

Spatio-temporal patterns and drivers of the transition from traditional to emerging growth drivers in the Yangtze River Economic Belt

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Article

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Abstract

Many regional economies must develop new industries while modernising established ones. Existing studies of this transition often measure either the speed at which new activities expand or the extent to which they improve the existing industrial base, making it difficult to judge whether rapid change is also locally effective. This study develops a two-part framework that combines transition speed with transition effectiveness and applies it to 110 prefecture-level cities in the Yangtze River Economic Belt from 2015 to 2023. Composite indices of emerging and traditional growth drivers are calculated using entropy weighting and the Technique for Order Preference by Similarity to Ideal Solution. An improved coupling-coordination model assesses whether the rise of emerging drivers is matched to local manufacturing activity. Global and local Moran's I statistics identify spatial dependence, and geographically and temporally weighted regression estimates how the effects of transport accessibility, government intervention, city size and market size vary across space and time. The transition strengthened steadily, but a persistent downstream–midstream–upstream gradient remained and substantial differences were found within each subregion. Positive spatial clustering was present throughout the study period, while the pattern evolved from a downstream concentration of high-performing cities towards a layered structure in which downstream cities led, midstream cities increasingly absorbed industry and innovation, and upstream cities gradually caught up. The effect of transport accessibility changed from negative to positive; market size became broadly supportive; and government intervention and city size shifted from local positive effects to overall negative effects. These findings show that growth-driver transition is not a uniform process and that regional policy should match infrastructure, market development and public intervention to local industrial conditions.

Keywords: Yangtze River Economic Belt; Transition from traditional to emerging growth drivers; Modified coupling coordination degree model; Spatio-temporal differentiation; Driving factors

1. Introduction

Since the founding of the People's Republic of China, and especially since the start of reform and opening-up, economic growth has relied heavily on capital and labour inputs and large-scale manufacturing. These traditional growth drivers supported industrialisation and urbanisation. Rising factor costs, tighter environmental constraints and greater external uncertainty, however, have made a high-input, high-consumption model increasingly unsuited to high-quality development. China has therefore placed greater emphasis on “new quality productive forces”, a policy term referring to productivity gains led by scientific and technological innovation, and on the transition from traditional to emerging growth drivers

(Shen et al., 2024). The policy agenda also stresses the parallel tasks of developing new sources of growth, modernising established industries and strengthening economic resilience (Li et al., 2025). Emerging growth drivers include new industries, technologies and business forms, but also the digital, intelligent and green upgrading of traditional sectors and the orderly withdrawal of obsolete capacity (Ren et al., 2025). The transition is therefore not a simple replacement of one sector by another. It is a long-term process of reallocating production factors and reshaping technology, industry, institutions and regional relations. Understanding this process is important both for explaining how economies overcome the limits of input-led growth and for designing practical routes towards more sustainable and higher-quality development.

Research on the transition from traditional to emerging growth drivers has developed along three main lines. The first concerns measurement. Some studies use total factor productivity, treating the transition as an improvement in productivity and the quality of growth and measuring it through growth-accounting decomposition or changes in efficiency (Zhou and Li, 2019). Others construct composite indices from the supply, demand and structural sides of the economy (Ma and Chen, 2023), from production-function approaches (Zheng et al., 2018), or from indicators of new technologies, industries, business models and organisational forms (Fang and Pei 2021). The second line examines determinants. Internal drivers include technological innovation (Liang, 2020), human capital (Gao and Ma, 2019), the intensity of market competition (Meng et al., 2025) and changes in demand (Li et al., 2021). External conditions include the digital economy (Cheng et al., 2025), the business environment (Jiao et al., 2023), the structure of financial supply (Zhang et al., 2018), resource-allocation mechanisms and policy guidance (Cheng and Wang, 2023). The third line considers geographical differences. Existing work has examined the Yellow River Basin (Su et al., 2025), the Yangtze River Delta and Guangdong – Hong Kong – Macao Greater Bay Area city clusters (Ma and Chen 2023), the Shanxi – Shaanxi – Inner Mongolia region (Tang et al., 2023), Shandong Province (Yu and Liu, 2023) and Hubei Province (Ding and Wu, 2018). These studies consistently identify marked differences between eastern and western China, among provinces and across urban regions (Wang and Li, 2022).

