

Comparative Study of Urban Innovation Ecology and Regional Synergy in Three Regions

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Abstract:

As global economic integration intensifies, the multilateral trading system undergoes restructuring, and regional trade agreements (RTAs) assume a more significant role, industrial policy at both national and regional levels confronts the critical challenge of adapting to the evolving institutional landscape. Considering these situations and based on the theory of regional economic integration, this study uses the Ruhr region, Silicon Valley, and the Yangtze River Delta as typical cases to systematically compare the institutional suitability of industrial policies in the context of global economic integration. This is done against the backdrop of the rapidly deepening global economic integration, the reconfiguration of the multilateral trading system, and the prominent role of regional trade agreements. Quantitative information and qualitative examples are combined to compare the industrial policies of the three regions. Underutilization of international rules and notable institutional cost disparities are identified as issues facing the Yangtze River Delta region. Thus, by dismantling administrative divisions, encouraging innovation and transformation, and generating cash, this study suggests enhancing the administrative effectiveness of domestic cities through institutional openness.

Keywords: Regional Economic Integration, Industrial Policy, Yangtze River Delta, Ruhr Region, Silicon Valley.

1. Introduction

Against the backdrop of accelerated deepening of global economic integration and the reconfiguration of the multilateral trading system and the prominent role of regional trade agreements, regional industrial policy, as a key tool for countries to participate in

international competition, cope with supply chain risks, and promote the resilience of the local economy, is undergoing a profound change in its strategic position and design logic. Agreements represented by the Regional Comprehensive Economic Partnership (RCEP) have dramatically transformed the regional industrial chain division of labor model by decreas-

ing tariff barriers and optimizing rules of origin. In this study, the Yangtze River Delta (YRD) region of China, Silicon Valley of the United States, and the Ruhr area of Germany, which are typical representatives of developed global economies, are selected for cross-country comparisons, as they have a high degree of representativeness and influence on the practice of regional industrial policy. Under this framework, the industrial policies of the Yangtze River Delta (YRD), Silicon Valley (USA), and the Ruhr area (Germany), as typical developed economies in the world, are comparable in some ways: all of them focus on “innovation-driven” policies to cultivate industrial clusters, optimize government-market collaboration, and build up innovation ecosystems through policy tools. At the same time, there are also disparities attributable to distinct national conditions: the institutional environments and governing skills of the three locales are notably different. For example, the Yangtze River Delta promotes integration through government-led industrial policies and relies on industrial planning and financial incentives to promote regional integration; Silicon Valley relies on market-oriented innovation ecosystems supported by a venture capital system and intellectual property laws; and the Ruhr region guides the structural transformation of traditional industries through cross-administrative collaboration and social partnership mechanisms. The pathways of policy execution in the three regions are notably differentiated by the differences in institutional foundations, which are primarily anchored in the constrained choice of policy tools by political and economic systems.

Focusing on cross-country comparative perspectives, this work carefully investigates the logic of picking industrial policy tools, the coordination mechanism of government-market relations, and the development path of innovation ecosystems under varied institutional contexts. By refining the differentiated policy experiences under the RCEP framework, the study aims to provide theoretical references and practical guidelines for Chinese cities to optimize their industrial policies and avoid geopolitical risks in the “double-circle” pattern, which is of strategic significance for promoting the high-quality development of regional integration in China.

This study employs a comparative case study technique, selecting the Yangtze River Delta region in China, Silicon Valley in the United States, and the Ruhr area in Germany as the core research objects. The rationale for choosing these three cases in this paper is that all three represent core economic engines at the national level but are in different institutional environments and stages of development—the Yangtze River Delta as a model for urban agglomerations in emerging economies, Silicon Valley as a global benchmark for market-led innovation, and the Ruhr area as a successful paradigm for the transformation of old industrial bases.

The research methodology integrates the “three-dimensional” comparative framework (industrial policy instruments, government-market relations, and innovation ecology) with the analysis of institutional constraints and combines quantitative data and qualitative cases to reveal the adaptability and specificity of regional industrial development under the multilateral framework.

