

Research on the Measurement and Approaches of National-Level New Areas in Boosting Regional Supply Chain Finance Development: A Case Study of the Yangtze River Delta Urban Agglomeration

Wenwen Ye¹, Yanan Wu²

¹School of Finance, Anhui University of Finance and Economics, Bengbu, Anhui 233030, China

²School of Finance and Public Administration, Anhui University of Finance and Economics, Bengbu, Anhui 233030

Email address: yewenwen0113@163.com

Abstract—National level New Areas (NNAs) are strategic platforms for experimenting with high-quality development in China. Taking 25 prefecture-level cities in the Yangtze River Delta (YRD) as a balanced panel (2010-2021), this paper constructs a composite Supply-Chain Finance Development Index (SCFDI) with four first-order dimensions—high technology, high efficiency, high quality, and optimized integration—and eleven second-order indicators. Entropy weighting and fixed-effect regression demonstrate that (i) the average SCFDI in the YRD rose from 0.19 to 0.53, with Jiangsu leading and Anhui lagging; (ii) establishing an NNA raises the local SCFDI by 0.044 on average, after controlling for infrastructure and science-education expenditure; (iii) greater science-education spending ($\beta = 0.375$) and infrastructure investment ($\beta = 0.034$) significantly reinforce the policy effect. A *k*-means cluster of 2021 cross-sectional data (optimal *k* = 3) identifies Hangzhou as the most suitable candidate for the next NNA.

Keywords— National-level new area; supply-chain finance; entropy method; panel regression; Yangtze River Delta.

I. INTRODUCTION

China's pursuit of high-quality growth under an increasingly uncertain global environment elevates supply-chain finance (SCF) as a key catalyst for overcoming financing bottlenecks, particularly for small and medium-sized enterprises (SMEs), and fostering industrial upgrading. Within this context, National New Areas (NNAs)—comprehensive reform platforms authorized by the central government to pilot institutional innovations—possess distinct advantages in assembling critical financial resources, digital infrastructure, and innovative institutions essential for robust SCF ecosystems. Consider the Yangtze River Delta (YRD), which is known as one of China's most economically vibrant, open, and creative mega-regions and which provides a fascinating natural laboratory. It provides an ideal setting to empirically evaluate how NNAs reshape regional SCF development and to explore optimal site selection criteria for establishing future NNAs to maximize their catalytic impact. This study, therefore, addresses three pivotal questions central to leveraging NNAs for enhancing regional SCF: (1) How can SCF development be effectively measured at the city level? (2) What is the net impact of NNA establishment on SCF development, controlling for other key drivers? (3) Which

YRD city demonstrates the strongest positioning to host the forthcoming NNA from a holistic SCF development perspective?

As pivotal national strategies, NNAs are designed to spearhead high-level openness, facilitate investment, and drive industrial transformation through high-quality development. Their emergence aligns with China's deepening economic restructuring and the rapid ascent of the digital economy, creating new imperatives and opportunities for optimizing production and supply chains. Researching the influence of NNAs on SCF development within the YRD, given its exceptional economic vitality and strategic importance, holds significant theoretical and practical value for national policy formulation and regional development strategies. This paper aims to construct a comprehensive evaluation system to measure SCF development across YRD cities, empirically isolate the net effect of NNA policy on SCF advancement using rigorous econometric methods, and identify the most suitable location for the next NNA within the region based on SCF development potential and supporting factors. The findings are expected to contribute to refining NNA policies specifically for SCF enhancement and provide a data-driven, financial-ecology perspective for strategic NNA site selection, ultimately supporting the coordinated development and high-quality economic growth of the YRD region.

The remainder of this paper proceeds as follows: Section 2 reviews relevant literature. Section 3 outlines the research hypotheses. Section 4 details the research design, including data, variable construction, and methodology. Section 5 presents the empirical analysis and findings on SCF measurement and the impact of NNAs. Section 6 applies cluster analysis for NNA site selection. Section 7 discusses policy implications and concludes.

II. LITERATURE REVIEW

2.1 Economic Development and Innovation Leadership

National New Areas (NNAs) serve as critical engines for economic growth and institutional innovation (Jin Guanping, 2023). Exemplified by the Shanghai Pudong NNA – China's first such zone established in 1992 – these areas have demonstrated significant economic impact. Pudong remains

the top-performing NNA with a GDP exceeding 1.5 trillion yuan (Tang Qin, 2024). Macroscopically, NNAs function as comprehensive platforms for national strategic development and reform (Pan Lingrui et al., 2024), acting as key vehicles for deepening innovation (Jin Guanping, 2023). Their role in advancing regional innovation, crucial for high-quality supply chain finance (SCF) development, operates through three primary mechanisms: (1) agglomeration of skilled labor and enhanced enterprise vitality (Lu Fei et al., 2023); (2) utilization of unique policy advantages and pilot privileges, as seen in Lanzhou New Area's green finance reforms (Zeng Guang et al., 2023); and (3) acceleration of human capital accumulation, financial sector development, and industrial structure optimization (Shi Mingcan, 2023).

