Dean&Francis
ISSN 2959-6157

Institutional Constraints, Innovation Flows and Regional Synergy: A Study on the Integrated Development of New Energy Industries in the Yangtze River Delta: An Exploration Based on Hefei Practice

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Abstract:

Driven by the global energy revolution and the goal of carbon neutrality, the integrated development of the Yangtze River Delta, as the core area of China's new energy industry, faces institutional barriers. Based on Acemoglu's institutional economics perspective, this study constructs the framework of "system-innovation-coordination" and finds that the lack of regional policy coordination mechanism, market barriers caused by local protectionism, and obstruction of the flow of innovation factors are the main factors leading to the high degree of dependence on foreign countries for core technologies, homogeneous competition and resource mismatch, and insufficient resilience of the industrial chain. resource mismatch, insufficient industry chain resilience, imbalance of talent structure and other problems. By comparing the differentiated development of Hefei (large-scale production), Shanghai (source of innovation), Suzhou (supporting hub), and the experience and defects of Germany's Ruhr area and the U.S. "Battery Belt", the study puts forward a path to break the barrier: strengthen the mechanism of information sharing and service coordination, and deepen the regional consultation relying on existing platforms. The study proposes the following paths: strengthening the information sharing and service coordination mechanism, deepening regional consultation based on existing platforms; breaking down the hidden barriers to the flow of talents, technologies and capitals, and activating the market-driven circulation of innovation factors; guiding the division of labour in the industrial chain based on comparative advantages, and encouraging enterprise-led project-based cooperation; and optimizing the precision of the policy tools to avoid incentive distortion. Pragmatic promotion of institutional innovation

ISSN 2959-6157

and factor flow is the key to unleashing the overall competitiveness of new energy industries in the Yangtze River Delta and creating world-class clusters.

Keywords: institutional constraints, innovation flow, regional synergy, new energy industry, Yangtze River Delta integration, Asimoglu

1.Introduction

Driven by both the global energy revolution and the goal of carbon neutral strategy, the new energy industry is reshaping the global industrial landscape at an unprecedented speed. As the core cluster of China's new energy industry, the Yangtze River Delta (YRD) region occupies a significant share of the national output of new energy vehicles, highlighting its central position. However, while the importance of regional synergy and industry concentration is becoming increasingly important in the context of the booming development, problems such as homogeneous competition and high dependence on foreign countries for core technologies have become bottlenecks restricting high-quality development. The synergistic development of the new energy industry in the Yangtze River Delta (YRD) region shows significant differentiation, with Hefei, Suzhou and Shanghai forming distinctive industrial layouts based on their respective advantages. This study focuses on the path of the new energy industry in the Yangtze River Delta from local clusters to deep regional synergy, with particular attention to the role and inspiration of Hefei's practice. The study aims to reveal the institutional barriers to synergistic development and the ways to break them down, with theoretical value in expanding the application of institutional economics in the field of regional industrial synergies, and practical significance in providing decision-making references for government departments and enterprises. Acemoglu stresses that institutions are key factors in shaping economic performance, and that different institutional arrangements create differentiated incentives that affect individual and organisational behavioural choices and resource allocation efficiency. This study will draw on this perspective to analyse the institutional constraints faced by the new energy industry synergy in the Yangtze River Delta and its cracking path.

