form a positive cycle of "logistics cost reduction - consumption expansion - industrial upgrading", and transform the county potential into the core competitiveness to undertake the industrial transfer in the Yangtze River Delta.

5 SUMMARY AND PROSPECT

At present, China's regional development is unbalanced and inadequate, and the sustainable promotion of regional coordinated development is facing difficulties [25-26]. Give full play to the resource endowment and development degree of various regions, and reasonably arrange regions to undertake industrial transfer. The key is to find out the key factors that affect regional industrial transfer, and scientifically and accurately assess the level of regional industrial transfer. Therefore, this paper proposes a data-driven comprehensive evaluation method of regional industrial transfer succession, observes the evolution trend of regional industrial transfer succession, and identifies its key influencing factors, so as to reasonably undertake the transferred industries, realize the upgrading of industrial structure, and promote industrial agglomeration.

Although this study has made some breakthroughs and innovations on the basis of previous literature, there are still some limitations. On the one hand, the research of this paper is based on the static and ex post basis of regional industrial transfer, and does not fully consider the dynamic and predictive changes of the ability of different regions to undertake industrial transfer. Future related research will refine the time node to further study the prediction of regional industrial transfer; On the other hand, due to the availability of data and the number of missing values, this study focuses on 16 prefecture level cities in Anhui Province. Although the research results can clearly show the status of prefecture level cities' industrial transfer, the county-level industrial characteristics are also obvious. Future research will break through the limitations of incomplete county-level data and focus on the county-level in order to obtain more targeted policy recommendations.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This research was supported by the Anhui Province Social Science Innovation and Development Project (No. 2022CX076) , (No. 2023CX023); Key Research Projects of Philosophy and Social Sciences in Anhui Province (No.2023AH052209); Major research projects of philosophy and Social Sciences in Anhui Province (No. 2022AH040204); Provincial New Professional Quality Improvement Project (No. 2023xjzlts069).

REFERENCES

[1] Hong J, Chen Y, Yang Z. Strategic Considerations of China's Industrial Transfer: Characteristics, Motivation and Policy Outlook. International Trade, 2024(07): 11-21.
[2] Zhang F, Xue H. Analysis on the Internal Dynamic Mechanism of Rural Undertaking Industrial Transfer under the Background of Urban Rural Integration -- Taking the Yellow River Delta as an Example. Journal of Harbin University of Commerce (Social Science Edition), 2020(04): 106-120.
[3] Liang X, Luo Y, Peng D. Comprehensive Evaluation of Industrial Undertaking Capacity in Central China. Finance and Economy, 2020(07): 91-96.
[4] Liu M, Wang X, Jin Y. Evaluation of the Ability of the Western Region to Undertake the Transfer of Manufacturing Industry and its Strategies. Statistics and Information Forum, 2020, 35 (08): 91-101.
[5] Xu L, Tao J, Zhang M, et al. Measurement and Zoning Optimization of County Industrial Undertaking Potential in the Poverty Belt Around Beijing and Tianjin Based on Multi-source Data. Geography and Geographic Information Science, 2021, 37(02): 135-142.
[6] Wang S, Liu Z. The Mechanism of Interregional Industrial Transfer: an Analysis based on the "Push-Pull" Model. Xue Hai, 2023(01): 74-81.
[7] Liu L, Kang J, Liu Y. Analysis on the Evolution Characteristics and Succession Trend of Manufacturing Development Types in the Yangtze River Economic Belt Based on Shift Share Method. Journal of Chongqing University (Social Science Edition), 2020, 26(01): 31-44.
[8] Yuan G, He Z. Industrial Transfer, Undertaking Capacity and Undertaking Industry Directory: Guangxi Countermeasures. Social Scientist, 2020(02): 68-74.
[9] Peng J, Wang Y, Li S. Feasibility Study on the Integration of Ganzhou into Guangdong Hong Kong Macao Bay Area -- Based on the Perspective of Undertaking Industrial Transfer. Finance and Economy, 2020(05): 89-96.
[10] Cao W, Liu C, Miao J. Dual Network Analysis of Industrial Space for Regional Undertaking Industrial Transfer -- Based on the Comparative Perspective of Financial Development and Resource Endowment Factors. Operations Research and Management, 2021, 30(05): 176-181.
[11] Song L. Research on Dynamic Comprehensive Evaluation of Environmental Carrying Capacity of Industrial Transfer Undertaking Areas in Central China -- a Case Study of Wan jiang City Belt. Finance and Trade Research, 2021, 32(09): 47-56.
[12] Wang X, Jia R. Comparative Advantage, Competitive Advantage and Industrial Transfer of Undertaking Area -- An Empirical Study Based on the Data of Shanghai Enterprises' Foreign Investment. Investment Research, 2020, 39(01): 39-50.
[13] Qiu H, Pan H, Liu D, et al. Industrial Agglomeration Index, Industrial Attraction Index and Industrial Transfer and Undertaking. Scientific Decision Making, 2020(06): 41-68.
[14] Saurodin Li F, Zhu X. Analysis on the Industrial Undertaking Capacity and Direction of Huai He Ecological Economic Belt. Ecological Economy, 2021, 37(01): 64-69+110.
[15] Sun J, Zhao H. Research on Improving the Ability of Scientific and Technological Innovation and Accelerating the Undertaking of Industrial Transfer in the Western Region-Based on the Questionnaire Survey Data of 120 Enterprises. Scientific Management Research, 2021, 39(03): 76-84.
[16] Yue L, Miao J. Situation and Matching of Interregional Industrial Transfer and Undertaking under the Dual Cycle Pattern. Statistics and Information Forum, 2021, 36(09): 45-56.
[17] Wei J, Chi Y, Li Y, et al. Research on the Impact Potential of Maritime Transport based on the Industrial Transfer Relationship of Countries along the "Maritime Silk Road". China Maritime, 2022, 45(04): 78-86.
[18] Wang S, Chen X, Long X, et al. Influencing Factors and Spatial Effects of Henan, Anhui, Hubei, Hunan and Jiangxi Undertaking International Industrial Transfer. Geography and Geographic Information Science, 2022, 38(06): 60-67.
[19] Lin A, Liu Y, Zhou S, et al. Data-driven Analysis and Evaluation of Regional Resources and the Environmental Carrying Capacity. Sustainability, 2023, 15(10): 8372.
[20] Tian Y, Jiang G, Zhou D, et al. Regional Industrial Transfer in the Jingjinji Urban Agglomeration, China: An Analysis Based on a New “Transferring Area-undertaking Area-dynamic Process” Model. Journal of Cleaner Production, 2019, 235: 751-766.
[21] Fu S, Ma Z, Ni B, et al. Research on the Spatial Differences of Pollution-intensive Industry Transfer Under the Environmental Regulation in China. Ecological Indicators, 2021, 129: 107921.
[22] Zhao H, Liu Y, Lindley S, et al. Change, Mechanism, and Response of Pollutant Discharge Pattern Resulting from Manufacturing Industrial Transfer: A Case Study of the Pan-Yangtze River Delta, China. Journal of Cleaner Production, 2020, 244: 118587.
[23] Bai H, Irfan M, Hao Y. How does Industrial Transfer Affect Environmental Quality? Evidence from China. Journal of Asian Economics, 2022, 82: 101530.
[24] Zheng X, Yu H, Yang L. Factor Mobility, Industrial Transfer and Industrial Carbon Emission: a Spatial Matching Perspective. Frontiers in Environmental Science, 2022, 10: 822811.
[25] Wang Y. Efficient Adverse Event Forecasting in Clinical Trials via Transformer-Augmented Survival Analysis. Preprints, 2025. DOI: 10.20944/preprints202504.2001.v1.
[26] Gui L, Hu X, Li X, Zheng M. Study on the Influence of Undertaking Industrial Transfer on the Sustainability Development of Wanjiang City Belt. Sustainability, 2022, 14(22): 14993.

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3043

THE MECHANISM OF PROMOTING THE SOUND DEVELOPMENT OF THE DIGITAL ECONOMY THROUGH ICT STANDARD

XueQian Zhang*, Hong Zhang
China Electronics Standardization Institute, Dongcheng District, Beijing 110101, China.
Corresponding Author: XueQian Zhang, Email: 15210681944@163.com

Abstract: The integrated innovation of new-generation information and communication technology(ICT), while releasing substantial industry benefits, also conceals risks of an equivalent magnitude. The sound development of the digital economy enables the nation to exploit these benefits more fully and minimize the corresponding risks to the maximum extent. Against this backdrop, ICT standard, with its unique guiding and regulatory mechanisms, can ensure device interconnectivity and data interoperability, drive technological research and application, strengthen security protection systems, optimize industrial agglomeration models, and enhance competitive advantages for enterprises, so as to facilitate the digital economy in terms of improving quality and increase efficiency, achieving inclusive and mutually beneficial outcomes, as well as maintaining stable and long-term development.
Keywords: ICT; Standard; Digital economy; Sound development

1 BACKGROUND AND CONNOTATION OF DIGITAL ECONOMY DEVELOPMENT

Since entering the second decade of the 21st century, China's digital economy has seen rapid growth in both quantity and quality. In terms of quantity, the scale of China's digital economy has grown from nearly 10 trillion yuan in 2011 to 53.9 trillion yuan in 2023, and its share of GDP has increased from 20.3 percent to 42.8 percent[1]. In the field of industrial scale, corporate expenditure, patent ownership, and platform value, it has formed a duopoly pattern with the United States[2]. In terms of quality, China's digital economy follows the two directions of digital industrialization and industrial digitalization, with ubiquitous interconnection of all things as the foundation, data integration and application as the impetus, and multi-layer collaborative intelligent computing as the core, promoting society into an era of digitalization, networking and intelligence.

The rapid development of the digital economy has provided major opportunities and opened up broad space for China to build a modern industrial system and promote high-quality economic development, but it has also brought unprecedented challenges. Compared with the traditional real economy, the digital economy is characterized by the continuous emergence of disruptive innovations, the platform economy driving super-fast growth, the "network effect" giving rise to winner-takes-all, and the "dandelion effect" leading industrial competition[3]. On the one hand, this puts forward higher requirements for technology and system integration, and on the other hand, it brings more challenges to the risk governance and ecological cultivation of the industry[4]. These requirements and challenges all need to be addressed by establishing "sound development" as the basic connotation of the development of the digital economy, in order to eliminate development risks, take the strategic initiative and ensure the continuous improvement of the digital economy.

The core of "sound development" lies in not only breaking away from the laissez-faire management model, the profit model that overly relies on the huge market, the evaluation model that unilaterally emphasizes economic benefits, but also paying more attention to the autonomy and controllability of the industrial chain, the safety and reliability of the products, as well as the cultivation of innovation capacity and innovation ecosystem[5]. As a result, the digital economy will, on the basis of rapid and large-scale development, further improve quality and increase efficiency, achieve inclusive and mutually beneficial outcomes, as well as maintain stable and long-term development. Therefore, sound development is an urgent requirement for the high-quality development of the digital economy, and promotes, supports, dynamically balances and evolves in tandem with high-quality development in terms of institutional design, technological governance and resource allocation[6].

2 CONSTRUCTION OF ICT STANDARDS FOR THE SOUND DEVELOPMENT OF THE DIGITAL ECONOMY

For the sound development of the digital economy, whether it is autonomy and controllability, security and reliability, or innovation capacity and innovation ecosystem, it cannot do without the boost and support of information and communication technology(ICT) standardization work. ICT standardization involves the collection, representation, processing, transmission, exchange, description, management, organization, storage, retrieval and technology of information, as well as the design, development, management, testing of ICT systems and products and the development of related tools. Since the 21st century, China's ICT standardization construction has widely mobilized and organized all stakeholders to systematically advance domestic and international standardization work around basic commonalities, key technologies and key applications, achieving remarkable results. As of May 2025, China has issued 1,953 national standards for information technology (including current and upcoming standards, the same below), 1,762 standards for the electronics industry, 5,227 standards for the communications industry, and 337 standards for radio, television and online audio-visual industry, had established a comprehensive and wide-ranging IC standard system(Data source: National Standard Information Public Service Platform. https://std.samr.gov.cn/). During this period, China's ICT standardization work responded promptly to emerging market demands such as interconnection, full-process and full-network, digital content, and information accessibility, guided the promotion and implementation of various applications such as Internet of Vehicles, intelligent manufacturing, smart cities, and smart homes, and drove the integration and innovation of technologies such as the Internet, Internet of Things, big data, cloud computing, mobile communication, and artificial intelligence. It has provided a strong guarantee for the digital economy to grow from its initial stage.

In the face of the new challenges and requirements for the sound development of the digital economy, the ICT standard system should be further improved and the construction of ICT standards should be further strengthened. A standard is a normative document formulated by consensus and approved by recognized institutions for common and repeated use in order to achieve the best order within a certain scope[7]. ICT standards, with their unique functional attributes, can play a fundamental and leading role in five aspects of the digital economy: common elements, innovative vitality, risk governance, ecological structure, and active subjects(Figure 1). The following will discuss the role that ICT standards play at each of these levels.

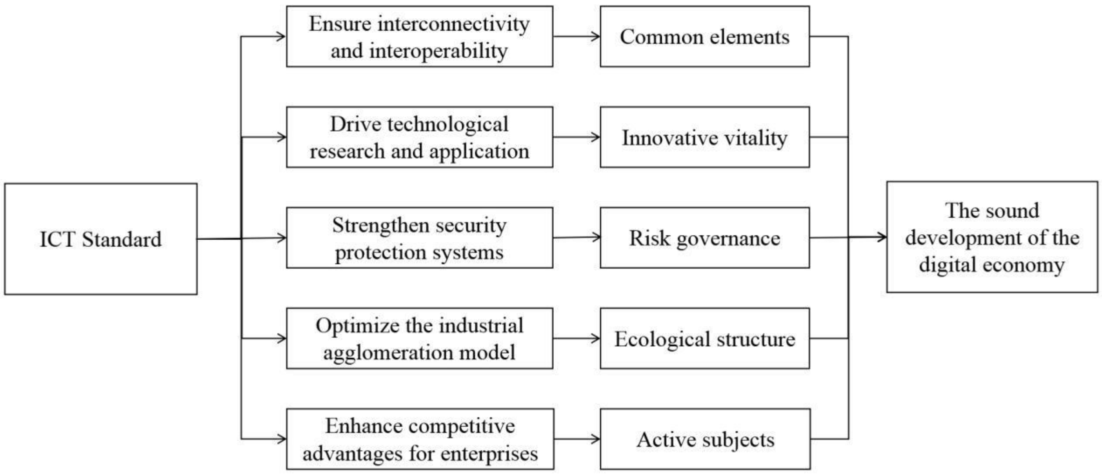


Figure 1 The Mechanism of Promoting the Sound Development of the Digital Economy through ICT Standard

3 THE SPECIFIC ROLE OF ICT STANDARDS IN PROMOTING THE SOUND DEVELOPMENT OF THE DIGITAL ECONOMY

3.1 Ensure Device Interconnectivity and Data Interoperability Focusing on the Digital Economy's Common Elements

The integration scope, innovation capacity and empowerment efficiency of the digital economy largely depend on the maximum interconnection and intercommunication among data, networks, systems and devices. The Internet, which has flourished based on the unified TCP transmission protocol, is the most powerful proof. The current digital transmission's dominant architecture is evolving from interconnection of human to intelligent interconnection of all things, and how to handle data heterogeneity, network switching, the complexity of terminal devices, and the large-scale integration of application systems will be the decisive factor for the in-depth expansion of Internet of Things technology, applications, and industries. Consequently, the sound development of the digital economy demands highly compatible ICT standards to connect and invoke multiple types of data interfaces. By conducting modularization, serialization, and generalization operations on ICT, the underlying architecture for data exchange and interoperability among systems and devices should be unclogged, eradicating the "information isolated island" phenomenon that emerges during the process of digital construction, and laying a solid foundation for the sharing and co-creation of data resources and the in-depth mining of data value.

3.2 Drive Technological Research and Application Focusing on the Innovative Vitality of the Digital Economy

Firstly, standardization often assumes the form of standard systems, series, and collections, constructing interrelated structures among standards that are mutually cooperative, consecutive, and guaranteeing. As a result, an innovation achievement can drive a group of technological and application innovations through standardization, thereby facilitating the formation and development of emerging industries. Secondly, against the backdrop of the digital economy, the network effects, transformation costs, policy dividends, market dividends, and related external environments formed around technological and application innovations are highly uncertain. Thus, ICT standards, with their functions of unifying, coordinating, simplifying, and optimizing technologies, will play an increasingly significant role in the digital economy's innovation ecosystem[8]. Thirdly, the technological and application innovations of ICT are characterized by diversified entities and networked collaboration. Meanwhile, ICT standards can offer relatively clear behavioral references for the R&D and production activities of various innovation entities and influence them to clarify the key points and objectives of R&D and production centered on core technical standards. Finally, the dissemination and diffusion of new technologies and applications are of paramount importance for achieving innovation goals, obtaining innovation benefits, and forming innovation cycles. Standardization, with its high distinctiveness and credibility, is a reliable approach to promoting social acceptance and recognition and boosting the dissemination and diffusion of innovation achievements.