2.2 Current Challenges

Despite their potential, NNAs face significant operational challenges. Key issues include intergovernmental coordination dilemmas stemming from fragmented fiscal systems, incomplete delegated governance authority, and decentralized personnel management – collectively forming "loosely coupled development coalitions" (Li Zhongren, 2023). Additional problems encompass homogeneous competition between NNAs, insufficient industry-city integration, weak industrial competitiveness, inefficient land use, and limited spillover effects (Feng Feng, 2021). Furthermore, some NNAs exhibit deviations from their original strategic objectives. Three systemic challenges persist: (1) inadequate central-local coordination on institutional design and grassroots innovation; (2) unresolved mechanisms for internal interest coordination; and (3) continued reliance on local government-led, land-financed investment models (Bo Wenguang et al., 2017).

2.3 Methodological Approaches

Scholars employ diverse methods to study regional SCF. Zhou Jiahui (2024) constructs evaluation systems measuring high-tech, high-efficiency, and high-quality SCF dimensions through laborer, labor tools, and labor object indicators. Zhu Di et al. (2024) adopt a similar framework for agricultural SCF. Regarding impact mechanisms, Yang Zhuang (2022) uses city-level panel data (2003-2019) to analyze NNAs' effects via factor siphoning, industrial agglomeration, and innovation-driven pathways. Wang Zhifeng et al. (2019) apply Difference-in-Differences (DID) at the county level to assess NNA economic impacts. For regional SCF comparisons, Cao Qingfeng et al. (2024) utilize the Theil index to measure disparities in industrial SCF development between city clusters and non-cluster areas (2004-2013).

2.4 Policy Recommendations

Scholars propose two main pathways to enhance NNA effectiveness:

- (1) Governance Innovation: Transitioning from government-centric models towards networked collaborations involving enterprises and social organizations, tailored to each NNA's developmental context (Bo Wenguang et al., 2017).
- (2) Innovation-Driven Policy: Strengthening intellectual property protection, incentivizing core technology R&D, and refining fiscal, tax, and trade policies to support technological

innovation while maintaining market competitiveness (Feng Feng, 2021).

Research Gap: While existing studies affirm NNAs' role in fostering high-tech industries and productivity, there is limited focus on their specific impact on local SCF ecosystems. Given the emphasis on regionally balanced, high-quality development in the 20th CPC National Congress report, investigating how NNAs catalyze advanced productive forces like SCF is of critical importance. This study addresses this gap.

III. RESEARCH HYPOTHESES

National New Areas (NNAs) emphasize the importance of technological innovation, driving comprehensive reforms and breakthroughs in key domains. They serve as crucial catalysts for advancing supply chain finance (SCF) development. NNAs are dedicated to promoting high-level, all-round openness, enhancing investment facilitation, and are recognized as vital platforms for deepening reform, opening-up, and high-quality development [1]. Focusing on developing the real economy while nurturing emerging industries and business models, NNAs propel high-quality industrial growth. The Yangtze River Delta (YRD), as one of China's most economically advanced and rapidly developing regions, experiences profound impacts from NNAs on regional transformation and productivity enhancement. Drawing on the definition of SCF development and Zhou Jiahui's (2024) research, this study decomposes SCF development (Y~it~) into four primary dimensions: high-tech, high-efficiency, high-quality, and optimized integration. Within these, the high-tech, high-efficiency, and high-quality dimensions are further subdivided into three secondary indicators each: laborers, labor tools, and labor objects, precisely capturing the key characteristics and influencing factors of SCF development. The analysis examines the impact of NNAs on these decomposed factors.

High-Tech Dimension: Indicators such as science and education expenditure reflect the level of support for technological innovation capacity. To capture technological utility, the number of invention patent applications and grants within the year are included, reflecting local demand for fintech tools and innovation intensity. Science and education expenditure is a critical driver for technological innovation and industrial development, significantly impacting national education levels, talent cultivation, and overall societal progress. Based on this, Hypothesis H1 is proposed:

H1: The establishment of an NNA significantly enhances the technological content (Fin-Tech penetration rate) of local SCF.