2. Literature Review

Existing studies have explored the synergistic development of new energy industries in the Yangtze River Delta from multiple perspectives, revealing the main challenges currently faced. Firstly, the problem of homogenised competition is becoming increasingly prominent (Niu and Mao, 2023), and the duplicated layout of key links in emerging industries in multiple locations may lead to a waste of resources. Second, the external dependence of key links in the industrial chain is too high (Zhao and Han et al., 2011), which constitutes an industrial security risk. Furthermore, regional development imbalance is obvious (Feng et al., 2024), which is reflected in the differences in innovation costs, industrialisation capabilities, and supporting levels. In response to these challenges, various solutions have been proposed by academics. Zhu Kejiang (2021) emphasised the role of "capital investment" in building a complete industrial chain through the study of Hefei's development model. Tianze et al. (2023) advocate strengthening the leadership of scientific and technological innovation, and suggest strengthening the investment in research and development and talent training. From the perspective of financial support, Xin Yaoyao et al. (2021) put forward the suggestion of improving green financial instruments. In terms of international experience, the transformation of the Ruhr area in Germany and the rapid development of the "Battery Belt" in the United States provide reference, but the differences in the institutional background require careful consideration of localised application. The existing literature has laid a foundation for understanding the YRD synergy problem, but there is still room for deepening the systematic analysis of constraints from the institutional root causes, critical reference to the shortcomings of international cases, and more operational localised solutions.

3. Status of New Energy Industry Synergy in Yangtze River Delta, Challenges and International Mirrors

3.1 Differential division of labour and synergis-

tic dilemmas in the Shanghai-Suzhou-Harmony industry

The development of new energy industry in the Yangtze River Delta (YRD) presents a significant pattern of differentiation, but also faces deep synergy challenges. International experience provides an important reference, but its shortcomings also need to be guarded against.

Hefei: A Scale-up Base for Strong Manufacturing and Weak R&D

Relying on the government-led "chain leader system" coordination mechanism and industrial fund injection, Hefei has rapidly built the second largest new energy vehicle production base in China, with an output of 1.376 million vehicles in 2024, accounting for 10.5% of the national total, with BYD, Volkswagen, Anhui and other six major vehicle manufacturers contributing to the core production capacity. However, the lack of market mechanism and innovation ecosystem cultivation has led to the highlighting of technological shortcomings: the intensity of R&D investment is only 3.2%, less than half of Shanghai's; the dependence on imported automotive-grade MCU chips is as high as 85% (China Association of Automobile Manufacturers (CAAM), 2024); and the conversion rate of production, learning, research and development is lower than that of the average value of the Yangtze River Delta (Hefei Bureau of Science and Technology (HBST), 2024) at 24.7%. The density of R&D personnel is 68% of the regional average, restricting the enhancement of endogenous capacity of technology.

Shanghai: A technology centre with strong R&D and weak manufacturing

With an international business environment and scientific and educational resources, Shanghai has gathered 42% of the top R&D talents in the Yangtze River Delta, with an R&D investment intensity of 8.7%, and the IC industry accounting for 23.5% of the national share. However, the high cost of land constrains the industrialisation - the price of industrial land in Lujiazui exceeds RMB 20 million per mu, and the manufacturing space in Zhangjiang Science City is close to saturation. This has forced 60% of R&D results to spill over to the Suzhou-Wuxi-Changzhou region for transformation, and Tesla's Shanghai factory will produce 916,000 units in 2024, down 3% year-on-year, reflecting cost pressures in the high-end manufacturing segment. In the absence of regional coordination, the innovation "highland effect" has evolved into a resource "siphon effect", with 30% of Suzhou's biomedical start-ups moving to Shanghai's Zhangjiang, further exacerbating regional imbalances.

Suzhou: A Supply Chain Hub with Strong Supporting Facilities and a Weak Core

With 75% of the local supporting rate to support the Yangtze River Delta new energy automotive supply chain (GGLI, 2024), power battery shells, wiring harnesses and other parts and components production capacity in the country's first. However, the institutional environment focuses on cost control and service efficiency, and fails to drive breakthroughs in core technology innovation: 100% of the core algorithms of BMS rely on the authorisation of Bosch of Germany, and the dependence on imports of battery core materials reaches 55%. 2024 R&D investment of new energy enterprises in the regulation accounted for only 1.8%, which is lower than the provincial average, reflecting the innovation bottleneck of the supporting-oriented development model.