3.3 Strengthen Security Protection Systems Focusing on the Digital Economy's Risk Governance

Network and information security serves as the bedrock of all digital economic activities. Despite the incalculable innovation space and application prospects of the new generation of information technology, security has emerged as the critical constraint impeding the realization of its potential. Particularly as a core constituent of the new infrastructure, the application domains that information technology pertains to often concern the most fundamental well-being of the people. Hence, the fundamental experience of China over the past two decades, which entailed weakening certain security requirements in the Internet domain to fulfill development demands, is not replicable in the current information technology sphere. In the future, whether the digital economy can achieve a high-level coordination and dynamic equilibrium between security and development will constitute a restrictive factor for its sound development. Moreover, ICT standards can exert their regulatory function by integrating security standards into various standard systems. Through classifying security levels, clarifying security requirements, formulating operation guidelines, and guiding testing and certification, they impose restrictive effects on all aspects such as related infrastructure, system architecture, networks, businesses, applications, terminals, and management.

3.4 Optimize the Industrial Agglomeration Model Focusing on the Digital Economy's Ecological Structure

Firstly, ICT standards have effectively enhanced the support system for technological and application innovations, thereby exerting a driving force on the evolution of the ICT industrial cluster model. During the process of developing, releasing, and implementing one or a series of ICT standards, the standard owners often expand the usage of the standards through granting patent licenses externally and form standard alliances[9]. This subsequently triggers related upstream and downstream enterprises to undertake extensive, imitative, and compliance measures centered around this standard, establishing an extensive ICT standard cooperation network[10]. Consequently, what is carried by standardization is no longer merely an individual innovation outcome but rather an efficient, mutually beneficial, and symbiotic cooperative relationship, thereby playing a distinctive role in connecting and integrating the formation, evolution, and optimization of the ICT industrial ecosystem. Secondly, the rapid advancement of the digital economy is propelling the international digital governance system into a transitional and window period marked by alterations in power relationships and shifts in the power center. Among these, the rule discourse power related to ICT governance constitutes the focus of international competition, and the sequence of "technological patenting - patent standardization - standard internationalization" represents the key path to acquiring the rule discourse power. Therefore, the collaborative mechanism composed of standards and patents can solidify and expand the "technical solutions" featuring Chinese wisdom and characteristics into "technical facts", thereby seizing more opportunities and resources for industrial promotion and commercial implementation on a global scale.

3.5 Enhance Competitive Advantages for Enterprises Focusing on the Digital Economy's Active Subjects

Enterprises actively engage in standardization activities, heightening their participation and discourse power within the standardization process, and facilitating the transformation of their enterprise standards into group standards, national standards, and international standards. This is conducive to the ripening of achievements, the opening up of markets, and the stimulation of trade. Throughout the entire life cycle of ICT standards, the starting point lies in the research and development of new technologies and new applications; the midpoint is the formulation of standards and the establishment of standard systems; and the endpoint is the promotion and dissemination of technical standards, as well as the production of products and services related to the standards. Especially considering that behind specific standards, several related technology patents may be bound, the promotion and dissemination of standards will also lead to the large-scale utilization of patents, thereby generating considerable revenues for enterprises[11]. Hence, an increasing number of enterprises are currently applying for patent protection for their innovative achievements on the one hand, and developing standards based on them on the other hand, while striving to make them prototypes of group standards, national standards, and international standards. Once such a standardization strategy succeeds, it will play a significant role in consolidating the industry's dominant position, expanding market share, and enhancing economic benefits.

4 CONCLUSION

The sound development of the digital economy will enable all industries and fields to exploit these benefits more fully and minimize the corresponding risks hidden behind these benefits to the maximum extent[12]. By forming guiding and normative mechanisms as mentioned above, ICT standards can support the organic synergy among various production departments, the efficient allocation of production factors, and the sequential connection of production links in the digital economy. As a result, ICT standards can facilitate the alignment of security requirements and development demands in the digital economy, the correspondence between innovation-driven and market-driven forces, and the integration of social and economic benefits, thereby promoting the sound development of China's digital economy in the digital realm.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] China Academy of Information and Communications Technology. China Digital Economy Development Research Report. 2024. 08. https://www.caict.ac.cn/kxyj/qwfb/bps/202408/P020240830315324580655.pdf

[2] UNITED NATIONS. Digital Fconomy Report 2019: Value Creation and Capture: Implica-tions for Developing Countries. 2019. https://unctad.org/en/PublicationsLibrary/der2019_en.pdf.

[3] Li Xiaohua. New Features and the Formation Mechanism of New Growth Drivers of Digital Economy. Reform, 2019, (11): 40-51.

[4] Banalieva E R, Dhanaraj C. Internalization theory for the digital economy. Journal of International Business Studies, 2019, 50(4): 1372-1387.

[5] Nambisan S, Wright M, Feldman M. The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. Research Policy, 2019, 48(8): 103773.1-103773.9.

[6] Central People's Government of the People's Republic of China, "14th Five-Year Plan" for Digital Economy Development. 2021. https://www.gov.cn/zhengce/zhengceku/2022-01/12/content_5667817.htm

[7] GB/T 20000.1-2002 Guidelines for Standardization Work - Part 1: General Vocabulary for Standardization and Related Activities. General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China. 2002.

[8] Li Chuntian (Editor-in-Chief). Introduction to Standardization (6th Edition). China Renmin University Press, 2014, 212.

[9] Teece D J. Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. Research Policy, 2018, 47(8): 1367-1387.

[10] Chuang H. Standard Essential Patent in Telecommunication Standard: United States and China Comparison. Thesis, University of Washington, 2016, 8.

[11] Wen Jun, Zhang Sen. Digital Economy Innovation: From the Perspective of Synergistic Advancement of Intellectual Property Rights and Technical Standards. Modern Economic Inquiry, 2021, (04): 1-7.

[12] Meyer Klaus E, Li J, Brouthers K D, et al. International business in the digital age: Global strategies in a world of national institutions. Journal of International Business Studies, 2023, 54(4): 577-598.

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3044

AN EXPLORATION OF FOREIGN DIRECT INVESTMENT IN THAILAND

Xu Wang
Department of Humanities and Finance, The Hi-tech College of Xi'an University of Technology, Xi'an 710109, Shangxi, China.
Corresponding Email: 942615811@qq.com

Abstract: Against the backdrop of economic globalization and the disruptions triggered by the U.S. reciprocal tariff policy, this study explores Thailand's attractiveness as a foreign direct investment (FDI) destination and its role in the global economy. Analyses of its economic development indicate that Thailand's GDP grew steadily at 3.9% in 2023 and 2.3% in 2024, reaching approximately $526.8 billion in 2024, with FDI serving as a critical driver of this growth. The Thai government's policies, such as tax incentives and the one-stop services offered by the Board of Investment (BOI), have significantly facilitated FDI inflows. Key investment sectors include electronics, digitalization, automotive manufacturing, and agriculture. For example, Chinese investments in electric vehicle (EV) components and Japanese advancements in automotive technology have boosted industrial upgrading. This study provides actionable insights for global enterprises to leverage Thailand's advantages for trade substitution and sustainable development, highlighting its potential as a key node in global value chains.
Keywords: Thailand; Foreign direct investment(FDI); Economic growth; Industrial development

1 INTRODUCTION

In the context of economic globalization, the international trade landscape is undergoing significant transformations. The reciprocal tariff policy implemented by the United States has introduced substantial disruptions to the global trade order, posing severe challenges to the overseas development of enterprises from various countries. Since the inception of trade frictions, the United States has repeatedly imposed high tariffs on export products from multiple nations, targeting numerous key industries. This has directly eroded the profit margins of exports for these enterprises and, in some cases, led to a precipitous decline in their market share. Consequently, enterprises from around the world have been compelled to reassess and reconfigure their global investment strategies.

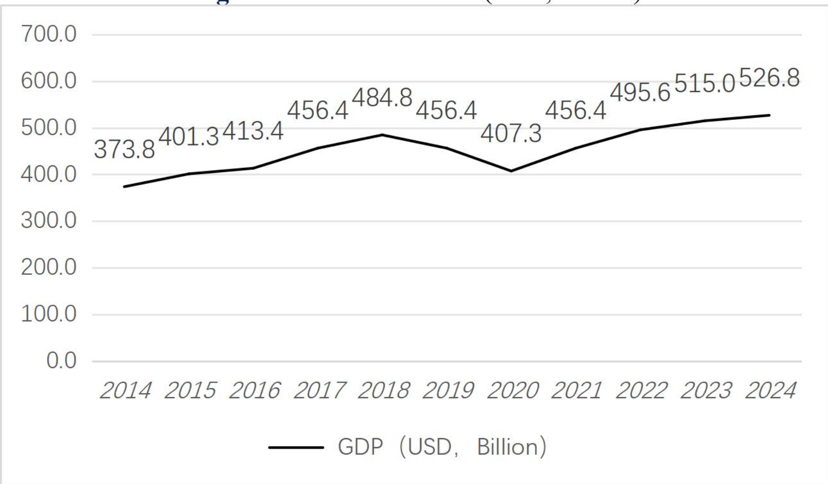
Thailand, as a vital economy in Southeast Asia, holds a strategic position within the region. Over the past decades, Thailand has witnessed a continuous deepening of cooperation across political, economic, and cultural domains with numerous countries. Thailand's strategic geographical location, coupled with its abundant natural resources and vast potential consumer market, renders it an attractive destination for foreign investment. Moreover, the political environment in Thailand remains relatively stable. The Thai government's proactive efforts in economic reform and liberalization have led to the introduction of a series of investment promotion policies, creating a conducive environment for foreign enterprises[1].

This study aims to provide an analysis of Thailand's economic environment and investment landscape. By examining the relevant factors, this research seeks to offer targeted and actionable recommendations for enterprises from different countries to engage in entrepreneurial activities, make informed investment decisions, and optimize their employment strategies in Thailand. These insights are intended to assist enterprises in effectively mitigating the adverse impacts of U.S. tariff policies and leveraging Thailand's unique advantages to achieve sustainable development.

2 ECONOMIC DEVELOPMENT OF THAILAND

Thailand occupies a significant position in the Southeast Asian economy, with its GDP growing steadily in recent years[2]. In 2023 and 2024, the Thai economy sustained its recovery, with GDP growth rates of 3.9% and 2.3%, respectively. In 2024, Thailand's GDP reached approximately 526.8 billion US dollars. This performance highlights the robustness of the Thai economy within the Southeast Asian region.This robust economic growth is primarily attributed to the Thai government's proactive economic stimulus policies, the vigorous recovery of the tourism sector, and the stable development of the manufacturing industry, all of which have created a favorable environment for foreign investment, see Figure 1.

Figure 1 GDP of Thailand (USD, Billion)



Sources: National Economic and Social Development Council (Thailand)

The role of Foreign Direct Investment (FDI) in driving Thailand's economic growth is significant[3]. According to data from the Thailand Board of Investment (BOI), in 2024, the number of FDI projects in Thailand reached 1605, foreign direct investment (FDI) in Thailand reached approximately 703.09 billion baht, marking a 59% year-on-year increase during 2020-2024, see Table 1.

Table 1 FDI in Thailand (2020-2024)

Year	Number of FDI Projects	FDI Amount (in billion baht)	Growth Rate of FDI Amount (%)
2020	559	109.18	-38.22
2021	458	180.43	65.26
2022	608	252.28	39.82
2023	976	453.04	79.58
2024	1605	703.09	55.19

Sources: The Board of Investment of Thailand (BOI)

Thailand has long been a popular destination for foreign investment[4]. In 2024, foreign direct investment (FDI) in Thailand reached approximately 703.09 billion baht, marking a 59% year-on-year increase during 2020-2024. The sources of investment are diverse, with countries and regions such as China, Singapore, Japan, and the United States playing important roles in various industries[5]. These investments have spurred Thailand's industrial upgrading, economic development, and job creation[6].

The neoclassical growth theory underscores the significance of capital accumulation in driving economic growth. The influx of FDI has brought a substantial amount of external capital to Thailand, directly augmenting the country's capital stock. According to the Solow Growth Model, an increase in capital can stimulate the development of related industries through a multiplier effect, thereby propelling overall economic growth[7]. For instance, investment projects by Chinese firms in Thailand have not only generated immediate economic value but also spurred the coordinated development of upstream and downstream industries through supply chain linkages, further invigorating Thailand's economy.

The endogenous growth theory, on the other hand, highlights the decisive role of technological progress and human capital in economic growth[8]. The inflow of FDI has introduced advanced technology and managerial expertise to Thailand, thereby enhancing the level of human capital in the country. For example, Japanese investments in Thailand's automotive industry have not only brought state-of-the-art automobile manufacturing technology but also improved the skill level of Thai workers through training and technology transfer. This technological spillover effect has significantly boosted Thailand's total factor productivity (TFP), thereby driving long-term economic growth.

3 ANALYSIS OF FDI IN THAILAND

The Board of Investment of Thailand (BOI) has formulated comprehensive investment promotion policies based on the national economic development strategy and industrial planning[9,10]. These policies are designed to provide one-stop services for projects that align with priority industries, such as high-end manufacturing, technological innovation, and green energy. These services include assistance with investment approval, recommendations for land acquisition, and solutions to issues encountered during the investment process, thereby enhancing the convenience and efficiency of corporate investment.

In terms of tax incentives, the BOI offers customized tax exemptions for different investment projects. High-tech enterprises can enjoy up to 15 years of corporate income tax exemption. Companies located in designated economic zones are also exempt from import duties on equipment and raw materials, which helps to reduce production costs. In addition to tax incentives, the BOI provides non-tax benefits, such as assisting investors in acquiring land ownership or long-term lease rights, and facilitating the processing of work visas and permits. These measures help enterprises attract overseas talent, see Table 2.

Table 2 Proportion of FDI in Thailand (2020-2024)

Year	Number of FDI Projects	FDI Amount (in billion baht)	Percents of FDI Projects	Percents of FDI Amounts (%)
2020	559	109.18	33	23
2021	458	180.43	27	37
2022	608	252.28	29	38
2023	976	453.04	42	62
2024	1,605	703.09	51	62

Sources: The Board of Investment of Thailand (BOI)

From a macro perspective, FDI holds an important position in Thailand's total domestic investment. According to data from the Board of Investment of Thailand (BOI), in recent years, the proportion of FDI inflows in Thailand's total domestic investment has been rising year by year, which shows that the importance of foreign capital in Thailand's economic growth is becoming more and more prominent.

3.1 Singapore

Singapore is a significant investment partner for Thailand. In 2024, Singaporean investments accounted for 16.45%of Thailand's foreign direct investment (FDI), with 264 projects totaling 224.36 billion baht (approximately 6.23 billion US dollars, 31.91% of Thailand's FDI), mainly in the areas of digital services and electronics manufacturing. Leveraging Thailand's geographical location and telecommunication infrastructure, Singaporean enterprises have developed projects in data center services and electronic component manufacturing.

3.2 China

In 2024, Chinese enterprises were highly active in investing in Thailand, launching 743 projects with a total investment value of 174.44 billion baht (approximately 4.85 billion US dollars), primarily concentrated in the fields of electronics, automotive manufacturing, and metal processing. Among foreign direct investment (FDI) in Thailand, Chinese investment account for 46.29% of the total number of investment projects and 24.81% of the total investment amount. In alignment with Thailand's Eastern Economic Corridor(EEC) initiative, Chinese enterprises made strategic investments in the production of electric vehicle(EV) components and data center infrastructure[11].

3.3 Japan

Japan has maintained long-term investment cooperation with Thailand. In 2024, there were 295 Japanese projects (18.38% of Thailand's FDI) with an investment value of 62.30 billion baht (approximately 1.73 billion US dollars, 8.86% of Thailand's FDI), focusing on areas such as automotive and motorcycle manufacturing, and electronic equipment (11.04 billion baht). Japanese investments in automotive component production and EV charging infrastructure have propelled the upgrading of Thailand's automotive industry.

3.4 American

American enterprises have maintained stable investment in Thailand. In 2024, there were 62 U.S. projects with an investment value of 30.58 billion baht (approximately 0.85 billion US dollars), covering fields such as electronic equipment(4.97 billion baht), and automotive and motorcycle manufacturing(5.28 billion baht). By leveraging Thailand's market access and policy advantages, American enterprises have expanded their business in Southeast Asia through data center services and electronic equipment manufacturing, see Table 3.

Table 3 The Top 10 Countries's FDI in Thailand (by Investment Amount)

Source	Number of Projects	Investment Amount (in billion baht)
Singapore	264	224.36
People's Republic of China	743	174.44
Hong Kong Region	146	71.37

Netherlands	46	67.21
Japan	295	62.30
Taiwan Region	117	51.87
United States of America	62	30.58
Australia	22	19.26
Ireland	5	8.81
Indonesia	5	7.87

Data Sources: The Board of Investment of Thailand (BOI)

4 ANALYSIS OF INDUSTRIES WITH FDI IN THAILAND

Thailand's industrial structure is highly diversified. In the agricultural sector, Thailand is a major global exporter of agricultural products, holding a significant competitive edge in the production and export of key commodities such as rice, rubber, cassava, and tropical fruits[12]. The agricultural industry is also evolving towards modernization and technological advancement. In manufacturing, the automotive industry has established a complete industrial chain, emerging as a vital automotive production base in the ASEAN region. Moreover, Thailand is actively developing the electric vehicle sector. The electronics and electrical appliances industry has also experienced rapid growth, securing a place in the global electronics value chain. The service sector, with tourism as its cornerstone, has attracted a large number of international tourists due to its rich tourism resources, thereby driving the prosperity of related industries, see Table 4.