High-Efficiency Dimension: Economic development level and labor productivity are directly linked to economic benefits and production efficiency. As SCF development also emphasizes environmental protection and efficient resource utilization, the total number of green patents granted is introduced. NNAs demonstrably boost economic growth, labor productivity, and technological progress, reflecting efficiency gains in enterprises following deeper financial service integration. Sun Jian et al. (2014) found that

preferential policies in high-tech zones effectively enhanced enterprise productivity compared to non-zone enterprises. The establishment of NNAs attracts high-tech industries, elevating regional labor productivity. Consequently, Hypothesis H2 is proposed:

H2: NNAs improve supply chain operational efficiency by reducing financing costs and shortening payment cycles.

High-Quality Dimension: Indicators including the number of tertiary industry employees, the proportion of tertiary industry value-added in GDP, and industrial structure advancement highlight the role of SCF development in attracting high-quality labor and promoting regional high-quality transformation. Lun Rui (2009) argues that high-quality resources and related preferential incentive policies further strengthen the attraction of high-caliber talent. Simultaneously, SCF development promotes green and sustainable production, warranting the inclusion of environmental regulation indicators. These metrics embody that SCF development pursues not only maximized economic benefits but also social welfare and environmental protection. Thus, Hypothesis H3 is proposed:

H3: The policy superposition effect of NNAs promotes the optimization of SCF business structures and risk reduction.

Optimized Integration Dimension: The market openness indicator measures the convenience of cross-border SCF, reflecting the region's participation level in international division of labor, international trade, factor mobility, and globalized production[5]. It embodies the effective integration and optimization of SCF development across different industries and regions. Based on this, Hypothesis H4 is proposed:

H4: Enhanced market openness driven by NNAs increases the activity of cross-border SCF.

IV. RESEARCH DESIGN

4.1 Selection of data and variables

This paper studies the establishment of national high-tech zones on the development of supply chain financial development and the development of the impact of the realisation of the path to explore, so the use of relevant indicators to build a high-quality development of the economy indicator system, in addition to the impact of the high quality development of the regional economy, there are many other factors, so the introduction of other control variables. The variables in this paper are selected as follows:

4.1.1 Supply chain finance development indicators

The explanatory variable of this paper is the supply chain financial development indicator system, drawing on General Secretary Xi Jinping's description of the connotation of supply chain financial development in the eleventh collective study of the Political Bureau of the CPC Central Committee and Zhou Jiahui's (2024) idea of constructing a supply chain financial development measurement indicator system, and integrating the four main aspects of high technology, high efficiency, high quality, and optimal combination, to construct a supply chain financial development development indicator system. When assigning weights to the four comprehensive indicators, this paper draws

on the entropy weight method of Zhou Jiahui's (2024) supply chain finance development measurement method to assign weights according to the variability of each indicator. The majority of the information utilized in this study comes from the China Statistical Yearbook, the Yangtze River Delta City Yearbook, the Jiangsu Statistical Yearbook, the Anhui Statistical Yearbook, the Zhejiang Statistical Yearbook, and the National Bureau of Statistics' website for certain years.

Based on Zhou Jiahui's (2024) idea of constructing secondary indicators of the supply chain finance development index system, this paper examines high-tech, high-performance, high-quality and optimal combination from the aspects of workers, labour objects and labour materials.

In terms of high-tech indicators, innovation input is measured by the indicator of science and education expenditure, which is an important driving force for scientific and technological innovation and economic development, and plays an important role in promoting regional economic development, scientific and technological innovation and overall social progress. Therefore, it has a positive effect on technological innovation and is expected to be a positive indicator. The number of inventions applied for in the year and the number of inventions obtained in the year are selected for technological application and technological capability respectively, the higher the number indicates that the technological development of the region is better, the more prominent the high-tech capability is, which has a positive effect on high-tech, and it is expected that this indicator is a positive indicator;

Labor productivity is used as a measure of labor efficiency in the context of high performance. The degree of economic development, which often has a large positive effect on economic efficiency, is used to gauge economic efficiency, and the higher the level of development, the faster the economic growth, so it is expected that these two variables will be positive indicators; for environmental efficiency, the total number of green patents granted is taken, and the green technology helps to reduce pollution, which is beneficial to the environment, so it is expected that this variable will be a positive indicator;

In terms of high quality, the number of employees in the tertiary industry, the share of value added of the tertiary industry in GDP, the advanced industrial structure and environmental regulation were selected to measure that the more optimised the structure, the higher the quality of development, so the three variables are expected to be positive indicators;

For the optimal mix, it is measured by market openness, which reflects the degree of participation of the region's economy in the international division of labour, international trade, factor flows and international production. This indicator is expected to be positive.

According to the supply chain financial development index measurement index system to construct the explanatory variables, the standardisation of the indicators for entropy weighting method to obtain Y_i , indicating the value of high-quality development of the economy of each prefecture-level city in the current year, where i represents the prefecture-level

city, t represents the time year.