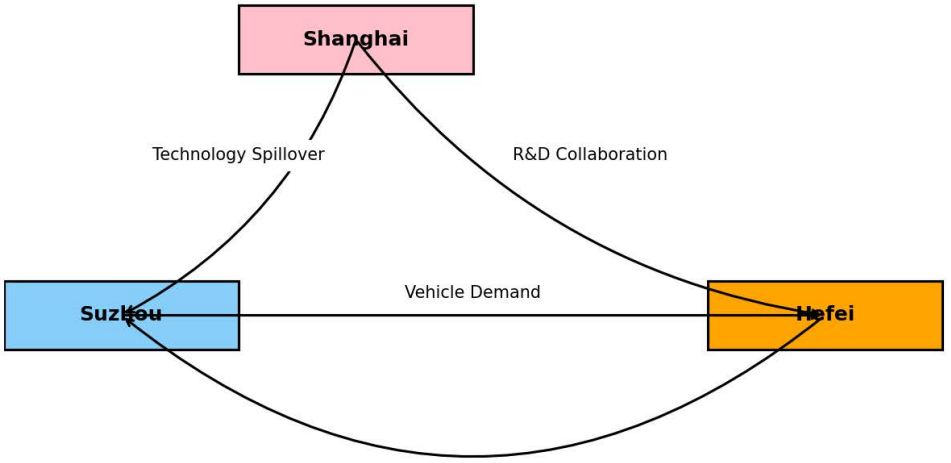

Figure 1. Industrial Transfer in the Yangtze River Delta Region [Owner-draw].

ISSN 2959-6157

3.2 International Experience

Germany's Ruhr region: the effectiveness and limitations of systematic coordination

Through the Ruhr Area Consortium Act, an inter-municipal coordination organisation (RVR) was set up to integrate the land planning rights and financial resources of 53 cities and towns, and to construct a three-level decision-making system of "federal-regional-local". This mechanism has successfully transformed the traditional coal and steel belt into a digital cluster: Duisburg, Europe's largest inland port, has been built, and seven cities, including Dortmund, have digitalisation indices that exceed the national average by 19 percentage points (Deutsche Wirtschaftsinstitut, 2025). However, there are significant institutional weaknesses: administrative coordination costs account for 19 per cent of total transformation expenditures (RVR, 2023), the unemployment rate of miners over 45 is as high as 19 per cent; the government-led model inhibits market dynamism, with business participation in R&D at only 30 per cent, and the value of the digital economy at 35 per cent of that of the Munich metropolitan area. This confirms Asimoglu's point about the lack of institutional complementarities - the lack of market incentives in a single administrative co-ordination, leading to a break in the 'planning-innovation' chain.

The U.S. Battery Belt: The Double Effect of Incentives

The Inflation Reduction Act (IRA) designed a tiered subsidy system that efficiently guided industry chain agglomeration through tax credits tied to vehicle localisation ratios. In the short term, it has attracted 72% of investment from Japanese and Korean companies, and the local battery production capacity is planned to exceed 800GWh (DOE, 2024). However, the radical policy triggers triple risks: lithium raw material import dependence soaring from 65% to 82% in 2022 (USGS, 2024); EU's Net Zero Industry Act countermeasures leading to an 18% surge in battery costs; in order to meet the requirements of localisation of components, companies are forced to purchase high-priced diaphragms (27% more expensive than Asian products), and R&D budgets have been squeezed by 15%. Asimoglu's warning about the unintended consequences of the system comes to the fore here - places such as Tennessee offer tax exemptions equivalent to 40% of the investment, distorting the nature of resource allocation.