Table 4 Top 5 FDI Industry (2024)

Industry	Number of Projects	Investment Amount (in billion baht)
Electronics	349	256.33
Digitalization	91	95.21
Automotive and Components	235	87.76
Chemicals and Chemical Products	193	52.21
Agriculture and Food Processing	110	25.58

Data Sources: The Board of Investment of Thailand (BOI)

4.1 Electronics

The electronics and electrical appliance manufacturing industry integrates traditional manufacturing with advanced technologies, covering areas such as electronic components, consumer electronics, and semiconductor packaging. It is one of Thailand's most globally integrated manufacturing sectors. Long-term foreign investment has fostered industrial clusters centered around component production, final assembly, and research and development, with major companies like Apple, Samsung, and Foxconn operating important production bases in Thailand. In 2024, the sector attracted 349 projects with a total investment of 256.33 billion Thai baht (approximately USD 7.12 billion). Its competitive advantages include a vertically integrated value chain formed within the Eastern Economic Corridor, a plentiful and cost-competitive labor force, an efficient logistics network, and its strategic position as an ASEAN electronics manufacturing hub offering strong market reach.

4.2 Digitalization

As the frontier of high-tech innovation, the digital sector encompasses key areas such as data center construction, cloud computing, and digital communication technologies, serving as the core driver of Thailand's economic digital transformation. Against the backdrop of the global digital economy's rapid expansion, it has successfully attracted investments from multinational corporations such as Alphabet (Google) and NextDC. In 2024, the sector secured 91 projects with a total investment value of THB 95.21 billion (approximately USD 2.64 billion).

This remarkable growth has been fueled by the Thai government's Digital Economy Development Plan, which offers tax incentives and streamlined approval processes. Additionally, Thailand's strategic geographical location, continuously improving 5G and fiber-optic network infrastructure, and the vast market demand from internet users across Southeast Asia have further reinforced the sector's momentum.

4.3 Automotive and Components

The automotive industry is a pillar of Thailand's economy, encompassing vehicle manufacturing, auto parts production, and electric vehicle (EV) research and development. It serves as a major automotive manufacturing hub in Southeast Asia. In recent years, apart from Japanese manufacturers, European and Chinese enterprises have increased their investments in the new energy vehicle sector.

In 2024, the sector attracted 235 projects in this industry, with investments reaching THB 87.76 billion (approximately USD 2.44 billion), of which EV-related investments accounted for 40%. Policy incentives, a mature supply chain, an expanding market, and professional talents cultivated by universities have provided strong support for the industry's development.

4.4 Chemicals and Chemical Products

The petrochemical and chemical industry — a capital- and technology-intensive sector comprising petroleum refining, basic chemicals, and fine chemicals — plays a pivotal role in Thailand's industrialization. While its investment scale remains smaller than some key industries, the sector has attracted global giants such as BASF, Shell, and Reliance Industries to invest in mid-to-high-end product lines.

In 2024, the industry saw 193 projects with total investments reaching 52.21 billion Thai baht (approximately 1.45 billion US dollars). Its growth is driven by multiple factors: proximity to oil and gas resources, well-established infrastructure, close integration with downstream industries, and rising chemical demand across the ASEAN region.

4.5 Agriculture and Food Processing

Thailand's agricultural food processing industry relies on the country's abundant agricultural resources and covers crop cultivation, agricultural product processing, food manufacturing, and export trade. It represents a traditional economic strength and a major source of foreign exchange. The industry has attracted global food giants such as Nestlé, Unilever, and Mars through well-known brands like "Thai Hom Mali Rice" and "Siamese Tropical Fruits."

In 2024, the sector secured 110 new FDI projects, amounting to 25.58 billion Thai baht (equivalent to approximately 0.71 billion U.S. dollars), with a focus on tropical fruit processing, aquaculture, and innovative functional foods. Thailand's core competitiveness in this industry stems from its natural resources, processing technologies, global market access, and policy support.

5 CONSLUSION

This study provides an analysis of the global investment in Thailand, highlighting the country's appeal as an emerging investment destination and its significance within the global economy. Thailand's robust economic growth in recent years, coupled with the diversification of its industrial structure and the implementation of a range of economic policies and investment promotion measures by the government, has collectively created extensive investment opportunities for global enterprises. The country's competitive edge in multiple sectors, including agriculture, manufacturing, and services, as well as its relatively lenient tariff policies, have provided favorable conditions for global firms to achieve trade substitution and industrial upgrading.

From a global perspective, Thailand has attracted substantial direct investment from various countries and regions, with investment primarily concentrated in emerging and advantageous industries such as the digital sector, electronics and electrical manufacturing, and the automotive industry. These investments have not only spurred Thailand's economic growth but also driven the upgrading and innovation of related industries. Although global enterprises face certain industry-specific risks in their investment activities in Thailand, these risks can be effectively mitigated through strategies such as enhanced market research, increased investment in technological development, and active engagement in cooperation, thereby achieving sustainable development.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Manuel F Montes, Jerik Cruz. The political economy of foreign investment and industrial development: the Philippines, Malaysia and Thailand in comparative perspective. Journal of the Asia Pacific Economy, 2020, 25(1): 16-39.

[2] Boge Triatmanto, Suryaning Bawono, Nanik Wahyuni. The contribution and influence of total external debt, FDI, and HCI on economic growth in Indonesia, Thailand, Vietnam, and Philippines. Research in Globalization, 2023, 7(1): 100163.

[3] Patcharee Preepremmote. Impacts of foreign direct investment on economic development: The case of Thailand. Montenegrin Journal of Economics, 2024, 20, 2: 19-26.

[4] Abdul Razak Abdul Hadi, Eddy Yap Tat Hiung, Mohd Hisham Hashim. How important is foreign direct investment to Malaysia and Thailand? Evidence from the emerging economies. Turkish Journal of Computer and Mathematics Education, 2021, 12(7): 2959-2970.

[5] Hsiang-Hsi Liu, Pitprapha Dejphanomporn, Guan-Ting Liu. Main determinants influencing inward and outward foreign direct investments in Thailand: comparisons and vital implications. Advances in Management & Applied Economics, 2022, 12(1): 1-25.

[6] D Tripati Rao, Narayan Sethi, Devi Prasad Dash, et al. Foreign aid, FDI and economic growth in South-East Asia and South Asia. Global Business Review, 2020, 24(1): 31-47.
[7] Robert M Solow. A Contribution to the theory of economic growth. The Quarterly Journal of Economics, 1956, 70(1): 65-94.
[8] Paul M Romer. Increasing returns and Long-run growth. Journal of Political Economy, 1986, 94(5): 1002-1037.
[9] Siwapong Dheera-aumpon, Piyaphan Changwatchai. The effect of institutional distance on foreign direct investment in Thailand. International Journal of Monetary Economics and Finance, 2024, 17(2-3): 221-228.
[10] Piyaphan Changwatchai, Siwapong Dheera-aumpon. Cultural distance and Thailand's foreign direct investment attractiveness. International Journal of Monetary Economics and Finance, 2020, 13(3): 198-205.
[11] Wannaphong Durongkaveroj. The economic impact of special economic zones: Evidence from Thailand. Kasetsart Journal of social sciences, 2023, 44(2): 377-386.
[12] Yan xuchong. The impact of foreign direct investment on the change in Thailand's industrial structure. European Journal of Economic and Financial Research, 2024, 8(3): 79-97.

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3045

DYNAMIC RISK ASSESSMENT IN THE INSURANCE INDUSTRY BASED ON A HIGH-RISK UNDERWRITING DECISION MODEL

BinHao Guo, ShuJie Shi*, GuoLiang Wen, XingPeng Zhuo
School of Electronic Countermeasures, National University of Defense Technology, Hefei 230000, Anhui, China.
Corresponding Author: ShuJie Shi, Email: 17730001109@163.com

Abstract: With the increasing frequency of extreme weather events, dynamic risk assessment has emerged as a crucial research topic for the sustainable development of the insurance industry. To address the underwriting decision-making challenges faced by insurers in high-risk areas, this study develops a risk assessment model that integrates historical data to predict property loss ratios in such regions for the coming year. By considering the perspectives of both insurers and policyholders, we propose a utility value model that evaluates the utility values of risk-free and risk-exposed properties separately. This framework derives the conditions for insurance underwriting and identifies a reasonable range for premium rates, thereby determining the optimal underwriting strategy for insurers. Finally, the model is applied to two regions in China—Fujian and Guizhou—for validation. Simulation results demonstrate that the proposed model exhibits high predictive accuracy and sensitivity in risk assessment, confirming the feasibility of the proposed underwriting strategy.
Keywords: Extreme weather; Insurance industry; Risk assessment; Grey time series prediction; Utility value

1 INTRODUCTION

In recent years, the frequent occurrence of extreme weather events and their associated economic losses have become a global concern. Ben J. Clarke et al. highlighted that global losses caused by extreme weather events over the past decade have exceeded $1 trillion, encompassing thousands of natural disasters, including floods, hurricanes, tornadoes, droughts, and wildfires [1]. According to the IPCC, the frequency and intensity of such events are likely to escalate further due to climate change [2].
Multiple studies indicate that extreme weather events not only cause significant damage to personal property but also pose unprecedented challenges to the insurance industry. The increasing frequency of these events has directly led to a surge in insurance claims. For instance, in 2022, the insurance industry's payout for natural disasters was 115% higher than the 30-year average [3]. This trend is projected to continue until 2040, with premium prices expected to rise by 30%–60% over the next two decades [4]. Peter Zweifel noted that such rapid premium increases not only make insurance more expensive but also reduce its accessibility in many regions [5]. Many insurers are adjusting their underwriting strategies by limiting coverage in high-risk areas, further exacerbating market tensions. Research by Ganesan and Reva reveals that the global insurance protection gap averages 57%, and this figure continues to rise [6]. This gap signifies that a substantial portion of properties damaged by extreme weather events lack adequate insurance coverage, threatening insurers' profitability and exposing property owners to significant financial risks [7].
Academic interest in this phenomenon is growing, with existing literature exploring the causes and mitigation strategies from multiple perspectives. For example, Peterson et al. argued that climate change is redefining the risk landscape of the insurance industry, rendering traditional actuarial models inadequate for accurately predicting the frequency and impact of extreme weather events [8]. Chloe H. Lucas et al. reviewed 175 studies on extreme weather and household insurance, emphasizing that flood insurance dominates current research and calling for expanded focus on storms and wildfires [9]. Additionally, Smith and Johnson examined the potential impacts of extreme weather on the sustainable development of the insurance industry, proposing novel risk-sharing mechanisms to address future uncertainties [10]. Tian-Zhen Hua et al. advocated for leveraging fiscal policies to amplify support and establish agricultural insurance mechanisms under extreme weather conditions [11]. Yang-Xiao Tong summarized strategies for building robust catastrophe insurance systems and multi-layered risk protection frameworks to enhance the "stabilizing role" of catastrophe insurance [12].
However, traditional insurance models rely on static risk assessments, failing to account for the dynamic impacts of climate change. This shortcoming has led insurers to reduce coverage in extreme weather-prone regions due to mounting underwriting pressures, aggravating market failures in high-risk areas. Consequently, insurers urgently need to enhance their risk assessment and prediction capabilities to make informed underwriting decisions. This study establishes a high-risk underwriting decision model that combines historical data to forecast risk parameters, evaluates underwriting conditions in extreme weather-prone regions through utility value analysis, and identifies optimal underwriting strategies to balance the insurer's need for profit maximization and risk minimization. Finally, the model is validated through case studies in Fujian and Guizhou provinces, China.

2 HIGH-RISK UNDERWRITING DECISION MODEL

Insurance companies face a contradiction between underwriting risks and profitability: Generally, refusing to underwrite catastrophe policies may lead to insufficient profits and potential bankruptcy, while underwriting excessively risky policies could result in substantial claim payouts that exceed revenues. Therefore, this paper first establishes a risk assessment model to predict risk scenarios and then constructs a utility value model to determine underwriting decision conditions in regions prone to extreme weather events.

2.1 Risk Assessment Model

Using historical data on the frequency of extreme weather events, direct economic losses, and Gross Regional Product in a specific area over recent years, the annual economic loss rate caused by a specific extreme weather event is calculated. The grey prediction model GM(1,1) is employed to forecast the economic loss rate for the next year, thereby quantifying the underwriting risk of the policy.

The damage rate time series $X^{(0)}$ contains four observed values:

$$X^{(0)} = \left\{X^{(0)}(1), X^{(0)}(2), X^{(0)}(3), X^{(0)}(4)\right\} \tag{1}$$

By accumulating the original data to reduce volatility and randomness in the damage rate sequence, a new sequence is generated:

$$X^{(1)} = \left\{X^{(1)}(1), X^{(1)}(2), X^{(1)}(3), X^{(1)}(4)\right\} \tag{2}$$

where,

$$X^{(1)}(t) = \sum_{k=1}^{t} X^{(0)}(k) \tag{3}$$

A first-order linear differential equation for the GM(1,1) model is established for $X^{(1)}(t)$:

$$\frac{dX^{(1)}}{dt} + aX^{(1)} = \mu \tag{4}$$

Here, a is the development coefficient, and μ is the grey action quantity.

Let $\hat{\alpha}$ denote the parameter vector to be estimated. Construct the mean generation matrix B and constant term vector Y for the accumulated data:

$$\begin{cases} \hat{\alpha} = (\frac{a}{\mu}) \\ B = \begin{bmatrix} 0.5\left(X^{(1)}(1) + X^{(1)}(2)\right) \\ 0.5\left(X^{(1)}(2) + X^{(1)}(3)\right) \\ 0.5\left(X^{(1)}(3) + X^{(1)}(4)\right) \end{bmatrix} \\ Y_n = \left(X^{(1)}(2), X^{(1)}(3), X^{(1)}(4)\right)^T \end{cases} \tag{5}$$

Using the least squares method, solve for the parameter vector $\hat{\alpha}$:

$$\hat{\alpha} = (B^T B)^{-1} B^T Y_n \tag{6}$$

Substituting $\hat{\alpha}$ into the differential equation yields the predicted time sequence:

$$\hat{X}^{(1)}(k+1) = \left[X^{(0)}(1) - \frac{\mu}{a}\right] e^{-ak} + \frac{\mu}{a} \quad \left(k = 0, 1, 2, \cdots, n\right) \tag{7}$$

Discretize the predicted sequence $\hat{X}^{(1)}(k)$, and subtract $\hat{X}^{(1)}(k+1)$ from $\hat{X}^{(1)}(k)$ to restore the predicted sequence for $X^{(0)}(k)$:

$$\hat{X}^{(0)}(k+1) = \hat{X}^{(1)}(k+1) - \hat{X}^{(1)}(k) \tag{8}$$

2.2 Utility Value Model

2.2.1 Economic principles

From the client's perspective, failure to purchase insurance exposes their future personal assets to potential risks and losses, termed "risky assets". However, by obtaining insurance coverage with full compensation provisions, their future assets become fixed-value and risk-free, thus classified as "risk-free assets".

Conversely, for insurance companies, underwriting policies introduces probabilistic losses to their future corporate assets, making them "risky assets", whereas declining coverage maintains fixed-value future assets without risk exposure, hence making them "risk-free assets".

In practice, individuals do not make straightforward comparisons between risky and risk-free assets but exhibit a preference for risk-free options. Consequently, decision-making requires the conversion of actual asset values into utility-based measurements for proper evaluation.

2.2.2 Client perspective

Assume a client's protected asset is E_1, potential loss is X, and the premium paid is Y. Define the client's risky asset utility rate l_1 and risk-free asset utility rate k_1. The subjective value of assets is determined by:

$$\begin{cases} E_{Y1} = k_1\left(E_1 - Y\right) \\ E_{N1} = l_1\left(E_1 - X\right) \end{cases} \tag{9}$$

where E_{Y1} is the subjective value of the client's assets with insurance, and E_{N1} is the subjective value without insurance. The condition for a client to purchase insurance is:

$$E_{Y1} \geq E_{N1} \tag{10}$$

Define the damage rate $\eta = X/E_1$ and premium rate $r = Y/E_1$. The above condition becomes:

$$r \leq 1 - \frac{l_1}{k_1}\left(1-\eta\right) \tag{11}$$

2.2.3 Insurer Perspective

Assume the insurer's asset is E_2, and the number of policyholders is n. The subjective value of assets is determined by:

$$\begin{cases} E_{Y2} = l_2\left(E_2 + nY - nX\right) \\ E_{N2} = k_2 E_2 \end{cases} \tag{12}$$

where E_{Y2} and E_{N2} are the subjective values of the insurer's assets with and without underwriting, respectively, l_2 and k_2 are the insurer's risky and risk-free asset utility rates.

The condition for the insurer to underwrite the policy is:

$$E_{Y2} \geq E_{N2} \tag{13}$$

Combining the damage rate η and premium rate r, assuming $E_2 = nE_1$, the above condition becomes:

$$r \geq \eta + \frac{k_2}{l_2} - 1 \tag{14}$$

Define the client's risk attitude index $u_1 = l_1/k_1$ and the insurer's risk attitude index $u_2 = l_2/k_2$. The condition further simplifies to:

$$\eta < \eta_{\max} = 1 - \frac{\frac{1}{u_2} - 1}{1 - u_1} \tag{15}$$

where $\eta_{\max}$ is the maximum allowable damage rate.

