Evaluation of the Impact of Financial Support on Industrial Integration in the Yangtze River Delta Integration Process in China

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Abstract. This study evaluates the impact of financial support on industrial integration in the Yangtze River Delta (YRD) from 2010 to 2022. Using an entropy-weighted coupling coordination model and fixed-effects regression, we analyze the synergy between financial mechanisms and industrial ecosystems. Findings reveal that financial support significantly drives industrial integration, with urbanization acting as a vital multiplier for regional coordination. While Jiangsu and Zhejiang have achieved high-quality coordination, Shanghai faces structural misalignments—including regulatory fragmentation and service overconcentration—that limit its synergistic potential. The study advocates for targeted green finance and cross-regional policy reforms to ensure sustainable, high-quality integration.

Keywords: Yangtze River Delta in China; Industrial integration; Financial support; Coupling coordination model; Sustainable development

1 Introduction

The Yangtze River Delta (YRD) is a critical economic engine, contributing approximately 24% of China's GDP. However, its high-quality integration is hindered by imbalanced financial allocation and fragmented regulatory systems. While financial integration is a vital catalyst for industrial synergy, current research often overlooks qualitative dimensions like environmental sustainability and the nonlinear interactions within financial-industrial ecosystems.

This study addresses these gaps by constructing a multidimensional analytical framework that incorporates environmental indicators. Utilizing panel data from 2010–2022, we employ an entropy-weighted coupling coordination model and fixed-effects regression to quantify the synergy between financial support and industrial integration.

Our findings reveal significant spatial heterogeneity: Jiangsu and Zhejiang achieve high coordination levels through robust green finance initiatives, whereas Shanghai's synergistic potential is limited by its reliance on high-end services and regulatory

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barriers. This research contributes to the field by providing empirical evidence on financial-industrial interactions and identifying urbanization as a critical driver in bridging regional developmental disparities.

2 Literature Review

Regional economic integration theory remains the cornerstone for analyzing the YRD's evolution from policy coordination to market consolidation. Contemporary research by Liu et al. (2023) emphasizes that higher-quality integrated development in the YRD is driven by synergistic industrial linkages and the elimination of market segmentation.[1] Furthermore, recent empirical evidence from Wang et al. (2023) underscores that market integration among YRD cities significantly boosts regional innovation capacity and economic growth by facilitating the free flow of resources across administrative boundaries.[2]The role of financial mechanisms in industrial development has shifted toward high-tech and sustainable sectors. Zhu and Zhao (2024) argue that the stability and rapid evolution of China's financial system have created indispensable conditions for effective industrial upgrading.[3] In the YRD context, financial openness is found to significantly enhance industrial agglomeration, although spatial heterogeneity persists (Ma & Yu, 2022).[4] Moreover, the integration of digital finance into traditional systems is now recognized as a key tool for reducing information asymmetry and lowering transaction costs for SMEs (Wu et al., 2025).[5]Coupling coordination theory provides the rigor to quantify interactions between finance and industry. Recent studies, such as Zhang et al. (2023), have successfully applied VAR and coupling coordination models to demonstrate that green finance in the YRD directly fosters high-quality economic development.[6] While regional integration can sometimes challenge green efficiency due to secondary industry shifts, strategic inter-regional coordination can mitigate these adverse effects. This underscores the necessity of a "finance-industry-space" trial to ensure that regional growth aligns with long-term sustainability goals.

Liu et al. (2019) demonstrated that financial openness drives agglomeration in the YRD through capital mobility and policy coordination[7], while Zhang (2020) identified its indirect effects via industrial upgrading, and Xie et al. (2021) revealed synergies among finance, openness, and industrial transformation[8]. Chen (2019) proposed green bonds for ecological synergy but lacked empirical validation[9]. However, prior studies have predominantly relied on economic metrics and static policy analyses, overlooking multidimensional sustainability indicators, dynamic spatiotemporal interactions, and the roles of fintech and green finance. This study addresses these gaps by integrating sustainable development theory into a "finance-industry-space" triad, employing entropy weighting, panel regression, and social network analysis to construct a dynamic evaluation framework, thereby offering a replicable paradigm for analyzing regional synergies.