TABLE 1. Indicator System for Measuring Supply Chain Finance Development Indicators

| Level 1 indicators | Secondary indicators | Basic indicators (units) |
|-----------------------|---|---|
| high tech | labourer (technical capacity) | Number of inventions filed in the year q1 |
| | labour resources (Innovation inputs) | Science and education expenditure q2 |
| | object of labour (Technology applications) | Number of inventions acquired during the year q3 |
| effectivity | labourer (Labour efficiency) | Labour productivity q4 |
| | labour resources (Economic benefits) | Level of economic development q5 |
| | object of labour (Environmental efficiency) | Total green patents granted q6 |
| high quality | labourer (Market contribution) | Employees in the tertiary sector q7 |
| | labour resources (Quality of production) | Value added of tertiary sector as a share of GDP q8 |
| | object of labour (Environmental efficiency) | Advanced industrial structure q9 |
| optimise combinations | Market transformation | Environmental regulation q10 |
| | | Market openness q11 |

4.1.2 Policy variables

The key explanatory variable in this study is the binary indicator Policy it, which indicates whether a national new zone has been established in the prefecture-level city. If a prefecture-level city has a new or established national high-tech zone in a specific year, this variable has a value of 1; otherwise, it has a value of 0. This variable is used to measure the policy impact of the construction of national new zones. According to relevant documents, up to now, three national-level new zones have been successfully established in the Yangtze River Delta region, namely Shanghai Pudong New Area, Zhejiang Zhoushan Islands New Area and Jiangbei New Area. Among them, Zhejiang Zhoushan Islands New Area and Jiangbei New Area were approved to be established in 2011 and 2015, respectively, with data from the aforementioned literature.

4.1.3 Control variables

In order to control the influence of other factors on the development of supply chain finance, based on combing the related literature (Li Yang et al., 2024; Zhou Jiahui, 2024), this paper chooses a series of control variables. Infrastructure level and scientific expenditure, respectively. The control variables are fitted. The explanatory notes of the control variables are shown below:

- (1) Level of infrastructure
- (2) Science expenditures

Descriptive statistics for the above mentioned main variables are shown in table 2.

4.2 Statistical measurement of supply chain finance development

For the weights of the indicators of supply chain finance development, we choose an objective method of determining the weights - entropy weight method, which assigns weights according to the variability of each indicator. In this method, the greater the variability of an indicator, the lower its information entropy, which is considered to be more useful information, and therefore should be given a higher weight. In this part, this paper will use the entropy weight method to calculate the supply chain finance development index.

TABLE 2 Descriptive Statistics for Key Variables

| Name | N | Minimum value |
|----------------|---------------|--------------------|
| q1 | 494 | 2.00 |
| q2 | 494 | 12167.00 |
| q3 | 494 | 0.00 |
| q4 | 494 | 9223.37 |
| q5 | 494 | 8.49 |
| q6 | 494 | 0.00 |
| q7 | 494 | 3.79 |
| q8 | 494 | 23.36 |
| q9 | 494 | 0.31 |
| q10 | 494 | 70.21 |
| q11 | 494 | 9.01 |
| Yit | 494 | 5318.59 |
| maximum values | average value | Standard Deviation |
| 85742.00 | 7218.54 | 12438.18 |
| 14621719.00 | 1150073.26 | 1932277.68 |
| 32860.00 | 1947.76 | 3893.78 |
| 20224356.27 | 9223.37 | 9223.37 |
| 12.20 | 10.89 | 0.75 |
| 12847.00 | 783.22 | 1544.86 |
| 528.97 | 42.05 | 69.71 |
| 73.28 | 42.52 | 8.66 |
| 2.77 | 0.89 | 0.35 |
| 108.05 | 94.02 | 5.39 |
| 16.49 | 13.31 | 1.48 |
| 938877.71 | 92233.72 | 9223.37 |

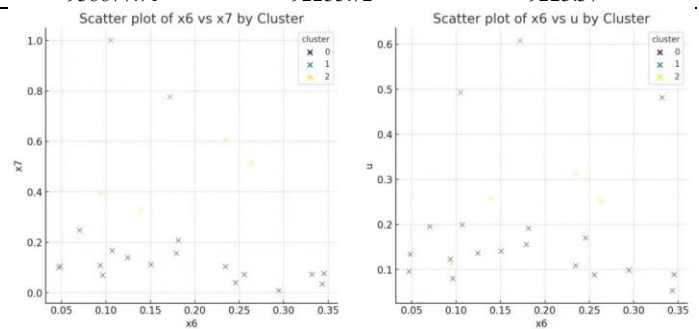


Figure1 Scatterplot of control variables

The formula for calculating the composite index of supply chain finance development is as follows:

4.2.1 Data standardisation

$$Q_{ij} = \frac{q_{ij} - \min(Q_i)}{\max(Q_i) - \min(Q_i)} \quad (1)$$

Where Q_{ij} represents the original data and Q_{ij}' represents the normalised data.