3 CASE ANALYSIS

3.1 Case Setup

Taking Fujian Province and Guizhou Province in China, which frequently experience extreme weather, as examples (as shown in Tables 1 and 2), data on economic losses caused by typhoon disasters and Gross Regional Product (GRP) in Fujian Province from 2016 to 2024, as well as data on economic losses caused by floods and hailstorms and GRP in Guizhou Province from 2018 to 2024, were collected from publicly accessible web sources (https://www.fujian.gov.cn/, http://fjnews.fjsen.com/, https://www.guizhou.gov.cn/, https://yjgl.guizhou.gov.cn/). Simulations were conducted to evaluate the effectiveness of the high-risk underwriting decision model, considering whether insurance companies should provide catastrophe insurance for these regions.

Table 1 Impact of Typhoon Disasters in Fujian Province (2016–2024)

Year	Direct Economic Loss (100 million CNY)	Gross Regional Product (100 million CNY)	Economic Loss Rate (%)
2016	382.34	28519.15	1.3406
2017	9.54	32298.28	0.0295

2018	29.04	38687.77	0.0751
2019	0.13	42395.00	0.0003
2020	12.10	43903.89	0.0276
2021	0.49	48810.36	0.0010
2022	67.31	53109.85	0.1267
2023	198.09	54355.10	0.3644
2024	26.41	57761.02	0.0457

Table 2 Impact of Flood and Hailstorm Disasters in Guizhou Province (2018–2024)

Year	Disaster Type	Direct Economic Loss (100 million CNY)	Gross Regional Product (100 million CNY)	Economic Loss Rate (%)
2018	Flood	6.29	14806.45	0.0425
	Hailstorm	13.78		0.0931
2019	Flood	43.56	16769.34	0.2598
	Hailstorm	1.63		0.0097
2020	Flood	86.03	17826.56	0.4826
	Hailstorm	4.5		0.0252
2021	Flood	19.88	19586.42	0.1015
	Hailstorm	8.18		0.0418
2022	Flood	43.2	20164.58	0.2142
	Hailstorm	9.9		0.0491
2023	Flood	10.2	20913.25	0.0488
	Hailstorm	11.3		0.0540
2024	Flood	61.08	22667.12	0.2695
	Hailstorm	12.22		0.0539

3.2 Underwriting Decision

Considering that different property owners possess varying total assets, insurance companies tend to be more risk-averse compared to policyholders [13,14], therefore, the risk attitude index of the insurance company is set as $u_2 = 0.751$, and that of the policyholder as $u_1 = 0.667$. The maximum acceptable loss rate for the insurance company, calculated using the utility value model, is $\eta_{\max} = 0.4331\%$.

3.2.1 Underwriting decision for typhoon disasters in Fujian Province

First, the risk assessment model was used to predict the economic loss rates caused by disasters in Fujian Province from 2020 to 2024. A comparison between predicted and actual values is shown in Table 3. The results indicate high model accuracy, with errors controlled within 15%, meeting the requirements for addressing uncertainties in extreme weather risks.

Table 3 Comparison of Predicted vs. Actual Economic Loss Rates in Fujian Province (2020–2024)

Year	Predicted Loss Rate (%)	Actual Loss Rate (%)	Relative Error (%)
2020	0.0288	0.0276	4.35
2021	0.0009	0.0010	10.00
2022	0.1165	0.1267	8.05
2023	0.3126	0.3644	14.22
2024	0.0482	0.0457	5.47

Furthermore, the expected loss rate for Fujian Province in 2025, denoted as $\hat{\eta}$, is calculated to be 0.2095%, which is less than the maximum acceptable loss rate $\eta_{\max}$. Therefore, the insurance company may choose to provide typhoon catastrophe insurance. Based on the utility value model, the premium rate range is determined as $r \in [3.337\%, 3.344\%]$. Thus, a premium rate of 3.344% can be selected for insurers.

3.2.2 Underwriting decision for flood and hailstorm disasters in Guizhou Province

Table 4 Comparison of Predicted vs. Actual Economic Loss Rates in Guizhou Province (2022–2024)

Year	Disaster Type	Predicted Loss Rate (%)	Actual Loss Rate (%)	Relative Error (%)
2022	Flood	0.2215	0.2142	3.41
2023		0.0541	0.0488	10.86
2024		0.2517	0.2695	6.60
2022	Hailstorm	0.0516	0.0491	5.09
2023		0.0523	0.0540	3.15
2024		0.0530	0.0539	1.67

A comparison of predicted versus actual economic loss rates in Guizhou Province from 2022 to 2024 is shown in Table 4. The model's accuracy improves further when historical loss rates exhibit minimal fluctuations.

The predicted combined loss rate for floods and hailstorms in Guizhou Province in 2025, denoted as $\sum \hat{\eta}$, is 0.2439%, which is also less than the maximum acceptable loss rate $\eta_{\max}$. Therefore, the insurance company may choose to provide a combined catastrophe insurance package for these disasters.

3.2.3 Analysis of underwriting conditions

By analyzing the conditions under which customers choose to purchase insurance and insurers decide to underwrite risks in the model, it can be observed that insurers' decisions on corporate assets determine the lower bound of premium rates, while customers' decisions on personal assets determine the upper bound. This aligns with real-world scenarios. From the insurer's perspective, catastrophic risks may lead to substantial payouts, necessitating relatively high premium rates. However, customers' limited capacity and willingness to bear premiums constrain excessive rates, as overly high premiums would deter purchases and deprive insurers of revenue.

Furthermore, the underwriting decision criteria derived from the model are consistent with economic principles. Against the backdrop of increasing extreme weather events, loss ratios rise over time. On one hand, risk-averse customers will opt for insurance when their fixed assets without coverage equal their expected assets with coverage, thereby mitigating risks. On the other hand, insurers, also risk-averse, will decline underwriting if their expected assets from underwriting equal their fixed assets without underwriting. Therefore, the aversion coefficient must be less than 1, and a maximum loss ratio exists. Insurers may underwrite risks only when the expected loss ratio remains below this threshold.

3.3 Optimal Underwriting Strategies

3.3.1 Single extreme weather region

Using utility value theory, the utility values of assets for both insurers and customers are converted. By comparing the utility values of purchasing versus not purchasing insurance (for customers) and offering versus not offering insurance (for insurers), acceptable premium rate ranges for both parties are derived.

If the two ranges do not overlap, insurers cannot balance their interests with customer demand and should refrain from offering coverage.

If the ranges intersect, insurers may select an appropriate premium rate within the overlapping interval. The optimal scheme is to adopt the maximum value in this interval to maximize profits.

3.3.2 Multiple extreme weather regions

For regions prone to multiple extreme weather events, insurers must categorize risks and design distinct insurance products for each type. The total predicted loss ratio across all covered risks is compared against the maximum allowable loss ratio.

If $\sum_{i=1}^{N} \hat{\eta}_i \leq \eta_{\max}$, full coverage is offered, assuming all risks.

If $\sum_{i=1}^{N} \hat{\eta}_i > \eta_{\max}$, the combined risk exceeds acceptable thresholds, leading to unaffordable premium rates. In such cases, insurers should sequentially exclude underwriting for extreme weather events with higher loss ratios in descending order until the total loss ratio falls below the maximum allowable threshold. The resulting insurance combination at this stage represents the optimal underwriting scheme.

3.4 Sensitivity Analysis

Statistical data and model inputs in practical applications often contain errors, which may affect output reliability. To assess the model's robustness, a sensitivity analysis was conducted.

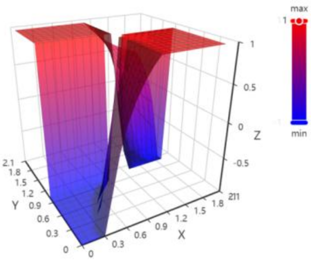


Figure 1 Sensitivity Analysis of Risk Attitude Index Model

The sampling diagram initially selected four sample points, yet the probability distribution across the entire region exhibited uniformity. By altering sampling points, variations were analyzed (Figure 1).

Adjusting the policyholder's risk attitude index X and the insurer's risk attitude index Y generated different risk attitude combinations. Figure 1 reveals that the model's maximum loss ratio may fall below 0 or exceed 1: a maximum loss ratio below 0 implies insurers may reject all extreme weather risks, while a ratio above 1 suggests insurers might underwrite all risks. Moreover, the surface plot trend indicates that the loss rate is highly sensitive to changes in the risk attitude indices of both parties. Any variation in either risk attitude index triggers significant fluctuations in the corresponding maximum loss rate, with the loss rate frequently exceeding the reasonable range of [0,1]. The analytical results demonstrate that the model exhibits robust sensitivity characteristics.

Practically, policyholders' risk attitude indices depend on their subjective perception of current risks, which is directly influenced by extreme weather events. Thus, precise quantification of extreme weather risks is critical for decision-making. Insurers can leverage this model to accurately assess risk levels and ensure informed underwriting decisions.

4 CONCLUSION

This study establishes a high-risk underwriting decision model to address insurers' challenges amid escalating extreme weather risks. Key conclusions include: (1) Insurers should provide coverage when the expected loss rate is below the maximum allowable threshold and assume risks when the premium rate falls within a feasible range. (2) For single extreme weather regions, the optimal scheme is to adopt the maximum premium rate within the overlapping acceptable range of both customers and insurers. (3) For regions with multiple extreme weather events, insurers should categorize risks and design coverage combinations where the total loss ratio remains below the maximum threshold, maximizing profitability. This model provides data-driven and theoretical support for insurers in risk assessment and underwriting decisions in high-risk regions, demonstrating practical applicability. While the current study focuses on underwriting strategies for single versus multiple extreme weather events, future research could explore coupling risk quantification methods for compound disasters and incorporate stochastic processes to simulate time-varying loss rate characteristics.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Ben J Clarke, Friederike E L Otto, Richard G Jones. Inventories of extreme weather events and impacts: Implications for loss and damage from and adaptation to climate extremes. Climate Risk Management, 2021, 32: 100285.
[2] IPCC. Climate Change 2022: Impacts, Adaptation and Vulnerability. Interaction (Melbourne), 2022, 50(2): 33.
[3] YangHan Lin, LiJun Wang, XinYang Shi, et al. Evolution of research on climate risk insurance: A bibliometric analysis from 1975 to 2022. Advances in Climate Change Research, 2023, 14(4): 592-604.
[4] Lukić Marija, Ćosić Milivoje, Prodanović Biljana. Impact of climate changes on the insurance market. International Review, 2022, 2022(3): 111-117.
[5] Peter Zweifel. Bridging the gap between risk and uncertainty in insurance. The Geneva Papers on Risk and Insurance - Issues and Practice, 2021, 46(2): 200-213.
[6] Ganesan, Reva. Climate crisis between APAC insurers and reinsurers. Asia Insurance Review, 2024: 70-71.
[7] Curcio, Domenico, Gianfrancesco, et al. Climate change and financial systemic risk: Evidence from US banks and insurers. Journal of Financial Stability, 2023, 66: 101132.
[8] Peterson R. Climate Change and Risk Management in the Insurance Industry. Journal of Risk Management, 2021, 45(2): 123-145.
[9] Chloe H Lucas, Kate I Booth, Carolina Garcia. Insuring homes against extreme weather events: a systematic review of the research. Climatic Change, 2021, 165(3): 1-21.
[10] Smith J, Johnson A. Adapting to Extreme Weather: Challenges and Innovations in Property Insurance. Journal of Insurance Economics, 2023, 30(1): 78-95.
[11] TianZhen Hua, WuXue Min, Qiu Jian. Operational Challenges and Countermeasures for Agricultural Insurance Under Extreme Weather. The Banker, 2022, (2): 110-112.

[12] YangXiao Tong. Leveraging Catastrophe Insurance as a "Stabilizer" for Resilient Urban Futures: Report on the 4th National Disaster Governance and Risk Protection Forum. China Disaster Reduction, 2024, (15): 20-23.
[13] D Finger, H Albrecher, L Wilhelmy. On the cost of risk misspecification in insurance pricing. Japanese Journal of Statistics and Data Science, 2024, 7(2): 1111-1153.
[14] Alan R Weil. Risk Adjustment, Insurance Markets, And More. Health affairs (Project Hope), 2024, 43(12): 1613.

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3046

SMART HOME CONSUMER NEEDS BASED ON K-MEANS CLUSTERING AND KANO MODEL

NuoLin Yu
School of Science, Shandong Jianzhu University, Jinan 250101, Shandong, China.
Corresponding Email: 15689096889@163.com

Abstract: With the rapid development and market expansion of smart home technology, the diversification and differentiation of consumer needs have become increasingly prominent. Based on survey data from 431 consumers, this study employs the K-means clustering algorithm to segment smart home consumers, using the silhouette coefficient method to determine the optimal number of clusters as 4, dividing consumers into bottom-tier frugal, middle-class pleasure-seeking, upper-middle comfort-seeking, and high-net-worth groups. The research further analyzes consumer need characteristics using the KANO model, identifying home security and product appropriateness as must-be attributes, entertainment and media control and installation services as expected attributes, and product reputation as an attractive attribute. The results indicate that smart home consumers across different income and age levels exhibit distinctly different need characteristics and purchasing power, while product safety and appropriateness remain fundamental needs across all groups. This research provides data support and theoretical guidance for smart home product development and marketing strategies, offering practical significance for promoting the healthy development of the smart home industry.
Keywords: K-means clustering; Smart home; KANO model; Consumer needs

1 INTRODUCTION

With the rapid advancement of information technology and the Internet of Things, smart home technology is gradually becoming mainstream as a new lifestyle, serving as an important means to enhance residential comfort, security, and convenience[1, 2]. Smart home technology integrates various devices and systems within the home environment to achieve automated control and intelligent management, creating a smarter and more efficient living environment for users[3]. However, the current smart home market presents a situation where products are diverse but user needs remain unclear. On one hand, the market offers a wide variety of smart home products with different functions and price ranges; on the other hand, consumer groups exhibit significant heterogeneity, with different populations showing marked differences in purchasing power, technology acceptance, and usage requirements. This disconnect between product supply and consumer demand has led to problems such as low market penetration and insufficient user satisfaction, hindering the healthy development of the smart home industry. Therefore, gaining an in-depth understanding of the characteristics and needs of different consumer groups to achieve precise product development and marketing strategies is of great significance for promoting the development of the smart home industry.

To address these issues, this study employs the K-means clustering algorithm to analyze 431 survey respondents, categorizing smart home consumers into four typical groups: the bottom-tier frugal group, the middle-class pleasure-seeking group, the upper-middle comfort-seeking group, and the high-net-worth group. The research identifies significant differences among these groups in terms of purchase intention, acceptable price range, gender, age, and income. Further, the study applies the KANO model to analyze the core needs of each group, classifying them into must-be attributes, expected attributes, attractive attributes, and indifferent attributes, and proposes priority recommendations for product development. These findings help smart home companies understand consumers' diverse needs, develop differentiated products, and implement precise marketing strategies, promoting the deep integration of smart home technology with users' actual needs.

2 CONSUMER SEGMENTATION ANALYSIS OF SMART HOME USERS BASED ON K-MEANS CLUSTERING

The K-means algorithm, also known as k-means clustering, is a partition-based clustering method. It divides 431 survey respondents into distinct groups, with each group named to provide an intuitive summary of participant profiles and characteristics, ultimately enabling better service to these populations.

The K-means clustering model segments consumers of smart home technology. The dataset consists of 431 user samples, each containing 11 attributes: smart home device usage status, smart home product purchase history, acceptable purchase price range for smart home devices, gender, age, annual household income, living situation, educational background, occupation, purchasing channels, and conceptual understanding of smart home technology. The number of clusters is assumed to be K.

The process involves selecting a k value, then iteratively calculating distances and centroids until meeting termination conditions, thereby determining the optimal solution. The K-means clustering algorithm operates on the principle of first initializing K cluster centers, then classifying samples into clusters based on the calculated distance between samples and center points. Through iteration, it achieves the objective of minimizing the distance between samples and their assigned cluster centers.

$$arg\ min\ J(C) = \sum_{k=1}^{K} \sum_{x^{(i)} \in C_k} ||x^{(i)} - \mu^{(k)}||_2^2 \quad (1)$$

The quality of clustering results can be evaluated using the "silhouette coefficient method." The core metric of this method is the silhouette coefficient. For a given sample point Xi, the silhouette coefficient is defined as follows:

$$S(X_i) = \frac{b(i) - a(i)}{max\{a(i), b(i)\}} \quad (2)$$

where a(i) = average, known as the cohesion, and b(i) = min, known as the separation. The silhouette coefficient value ranges between [-1,1], with values closer to 1 indicating relatively optimal levels of both internal cohesion and separation between clusters.

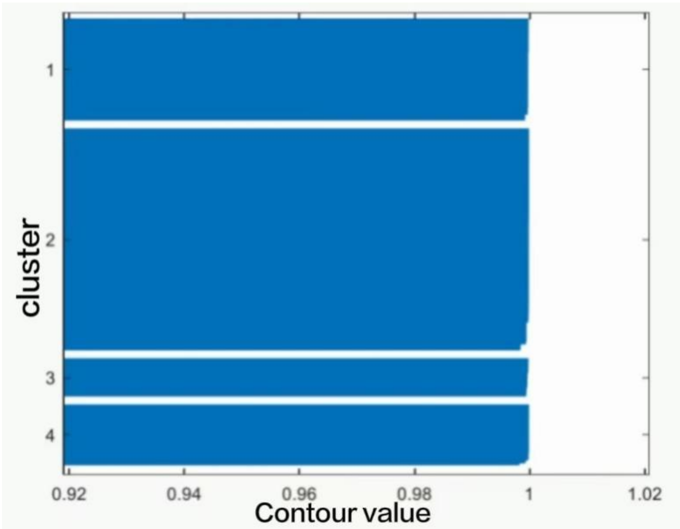


Figure 1 Silhouette Value Analysis Chart

This paper employs the "silhouette coefficient method" to analyze the data using MATLAB, generating visual representations. As shown in the figure 1, the silhouette values are concentrated around 1, indicating that a cohesion value of 4 is scientifically appropriate for this dataset and yields optimal partitioning quality.
In the implementation of K-means using MATLAB with K value set to 4, iterative and cluster analysis was performed using SPSS software based on 11 factors: whether smart home devices are used, whether smart home devices are purchased, acceptable price range for smart home devices, gender, age, annual household income, living status, education level, occupation, purchasing channels, and concept understanding. As shown in Table 1.