3 Model and Methods

3.1 Data Sources and Variable Selection

This study utilizes panel data spanning 2010–2022 from four provincial-level divisions in the YRD: Shanghai, Jiangsu, Zhejiang, and Anhui. Data were compiled from the China Industrial Statistical Yearbook, China Financial Yearbook, and China Environmental Statistical Yearbook.

As shown in Table 1, To evaluate the synergy between systems, two subsystems were constructed: Industrial Integration (S): Measured through 18 indicators across dimensions including scale strength, innovation capacity, and environmental sustainability. Financial Support (F): Comprises 7 indicators reflecting credit allocation, capital market development, and green finance.

Table 1. Main Indicators and Weights

Primary Indicator	Secondary Indicator	Entropy	Value	Weight
Scale Strength	Gross Industrial Output S1	0.9067	0.0933	6.93%
	Total Profit S2	0.9026	0.0974	7.23%
	Enterprise Density S3	0.9098	0.0902	6.71%
	Output per Employee S4	0.9115	0.0885	6.57%
Agglomeration Intensity	Regional Industrial Revenue Concentration S5	0.8996	0.1004	7.46%
	Strategic Emerging Industry Enterprises Proportion S6	0.9171	0.0829	6.16%
	Total Profit to Regional Industrial Profit Proportion S7	0.9086	0.0914	6.79%
Development Efficiency	Total Labor Productivity S8	0.9476	0.0524	3.89%
	Enterprise Production Efficiency S9	0.9607	0.0393	2.92%
Innovation Capacity	R&D Expenditure S10	0.9064	0.0936	6.95%
	Output Value of High-tech Products S11	0.9267	0.0733	5.45%
	Number of Patents Granted S12	0.8997	0.1003	7.45%
Openness Agglomeration Benefits	Export Delivery Value S13	0.9074	0.0926	6.88%
	Regional Fixed Asset Investment Concentration S14	0.8987	0.1013	7.53%
Environmental Effects	Carbon Emission Intensity S15	0.946	0.054	4.01%
	Industrial Wastewater Emission Intensity S16	0.9825	0.0175	1.30%
	SO_2 Emission Intensity S17	0.9526	0.0474	3.52%
	Industrial Particulate Emissions S18	0.97	0.03	2.23%
Bank Credit	Corporate Loan Volume F1	0.9488	0.0512	10.13%
	Provincial Loan Balance F2	0.9736	0.0264	5.23%
Government Capital Market	Government R&D Expenditure F3	0.9433	0.0567	11.21%
	Aggregate Stock Market Value F4	0.8863	0.1137	22.49%
Green Finance	Bond Financing Volume F5	0.9049	0.0951	18.82%
	Insurance Premium In-come F6	0.9063	0.0937	18.55%
	Pollution Control Investment F7	0.9314	0.0686	13.57%

3.2 Modeling Framework and Panel Regression Specification

To quantify the synergistic relationship between F and industrial S, an entropy-weighted coupling coordination model was employed. This method minimizes subjective bias in assigning weights and objectively evaluates system interactions.

As shown in Table 2, an entropy-weighted method was employed to determine indicator weights. The coupling coordination degree (D) is then utilized to evaluate the collaborative development level between financial support (F) and industrial integration (S):

$$C = 2\sqrt{\frac{F \cdot S}{(F+S)^2}}, D = \sqrt{C \cdot T}, T = \alpha F + \beta S \tag{1}$$

where T represents the comprehensive development level, with $\alpha = \beta = 0.5$. The coordination levels were classified into ten tiers on the basis of D values.