4.2.2 Calculate the weights of the indicators

$$P_{ij} = \frac{Q_{ij}}{\sum_{i=1}^m Q_{ij}} \quad (2)$$

Where P_{ij} is the weight of indicator j for region i and n is the number of indicators.

4.2.3 Calculate the entropy value

$$E_j = - \frac{1}{\ln(n)} \sum_{i=1}^m P_{ij} \ln(P_{ij}) \quad (3)$$

Where E_j represents the entropy value of indicator j and m is the number of regions.

4.2.4 Calculate the degree of variation

$$D_j = 1 - E_j \quad (4)$$

where D_j represents that the greater the information entropy of indicator j , the less important the indicator is.

4.2.5 Calculation of weights

$$W_j = \frac{D_j}{\sum_{j=1}^n D_j} \quad (5)$$

Where W_j is calculated based on the degree of variation D_j , reflecting the relative importance of each indicator.

4.2.6 Calculation of a composite index of supply chain finance development

$$CI_i = \sum_{j=1}^n W_j \times Q_{ij} \quad (6)$$

where CI_i is obtained from the weighted sum of the indicators, reflecting the level of supply chain finance development in region i .

The above steps form a statistical measurement model of an object, which can realise the quantification of the development level of supply chain finance development through multiple indicators. Calculated by the entropy weight method, the weight of each indicator is obtained as shown in table3.

TABLE 3. Supply Chain Finance Development Indicator Weights

| Level I indicators | Secondary indicators | Basic indicators (units) | weights |
|-----------------------|--|--|---------|
| high tech | Labour (technical skills) | Number of inventions filed in the year | 5.81% |
| | Labour inputs (innovation inputs) | Expenditure on science and education | 6.34% |
| | Objects of labour (technical applications) | Number of inventions acquired during the year | 4.48% |
| | Workers (labour efficiency) | labour productivity | 4.05% |
| effectivity | Labour means (economic benefits) | Level of economic development | 11.66% |
| | Objects of labour (environmental efficiency) | Total green patents granted | 4.64% |
| high quality | Labour (market contribution) | Tertiary sector workers | 6.08% |
| | | Value added of tertiary sector as a share of GDP | 15.84% |
| | Labour resources (quality of production) | Advanced industrial structure | 14.64% |
| | Objects of labour (environmental efficiency) | environmental regulation | 13.05% |
| optimise combinations | Market transformation | market openness | 13.40% |

4.3 Modelling

Using panel data regression analysis and a fixed effects model, this study examines the net impact of the establishment of new national-level zones on the growth of supply chain finance development in prefecture-level cities. This study covers 25 prefecture-level cities in the Yangtze River Delta region during the period from 2012 to 2021 to ensure the completeness of the data. In total, these cities have established two national new zones during this period. To eliminate possible effects due to differences in national new zone policies, we excluded the sample of Shanghai Pudong New Area, which was established earlier and has significant policy advantages. Zhoushan, Zhejiang Province and Nanjing, Jiangsu Province were selected for the experimental group, while the other prefecture-level cities constituted the control group. The study is analysed using a panel data regression model as shown below:

$$Y_{i,t} = \beta_0 + \beta_1 x_{1,i,t} + \sum \beta_j x_k + \gamma_{i,t} + \mu_{i,t} + \varepsilon_{i,t} \quad (7)$$

In equation (7) the explanatory variable is Y_{it} , which is regarded as a quantitative indicator of supply chain finance development, with the subscripts i and t representing the i th prefecture-level city and the year, $x(1,i,t)$ representing whether the national new area is established or not (taking the value of 0 means that it has not been established, and taking the value of 1 means that it has been established), x representing a series of other variables, Y_{it} representing the time fixed effect, μ_{it} representing the fixed effect of the region, and ε_{it} being the random error term. Of all the parameters set up in this study, ρ is the kernel metric estimator, the magnitude of which, as well as its positive or negative value, implies the magnitude of the policy effect and whether or not the policy's role is positive. β_i . It represents the weight that each explanatory variable occupies, and a larger value means that the explanatory variable contributes more to the development of supply chain finance.

V. EMPIRICAL TREATMENT AND ANALYSIS OF RESULTS

5.1 Level of development of supply chain finance

After standardising the data and calculating it, the following table is obtained: Supply Chain Finance Development Index of Yangtze River Delta Provinces from 2010 to 2021, on the whole, we analyse and get that the comprehensive index of Supply Chain Finance Development shows an upward trend between 2010 - 2021. It grows from 0.19384 in 2010 to 0.531828 in 2021 respectively, with an annual growth rate of 14.53%. It reveals the positive changes in policies, infrastructure pointed out and scientific expenditures of new national-level zones, which promote the development of supply chain finance, and also reveals the uneven development among different regions.