Table 1 One-way analysis of variance table

Variable	Cluster (Mean Square)	df (Cluster)	Error (Mean Square)	df (Error)	F	Sig. (p-value)
Willingness to Buy	0.487	3	0.080	427	6.118	.000
Purchase Amount	1127243619.490	3	0.000	427	—	—
Gender	1.084	3	0.224	427	4.834	.003
Age	1465.810	3	76.748	427	19.099	.000
Annual Income	14490.590	3	516.975	427	28.030	.000
Living Status	5.214	3	0.900	427	5.795	.001
Education Level	1.209	3	0.553	427	2.187	.089
Occupation	37.364	3	9.248	427	4.040	.007
Purchase Channel	3.393	3	0.808	427	4.199	.006
Awareness	4.243	3	0.625	427	6.789	.000
Usage	0.475	3	0.194	427	2.446	.063

From the ANOVA (one-way analysis of variance) output generated by SPSS, it can be seen that both education level and whether smart home devices are used exceeded 0.05, indicating that these two indicators have minimal impact on clustering and can be eliminated. Therefore, nine factors were ultimately selected as new clustering measurement factors: whether smart home devices are purchased, acceptable price range for smart home devices, gender, age, annual household income, living status, occupation, purchasing channels, and understanding of smart home concepts.

Based on the clustering results above, we have categorized smart home consumers into four distinct groups:

The bottom-tier frugal group represents approximately 10% of the total population. This demographic shows relatively low purchase intention for smart home products and is predominantly female. They are willing to spend less than 1,000 yuan on smart home devices, with ages typically between 20-30 years old and annual incomes below 120,000 yuan. Most live alone or with one other person and work as ordinary employees. Their purchasing pattern involves examining products in physical stores first before buying online, and their understanding of smart home technology is relatively limited.

The middle-class pleasure-seeking group accounts for about 59% of the total population and contains the majority of survey respondents. Predominantly female with high purchase intention, they are willing to spend between 1,000-5,000 yuan on smart home products. Their age range is primarily 20-30 years old, with household annual incomes between 120,000-300,000 yuan. Most live alone or with one other person and work as ordinary employees. Like the first group, they prefer to view products in physical stores before purchasing online. They possess moderate knowledge about smart home technology and tend to be young, quick to accept new things, and have some disposable income.

The upper-middle comfort-seeking group represents approximately 23% of the total population. This group is predominantly male with high purchase intention for smart home products and is willing to spend between 5,000-10,000 yuan. Their ages concentrate in the 30-40 range, skewing toward the early thirties, with household annual incomes ranging from 300,000-1,000,000 yuan. They typically work in corporate management positions and live in multi-person households. Their purchasing pattern mirrors the other groups—examining products in physical stores before buying online. Their understanding of smart home technology is high, and they tend to be well-educated.

The high-net-worth group makes up about 8% of the total population. They show high purchase intention for smart home products and are willing to spend over 10,000 yuan. Predominantly male, their ages concentrate in the 30-40 range, skewing toward the early forties, with household annual incomes typically above 500,000 yuan. Like other groups, they prefer examining products in physical stores before purchasing online. They possess extensive knowledge about smart home technology.

In summary, regardless of age group, people tend to approach smart home purchases rationally, generally choosing products with higher value for money. Similarly, smart home purchasing decisions align with individuals' economic circumstances—the better one's financial situation, the higher the acceptable spending threshold for smart home products. Among different age groups, younger people show a higher acceptance of smart home technology. Understanding these varying consumer needs allows businesses to design products at different price points with different features, thereby more effectively meeting market demands.

3 PRIORITY RESEARCH ON SMART HOME CONSUMER NEEDS BASED ON KANO MODEL

The KANO model, developed by Professor Noriaki Kano of Tokyo Institute of Technology, classifies and prioritizes user requirements by analyzing how these requirements impact user satisfaction, thereby establishing priorities for product feature upgrades[4-6]. Based on the relationship between different quality characteristics and customer satisfaction, the KANO model categorizes product and service quality characteristics into five types. The KANO model graph illustrates the developmental features of these five attributes:

In attractive attributes, high levels of service refinement lead to a significant increase in user satisfaction. Meanwhile, in one-dimensional attributes (expected attributes), high levels of service refinement result in increased user satisfaction; conversely, low levels lead to decreased satisfaction. For must-be attributes (basic attributes), high levels of service refinement do not significantly increase user satisfaction; however, low levels cause a marked decrease in satisfaction. Regarding indifferent attributes, there is no discernible relationship between service refinement and user satisfaction. Lastly, in reverse attributes, high levels of service refinement actually lead to decreased user satisfaction.

This research utilizes SPSSAU software, and the results show that: in terms of service provision priorities, the general sequence is: must-be attributes > expected attributes > attractive attributes > indifferent attributes[7-8].

Must-be attributes: Based on the KANO model results above, this study concludes that the essential requirements for potential consumers are home security and appropriate products. These two indicators are viewed as basic attributes and represent the highest priority needs. Only when these conditions are met in smart home products can the basic requirements of potential consumers be satisfied.

Expected attributes: Entertainment and media control, along with installation services, are expected attributes for potential smart home consumers. Having entertainment and media control capabilities and installation services significantly increases potential consumers' satisfaction with smart homes. Conversely, the absence of these features would decrease satisfaction among potential smart home consumers.

Attractive attributes: Product reputation is an attractive attribute; a good product reputation generates positive emotions in potential consumers. After ensuring entertainment and media control capabilities and installation services, manufacturers should consider enhancing product reputation and expanding brand awareness along with positive messaging, thereby further increasing consumer satisfaction with smart home products.

Indifferent attributes: Potential smart home consumers are indifferent to the experiential aspects of smart homes or whether they meet personalized needs. These are considered indifferent factors, and their presence or absence does not influence potential consumers' purchasing behavior at the current stage. Therefore, these have the lowest priority and can be developed last.

In conclusion, to better enhance consumer satisfaction with smart home products, this research suggests first ensuring the safety and appropriateness of smart home products. Next, the development of entertainment and media control features and improvement of installation services can significantly enhance consumers' experience and satisfaction with smart homes. Finally, improving smart home product reputation through consistent quality across every product and providing comprehensive services will maximize the potential to reach latent smart home consumers.

4 CONCLUSIONS

This study conducted an in-depth analysis of the smart home consumer market using the K-means clustering algorithm and KANO model. The research identified four distinct categories of smart home consumers: the bottom-tier frugal group (10%), middle-class pleasure-seeking group (59%), upper-middle comfort-seeking group (23%), and high-net-worth group (8%). These four groups showed significant differences in purchase intention, acceptable price range, age, income, and understanding of smart home technology.

The KANO model analysis indicated that smart home product development should prioritize satisfying basic attributes, specifically home security and product appropriateness. Next, expected attributes such as entertainment and media control features and installation services should be emphasized. Enhancing product reputation, as an attractive attribute, can further increase consumer satisfaction. Experience-related and personalized needs were identified as indifferent attributes that can be developed at later stages.

The findings provide clear market segmentation and product development guidance for smart home businesses, enabling them to design products with different price points and features more strategically to meet various consumer needs effectively and enhance market competitiveness. By understanding the diverse characteristics and priority order of consumer needs, smart home enterprises can achieve precise product positioning, optimize resource allocation, and ultimately achieve sustainable development.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] ROCK L Y, TAJUDEEN F P, CHUNG Y W. Usage and impact of the internet-of-things-based smart home technology: a quality-of-life perspective. Universal access in the information society, 2024, 23(1): 345-364.

[2] KUMAR S, TIWARI P, ZYMBLER M. Internet of Things is a revolutionary approach for future technology enhancement: a review. Journal of Big data, 2019, 6(1): 1-21.

[3] TAIWO O, EZUGWU A E, OYELADE O N, et al. Enhanced intelligent smart home control and security system based on deep learning model. Wireless communications and mobile computing, 2022, 2022(1): 9307961.

[4] WOLNIAK R. The usage of Kano model in Industry 4.0 conditions. Silesian University of Technology Scientific Papers. Organization and Management Series, 2024, 196: 625-640.

[5] LIU X. Research on function optimization of electric vehicle charging stations based on user demand analysis: An empirical study using the Kano model and AHP method. Sustainability, 2024, 16(23): 10783.

[6] YUAN S, HAO X, LI P, et al. Research on the Priority of Online Service of University Library Based on Kano Model. Proceedings of the 2024 15th International Conference on E-business, Management and Economics. Association for Computing Machinery, New York, NY, USA. 2024, 377-382.

[7] DENG L, R Deng L, Romainoor NH, Zhang B. Evaluation of the Usage Requirements of Hospital Signage Systems Based on the Kano Model. Sustainability. 2023, 15(6): 4972.

[8] YANG T, DANG Y, WU J. How to prioritize perceived quality attributes from consumers' perspective? Analysis through social media data. Electronic Commerce Research, 2025, 25(1): 39-67.

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3047

ANALYSIS OF INTEREST RELATIONSHIPS IN THE INDUSTRY-EDUCATION INTEGRATION COMMUNITY FOR FINANCIAL AND COMMERCIAL PROFESSIONAL GROUPS IN HIGHER VOCATIONAL COLLEGES

DeJun Zou
Guangdong Industry and Commerce Vocational and Technical College, Guangzhou 510150, Guangdong, China.
Corresponding Email: zoudejun2011@126.com

Abstract: The core of the industry-education integration community for financial and commercial professional groups in higher vocational colleges lies in deepening industry-education integration and school-enterprise cooperation to build a technical and skilled talent training system adapted to the modern industrial system. This involves systematically integrating government policy guidance, industry standard specifications, enterprise practical resources, and college educational resources to form a "government-industry-enterprise-college" four-party collaborative education pattern. The government promotes community construction through policy tools such as financial subsidies and tax incentives; industry associations leverage their market information advantages to build supply-demand docking platforms, formulate industry talent capability maps, issue job skill white papers, and establish coupling mechanisms for standard docking. Enterprises provide real job scenarios to promote the transformation of teaching practice, showing differentiated value orientations in the participation process. This collaborative network of multi-dimensional interests not only reflects the value consensus of each subject on the goal of talent training but also implies deep-seated game relationships in resource investment, income distribution, responsibility boundaries, etc.
Keywords: Higher vocational colleges; Financial and commercial professional groups; Industry-education integration community; Government-industry-enterprise-college collaborative education; Interest game

1 INTRODUCTION

At present, with the vigorous development of emerging business forms such as the digital economy and cross-border e-commerce, the demand for skilled talents with digital operation and supply chain management capabilities in the financial and commercial sector continues to rise. As a general technology, the digital economy has promoted industrial structure adjustment [1], with the main driving factor shifting from capital to data [2]. For this reason, workers need to continuously improve their digital literacy and adhere to promoting employment through development [3-4]. As the main force in building a skilled society, higher vocational colleges systematically integrate government policy guidance, industry standard specifications, enterprise practical resources, and college educational resources through the construction of industry-education integration communities for financial and commercial professional groups, forming a "government-industry-enterprise-college" four-party collaborative education pattern. Industry communities serve talent training and economic development, fully highlighting the needs of industry and enterprises [5-6]. In this process, the construction of industry-education integration communities for financial and commercial professional groups must take into account the interests of all parties. Therefore, it is necessary to deeply analyze the interest relationships of the industry-education integration community for financial and commercial professional groups in higher vocational colleges.

2 ANALYSIS OF INTEREST CONSISTENCY IN THE INDUSTRY-EDUCATION INTEGRATION COMMUNITY FOR FINANCIAL AND COMMERCIAL PROFESSIONAL GROUPS IN HIGHER VOCATIONAL COLLEGES

2.1 Cultivating Talents to Meet Market Demand

The industry-education integration community for financial and commercial professional groups builds a talent training system through a multi-subject collaborative mechanism and establishes an innovation community [7]. As the policy guidance subject, government agencies formulate regional industrial plans and special industry-education integration policies to establish a government-enterprise-school collaborative education framework, which is in line with the needs of industrial digital development [8]. Taking an economic demonstration zone as an example, the local government promotes vocational colleges to form strategic cooperation alliances with above-scale enterprises through the construction of fiscal and taxation incentive mechanisms, focusing on cultivating talents in emerging fields such as e-commerce operation and intelligent logistics management, effectively promoting the upgrading of regional industrial chains and the growth of the digital economy industry. As market entities, enterprises provide real projects and internship positions to enhance students' practical capabilities.

Higher vocational colleges adjust curriculum settings according to market demand to ensure a seamless connection between training programs and enterprise needs, achieving a interaction between talent training and industrial development. As the core subject of supply-side reform, vocational colleges realize the dynamic adaptation of the education chain to the industrial chain through the training model of the industry-education integration community. A higher vocational college in Guangdong has built a three-level collaborative framework of "Professional Construction Committee-Enterprise College-Industrial Professor Workstation" and implemented a mechanism for integrating curriculum standards with professional standards. Specific practices include co-constructing industrial colleges with leading enterprises, introducing real project data to build a modular training system, and establishing a dynamic professional adjustment response mechanism to improve graduates' job fit and employer satisfaction, thus forming a applicable industry-education integration paradigm.

Based on the demand for optimizing human capital investment returns, enterprises achieve customized talent training within the cooperation framework of the industry-education integration community. A leading enterprise in an industrial zone has developed a modular curriculum system through job capability models, established an enterprise teaching department to implement work-study alternate training, and established a dual-tutor quality monitoring system. Practices have shown that the enterprise's application of this model has significantly reduced the new employee training cycle and employment costs, with a systematic increase in the stability rate of key talents and the compliance rate of core skills.

Industry associations build an information hub platform for industry-education integration through the industry-education integration community, specifically including: dynamically releasing industry talent demand white papers, formulating professional skill level standards, and developing integrated training programs for "courses-positions-competitions-certifications". By organizing skill competitions and school-enterprise docking activities, industry associations effectively promote the update rate of professional construction plans, forming a positive development pattern with competency-based as the core, especially showing significant improvements in digital skills training.

2.2 Promoting Collaborative Development of Industry and Education

The industry-education integration mechanism plays a core driving role in the collaborative development of the financial and commercial industry and vocational education. It effectively eliminates the structural barriers between the industrial and educational sectors, promotes the deep coupling and collaborative evolution of resource elements between the two sides, and constructs a systematic support for cultivating high-quality composite skilled talents meeting the needs of modern industries. From the perspective of industrial development, the digital transformation and high-quality development of the financial and commercial industry put forward multi-dimensional ability requirements for practitioners. In the context of an intelligent business ecosystem, enterprises urgently need talents with innovative strategic thinking, digital technology application capabilities, and a global business vision to drive organizational change and innovative ecosystem construction. Through deepening industry-education integration, the industrial sector can systematically implant the technical paradigms and practical experience of cutting-edge fields such as block chain technology, intelligent financial systems, and cross-border e-commerce into the vocational education system, providing resource support for talent training in vocational colleges. Specifically, leading enterprises not only provide training platforms for real business scenarios through co-constructing industry-university-research collaborative innovation centers but also deeply participate in talent training program design, modular curriculum development, and capability evaluation system construction. Taking an e-commerce group as an example, the intelligent business training base co-constructed with vocational colleges indicatively implements a "job rotation + project-driven" training model. The dual-teacher teaching team composed of senior technical experts and operation managers of the enterprise enables trainees to accurately master the core skills of the entire e-commerce operation chain through real project case analysis and sand table.

From the perspective of vocational education reform, the industry-education integration community provides innovative momentum for the supply-side structural reform of education and teaching in financial and commercial professional groups in higher vocational colleges. Vocational colleges achieve precise docking between professional clusters and industrial chains by constructing a dynamic response mechanism of "industrial demand-professional construction-curriculum system". In terms of teaching staff construction, a two-way flow mechanism of "enterprise tutors stationed in schools + college teachers entering enterprises" has been formed: enterprise technical directors regularly carry out industry frontier series lectures to transform real business cases into teaching projects; college teachers continuously update their practical knowledge systems by participating in enterprise horizontal research. The logistics management major of a vocational college has strengthened students' technical application capabilities and cultivated their decision-making capabilities based on big data analysis by implementing a teaching model combining courses and competitions and carrying out intelligent warehouse system operation competitions in conjunction with logistics enterprises. The teaching team has transformed practical achievements into patent technologies and core curriculum standards by participating in the intelligent logistics system upgrading project of enterprises.