3.3 Key synergy challenges

The YRD faces a triple synergy dilemma under the pattern of differentiated division of labour:

Homogenised competition and overcapacity, lack of co-ordination of local government industrial planning, Changzhou, Hefei and Suzhou are planning over 200GWh of power battery capacity in 2024 (GGLI, 2024), which is 1.8 times of the national total demand. However, the actual capacity utilisation rate is only 65% (China Association of Automobile Manufacturers (CAAM), 2024), 15 percentage points below the healthy level. At the same time, the core industry and components rely heavily on Japan, South Korea, France, Italy and other countries technology. What is more alarming is the imbalance in resource allocation exacerbated by the "investment race": the capacity utilisation rate of the BYD factory in Hefei reached 95%, while the capacity of the Tesla factory in Shanghai was idle for more than 30% due to cost pressures during the same period. Barriers to factor mobility inhibit innovation synergy. Administrative divisions have hindered the flow of technology, capital and talent: only 35% of universities in the YRD have achieved inter-provincial transformation of scientific and technological achievements (Tianze et al., 2023); less than 20% of venture capital has been invested in inter-regional projects; 30% of biomedical startups in Suzhou have moved away due to the siphon effect of Shanghai's Zhangjiang River, but spillover fruits have been difficult to industrialise in Hefei due to policy differences. Industrialisation in Hefei. The case of a car chip design enterprise shows that the mass production of Shanghai R&D results in Hefei needs to repeat the administrative procedures such as environmental assessment, and the transformation cycle is extended by 6-8 months. External dependence exacerbates the risk of industrial security, and the dependence of key materials and technologies on foreign countries continues to climb: the dependence on lithium raw material imports reaches 72.4% (SMM, 2024), an increase of 24 percentage points compared with 2020; the localisation rate of automotive-grade chips is less than 15%, and 90% of the IGBT modules rely on Infineon. Asimoglu theory points out, this fragmented system is caught in the trap of "extractive system" - local competition gives rise to short-term performance projects, factor barriers block the formation of innovation networks, and ultimately inhibit the total factor productivity.

4. Analysing the institutional roots of the synergy dilemma

Asimoglu pointed out in "Why Nations Fail" that "economic prosperity depends on an inclusive system, whereas an extractive system can bring short-term growth but stifle innovative vigour". The synergy dilemma of the new energy industry in the Yangtze River Delta is essentially a concentrated manifestation of the non-inclusive system under the fragmented administrative system.

4.1 Systematic distortion of innovation incentive mechanism

The current performance appraisal system overemphasises short-term economic indicators, leading to a serious deviation of local government behaviour from the law of innovation. Of the subsidies for the new energy vehicle industry in Hefei for the period 2021-2023, 75.6 per cent went to capacity expansion projects and only 8.3 per cent supported basic R&D (Hefei Finance Bureau, 2024). The enterprise level is also affected by this incentive: Guoxuan Hi-Tech's R&D investment in 2023 will account for only 3.1 per cent, much lower than Ningde Times' 7.2 per cent, yet it will receive government land concessions equivalent to 23 per cent of its annual profit. This distortion is transmitted to the industry-university-research collaboration - university evaluation "only thesis-oriented", China University of Science and Technology in the field of new energy patents conversion rate of only 11%; enterprises are reluctant to share technology needs due to weak intellectual property rights protection, Azure Automobile and Hefei University of cooperation projects, 73% of the Of the cooperation projects between Azera Motors and HIT, 73 per cent stopped at the laboratory stage.

4.2 Institutional Conflict between Local Competition and Regional Coordination

Under the GDP championship system, three provinces and one city have formed the rigid constraint of "competition for growth". In order to counterbalance Hefei's dominance in vehicle manufacturing, Suzhou offered a subsidy equivalent to 40% of equipment investment to attract a battery company to build a factory in 2023, which directly led to the idle rate of 45% of the capacity of similar projects in Changzhou. More serious is the virtualisation of the coordination mechanism: the Yangtze River Delta New Energy Vehicle Industry Chain Alliance held four coordination meetings in 2023, but only three of the 12 proposals involving capacity layout reached consensus. Convergent policies have evolved into de facto barriers - Shanghai's R&D subsidy requires "tax landing in Pudong", Suzhou's talent policy stipulates "continuous payment of social security for five years", and Hefei's Chain Leader Fund is "tied to local procurement". The Hefei Chain Leader Fund is tied to local procurement, a triple institutional shackle that locks up the flow of factors across regions.