From within the provinces, the level of supply chain finance development in each province has become an increasing trend, and a horizontal comparison yields that Anhui Province has the lowest level of supply chain finance development and Jiangsu Province has the highest level of supply chain finance development. This may be due to its higher level of economic

development and more open market.

TABLE 4. Supply Chain Finance Development Composite Index

| vintages | Jiangsu Province | Zhejiang Province | Anhui |
|---------------|------------------|-------------------|----------|
| 2010 | 0.069184 | 0.081413 | 0.043243 |
| 2011 | 0.085074 | 0.091106 | 0.047977 |
| 2012 | 0.103812 | 0.100778 | 0.053255 |
| 2013 | 0.120453 | 0.114392 | 0.058694 |
| 2014 | 0.126107 | 0.124596 | 0.066702 |
| 2015 | 0.148601 | 0.143406 | 0.078143 |
| 2016 | 0.16635 | 0.155173 | 0.093778 |
| 2017 | 0.177531 | 0.168694 | 0.098742 |
| 2018 | 0.191055 | 0.191447 | 0.108158 |
| 2019 | 0.190557 | 0.200236 | 0.105051 |
| 2020 | 0.221382 | 0.223068 | 0.117445 |
| 2021 | 0.253699 | 0.238757 | 0.125373 |
| average value | 0.154484 | 0.152756 | 0.083047 |

5.2 Path to realising the development of supply chain finance

According to the statistical model set in the previous part, we take infrastructure expenditure and science and education expenditure indicators as control variables, and the ten-year supply chain financial development index as the explanatory variables of supply chain financial development, followed by the introduction of time effects and individual effects, and then on the basis of the panel data regression again, and before regression, we first carry out the Breusch-Pagan test, Hausman test, and so on. The results are as follows:

TABLE 5. Test results

| Type of test | statistic | P | reach a verdict |
|--------------------|-----------|----------|-----------------|
| Breusch-Pagan test | 1080.057 | 0.000*** | RE model |
| Hausman test | 0.64 | 0.887 | RE model |

Breusch-Pagan test is used to determine the superiority between RE model and POOL model, where P-value below 0.05 indicates that RE model is more suitable; on the contrary, POOL model should be selected. Hausman test is used to compare FE model with RE model, where P-value below 0.05 indicates that FE model is better. According to the Breusch-Pagan test, the P-value of 0.000*** shows significance, so the original hypothesis is rejected and the RE model is chosen. Whereas the Hausman test has a p-value of 0.887 which does not show significance and thus the original hypothesis cannot be rejected and the RE model is continued. Based on these analyses, this paper decides to use the panel data regression model with fixed effects for subsequent studies.

TABLE 6. Model Tests

| variant | ratio | standard error | t | P | R ² | F |
|---------|-------|----------------|--------|----------|--|-------------------------|
| const | 0.081 | 0.005 | 17.512 | 0.000*** | within=0.773 between=0.484 overall=0.572 | f=127.458 p=0.000*** |
| x1 | 0.044 | 0.02 | 2.208 | 0.028** | | |
| x6 | 0.034 | 0.014 | 2.395 | 0.017** | | |
| x7 | 0.375 | 0.044 | 8.479 | 0.000*** | | |

The F-test of the time-individual fixed effects model shows that the significance p-value is 0.000***, which presents significance at the level and rejects the original hypothesis, thus the fixed effects model is valid. The coefficient of x2, 0.034, indicates that for every unit increase in x6, the

explanatory variable increases by 0.034 units, which is significant at the 10 per cent level of significance. This is a relatively weak but still statistically significant positive effect. It shows that the level of infrastructure development in a region has a positive effect on supply chain finance development enhancement. Meanwhile, the control variable x3 coefficient of 0.375 is the largest of all variables, indicating that x3 has the most significant effect on the explanatory variables, with an increase of 0.375 units for every unit increase in the explanatory variables, and is highly significant at the 1% significance level. This shows that more expenditure on science and education has a significant impact on the improvement of supply chain finance development in the region. The coefficient of the core variable x1 is 0.044, indicating that for every unit increase, the explanatory variable increases by an average of 0.044 units and is significant at the 5% level of significance. This indicates a positive and significant impact of the policies of the new national level zones on the development of supply chain finance.

The results show that the policy of establishing new national zones in the region is positive and effective in enhancing the development of supply chain finance in the region, which in turn indicates that the establishment of new national zones and the improvement of regional infrastructure, and the increase of the proportion of science and education expenditure in the regional finance are three ways to promote the innovation capacity of the region, which has a great potential to develop the economy.