3 ANALYSIS OF INTEREST CONFLICTS

3.1 Contradiction between Short-term and Long-term Interests

In the industry-education integration community of financial and commercial professional groups, there is a clear conflict between the short-term and long-term interests of enterprises and colleges, which has become a major bottleneck restricting the in-depth promotion of industry-education integration. As the core participant in the market economy, the primary goal of an enterprise is undoubtedly the maximization of economic benefits. Therefore, when participating in industry-education integration, enterprises tend to pursue visible benefits in the short term. Enterprises hope to quickly obtain talents that meet their current production and operation needs through cooperation with colleges. Enterprises expect these talents to immediately create value for the enterprise and bring direct economic benefits. Enterprises prefer graduates who can quickly adapt to positions and reduce the training cycle when recruiting, aiming to reduce employment and training costs and improve operational efficiency. When participating in talent training, enterprises often focus on the mastery of practical skills by students but ignore the cultivation of comprehensive qualities and the cultivation of future sustainable development capabilities. For example, in the process of cooperating with vocational colleges to train e-commerce talents, enterprises usually adopt an order-based training model, adjust curriculum settings according to market demand, and ensure that students can master the practical skills of e-commerce platform operation and customer service. This excessive pursuit of short-term benefits allows enterprises to meet their employment needs in the short term, but in the long run, it is not conducive to the innovation development and talent reserve of enterprises.

As an important place for talent training, higher vocational colleges have the characteristics of long-term and systematic talent training, focusing on the comprehensive development of students and the cultivation of future sustainable development capabilities. When formulating talent training programs, higher vocational colleges will consider from multiple aspects such as the improvement of students' comprehensive qualities, the construction of professional knowledge systems, and the cultivation of innovative capabilities, and are committed to laying a solid foundation for students' future development. Higher vocational colleges not only pay attention to students' current employment ability but also focus on cultivating students' learning ability, innovative ability, and social responsibility, so that students have the ability to adapt to the changes in social development in the future. In terms of curriculum settings, higher vocational colleges will arrange rich basic courses and professional courses to cultivate students' theoretical knowledge and professional literacy; at the same time, they will also carry out various practical teaching activities and innovation and entrepreneurship education to improve students' practical ability and innovative ability. However, there is a certain conflict between the long-term talent training goals of higher vocational colleges and the demand of enterprises to pursue short-term benefits. The students trained by higher vocational colleges may not fully meet the actual needs of enterprises in the short term, and enterprises need to invest extra time and cost in retraining, which leads to enterprises' dissatisfaction with the talents of higher vocational colleges, and then weakens the willingness of enterprises to participate in industry-education integration.

This contradiction between short-term and long-term interests is also reflected in the investment and expectations of both sides for cooperation projects. When participating in industry-education integration projects, enterprises not only expect to obtain economic benefits in the short term, such as reducing employment costs and improving production efficiency, but also are committed to promoting technological innovation, talent training, and industrial development through long-term collaborative innovation, and forming a sustainable development mechanism. Therefore, enterprises may be relatively cautious in investing in cooperation projects and pay more attention to the short-term benefits of projects. Higher vocational colleges, on the other hand, hope to improve the school's teaching quality, faculty level, and social influence through industry-education integration projects, which often require long-term investment and effort. Higher vocational colleges may invest more resources in teaching reform, faculty training, and practice base construction in cooperation projects to ensure the improvement of talent training quality. The unequal investment and expectations between the two sides often become the source of divergence and contradictions in the cooperation process, thus hindering the smooth progress of the industry-education integration community.

3.2 Imbalance between Resource Input and Income of Different Subjects

There is a structural imbalance between the resource input and income distribution of multiple subjects in the industry-education integration community of financial and commercial professional groups in higher vocational colleges, which significantly restricts the enthusiasm and initiative of government, vocational colleges, enterprises, industry associations, and social organizations to participate. In terms of resource input, each subject shows significant heterogeneous characteristics. As the core input subject, vocational colleges need to configure professional teacher teams to carry out project-based teaching and practical guidance in terms of human resources, and continue to invest in teaching and research time for curriculum system reconstruction; in terms of material resources, they need to build special teaching facilities, including training bases, virtual simulation training rooms, and other practical teaching platforms; in terms of financial resources, they involve continuous investment in teaching resource development, double -teacher training, internship special subsidies, etc. Through the school-enterprise joint training mechanism, teachers in higher vocational colleges participate in enterprise practice training, which significantly improves their practical teaching ability. However, the income of higher vocational colleges shows the characteristics of hysteresis and non-monetization, mainly reflected in the long-term effects such as the improvement of employment quality and the improvement of college social evaluation.

Enterprise subjects show selective characteristics in resource input: first, providing internship positions involves job development costs and operation risks; second, the enterprise tutor mechanism leads to core technical personnel investing in teaching time; third, participating in curriculum development needs to invest in industry standards and other resources. Although enterprises expect to obtain talent reserve dividends through industry-education integration, there is a risk of human resource sunk costs, and technology diffusion may weaken their competitive advantages. The government subject carries out resource allocation through institutional supply and financial leverage, promulgates a series of policies and regulations to provide guarantee for industry-education integration, and gives support to the construction of training bases, enterprise tax incentives, etc. The government's income is reflected in the macro social and economic effects, but there is a problem in policy performance evaluation. Industry associations and social organizations mainly play the role of resource integration and participate in non-capitalized ways such as building industry-education information platforms and organizing industry dialogue meetings. Their income is manifested as non -economic benefits such as the improvement of industry governance capabilities, but there is a resource dependence dilemma.

This structural contradiction leads to the construction of the community into a multi-dimensional dilemma: the imbalance between input and output of colleges, the marginal decrease of enterprise participation, and the risk of policy implementation suspension. Therefore, constructing a collaborative mechanism based on the interest balance matrix and establishing an institutional framework including resource measurement, income compensation, and risk sharing has become the key path to breaking the development bottleneck of the industry-education integration community for financial and commercial professional groups.

4 INTEREST BALANCE MECHANISM

The government implements precise regulation in the industry-education integration community by constructing a targeted policy system, forming a collaborative mechanism of tax incentives, financial support, land security, and college construction, and effectively coordinating the interest relations of multiple subjects. In terms of tax policies, a linkage mechanism of education surcharge credit and enterprise income tax reduction is implemented. Certified enterprises can enjoy corresponding credit policies according to the investment scale, and at the same time, the R&D expense plus deduction system for school-enterprise cooperation projects is implemented, which significantly reduces the operation cost of enterprises, improves the efficiency of technological innovation and transformation, and forms a sustainable cost compensation and benefit mechanism. The financial support mechanism establishes a special fund hierarchical allocation system. The central finance focuses on guaranteeing the construction of training bases, the provincial finance supports curriculum development, and higher vocational colleges raise funds by themselves to strengthen teacher training. The land policy implements a model combining targeted supply and elastic development, and includes industry-education integration projects in the priority sequence of planning. In the specific implementation of industrial college construction projects, through the ladder land transfer fee reduction policy, the land cost structure is significantly optimized, the project landing cycle is compressed, and a land policy innovation scheme with demonstration effect is formed. By constructing a closed-loop system of financial investment and quality evaluation, a dynamic growth mechanism of student average appropriation is implemented, and an assessment system including indicators such as double-teacher construction and horizontal transformation is established. Monitoring data show that the policy has significantly improved the intensity of scientific research investment in colleges and accelerated the transformation of school-enterprise cooperation achievements, forming a development pattern of coordinated improvement of institutional guarantee and education quality.

The systematic negotiation and communication mechanism and the normalized information interaction channel play a key role in coordinating the internal interest contradictions of the industry-education integration community for financial and commercial professional groups and promoting the collaborative cooperation of multiple subjects. Through the establishment of a professional negotiation platform, each stakeholder can effectively express their core demands, jointly formulate differentiated solutions, and finally achieve the dynamic balance and optimized configuration of the interest pattern. Multiple subjects such as government departments, vocational colleges, enterprise entities, and industry associations should carry out regular consultation activities such as joint meetings and special discussions, focusing on in-depth dialogue on the core issues in the process of industry-education integration. For example, in the joint meeting system of a financial and commercial industry-education integration, the government functional departments, as organizational coordinators, regularly convene representatives of vocational colleges and industry enterprises to carry out strategic consultations, systematically study the major issues of regional industry-education integration development, and effectively bridge the matching gap between talent supply and industrial demand.

The establishment of resource compensation mechanisms and interest sharing systems has further consolidated the foundation of interest balance. By formulating detailed rules for the mutual exchange of resources between schools and enterprises, a contractual management framework centered on projects has been formed, which clearly stipulates the quantitative conversion standards for rights and interests such as enterprise equipment donations, faculty sharing and other resource investments, as well as preferential transfer of scientific research achievements and talents by universities. The supporting performance evaluation system adopts a third-party audit mechanism to conduct annual assessments of the contract performance of community members, and links the evaluation results with policy support such as financial subsidies and tax incentives. Monitoring data shows that over the past three years of operations, this mechanism has enabled an average annual growth rate of 23.6% in enterprise resource investment and a 19.8 percentage point increase in the conversion rate of scientific research achievements in universities. It is worth noting that in the practice of an industry-education integration demonstration zone in the Guangdong-Hong Kong-Macao Greater Bay Area, by establishing a "risk sharing-revenue sharing" agreement template, 12 multinational enterprises and 5 higher vocational colleges have been successfully coordinated to reach in-depth cooperation, among which the number of joint technical patent applications has increased by 3.2 times compared with that before the agreement was signed, and the customized talent training cycle of enterprises has been shortened by 40%.

5 CONCLUSIONS AND OUTLOOK

The government promotes the construction of the community through policy tools such as financial subsidies and tax incentives; industry associations rely on market information advantages to build supply-demand docking platforms, serve as third-party coordination agencies, and strive to solve the stubborn problem of "hot schools and cold enterprises" in traditional school-enterprise cooperation. They establish a coupling mechanism for standard docking by formulating industry talent capability maps and issuing job skill white papers. Enterprises provide real job scenarios to promote the transformation of teaching practice and show differentiated value orientations in the participation process: leading enterprises focus on reserving strategic talents through forms such as "order classes" and "industrial colleges", while small and medium-sized enterprises pay more attention to the immediate satisfaction of short-term employment needs. This collaborative network of multi-dimensional interests not only reflects the value consensus of each subject on the goal of talent training but also implies deep-seated game relationships such as resource investment, income distribution, and responsibility boundaries. The interweaving of multiple demands makes it necessary to establish a flexible resource allocation mechanism in professional group construction, which should not only protect the intellectual property rights of enterprise technical backbones participating in curriculum development but also improve the contractual management of students' post practice, forming a closed-loop feedback system between the education chain and the industrial chain.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This paper is a phased achievement of the 2023 Guangdong Higher Vocational Education Teaching Reform Research and Practice Project (Project No.: 2023JG605).

REFERENCES

[1] Zhang Xun, Liu Yingjie. The Development Status and Economic Effects of China's Digital Economy: A Review and Inspiration. Studies of International Finance, 2025(05): 3-16.
[2] Liu Cheng. The Leap of Productive Forces in the Digital Economy Era. Research on Financial and Economic Issues, 2025(03): 33-45.
[3] Liu Cuihua, Wang Han, Ding Shulei. How Does Digital Literacy Affect Workers' Employment Quality—Micro Evidence Based on CFPS. Study and Practice, 2025(04): 89-99.
[4] Zhang Bingzi. Promoting Employment Expansion and Quality Improvement through High-Quality Development. People's Forum: Academic Frontier, 2025(06): 34-42. DOI: 10.16619/j.cnki.rmltxsqy.2025.06.005.
[5] Liu Xiao, Wang Yeqing. The Connotation, Construction Goals, and Implementation Path of Industry-Education Integration Communities. Modern Education Management, 2024(11): 106-115. DOI: 10.16697/j.1674-5485.2024.11.010.
[6] Li Yuqian. The Construction Logic and Path of Industry-Education Integration Communities from the Perspective of New Productivity. Nanjing Social Sciences, 2023(12): 122-129. DOI: 10.15937/j.cnki.issn1001-8263.2023.12.014.
[7] Liu Zhimin, Zhang Hongsi. The Core Mechanism for Deepening Industry-Education Integration by Building an Innovation Community. Higher Education in China, 2019(10): 16-18.
[8] Yang Yi, Wang Yan. The Connotation, Typical Characteristics, and Development Path of "High-Skilled Talents": A Case Study of the "Economy and Trade Major Category". Chinese Vocational and Technical Education, 2025(3): 20-2534

World Journal of Economics and Business Research
ISSN: 2960-0081
DOI: https://doi.org/10.61784/wjebr3048

CROSS-BORDER E-COMMERCE POLICIES AND THE HIGH-QUALITY DEVELOPMENT OF URBAN ECONOMIES

JiaYao Zhou[1], HaiHui Wang[2,3*]
[1]*School of Applied Technology, Wuxi University, Wuxi 214105, Jiangsu, China.*
[2]*School of Digital Economics and Management, Wuxi University, Wuxi 214105, Jiangsu, China.*
[3]*Institute of China (Wuxi) Cross-Border Electronic Commerce Comprehensive Pilot Zone, Wuxi University, Wuxi 214105, Jiangsu, China.*
Corresponding Author: HaiHui Wang, Email: wanghh@cwxu.edu.cn

Abstract: Cross-border e-commerce has emerged as a pivotal force in China's international trade growth. Since 2015, the Chinese government has implemented city-level pilot zones to foster cross-border e-commerce, followed by a 2017 policy shift emphasizing high-quality development centered on sustainability and innovation. Leveraging panel data from 280 prefecture-level cities (2010–2021), we employ a multi-period difference-in-differences (DID) approach to evaluate the economic impact of these pilot zones on urban development. Complemented by qualitative policy analysis, the research further explores the underlying mechanisms driving these effects. The findings reveal that the pilot zones significantly enhance urban sustainability and innovation, with heterogeneous effects based on geographic location, industrial structure, city size, and cluster dynamics. Three key mechanisms are identified: digital infrastructure development, productive service agglomeration, and business environment optimization. These insights provide robust empirical support for refining cross-border e-commerce policies to maximize their economic benefits.
Keywords: Cross-border e-commerce; Sustainable development; Innovative development; Qualitative analysis

1 INTRODUCTION

The Chinese government's 2017 introduction of the high-quality economic development concept marked a strategic shift from growth quantity to development quality, emphasizing innovation, sustainability, and inclusiveness. In this context, digital trade - particularly cross-border e-commerce (CBEC) - has emerged as a transformative force in economic restructuring. Recognizing its potential, China has implemented comprehensive CBEC policies since 2015, beginning with pilot zones in Hangzhou and expanding nationwide, featuring innovative customs, tax, and financial support mechanisms. These policy experiments present a valuable opportunity to examine how digital trade policies influence urban economic transformation.

Existing literature reveals three significant research gaps. First, while numerous studies have documented digital trade's impact on economic growth, few have systematically examined its effects on development quality dimensions like sustainability and innovation. Second, most empirical analyses operate at national or provincial levels, leaving city-specific impacts underexplored. Third, current research tends to focus on quantitative assessments while neglecting qualitative policy analysis that could reveal underlying mechanisms. These limitations motivate our investigation into three core questions: how CBEC pilot zones affect high-quality urban development, through what mechanisms these effects operate, and whether impacts vary across cities with different characteristics.

This study makes several important contributions to the literature. By combining text analysis of policy documents with a multi-period difference-in-differences approach using panel data from 280 Chinese cities (2010-2021), we provide robust empirical evidence that CBEC pilot zones significantly enhance urban economic quality, with particularly strong effects in coastal cities, service-oriented economies, and large metropolitan areas. Our mechanism analysis reveals that this improvement operates through three key channels: the development of digital infrastructure, agglomeration of productive services, and optimization of local business environments. These findings not only extend digital trade research into the specific context of CBEC policy evaluation but also demonstrate the value of integrating qualitative and quantitative methods in policy impact assessment. Furthermore, our city-level analysis enriches understanding of how digital trade policies differentially affect urban economic trajectories, offering practical insights for regional development strategies.

2 QUALITATIVE ANALYSIS AND RESEARCH HYPOTHESIS

2.1 Frequency Analysis of Keywords

To gain a deeper understanding of the connotations of CBEC Pilot Areas policies and how these policies influence high-quality urban economic development, This study applies text mining and thematic analysis to policy documents from central and local governments in China, to identify key policy focuses and mechanisms. The results, as shown in Table 1 and 2, indicate that the policy focus is on digital infrastructure, the agglomeration of services, and the optimization of the business environment. These three themes occupy significant positions within the policy framework, with weighted proportions of 3.55%, 4.85%, and 2.57%, respectively. These themes reflect the government's strategic priorities and the key paths for promoting cross-border e-commerce, providing theoretical support for the research hypotheses discussed later.