2. Literature Review and Theoretical Foundations

2.1 Regional Economic Integration (REI)

Regional economic integration is a dynamic process of market integration fostered between diverse spatial economic agents to exploit the benefits of production, consumption, and trade. Its evolution follows the conventional analytical framework given by Balassa. In his important work *The Theory of Economic Integration*, Balassa first systematized the stages of economic integration, dividing it into five successive levels: Free Trade Area, Customs Union, Common Market, and Economic Union. Common Market, Economic Union, and Complete Economic Integration [1]. It is discovered that the process usually shows itself from the integration of product markets, eventually spreading to the integration of the markets of production elements (labor, capital, technology, information, etc.), and ultimately converging to the harmonization of economic policies [2]. The theory of regional economic integration has gone through an evolutionary process from customs union to common market to economic union. The core logic of this division lies in the fact that regional integration is not only the elimination of barriers to commodity trade but also the dynamic deepening process of the free flow of factors of production (labor, capital), the coordination of economic policies, and even the unification of political systems. Traditional theories largely focus on the free flow of goods through the elimination of tariff and non-tariff barriers, while newer theories pay more attention to the free flow of production factors and policy coordination. Chen Zhihua found that RCEP investment rules cover four aspects of investment: protection, liberalization, promotion, and facilitation, and the theoretical innovation is realized through the “cumulative rules of origin,” that is, member states are allowed to accumulate value-added in any country in the region, and as long as the total amount reaches a specified proportion, they can enjoy tariff preferences, which breaks the traditional This removes the regional restrictions of classic Free Trade Agreements (FTAs) and facilitates the regeneration of regional value networks [3].

2.2 Core Theoretical Distinctions in Industrial

Policy

There are three basic theoretical schools of thought in the present research on the industrial policy paradigm.

2.2.1 Government-driven

It is a model for many developing countries, drawing on the “East Asian model” and emphasizes strategic planning and resource management. For example, Chen Wenli observed that YRD policies are impacted by both the central and local governments and that the “Three-Year Action Plan” and other tools are utilized to boost inter-regional collaboration and promote regional integration [4]. For example, Chen Wenli found that the Yangtze River Delta policy is influenced by both the central and local governments, and through tools such as the “Three-Year Action Plan,” it encourages cross-regional cooperation, promotes resource sharing, breaks down administrative barriers, and promotes regional integration [4]. Wei et al.’s empirical study shows that the local governments in the Yangtze River Delta dominate the tilting of factors of production to the target industries through the strategic supply of land and the allocation of targeted credits, forming a closed loop of the three-positioned policy of “planning-resources-examination.” This style of deep government intervention is viewed as a new practice of the East Asian Developmental State at the regional level [5].

2.2.2 Market-driven

Saxenian’s famous analysis demonstrates that Silicon Valley’s primary competitiveness originates from a decentralized network of enterprises and a highly mobile talent market. Firms spontaneously develop innovation clusters through job-hopping and spin-offs, venture capital (rather than the government) serves as the key screening mechanism for technological commercialization, and the government merely provides fundamental mechanisms such

as property rights protection [6]. Qin Han found that the Silicon Valley Baidu Act promotes technology transformation in Silicon Valley by changing property rights from nationalization to privatization, and changing the ownership of federally-funded scientific research results from federal government ownership to unit ownership, which provides a key institutional safeguard for promoting technology transformation [7].

2.2.3 Collaborative governance

Focusing on multilevel consultation mechanisms, Rehfeld analyzes that the Ruhr transition relies on institutionalized multilevel consultation: regional associations (KVR/RVR) integrate municipalities, trade unions, and enterprises to translate social demands into concrete actions through a “project system”. Policy instruments (e.g. transition funds) are cooperatively designed by the three partners to ensure efficiency and equity [8]. Tang Chenghui and Ma Xueguang found that, by virtue of its highly flexible and problem-specific project cooperation and institutionalized, multi-level, multi-object consultation and decision-making mechanism, it provides support for regional synergistic development, thus achieving the purpose of improving industrial structure and solving specific problems such as environmental pollution [9].