VI. SELECTION OF SITES FOR INCUBATION SITES IN NEW NATIONAL-LEVEL DISTRICTS

At present, there are three national-level new zones in the Yangtze River Delta urban agglomeration, namely Zhoushan Islands New Zone in Zhejiang Province, Nanjing Jiangbei New Zone in Jiangsu Province and Shanghai Pudong New Zone. Among them, Zhoushan Islands is close to the mouth of the Yangtze River, which is an important shipping route hub in China; it is the first of the state-level new zones to focus on the marine economy, and it has now become China's largest energy security base, safeguarding the security of China's strategic materials and promoting the development of the Yangtze River Economic Belt; Nanjing Jiangbei New Area is an important node of the Eastern Coastal Economic Belt and the Yangtze River Economic Belt, which was built to promote the country's industrial transformation and As an open cooperation demonstration zone, different from the marine economy of Zhoushan Islands, Jiangbei New Area focuses on the development of integrated circuits, life and health industries, aiming to build a "City of Chips" and "City of Genes", which aims to strengthen regional cooperation and promote the opening up of foreign economy; The Yangtze River Economic Belt, which is being constructed to support the Yangtze River Economic Belt and the national industrial revolution, is centered on Shanghai Pudong New Area, a major hub of the eastern coastal economic belt. Shanghai Pudong New Area is the earliest state-level new area in China, which focuses on the role of innovation capacity, and has developed from farmland in the past to a modern new city

nowadays, reflecting the achievements of China's reform and opening up and socialist modernisation. With the economic development of the country and the Yangtze River Delta, the Yangtze River Delta needs more development opportunities and needs to explore new areas for new district construction. Therefore, we use the 2021 indicators of the 23 regions in the Yangtze River Delta city cluster that have not established national-level new zones, and use cluster analysis to find the next possible new zone construction sites within the Yangtze River Delta region.

In this paper, we use the data of control variables measured in 2021 for the 23 regions in the Yangtze River Delta that have not set up new national-level zones, firstly, we use the elbow rule to find the value of the optimal number of clusters K, and then we carry out K-mean clustering analysis, and through the results, we search for the next Yangtze River Delta city suitable for setting up a new national-level zone.

6.1 The Law of the Elbow

In order to make the decrease in the sum of the squares of the distances of the points to the cluster centres no longer significant, the relationship brought about by increasing the number of clusters is no longer significant, we use the elbow rule to calculate the inertia for different values of K. Equation (8) is given below:

$$S = \sum_{i=1}^n \min_{\mu_i \in C} \|x_i - \mu_i\|^2 \tag{8}$$

Interpretation of the variables in equation (8) is as follows:

x_i is a sample point

μ_i is the centre of clustering

C is the set of all cluster centres

n is the sample size

The data are calculated to produce the graph shown in Figure 2, looking for "elbow" points, i.e., points where the inertia drop becomes less dramatic, which are usually considered to be the appropriate number of clusters.

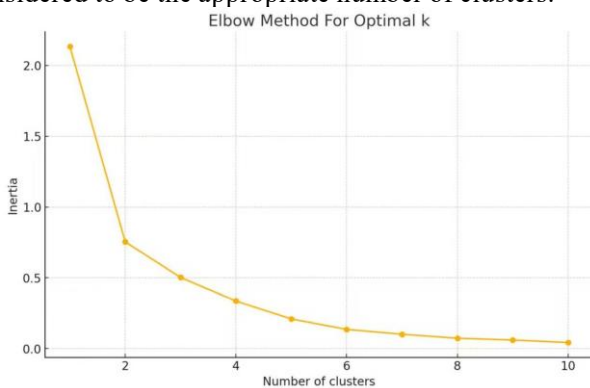


Figure 2. Elbow Rule Graphic

Figure 2 shows the contour coefficients corresponding to the different clusters K, measuring the closeness and separation of the clusters, with values closer to 1 indicating higher quality.

At K=2, the contour coefficient reaches its highest point, indicating that the two clusters are able to distinguish the data

well. Besides that, K=3 is also a value that can be chosen, although its contour coefficient is lower than the contour coefficient at K=2, it still maintains a high level.

The purpose of this paper is to classify the urban agglomerations in the Yangtze River Delta in a more detailed way, so K=3 was chosen to calculate the analysis, i.e., the urban agglomerations were classified into three categories.

6.2 K-mean classification

The method of K-mean classification is widely used and our goal is to classify the data points in the dataset into K clusters, ensuring that the similarity within the clusters is maximised while ensuring that the similarity between the clusters is minimised. Equation (9) is given below:

$$J = \sum_{i=1}^k \sum_{x \in S_i} \|x_i - \mu_i\|^2 \tag{9}$$

Among them:

J represents the total sum of squares, which is the minimisation objective function desired in this paper

K is the number of clusters

S_i is the set of all data points in the ith cluster

X is a data point

μ_i is the centre of the ith cluster, obtained by summing and averaging all points in that cluster.