Table 1 Policy Documents Related to Cross-Border E-Commerce

Serial no.	Year	Title of document	Issuing organization
1	2015	Official Reply of the State Council on Approving the Establishment of the China (Hangzhou) Cross-Border E-Commerce Comprehensive Pilot Zone	State Council
2	2016	Notice of the Ministry of Finance, the General Administration of Customs and the State Administration of Taxation on the Tax Policies on Cross-Border E-Commerce Retail Imports	Ministry of Finance General Administration of Customs State Taxation Administration
3	2018	Announcement No. 194 [2018] of the General Administration of Customs—Announcement on Matters concerning the Supervision of Retail Imports and Exports in Cross-Border E-commerce	General Administration of Customs
……	……	……	……
64	2024	Opinions of the Ministry of Commerce and Other Eight Ministries and Commissions on Expanding Cross-Border E-commerce Exports and Promoting the Construction of Overseas Warehouses	Ministry of Commerce National Development & Reform Commission Ministry of Finance Ministry of Transport People's Bank of China General Administration of Customs

Table 2 Policy High Frequency Word Statistics

Thematic	Related Keywords.	Thematic frequency
Digital infrastructure construction	Electronics, Payment, Information, Platform, Data, Network, Technology, System, Digitization, Cloud Computing, Logistics Informatization, Blockchain, API Integration, Smart Terminal, Network Security	3.55%
Service industry agglomeration	Service, Business, Enterprise, Organization, Business, Commodity, Collaboration, Cluster, Warehousing, Logistics, Supply Chain, Finance, Marketing, Consulting, Training, Innovation, Cooperation, Brand, Cross-border Service Ecosystem	4.85%
Business Environment	Customs, supervision, regulation, pilot, declaration, policy, tax, compliance, intellectual property, risk prevention and control, administrative licensing, standardization, trade facilitation, dispute settlement, local policy support	2.57%

2.2 Thematic Analysis and Research Hypotheses

2.2.1 Digital infrastructure construction

Policy documents emphasize digital infrastructure as a critical enabler of high-quality development in CBEC Pilot Areas, with frequent mentions of "network," "digitalization," and "cloud computing." Drawing on the Solow growth model, digital infrastructure enhances economic growth by improving information flows, optimizing resource allocation, and reducing transaction costs. Specifically, logistics informatization and cybersecurity upgrades contribute to more efficient cross-border trade operations.

2.2.2 Service industry agglomeration

CBEC policies promote service agglomeration through terms such as "clusters," "finance," and "cross-border service ecosystem." Industrial clustering enhances supply chain coordination, reduces information asymmetry, and fosters synergies among logistics, financial, and IT services. This integrated ecosystem improves trade efficiency and helps cultivate globally competitive e-commerce hubs, supporting sustainable economic development.

2.2.3 Business environment optimization

A key focus of CBEC policies is improving the business environment, as reflected in terms like "customs," "regulation," and "compliance." Streamlined administrative procedures, lower institutional costs, and stronger intellectual property protections contribute to a more transparent and stable trade environment. These reforms reduce transaction costs and enhance institutional efficiency, facilitating higher-quality economic growth.

2.3 Research Hypotheses

Building on policy text analysis and the extended Solow growth model, which is based on the original growth theory proposed by Solow [1]. This study proposes three mechanisms through which CBEC Pilot Areas drive high-quality development: (1) digital infrastructure (capital input), (2) service agglomeration (labor and resource allocation), and (3) business environment optimization (transaction costs). These mechanisms collectively enhance economic efficiency by improving technological progress, market coordination, and institutional quality.

2.3.1 Construction of production functions

According to the Solow growth model, total output Y is related to the level of technology A, capital input K, and labor input L. Therefore, The production function can be expressed as:

$$Y = AK^{\alpha}L^{1-\alpha} \tag{1}$$

where Y denotes total output, A is the level of technology, K is capital inputs, representing the construction of digital infrastructure, and L is labor inputs, representing the agglomeration of productive services. α is the output elasticity of capital, and $1-\alpha$ is the output elasticity of labor.

2.3.2 The dynamic process of capital and labor accumulation

Based on further exploration of the Solow growth model, it was found that capital accumulation is related to the rate of saving, i.e., the rate of capital investment and the rate of depreciation of capital. The capital accumulation equation is given by:

$$\dot{K} = sY - \delta K \tag{2}$$

where s is the savings rate and δ is the depreciation rate of capital. To reflect the dynamic process of capital and labor accumulation, the production function is substituted into the capital accumulation equation to obtain the dynamic growth equation of capital as as follows:

$$\dot{K} = sAK^{\alpha}L^{1-\alpha} - \delta K \tag{3}$$

This equation indicates that when the accumulation of capital reaches long-run equilibrium, i.e., the steady-state level, the growth rate of capital is 0, i.e., $\dot{K}$ = 0, and steady-state capital K^* can be derived as follows:

$$K^* = (\frac{sAL^{1-\alpha}}{\delta})^{\frac{1}{1-\alpha}} \tag{4}$$

2.3.3 Construction of an improved production function

$$Y = AK^{\alpha}L^{1-\alpha}T^{\gamma} \tag{5}$$

where T denotes transaction costs and γ denotes the output elasticity of transaction costs. A reduction in transaction costs leads to an increase in market efficiency, which in turn leads to an increase in aggregate output Y.

2.3.4 A study of the dynamic process with the inclusion of transaction costs

The derivation process above is not repeated, and after adding the transaction cost element, the steady state capital K^* is as shown in Equation (6):

$$K^* = (\frac{sAL^{1-\alpha}T^{\gamma}}{\delta})^{\frac{1}{1-\alpha}} \tag{6}$$

At this point, total output Y is given by:

$$Y^* = A(\frac{sAL^{1-\alpha}T^{\gamma}}{\delta})^{\frac{\alpha}{1-\alpha}}L^{1-\alpha}T^{\gamma} \tag{7}$$

Steady-state growth for high-quality development arises from capital investment, labor input, and lower transaction costs.Accordingly, CBEC Pilot Areas promote high-quality economic development through the construction of digital infrastructure, the aggregation of productive services, and the improvement of the business environment. Therefore, this paper proposes the following two hypotheses:

H1: The establishment of CBEC Pilot Areas promotes urban high-quality economic development.

H2: The establishment of CBEC Pilot Areas promotes urban high-quality economic development through the construction of digital infrastructure, the aggregation of productive services, and the improvement of the business environment.

3 RESEARCH DESIGN

3.1 Econometric Modeling

Between 2010 and 2021, 12 provinces were designated as CBEC Pilot Areas, covering 280 prefecture-level cities. Therefore, we employ a multi-period difference-in-differences (DID) model to explore the impact of CBEC Pilot Area establishment on urban high-quality economic development. By comparing the differences between the pilot cities, which serve as the treatment group, and the non-pilot cities, which serve as the control group, the study further analyze the impact of CBEC Pilot Areas on urban high-quality economic development. The model is specified in Equation (8):

$$HQD_{\mathrm{it}} = \alpha_0 + \alpha_1 CBEC_{it} + \alpha_2 Contral + \mu_i + v_t + \varepsilon_{it} \tag{8}$$

Where i represents the city and t represents the year. The dependent variable is HQD, representing the level of high-quality economic development in the city. $CBEC_{it}$ is the core explanatory variable, indicating whether city i is recognized as a CBEC Pilot Area in year t. If city i is confirmed as a CBEC Pilot Area in year t or thereafter, the value of CBEC in year t and beyond is 1; otherwise, it is 0. $Contral$ represents a set of control variables, ε_{it} denotes the random disturbance term, μ_i denotes city fixed effects, v_t denotes year fixed effects, and α_0 is the constant term. α_1 represents the direct effect of the establishment of CBEC Pilot Areas on the high-quality economic development of cities, which is the focus of this study.

3.2. Variable Selection

3.2.1 Dependent variable

The dependent variable in this study is the high-quality development (HQD) of urban economies. It is difficult to adequately measure its level using a single indicator because the HQD has multidimensional characteristics. Wei and Li indicated the development of a measurement system for the comprehensive evaluation of high-quality economic development has addressed this limitation [2]. Nie and Jian developed a high-quality development index system incorporating quality, benefits, and stability [3]. They found that the high-quality development index of China's provinces exhibits a spatial positive agglomeration pattern. This paper, drawing on the work of Liu et al. [4], constructs a comprehensive evaluation index system for high-quality economic development based on the five development concepts of "innovation, coordination, green, openness, and sharing," and employs the entropy method to measure the high-quality economic development index of Chinese cities.

3.2.2 Core explanatory variable

The core explanatory variable in this study is the interaction term of the CBEC Pilot Areas ($CBEC$). This variable is obtained by multiplying the spatial dummy variable $Treat$ with the time dummy variable $Ryear$. $Treat$ is used to identify cities involved in the establishment of CBEC Pilot Areas, and it is constructed based on whether a prefecture-level city has established a CBEC Pilot Area. If a city has established a CBEC Pilot Area, $Treat$ is assigned a value of 1; otherwise, it is assigned a value of 0. The time dummy variable $Ryear$ is used to identify the timing of the CBEC Pilot Areas initiative, set according to a multi-period difference-in-differences method. If city i is a CBEC Pilot Area from year t onward, $Ryear$ is assigned a value of 1; otherwise, it is assigned a value of 0.

3.2.3 Control variables

We have reviewed government policy documents related to the establishment of CBEC Pilot Areas and identifies characteristic variables that may influence their establishment. Building on the research of Qi et al. and Jiang et al. [5-6], this study identifies the factors influencing the establishment of CBEC Pilot Areas. These include population size (Popu), human capital (Capi), economic development (Ingdp), infrastructure development (Infra), government intervention (Inter), urbanization (Urban), household consumption (Incoms), and internet usage (Ininter).

3.3 Data Sources

This study investigates the impact of CBEC Pilot Areas on urban high-quality development using panel data from 280 cities between 2010 and 2021. Policy data were sourced from the China Government Website and State Council documents. Patent data come from the National Intellectual Property Administration. Data on economic development level, infrastructure construction level, government intervention level, household consumption level, and internet user level are from the China City Statistical Yearbook, various city statistical yearbooks and statistical bulletins, and the China Marine Statistical Yearbook. Missing values were interpolated to construct a balanced panel data for 280 cities nationwide from 2010 to 2021.

3.3.1 Descriptive statistics

Descriptive statistics for the core explanatory variable, control variables, and other variables are presented in Table 3.

Table 3 Descriptive Statistics

Variables	Obs	Mean	Std.Dev.	Min	Median	Max
CBEC	3360	0.0929	0.2903	0	0	1
lnpop	3360	5.9148	0.6638	3.4002	5.9463	8.1362
lnaca	3351	7.6926	1.3123	2.4849	7.6104	11.2343
lngdp	3360	16.6105	0.9256	14.1773	16.5039	19.8843
lngov	3360	14.8929	0.7595	12.9718	14.8323	18.24999
lninter	3360	13.4386	0.9627	9.2103	13.39999	17.7617
urban	3346	0.5487	0.1553	0	0.5333	1
lncons	3360	15.6009	1.0490	5.4723	15.5573	19.0129

4 EMPIRICAL ANALYSIS

4.1 Baseline Regression

The regression results in columns (1) and (2) of Table 4 show that the interaction term for CBEC Pilot Area development is significantly positive at the 1% level, indicating its role in promoting urban high-quality economic development. This supports the theoretical framework and confirms that the positive impact of CBEC Pilot Areas on economic growth dominates. Excluding centrally governed municipalities in column (3) yields similar positive results, further validating the robustness of the baseline regression. Thus, Hypothesis H1 is supported.

Table 4 Results of the Baseline Regression

Variables	HQD (1)	HQD (2)	HQD (3)
CBEC	0.0113*** (6.13)	0.0107*** (3.60)	0.0101*** (3.37)
Control variable	No	Yes	Yes
Urban fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
N	3336	3327	3279
R-squared	0.5989	0.6045	0.6004

Note:***,**,and*indicate significant at the 0.1%, 1%, and 5% levels, respectively, with standard errors in parentheses.

4.2 Parallst

We test the parallel trends assumption using a 10-year window. Figure 1 shows that pre-treatment coefficients are insignificant, indicating no systematic differences between treatment and control groups. Post-policy, coefficients become significantly positive, confirming that CBEC Pilot Areas significantly improve high-quality urban economic development.

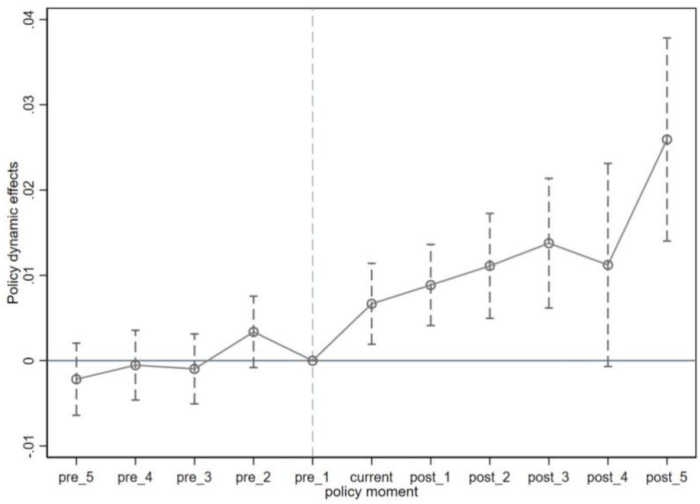


Figure 1 Results of the Parallel TrendTest

4.3 Robustness Tests

4.3.1 PSM-DID test

This section draws on the study by Jia [7], where the disposal and control group samples were first matched to ensure that the matched samples were better able to comply with the balance and co-support conditions. Subsequently, the causal treatment effect of digital trade policy on high-quality urban economic development and its mechanism are identified. Finally, robustness analysis is conducted.

The PSM-DID test conducted in this study includes sample matching, balance and common support tests, and causal treatment effects. First, a probit model is used to estimate the propensity score for each sample city to establish a CBEC Pilot Area.The model is specified as follows:

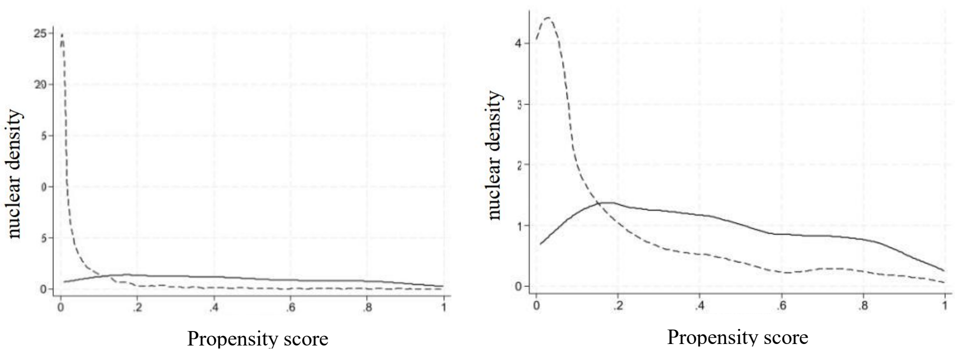
$$probit(treat_i = 1) = \alpha + \beta X_i + \varepsilon_i \tag{9}$$

Here, $treat_i$ is a dummy variable for the establishment of CBEC Pilot Areas: it is assigned a value of 1 if the sample city established a CBEC Pilot Area, and 0 otherwise. X_i represents the matching variables, as previously mentioned, including the natural logarithms of the urban resident population, real per capita GDP, number of teachers, infrastructure construction, government expenditure, urbanization rate, total retail sales of consumer goods, and internet user data.

To address selection bias from the non-random assignment of CBEC Pilot Areas, this study applies kernel-based propensity score matching (Epanechnikov kernel, bandwidth 0.20). Balance tests confirm no systematic differences post-matching (Table 5), and the probit model yields high R^2, indicating strong explanatory power. The common support condition is also satisfied, ensuring comparability and validity. As shown in Figure 2, propensity score overlap between treatment and control groups is limited before matching but substantially improves afterward, enhancing the accuracy of the average treatment effect. Based on the Heckman et al. and Lechner [8-9], we also test the common support condition, which is essential for comparability and estimation validity. A limited common support region only identifies subset effects. Figure 2 shows that before matching, propensity score overlap is small; after matching, overlap improves substantially, ensuring reliable estimation of the average treatment effect.

Table 5 Results of the Balance Test

Variable	Sample	Mean Difference Test			Standardized Difference	
		Treatment Group	Control Group	t-test (p-value)	Standardized Bias	Reduction (%)
Inpop	Before Matching	6.3295	5.8810	11.83 (0.000)	70.4	72.3
	After Matching	6.3263	6.202	2.25 (0.025)	19.5	
Inaca	Before Matching	9.2122	7.5432	23.02 (0.000)	137.5	81.1
	After Matching	9.2071	8.8922	2.87 (0.004)	25.9	
Ingdp	Before Matching	17.897	16.482	28.59 (0.000)	164.2	79.1
	After Matching	17.891	17.596	3.72 (0.000)	34.2	
Ingov	Before Matching	15.996	14.785	30.27 (0.000)	163.5	79.3
	After Matching	15.989	15.737	3.47 (0.001)	33.9	
urban	Before Matching	0.7083	0.5325	20.10 (0.000)	116.3	86.8
	After Matching	0.7106	0.6877	1.70 (0.090)	15.3	
Incons	Before Matching	16.987	15.469	26.97 (0.000)	162.3	79.3
	After Matching	16.98	16.665	3.81 (0.000)	33.6	
Ininter	Before Matching	14.772	13.307	28.55 (0.000)	187.7	81.6
	After Matching	14.768	14.499	4.00 (0.000)	34.5	
R^2		Before Matching			0.432	
		After Matching			0.024	



(a) Before Matching (b) After Matching

Figure 2 Kernel Density Results of the Propensity Scores before and after Sample Matching

After confirming that matched samples meet the conditional independence and common support assumptions, we estimate the average treatment effect of CBEC Pilot Areas on real per capita GDP growth. Results (Table 6) show consistent positive effects, confirming the robustness of baseline estimates and the policy's role in promoting high-quality economic development.

Table 6 Average Treatment Effects of the establishment of CBEC Pilot Areas

	Kernel Matching

	HQD
ATT	0.0303*** (0.0095)
Treated	311
Untreated	3003
Total	3314

Note: ***,**,and*indicate significant at the 0.1%, 1%, and 5% levels, respectively, with standard errors in parentheses.