4.3 Lack of Institutional Provision for Industrial Chain Resilience

There is a serious institutional vacuum in the regional risk prevention and control system.2024 In the Australian lithium export control incident, the lack of a joint reserve mechanism in the Yangtze River Delta led to a one-week surge in the price of lithium carbonate by 37% (Shanghai Non-Ferrous Network, 2024). Critical backup capacity building is also missing: when Bosch interrupted its BMS authorisation due to the Russia-Ukraine conflict, Suzhou Huichuan Technology was forced to shut down production, exposing a gap in the cultivation mechanism for alternative suppliers. The imbalance of talent structure is another shortcoming of the system: the salary difference between senior engineers in the field of new energy in Shanghai, Suzhou and Anhui is 2.4 times, but it takes 4 months to transfer social security, and the ratio of the quota for children moving to China is only 1:8, which is a significant inhibition of the optimal allocation of talent due to the cost of the system.

5. Pragmatic Path Suggestions for Deep Collaboration

5.1 Building a regional information synergy hub

Establish an industrial information sharing platform, with the authorities of three provinces and one city jointly building a digital information platform to disclose industrial policies, production capacity layout and supply chain risks in real time. Focus on the release of the "Yangtze River Delta Industry Chain Cooperative Development Catalogue", a clear division of labour between the three regions: early warning links (such as power battery): mark the risk of overcapacity, the three planned production capacity in 2024 exceeds the national demand by 1.8 times; attack links (such as automotive chips): set up a joint R & D fund, set up a joint laboratory in Shanghai, Suwann, Anhui, and complementary links (such as vehicle manufacturing): guidance to the three provinces and one city to build a digital information platform. (e.g. vehicle manufacturing): guide Hefei to take advantage of production capacity, Shanghai to focus on chip design. The platform will shorten the project approval cycle by 40%, avoiding the waste of resources caused by duplicated investment (e.g. Changzhou battery project capacity was cut by 35% after the joint review).

5.2 Unblocking Innovation Factor Market Circulation

Breaking down barriers to the flow of talent and technology, and implementing the "Yangtze River Delta New Energy Talent Card" system: cardholders can enjoy universal settlement, children's enrolment and medical insurance settlement services in the three places. Build a regional in-

ISSN 2959-6157

tellectual property trading centre to provide one-stop services for patent evaluation and pledge financing. Pilot the mechanism of "cross-provincial settlement of innovation vouchers", enterprises can use Hefei innovation vouchers to buy testing services in Shanghai. This has shortened the technology transformation cycle to 30 days and increased the talent mobility rate by 25%. Strengthen the industry-university-research co-operation, set up a platform to reveal the list of commanders, for the automotive chip and other "neck" areas issued a list of demand. Set up enterprise-led joint labs (e.g. Azure-CSU Chip Lab), with the government providing equipment sharing and customs clearance facilitation. Promote the construction of the Yangtze River Delta Venture Capital Fund Alliance, and implement mutual recognition of due diligence for cross-province projects.

5.3 Build a resilient supply chain system

Establish a joint reserve mechanism for raw materials, form a lithium, cobalt and nickel purchasing alliance, and reduce import costs by 15% through centralised negotiations. Build a 500,000-tonne strategic reserve base at Zhoushan Port in Ningbo. Develop a battery recycling cloud platform, and achieve a self-sufficiency rate of 35% for recycled materials by 2026. Layout of key components backup network, in Hefei, Chuzhou and other places to establish a 4-hour emergency supply chain circle. Automotive Chip: Shanghai Sigma Semiconductor and Hefei Jiefa Technology to build 28nm backup production; BMS system: Suzhou Bosch to local enterprises to open up the core algorithm licensing royalty rate of 0.5%; the development of the "supply chain contingency emergency guidelines", a clear rule of call for materials in the event of supply disruptions.