K=3 was chosen to classify the control variables and supply chain finance development data of the Yangtze River Delta city cluster with K-means, and the results obtained are shown in Table 7.

TABLE 7. Clustering results

| rank | Cluster 0 | | Cluster 1 | | Cluster 2 |
|-----------------------|-----------|-----------|-----------|----------|-----------|
| prefecture level city | Shaoxing | Anqing | Jinhua | Hangzhou | Hefei |
| | Tongling | Changzhou | Ma'anshan | Suzhou | Ningbo |
| | Quzhou | Chizhou | Nantong | | Wuxi |
| | Xuancheng | Chuzhou | Yangzhou | | Wuhu |
| | Zhenjiang | Huzhou | Taizhou | | |
| | | Jiaxing | Taizhou | | |
| number | 17 | | 2 | | 4 |
| Y_{it} | 0.14931 | | 0.550574 | | 0.467747 |

Y_{it} is an indicator system to measure the development of supply chain finance. By comparing the mean value of Y_{it} among the three categories, we get that the Y_{it} of cluster 1 is the highest, which is 0.550574, that is to say, the development level of supply chain finance development of cluster 1 is the best. Because Hangzhou is ranked first in this category, Hangzhou is selected as the location for the next national new area in the Yangtze River Delta region.

Li Qihang and Huang Lu (2021) point out that the site of a national new zone should be in a city with a high level of economic development and a greater influence on the surrounding area. In 2023, the total GDP of Hangzhou reached 2005.9 billion yuan, an increase of 5.6 per cent compared to last year. Among them, the added value of the primary industry was 34.7 billion yuan, up 3.7 per cent; the added value of the secondary industry was 566.7 billion yuan, up 1.8 per cent; and the added value of the tertiary industry was 140.45 billion yuan, up 7.2 per cent.

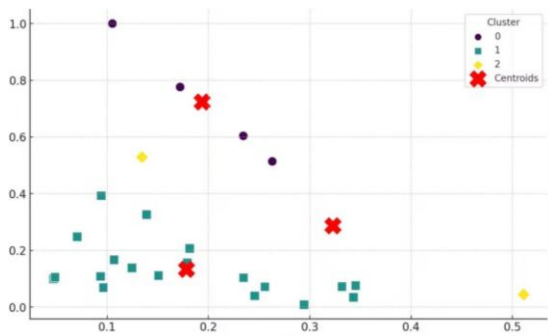


Fig.3 Clustering results graph

A series of data shows that HCM City's economic structure is being optimised continuously, with the tertiary industry occupying an increasingly important position in economic development. In terms of the growth of the new economy, the added value of the digital economy sector in HCM City was 567.5 billion yuan, a 8.5% rise from the year before, and the added value of the "three new" economy (new industries, new forms and new modes) is expected to account for 40% of the GDP, which shows that high-tech and digital economy industries in HCM City have achieved high speed development. Therefore, this study suggests that the high-tech industry and digital economy industry in Hangzhou should be selected. Therefore, this study concludes that Hangzhou should be selected as the next national new zone in the Yangtze River Delta region, focusing on the development of tertiary industry, high-tech industry and digital economy industry.

VII. CONCLUSIONS

7.1 Main Findings

This study focuses on analyzing the impact of national-level new zones on the development of supply chain finance in 25 prefecture-level cities in the Yangtze River Delta from 2010 to 2021. Using panel data and fixed-effects models, it confirms that the establishment of national new zones significantly promotes local supply chain finance through increased infrastructure and science and education spending. Regional differences are clear: Jiangsu, Zhejiang, and Anhui show varying levels of development, highlighting the need for differentiated strategies. Notably, science and education expenditure ($\beta = 0.375, P < 0.01$) and infrastructure investment ($\beta = 0.034, P < 0.05$) both have statistically significant positive effects on supply chain finance development. The study also finds that new zones play a

central role in enhancing economic competitiveness and adapting to global changes.

7.2 Policy Recommendation: Hangzhou as a New National-Level Zone

Cluster analysis identifies Hangzhou as the top candidate for a new national-level zone, with the highest Supply Chain Finance Development Index (0.550574) among cities without such zones. Hangzhou's strong economic base, high-tech capabilities, and leadership in digital industries make it ideal for further development. It is recommended to establish a new zone in Hangzhou focused on high-tech, digital economy, and tertiary sectors, which would not only boost local supply chain finance and economic quality, but also enhance regional competitiveness through spillover effects. Simultaneously, dynamic assessment systems and transparent feedback mechanisms should be established to optimize zone governance and ensure effective, adaptive policy implementation.

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