In summary, the government-driven type has advantages in rapid resource mobilization, but also faces the risks of information asymmetry and market distortion; the market-driven type can stimulate micro-energy, but has limitations in terms of investment in basic research and in addressing systemic market failures; and the collaborative governance type can help to balance the interests of all parties and improve policy acceptance, but the decision-making process may be relatively complex. Core features of the three industrial policy paradigms have been clearly compared in Table 1.

Table 1. Core elements of the three schools of thinking

Type of theory	Core mechanisms	Typical tools	Representative case
Government-driven	Strategic guidance and resource orientation	Industrial planning, special funds, tax incentives, administrative instructions	China’s Strategic Emerging Industries Policy
Market-driven	Property Rights Incentives and Market Allocation	Intellectual property protection, venture capital, competition policy	The Silicon Valley Model
Collaborative governance	Multi-body consultation and institutionalized cooperation	Multi-party consultative platforms, regional development funds, fiscal transfers	Transformation of the Ruhr Area, Germany, EU Structural Funds

2.3 Innovation Ecosystem Theory

In the framework of innovation ecosystem theory, Autio & Thomas pointed out that regional competitiveness depends on the dynamic network generated by numerous actors

(enterprises, universities, government, and intermediaries) through value co-creation. The basis of the idea consists in the alignment and liquidity of resources: the synergy of aims among the primary actors is achieved through institutional architecture and interactive platforms, and

the efficient movement of talent, capital, knowledge, and other elements across companies is ensured [10]. This theory reveals that the integration of “industry-university-research-use” in the Yangtze River Delta, the “Stanford-venture capital-startups” triangle in Silicon Valley, and the Fraunhofer Institute’s application of the transformation mechanism in the Ruhr region all reflect that the essence of the three places in the differentiation of the innovation ecosystem is the institutional environment, and that the institutional environment is the key to the development of innovation. The essence of the differentiated innovation ecosystems in the three places is the systemic innovation effectiveness determined by molding the collaboration mode of the major actors and the efficiency of factor allocation.

3. Multidimensional Comparative Analytical Framework

3.1 Comparison of Industrial Policy Instruments

The Yangtze River Delta has adopted a combination of “special funds + institutional innovation,” precisely supporting strategic industries through government-guided funds (e.g., the integrated circuit fund has a scale of RMB 300 billion), while relying on the Pilot Free Trade Zone to carry out institutional breakthroughs. Typical examples include the pilot registration system reform of the Science and Technology Innovation Board (STIB), which, according to the assessment of the Chinese Academy of Social Sciences (CASS), has shortened the listing review cycle from 24 months to 8 months and increased the efficiency of financing for science and technology enterprises by 30%. However, the “administrative fragmentation trap” brought out by Rodrik is underlined here: Differences in province industrial norms have contributed to an average prolongation of 45 days in the approval process for cross-provincial technological cooperation projects [11]. Silicon Valley has evolved a “venture capital-led + legal protection” strategy. Private venture money accounts for 92% of early-stage investments, and the Bayh-Dole Act, which Mazzucato dubbed “the cornerstone of American innovation,” has enabled Stanford’s patent conversion rate to soar from 5% in 1979 to 32% in 2020. Defense orders indirectly steer technology direction through agencies such as Defense Advanced Research Projects Agency (DARPA), but the model faces the twin challenges of long investment cycles in cutting-edge technologies (average payback period for quantum computing is 12 years) and fluctuating immigration policies that have led to a 15% annual increase in the departure rate of foreign engineers [12].