Table 2. Degree of Coordination

Coordination Degree Level	Range	Description
High Coordination	0.8–1.0	High-level coordination within the system
Moderate Coordination	0.6–0.8	Moderate-level coordination within the system
Low Coordination	0.4–0.6	Low-level coordination within the system
On the Verge of Disharmony	0.2–0.4	The system is on the verge of disharmony
Severe Disharmony	0–0.2	Severe disharmony within the system

The baseline model is specified as:

$$S_{it} = \beta_0 + \beta_1 F_{it} + \beta_2 PGDP_{it} + \beta_3 CITY_{it} + \beta_4 GOV_{it} + \epsilon_{it} \tag{2}$$

where S_{it} denotes industrial integration, F_{it} represents financial support, and the control variables include per capita GDP (PGDP), the urbanization rate (CITY), and government expenditure (GOV).

4 Results

4.1 Spatiotemporal Trends and Coupling Coordination Degree Analysis

The indices calculated via the entropy-weighted method reveal distinct regional trajectories within the YRD. In the financial support subsystem, capital market development and government R&D expenditure emerged as primary drivers. In the industrial integration subsystem, regional fixed asset investment and patent grants exhibited the highest weights.

As shown in Figure 1, the industrial integration indices for Jiangsu and Zhejiang demonstrated sustained growth, respectively. This upward trajectory was significantly catalyzed by the 2018 national strategy, which facilitated cross-provincial innovation clusters and policy alignment. However, Shanghai's industrial index stagnated, largely

due to a structural misalignment where financial resources remain concentrated in high-end services with limited spillover into neighboring manufacturing sectors. Regarding financial support, all provinces exhibited a fluctuating upward trend, indicating improved institutional alignment and credit accessibility across the YRD region.

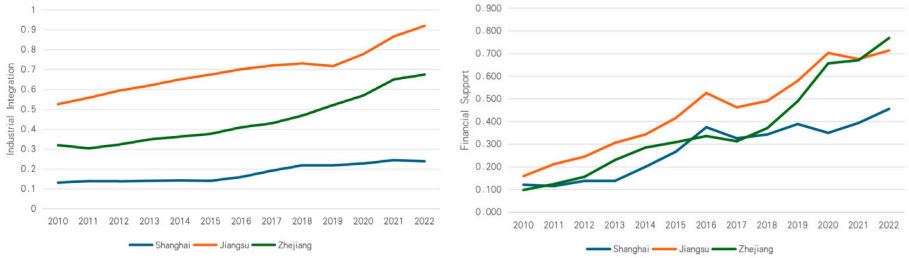

Fig. 1. Trends in the Industrial Integration Index and financial support index

The coupling coordination degree results indicate a significant transition from disharmony toward high-quality coordination across the YRD. As shown in Table 3, By 2022, Jiangsu and Zhejiang both achieved High-Quality Coordination. This progression is attributed to their diversified industrial structures and robust financial support for small and medium-sized enterprises. In contrast, Shanghai initially lagged in Severe Disharmony but transitioned to Barely Coordinated by 2021. While national strategies like "Dual Circulation" have fostered recent improvements, Shanghai's synergy remains constrained by regulatory fragmentation and a high-finance focus that lacks sufficient spillover into neighboring manufacturing sectors.

Table 3. Coupling Coordination Degree (D)

year	Shanghai	Jiangsu	Zhejiang
2010	0.144	0.472	0.222
2011	0.16	0.556	0.322
2012	0.184	0.602	0.39
2013	0.194	0.663	0.488
2014	0.246	0.7	0.538
2015	0.271	0.755	0.562
2016	0.37	0.822	0.597
2017	0.413	0.797	0.592
2018	0.457	0.815	0.647
2019	0.476	0.852	0.732
2020	0.47	0.923	0.823
2021	0.508	0.943	0.863
2022	0.526	0.974	0.908

4.2 Impact of Financial Support on Industrial Integration

To identify the determinants of industrial synergy, a panel regression analysis was conducted. Following an F-test and a Hausman test, the FE model was identified as the optimal estimator. As shown in Table 4, The regression results confirm that financial support has a statistically significant positive effect on industrial integration. A one-unit increase in the financial support index corresponds to a 0.394-unit rise in the industrial integration index. Among control variables, the urbanization rate exhibits a strong positive correlation, suggesting that agglomeration economies amplify the effectiveness of financial mechanisms in driving coordination. These findings underscore the role of market-based financial support and urban connectivity as critical catalysts for regional synergy, while direct fiscal support (GOV) showed limited direct influence in this framework.