4.4 Heterogeneity Analysis

China's vast territory entails considerable regional disparities in economic, political, and natural conditions.Therefore, the establishment of CBEC Pilot Areas in regions with differing factor endowments may exert heterogeneous effects on high-quality economic development.This study will analyze such heterogeneity from four perspectives: location heterogeneity, industrial structure heterogeneity, urban size heterogeneity, and urban cluster heterogeneity.

4.4.1 Locational heterogeneity

The impact of CBEC Pilot Areas on high-quality urban economic development exhibits regional heterogeneity. Based on national policies, 280 prefecture-level cities are divided into 51 coastal and 229 inland cities. Regression results are shown in columns (1)–(4) of Table 7. The results show that the policy significantly promotes high-quality development in coastal cities, but its effect in inland cities is positive yet insignificant. This likely reflects the advantages of coastal cities in location, industrial agglomeration, trade openness, infrastructure, human capital, and institutional support, which facilitate faster policy transmission. Inland cities, by contrast, face constraints due to geographic remoteness, weaker infrastructure, and slower institutional adaptation.

The impact of CBEC Pilot Area establishment on high-quality economic development varies by region. This section divides the sample cities into six eastern, six central, ten western, and three northeastern regions based on the Several Opinions on Promoting the Rise of the Central Region and data from the National Bureau of Statistics. Regression results are presented in columns (5)–(7) of Table 7. The results show significant positive effects in the east and northeast, but insignificant or negative effects in central and western regions. Eastern cities benefit from early digital trade adoption, geographic advantages, mature infrastructure, and innovation. The northeast leverages its border and port access, facilitates cross-border flows via digital technologies. The central region lags due to weak infrastructure, limited external connectivity, and fewer trade channels, though recent industrial upgrades have improved its potential. In the west, poor transport and digital capacity, coupled with the policy's recent rollout, delay measurable effects.

Table 7 Results of the Test for Locational Heterogeneity.

	Coastal cities (1)	Inland cities (2)	Eastern region (3)	Central region (4)	Western region (5)	Northeast region (6)
Coast×CBEC	0.0168*** (4.07)					
Inland×CBEC		0.0039 (1.03)				
East×CBEC			0.0182*** (5.16)			
Mid×CBEC				-0.0033 (-0.94)		
West×CBEC					-0.0103 (-1.45)	
Northeast×CBEC						0.0256** (2.78)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
N	3327	3327	3327	3327	3327	3327
R-squared	0.6872	0.6838	0.6893	0.6836	0.6843	0.6859

Note: ***,**,and*indicate significant at the 0.1%, 1% and 5% levels, respectively, with standard errors in parentheses.

4.4.2 Industrial structure heterogeneity

The impact of CBEC Pilot Area establishment on high-quality economic development varies significantly across cities with different dominant industrial structures. Cities are classified by the ratio of tertiary to secondary industry output: a ratio above one defines tertiary-led cities, otherwise secondary-led. The specific results of the regression analysis are shown in Table 8. The findings show that CBEC Pilot Areas significantly promote high-quality development in tertiary-led cities but have no effect in secondary-led ones. Based on the study by Zhang et al. [10], tertiary cities benefit from IT density, policy support, and service agglomeration, which attract capital and foster innovation. In contrast, secondary-led cities rely on low-end manufacturing, lack tech capacity, and face weak innovation. The establishment of CBEC Pilot Areas may further shift resources toward services, exacerbating these weaknesses and limiting their contribution to high-quality economic development.

Table 8 Results of the Test for Industrial Structure Heterogeneity

	Second (1)	Third (2)
Second × CBEC	0.0056 (1.58)	
Third × CBEC		0.0099*** (2.84)
Control variable	Yes	Yes
City fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
N	3327	3327
R-squared	0.6838	0.6859

Note: ***,**,and*indicate significant at the 0.1%, 1% and 5% levels, respectively, with standard errors in parentheses.

4.4.3 Heterogeneity analysis of different city sizes

The construction of CBEC Pilot Areas has had a significant heterogeneous impact on the high-quality economic development of cities of different sizes. According to the Notice on Adjusting the Standards for Dividing Urban Sizes issued by the State Council, cities with 5-10 million residents megacities, those with 1-5 million are large cities, and those with less than 1 million are small and medium-sized cities. Among 280 sample cities, 91 are megacities and 181 are large or medium-sized. The regression results are shown in Table 9. The results show that CBEC Pilot Areas significantly enhance high-quality development in megacities but have limited impact on large and medium-sized cities. According to Ming et al. [11], strong agglomeration effects in megacities attract capital, talent, and technology, amplified by CBEC incentives and efficient logistics. In contrast, weaker industrial bases and limited market capacity hinder smaller cities. The siphon effect redirects key factors to megacities, constraining the effect of CBEC Pilot Areas.

Table 9 Results of City Size Heterogeneity Test

	Mega city (1)	Large or medium-sized city (2)
Large × CBEC	0.0133*** (3.68)	
Medium × CBEC		0.0025 (0.56)
Control variable	Yes	Yes
City fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
N	3327	3327
R-squared	0.6871	0.6836

Note:***,**,and*indicate significant at the 0.1%, 1% and 5% levels, respectively, with standard errors in parentheses.

4.4.4 Heterogeneity of urban agglomerations

The establishment of the CBEC pilot area has a significantly heterogeneous impact on the ecological resilience of different urban agglomerations. According to the Outline of the Beijing-Tianjin-Hebei Cooperative Development Plan, Yangtze River Delta Urban Agglomeration Development Plan, and Outline of the Plan for the Reform and Development of the Pearl River Delta Region, this section divides the sample of cities into the three major urban agglomerations: Beijing-Tianjin-Hebei (JJJ), Yangtze River Delta (YRD) , and Pearl River Delta (PRD) regions. The regression results are summarized in Table 10. The results show that CBEC Pilot Areas significantly promote high-quality economic development in the Pearl River Delta, followed by the Yangtze River Delta, while the effect in the Beijing-Tianjin-Hebei region is insignificant. The PRD's advantage stems from robust digital economic policies, strong IT infrastructure, and innovation clusters. The YRD benefits from digital development but lags in R&D investment and patent intensity, resulting in a smaller effect. The Beijing-Tianjin-Hebei region, despite advantages in transport and industry, suffers from imbalanced development and weak high-end manufacturing agglomeration, limiting CBEC policy impact.

Table 10 Results of the Heterogeneity Test for City Clusters

	JJJ (1)	YRD (2)	PRD (3)
JJJ × CBEC	0.0133 (0.78)		
YRD × CBEC		0.0114* (2.11)	

PRD × CBEC			0.0271*** (3.39)
Control variable	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
N	3323	3323	3323
R-squared	0.6838	0.6844	0.6861

Note: ***,**,and*indicate significant at the 0.1%, 1% and 5% levels, respectively, with standard errors in parentheses.

5 MECHANISM TESTING

This section tests the mechanisms through which CBEC Pilot Areas affect high-quality urban economic development. Following the prior qualitative analysis, this study adopt the Sobel test to verify whether digital infrastructure, service agglomeration, and business environment act as transmission channels. Each variable is introduced as a mediator to assess its individual role and effect strength. The mediation model is specified as follows：

$$M_{it} = \beta_0 + \beta_1 cbec_{it} + \gamma X_{it} + \lambda_i + \mu_i + \varepsilon_{it} \tag{10}$$

$$\gamma_{it} = \beta_0 + \beta_1 cbec_{it} + \beta_2 M_{it} + \gamma X_{it} + \lambda_i + \mu_i + \varepsilon_{it} \tag{11}$$

In equations (10) and (11), M_{it} represents the mediator variable, which is substituted with the Digital Infrastructure Construction Index (diginf), Service Industry Agglomeration Index (spec), and the China Urban Business Credit Environment Index (envir), while other variables remain consistent with those previously discussed.

5.1 Digital Infrastructure Construction

Digital infrastructure captures both hardware investment and digital adoption. This section drawing on the work of Wang Qin et al. [12], constructing an index based on six input–output indicators. The data are sourced from the statistical yearbooks of each province and the China Urban Statistical Yearbook. A mediation model examines whether the construction of CBEC Pilot Areas promote high-quality urban economic development through the expansion of digital infrastructure. As shown in Table 11, both the regression coefficient and Sobel Z-statistic are significantly positive at the 1% level, indicating that digital infrastructure partially mediates the effect of CBEC Pilot Areas on economic growth.

Table 11 Mechanism Testing: Digital Infrastructure Development

	(1)
Variable	HQD
diginf	0.4116*** (7.24)
CBEC	0.0760*** (11.18)
Sobel Z	6.884***
Control variable	Yes
City fixed effect	Yes
Year fixed effect	Yes
N	3336

Note: ***,**,and*indicate significant at the 0.1%, 1% and 5% levels, respectively, with standard errors in parentheses.

5.2 Service Industry Agglomeration

This section employs a mediation model to assess whether CBEC Pilot Areas foster high-quality urban development by enhancing productive service agglomeration. Following Han and Yang [13], the overall specialized agglomeration index of the productive service industry is the sum of the agglomeration indices of all the subsectors, as shown in Equation (12):

$$spec_{it} = \frac{\sum_{j=1}^{J} S_{ijt} / \sum_{i=1}^{N}\sum_{j=1}^{J} S_{ijt}}{S_{it} / \sum_{i=1}^{N} S_{it}} \tag{12}$$

Where S_{it} denotes the total number of persons employed in each industry in year t for city i and N denotes the number of cities. Table 12 presents the regression results for the impact of CBEC Pilot Area development on service sector concentration, as well as the results of the Sobel test for the mediating effect. The regression coefficient for overall service sector concentration is significantly positive, as well as the results of the Sobel test for the mediating effect. Both low-end and high-end services show significant coefficients and Sobel Z-statistics at the 1% level, with a stronger effect for low-end services. These results suggest that CBEC Pilot Areas mainly promote service sector agglomeration by concentrating low-end services.

According to the latest Statistical Classification of Productive Services issued by the National Bureau of Statistics and the research of Gu [14-15], the productive services industry defined in this paper includes 6 industries: transportation, warehousing, and postal services; wholesale and retail trade; leasing and business services; information transmission, software, and information technology services; financial services; and scientific research and technology services. Following the Liu et al. [16], the first three industries belong to the low-end and middle-end productive service industries; the last three industries belong to the high-end productive service industries. The development of CBEC Pilot Areas has strengthened logistics networks, driving the rapid growth of low-end services to meet rising demand through improved efficiency and cost reduction. High-end services, however, require deeper innovation, longer investment cycles, and market readiness, leading to slower development under current conditions.

Table 12 Mechanism Test: Agglomeration of Services

Variable	HQD	HQD	HQD
spec	0.0338*** (7.24)		
Spec_low		0.0314*** (5.48)	
Spec_high			0.0166*** (2.94)
CBEC	0.0855*** (8.39)	0.0851*** (8.39)	0.0928*** (9.21)
Sobel Z	4.711***	5.651***	2.83***
Control variable	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
N	2780	2780	2780

Note: ***,**,and*indicate significant at the 0.1%, 1% and 5% levels, respectively, with standard errors in parentheses.

5.3 Improvement in the Business Environment

The business environment encompassing external factors such as public services, human resources, administrative environment, market environment, legal environment, and cultural environment. The construction of CBEC Pilot Areas encourage governments to lower operational costs and ease market access, fostering new entrants and improving transparency. Following Jia et al. [17], we use the Urban Commercial Credit Environment Index to measure business environment quality. As shown in Table 13, both the regression coefficient and Sobel Z-statistic are significantly positive, confirming Hypothesis H2.

Table 13 Mechanism Test: Improvements in the Business Environment

	(3)
Variable	HQD
envir	0.2154*** (5.71)
CBEC	0.0808*** (11.98)
Sobel Z	5.495***
Control variable	Yes
City fixed effect	Yes
Year fixed effect	Yes
N	3326

Note: ***,**,and*indicate significant at the 0.1%, 1% and 5% levels, respectively, with standard errors in parentheses.

6 CONCLUSION AND DISCUSSION

Cross-border e-commerce has emerged as a key driver of global trade. This study uses panel data from 280 cities from 2010 to 2021 and a multi-period DID model to evaluate the impact CBEC Pilot Areas on urban high-quality economic development. Results show robust positive effects, especially in border regions, tertiary-led cities, and megacities. At the cluster level, effects are strongest in the PRD, followed by the YRD. Mechanism tests confirm that CBEC Pilot Areas promote urban high-quality economic development through digital infrastructure, service agglomeration, and business environment improvements.

Based on the above research, this paper proposes the following policy recommendations:

First, the government should promote best practices of CBEC Pilot Areas, tailor implementation to local conditions, and prioritize support for smaller cities. Enhancing openness in these regions fosters coordinated cross-border e-commerce development and balanced growth, contributing to a more integrated national economic structure.

Second, improve infrastructure construction. The government should offer fiscal incentives such as subsidies and low-interest loans to support digital infrastructure, focusing on cloud platforms, 5G, and western coverage to enhance efficiency and innovation.

Third, increase support for productive services. The government should provide targeted subsidies to foster productive services, encouraging technological and managerial upgrading to support CBEC ecosystems and scalable service innovation.

Fourth, improve the business environment. The government should improve the business environment by streamlining approvals, lowering market entry barriers, and enhancing administrative efficiency. Facilitate flexible financing for CBEC firms, and establish dynamic policy evaluation mechanisms to ensure responsiveness to evolving market conditions.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Solow R M. A contribution to the theory of economic growth. The quarterly journal of economics, 1956, 70(1): 65-94. DOI: 10.2307/1884513.

[2] Wei M, Li S H. Study on the measurement of economic high-quality development level in China in the new era. J. Quant. Tech. Econ, 2018, 35: 3-20. DOI: 10.13653/j.cnki.jqte.2018.11.001.

[3] Nie C F, Jian X H. Measurement of China's high-quality development and analysis of provincial status. The Journal of Quantitative & Technical Economics, 2020, 37(2): 26-47. DOI: 10.13653/j.cnki.jqte.2020.02.002.

[4] Liu J, Huang X F, Chen J. High speed rail and high-quality development of urban economic: An empirical study based on the data of prefecture-level cities. Contemporary Finance & Economics, 2021(1): 14. DOI: 0.13676/j.cnki.cn36-1030/f.2021.01.003.

[5] Qi W H, Song C X, Cai H B. Construction of free trade pilot zones and regional economic security level. China Industrial Economics, 2024(3): 119–137. DOI: 10.19581/j.cnki.ciejournal.2024.03.007.

[6] Jiang L D, Lu Y, Zhang G F. The construction of the pilot free trade zone and Chinese exports. China Industrial Economics, 2021, 8: 75-93. DOI: 10.19581/j.cnki.ciejournal.2021.08.005.

[7] Jia J, Li Z, Qin C. Social security and economic growth: Analysis based on a quasi-natural experiment. China Industrial Economics, 2018, (11): 42-60. DOI: 10.19581/j.cnki.ciejournal.2018.11.003.

[8] Heckman J J, Ichimura H, Smith J A, et al. Characterizing selection bias using experimental data. 1998.

[9] Lechner M. ldenilication and Eisimation of Causal Eifeets of Muliple Trealments under the Conditional Independence AsumprionlI. Economeric evalution of luabour Market Polircies, 2001, 13(3): 43-58.

[10] Zhang C, Liu S C, Yu Z Y. The mechanism and path of cross-border e-commerce in promoting manufacturing industry upgrading: A perspective from the new dual circulation development pattern. Forum on Science and Technology in China, 2022(7): 77-88. DOI: 10.13580/j.cnki.fstc.2022.07.014.

[11] Ming C Q, Peng H L. Digital economic, high-quality development of urban economic, and spatial spillover effects: An empirical study based on 26 cities in the Yangtze River Delta. East China Economic Management, 2024(10): 25-35. DOI: 10.19629/j.cnki.34-1014/f.240203014.

[12] Wang Qin, Li Jing, Ding Keke, et al. Digital infrastructure, factor allocation efficiency and the income gap between urban and rural areas. Journal of statistics and decision, 2023, 39 (09): 29-34. DOI: 10.13546/j.cnki.tjyjc.2023.09.005.

[13] Han F, Yang L. How does the agglomeration of producer services promote the upgrading of manufacturing structure?: an integrated framework of agglomeration economies and schumpeter's endogenous growth theory. Management world, 2020, 36(2): 72-94. DOI: 10.19744/j.cnki.11-1235/f.2020.0022.

[14] Ye, L. The impact of digital trade on high-quality economic development: An empirical study. Journal of Jimei University (Philosophy and Social Sciences Edition), 2022, 05: 74-86.

[15] Gu N. Effects and channels between producer services and profits of industries—Empirical research based on cities' panel data and SFA mode. China Industrial Economics, 2010, 5: 48-57. DOI: 10.19581/j.cnki.ciejournal.2010.05.006.

[16] Liu Y, Yang L, Liu Z. Cross-border E-commerce and producer services agglomeration. Journal of World economic, 2023, 3: 63-93. DOI: 10.19985/j.cnki.cassjwe.2023.03.007.

[17] Jia F, Zhang Y, Li G. The Limited Incentive Effect of Informal Institution： An Empirical Study of Trust Environment on the Efficiency of Executive Compensation Contract. Nankai Business Review, 2017, 20(06): 116-128+149.