The Ruhr region relies on “EU Structural Funds + Land Remediation Subsidies” to encourage transformation. The European Union’s Regional Development Fund (ERDF) offers cash for cross-regional coordination (4.5 billion euros for the 2014-2020 cycle), and the German federal government supports the “Ruhr Coal and Steel Transformation Program” to pay rehabilitation of contaminated areas. However, Grabher’s warning of “institutional rigidity” is evident: the EU’s Industrial Emissions Directive compels steel mills to reduce emissions by 40% over three years, making compliance costs 18% of total sales (in 2023), substantially higher than the global average [13].

3.2 Comparison of Government-market Relations

In the Yangtze River Delta’s “government planning and leading” model, the government sets the industrial direction through five-year plans and special actions, such as the new energy automobile “4-hour industrial circle” jointly planned by the four provincial governments, which, according to the research of the Chinese Academy of Social Sciences, reduces the cost of parts and components logistics by 35% [14]. According to the research of the Academy of Social Sciences, the cost of logistics of parts and components has been lowered by 35% [14]. The market at the micro level autonomous allocation of resources, such as firms according to the cost-effective choice of industrial chain participation nodes. However, Rodrik criticized the “local tournament” drawbacks highlighted: 10 cities duplicated construction of semiconductor parks, resulting in capacity idle rate of 41% in 2022 [11]. In Silicon Valley’s “enterprise autonomy-based” paradigm, the government’s engagement is confined to basic research (National Science Foundation (NSF)’s yearly budget tops \$8.5 billion) and defense procurement guidelines (DARPA accounts for 21% of early AI investment). Mazzucato established through an input-output analysis that every \$1 invested in federal fundamental research creates \$7 in private Research and Development (R&D) profits. Startups, on the other hand, collectively construct technology roadmaps (ITRS) through the Semiconductor Industry Association (SIA), however the approach suffers from market failure in long-lead time innovations—quantum computing startups have a 50% failure rate in funding due to uncertain returns on investment [15].

The Ruhr’s model of ‘social partnership’ is reflected in the establishment of tripartite consultative mechanisms between government, trade unions, and business (e.g., the Coal Commission), which Grabher points out has succeeded in limiting the transition unemployment rate to 4.5% (lower than the European Union (EU) average of 6.2%) and in achieving a ‘rich state subsidizing a declining state’ (e.g., North Rhine-Westphalia receives 12 billion euros

in federal transfers annually) through fiscal balances. The fiscal balance permits the “rich states to subsidize the declining states” (e.g., North Rhine-Westphalia receives 12 billion euros in federal transfers annually). However, the tripartite game has led to inefficient decision-making: the average clearance timeframe for new technology parks is 26 months, which is 2.3 times greater than the EU average [13].

3.3 Comparison of Innovation Ecologies

The three regions differ significantly in terms of synergies among innovation agents.

The Yangtze River Delta is led by government-led industry-university-research alliances (e.g., the G60 Science and Innovation Corridor), which, according to the CASS, contributed 68% of the region’s key technology breakthroughs in 2022; Silicon Valley relies on firms’ self-initiated innovation networks (Stanford alumni firms have a spin-off rate of 32%), and Saxenian found that alumni circles increase the rate of technology diffusion by 40%; and the Ruhr region focuses on the application of translation by research institutes (Fraunhofer Institutes have a technology commercialization rate of over 75%) [12].

Table 2 reflects the significant differences between the three regions in terms of subject synergies and factor flows.

Table 2. Comparison of key elements of innovation ecosystems in three regions

dimension	Yangtze River Delta	Silicon Valley	Ruhr Area
innovation subject	Government-led Industry-Academia-Research Alliance (G60 Science and Innovation Corridor)	Enterprise Spontaneous Innovation Network (Stanford Alumni Circle)	Applied Translation in Research Institutions (Fraunhofer Institute)
capital support	Government-led funds dominate (over 60%)	Venture capital dominated (35% of U.S.)	Policy banks (KfW)
Knowledge transformation	Technology market transactions (annual turnover of over 2 trillion dollars)	Patent Licensing and Startup M&A	“Dual system” vocational education articulation
policy intervention	High-intensity R&D subsidies (3.2% of fiscal expenditure)	Lax regulation (e.g., road test waivers for unmanned vehicles)	Transformation Fund (EU structure)