The results advocate targeted financial policies such as enhancing credit accessibility for SMEs and scaling green finance initiatives—to bolster industrial integration. However, Shanghai's lagging performance necessitates structural reforms to align its finance-centric economy with manufacturing and innovation ecosystems in neighboring provinces.

Table 4. Panel Regression Results

Variable	Pooled OLS	FE Model	RE Model
F	0.773***	0.394**	0.773***
	(5.244)	(4.755)**	(5.244)
PGDP	-0.022	0.001	-0.022
	(-0.196)	(0.037)	(-0.196)
CITY	-0.115	0.885*	-0.115
	(-0.297)	(3.286)**	(-0.297)
GOV	-3.044***	-0.569*	-3.044***
	(-3.794)	(-1.696)	(-3.794)
Intercept	0.988	-0.293	0.988
	(0.921)	(-0.613)	(0.921)
R2	0.886	0.929	0.886
N	39	39	39
Test	F = 65.907, *p* = 0.000	F = 104.565, *p* = 0.000	χ^2 = 263.630, *p* = 0.000

[1]***p < 0.01, **p < 0.05, *p < 0.1; t statistics are in parentheses.

5 Conclusions

This study examines how financial support influences industrial integration in the Yangtze River Delta using theoretical analysis, entropy-weighted coupling coordination models, and panel regression. Findings show that banking, capital markets, and green finance are key drivers of integration, with urbanization amplifying synergistic effects. Regional disparities call for tailored approaches: Shanghai should align its financial strength with broader industrial needs, while Jiangsu and Zhejiang can benefit

from green finance and SME-focused innovation. By linking theory with policy, this research contributes to sustainable regional development.

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Disclosure of Interests

The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Liu, Z., Xu, N., & Kong, L. (Eds.). (2023). Integration Development in the China Yangtze River Delta. Routledge.
2. Wang, J., et al. (2023). A study of the economic growth effects of market integration: An examination of 27 cities in the Yangtze River Delta city cluster. PLOS One, 18(7), e0287970.
3. Zhu, H., & Zhao, C. (2024). Financial Mechanism in China's Industrial Development: Success Stories and Weak Links. In Industrial Upgrading in China in the Era of New Industrial Revolution (pp. 211-225). Singapore: Springer Nature Singapore.
4. Ma, H. J., & Yu, X. L. (2022). The impact of financial openness on financial agglomeration in the Yangtze River Delta urban agglomeration and regional heterogeneity. Journal of Jishou University (Natural Science Edition) , 43(1), 85–96.
5. Wu, G., Zeng, Z., Yang, D., Wang, H., & Niu, X. (2025). Does Regional Integration Enhance Green Development Efficiency? Evidence from the Yangtze River Delta Region in China. Systems, 13(10), 904.
6. Zhang, S., Liang, B. B., Xu, S. Z., & Hou, J. L. (2023). Empirical analysis of green finance and high-quality economic development in the Yangtze River Delta based on VAR and coupling coordination model. Frontiers in Environmental Science, 11, 1211174.
7. Liu ZB et al. (2019). Characteristics, problems, and basic strategies of integrated development in the Yangtze River Delta. Journal of Anhui University (Philosophy and Social Sciences) (5): 1–12.
8. Xie F, Yuan LH, Fu W (2021). How can high-quality market integration be achieved in the Yangtze River Delta? Perspectives from openness, industrial upgrading, and financial development. Regional Economy (6): 112–125.
9. Chen SY (2019). Green finance supports the integrated development of the Yangtze River Delta. Journal of Environmental Economics 4(1): 1–7. https://doi.org/10.19511/j.cnki.jee.2019.01.001.