6.Conclusion

Based on Asimoglu's institutional economics perspective, this study constructs the framework of "system-innovation-coordination", and systematically analyses the obstacles and paths of the integrated development of new energy industry in the Yangtze River Delta (YRD). The core conclusions are as follows: institutional barriers are the deep-rooted problems constraining synergy, and the challenges of core technology dependence, homogeneous competition, fragile industrial chain, and talent imbalance are rooted in the lack of regional coordination authority, distorted local competitive incentives (pursuit of short-term performance), factor flow barriers, and inadequate innovation ecological synergistic mechanisms. Asimoglu's theory that the system shapes the incentive structure has been fully proved here. The solution lies in pragmatic institutional innovation, with the core focus on optimising the service functions of existing regional coordination mechanisms (information sharing and collaboration platforms), strengthening the supply of institutions based on market rules (factor flow facilitation, property rights services), and designing more precise incentive policies (guiding R&D cooperation, guaranteeing resilience). Smooth regional circulation of innovation factors is the key engine of synergistic development, and the endowment differences between Shanghai (R&D source), Suzhou (manufacturing hub), and Hefei (production and application) form the basis for natural complementarities, of which the practice of Hefei provides a replicable path for the central and western regions: Wuhan can graft its "fund investment" model to merge with provincial-level investment funds. Wuhan can graft its "fund investment" mode mergers and acquisitions of provincial lithium resources, Chengdu needs to draw on the "patents as shares" mechanism to enhance the results of the conversion rate of 35%, Xi'an should be synchronised with the system of benefits of excellence to crack the imbalance of the talent structure. We must break the hidden barriers to the flow of talent, technology and capital by building a more fluid regional factor market environment, improving intellectual property collaboration services, encouraging market-oriented joint R&D and resource sharing, and activating the virtuous cycle of "innovation-manufacturing-application". Deep complementary collaboration is the only way to enhance the overall competitiveness of the region. International experience (the success and failure of systematic coordination in the Ruhr area, and the effectiveness and risks of the "Battery Belt" policy incentives) has shown that successful synergy relies on respecting comparative advantages and division of labour based on them. The Yangtze River Delta needs to deepen the division of labour (Shanghai's R&D and standards, Suzhou's manufacturing and core components, and Hefei's scale production and application transformation) through scientific information guidance (guiding catalogue), effective service coordination (information platform), precise policy fine-tuning (R&D support, factor flow facilitation), and the dominant role of the market mechanism, with an optimised systemic environment to build a world-class, efficient, resilient, and innovative battery zone with high efficiency. The three places are guided to deepen the division of labour (Shanghai is strong in R&D and standards, Suzhou is strong in manufacturing and core components, and Hefei is strong in large-scale production and application transformation), so as to jointly build a highly efficient, resilient and innovative new energy industry cluster. The exploration of Hefei's practice provides a useful sample for local clusters to integrate into regional synergies, and its dual characteristics of "science and innovation + manufacturing" and

its linkage with the G60 Science and Innovation Corridor are worth deepening. However, the release of its potential and greater contribution to regional integration needs to be built on the basis of smoother regional information sharing, more effective service coordination and closer market-based project cooperation. Promoting the deep integration of the new energy industry in the Yangtze River Delta is a complex systematic project. Only by breaking down barriers through continuous institutional innovation, effectively unimpeded regional circulation of innovative factors, and deepening the division of labour based on comparative advantages and market principles, can the overall competitiveness of the region be fully unleashed, and the Yangtze River Delta be built into a core engine leading the development of the global new energy industry. This study provides a theoretical basis and an operational path for the optimisation of relevant systems and policy adjustments.

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