4. Multilateral Framework Constraints and Development Trends

4.1 Differential Regional Impacts of RCEP

The Regional Comprehensive Economic Partnership (RCEP) on the three areas has distinct impacts. China’s imports and exports to the member states in 2024 increased by 4.5% to 13.16 trillion yuan. Behind the eye-catching numbers, the intermediate goods trade accounted for 66% of the regional industrial chain, indicating the depth of the integration, but Rodrik warned that the “rules of the complexity of the trap” substantially impede the release of the dividend! -- However, Rodrik’s warning of the “rules complexity trap” substantially restricts the release of dividends. The use rate of rules of origin by Vietnamese and Chinese exporters is just 0.67% and less than 5%, respectively, which is mainly owing to the fact that the certification cost of SMEs is as high as 12% of the value of their exports. Successfully acquiring the “RCEP origin” designation not only optimizes the cross-border division of labor but also decreases the production cost by 18%, which verifies the thesis of “in-

dustrial policy needing to be adapted to the institutional environment” advocated by Rodrik [11].

Geopolitical conflicts accelerate regional strategic differentiation, in the face of the U.S. Chip and Science Act technology blockade, the Yangtze River Delta to build a “new energy vehicle 4-hour industry circle” to promote the localization rate of power batteries from 35% in 2020 to 72% in 2024; Silicon Valley presents a “selective decoupling” situation manifested in the 2023 AI chip venture capital investment in China fell sharply by 47%, enterprises are forced to reduce long-term R&D budgets; the Ruhr region in the framework of the EU’s “de-risking” strategy to promote supply chain restructuring, the dependence on China’s rare earth imports will be reduced from 45% to 28% at the same time, through the African joint venture project to build three new cobalt supply bases, the restructuring of the essence of the echo of Grabher on the “traditional industrial zones need to break through the geographic lock-in” of the prescience of the analysis [13].

4.2 The Digital Economy and the New Green Rules Track

The game of digital commerce rules has entered a deep

water zone. Although the RCEP e-commerce chapter promotes the automatic verification of electronic certificates of origin between China, Japan, and South Korea, the conflict between China's data localization requirements and the European and US cross-border data free-flow advocates has led to a 40% reduction in cross-border blockchain technology cooperation projects in the Yangtze River Delta (YRD); the YRD's attempt to break through this situation is of strategic significance. Hangzhou has gathered 11.3% of the world's blockchain patents (2023 WIPO data) to support its "International Digital Transaction Laboratory" to develop cross-chain protocols, successfully realizing the trusted sharing of patent data between Chinese, Japanese, and Korean enterprises, an innovation that precisely practices the "autonomous governance of technology communities" model advocated by Saxenian [12].

Green trade obstacles have caused the reorganization of the industrial ecosystem. Since the trial run of the EU's Carbon Border Adjustment Mechanism (CBAM) in 2023, Ruhr iron and steel companies have gained a 16% tariff exemption through the early deployment of hydrogen-based direct-reduced iron technology, but with an additional certification cost of 43 euros per ton of steel, the mechanism has exerted double pressure on the Yangtze River Delta. The lack of a certification system has increased SMEs' export compliance costs by 30%; Grabher's Transformation Cost Model has been validated here: in order to meet the EU's "climate-neutral" standard in 2030, Ruhr area companies are forced to invest 30% of their R&D budgets in carbon capture technology, much higher than the global manufacturing average of 21%, a structural difference in inputs that will reshape the global competitive landscape in the next decade [13].

5. Inspiration and Recommendations for China

5.1 Cracking administrative Fragmentation with Institutional Innovation

At the level of institutional innovation, it is recommended that administrative barriers be broken down through the following initiatives. Drawing on the experience of the Ruhr Area's "cross-regional mutual recognition of permits", the state should utilize the established Huanshu Railway Company as a prototype to investigate a novel enterprise model for cross-regional unified operations; Concurrently, it will establish a tax-sharing framework for industrial transfers to enhance a cross-provincial coordination mechanism for GDP accounting and fiscal revenue distribution; it will draw inspiration from the evolutionary trajectory of the Ruhr Area's Kommunalverband Ruhrge-

biet-Regionalverband Ruhr(KVR-RVR) institutions to create a supra-provincial planning commission with legal authority; and it will implement a "negative list + commitment system" model for cross-provincial mutual recognition of administrative approvals, aiming to reduce approval timelines by over 50%.The cross-provincial general office model is being implemented, and the time limit for approval is being compressed by more than 50 percent [5].

5.2 Innovation Synergy: Building an Open Industry Chain

In the sphere of innovation and synergy, it is vital to focus on developing an open industry chain ecosystem. In order to achieve regional synergistic innovation, it is essential to amalgamate the strengths of "Silicon Valley Venture Capital" and "Yangtze River Delta Manufacturing." International venture capital, exemplified by Sequoia China, should be integrated into the G60 research and Innovation Corridor, with governmental support for the mother fund to direct investments in advanced research and technology. At the same time, it is vital to promote the creation of R&D enclaves such as the "Advanced Light Source" jointly created by Shanghai Zhangjiang and Hefei so as to actualize the sharing of large-scale scientific facilities. Furthermore, by establishing the "Yangtze River Delta Scientific and Technological Achievement Transformation Regulations," it is specified that the inventor's ownership of the results shall be at least 70%, thereby dismantling the constraints of the "unit priority" mechanism for result transformation.

6. Conclusion

This study systematically compares the policy suitability of the Yangtze River Delta (YRD), the Silicon Valley (SV), and the Ruhr Area (RA) under the multilateral rules of the RCEP/WTO by constructing a three-dimensional framework of "industrial policy tools, government-market relations, and innovation ecology." The study shows out that the efficiency of regional industrial plans depends on the fitness of the institutional environment with the multilateral regulations. The three regions belong to the same developed economy, the disparities in their institutional endowments have led to significant variance in policy paths. Specifically, the planning-led model of the Yangtze River Delta has the advantage of rapid integration of resources but needs to guard against excessive administrative intervention; the market-driven model of Silicon Valley effectively stimulates the vitality of micro-entrepreneurs but faces the challenge of insufficient supply of public goods; and the multilevel governance model of the Ruhr area, although guaranteeing the fairness of the transition, needs

to improve the efficiency of decision-making. It is worth emphasizing that institutional innovations such as the RCEP cumulative rules of origin have created new chances for the reconstruction of the regional industrial chain, but the underutilization of the rules has hampered the release of policy dividends. The core inspiration for China is that it should systematically build a new advantage of system-based openness through the three major paths of cross-regional governance innovation (e.g., the Huanshu Railway Company), innovation factor reorganization (fusion of venture capital and manufacturing), and inclusive institutional design (eco-compensation fund).

The future direction of this study can focus on three dimensions: first, analyze in-depth the cases of emerging economies, focusing on the industrial policy innovation practices of Vietnam and Thailand under the framework of RCEP; second, push forward the quantitative study of digital green rules, and strive to build a regional policy assessment model for the “dual-carbon” goal; third, systematically study the impact of RCEP expansion, and scientifically predict the trend of the evolution of the multilateral rules after the accession of Hong Kong and Chile; third, systematically study the impact of RCEP expansion, and scientifically predict the trend of the multilateral rules after the accession of Hong Kong and Chile. Third, the present study this paper will thoroughly examine the impact of RCEP expansion and scientifically estimate the pattern of multilateral rules evolution once Hong Kong and Chile join.

Under the new pattern of global economic integration and regionalization, China needs to base on the practice of the Yangtze River Delta, integrate the innovation vitality of Silicon Valley and the governance wisdom of the Ruhr area, explore the industrial policy system with Chinese characteristics, and contribute to the “Eastern Solution” for global economic governance.

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