This literature provides an important basis for understanding how changes in growth drivers relate to high-quality development, but three gaps remain. First, most assessments focus on a single dimension. They rarely place changes in emerging and traditional drivers within the same framework, so they cannot show both how quickly emerging activities gain relative weight and whether the resulting structure fits the local industrial base. Second, studies of determinants commonly estimate average linear relationships and give limited attention to spatial dependence or to the possibility that the same factor may operate differently across places and over time. Third, the Yangtze River Economic Belt has received less systematic city-level analysis than its strategic importance and geographical diversity warrant. This study addresses these gaps by examining 110 prefecture-level cities. It measures transition speed as the relative weight of emerging growth drivers, and transition effectiveness as the degree to which that change is matched to local manufacturing activity. Moran's I statistics and geographically and temporally weighted regression are then used to identify

spatial clustering and spatial – temporal variation in the effects of the main drivers.

2.Methods

2.1.Indicator system

The transition from traditional to emerging growth drivers involves two linked tasks: expanding emerging sources of growth and improving established industries. The indicator system therefore begins with factor inputs and supply (Chen et al., 2018). Four groups of inputs are considered. First, research and upgrading investment provide the initial impetus for innovation, higher industrial efficiency and structural change (Su, 2023). For emerging drivers, the research and development expenditure intensity of high-technology manufacturing and the share of public expenditure devoted to science and technology capture investment in new technologies and industries (Wu and Xu, 2021). For traditional drivers, investment in pollution control reflects the environmental pressure created by established industries and the urgency of upgrading them. Second, capital provides continued support. Capital for emerging drivers is measured by green-bond issuance and fixed-asset investment in information transmission, software and information technology services, finance, scientific research and technical services. Capital associated with traditional drivers is represented by the fixed assets and liabilities of large industrial enterprises, which affect both resource use and the difficulty of restructuring (Bian et al., 2021; Chen et al., 2025). Third, technology acts as an efficiency mechanism. Emerging activities expand through internet technologies, artificial intelligence and digital transformation, while established industries improve through process upgrading, equipment renewal and technological retrofitting (Liu and Sun, 2025). Fourth, human resources provide the people who carry out the transition (Lucas, 1988). University enrolment represents the pool of innovation-oriented talent, while enrolment in secondary vocational education represents the supply of technical skills needed to modernise manufacturing (Chai and Li, 2020).

Innovation is the central mechanism through which new activities become established and traditional activities are reorganised. Accordingly, drawing on previous studies (Zhang, 2017; Chen and Huang, 2024), this study selects indicators that capture the characteristics of regional industrial innovation and organisational change from the perspectives of industrial development and the transformation process. For emerging growth drivers, the number of nationally recognised high-technology enterprises and the output of strategic emerging industries describe technological innovation, movement towards higher-value parts of industrial chains and the formation of new clusters (Luo Q et al., 2019). Traditional growth drivers are concentrated in energy-intensive, resource-dependent and labour-intensive manufacturing. The number of industrial enterprises above the official size threshold and the ratio of their gross output to value added in the service sector capture the concentration, resource dependence and limited innovation associated with the traditional industrial structure (Huang Changsheng et al., 2020).

Green and low-carbon development is a central objective of the Yangtze River Economic Belt. The third

dimension therefore measures resource use and environmental outcomes so that the ecological costs and benefits of the transition are included (Acemoglu et al., 2012; Zhang and Li, 2022). Emerging growth drivers are associated with cleaner energy and new forms of input. Consumption of wind, hydropower and solar energy indicates the development of green industries and low-carbon technologies, while the share of days with good air quality and the green coverage of built-up areas measure environmental improvement (Gai et al., 2021). Traditional drivers depend more heavily on energy-intensive and high-emission industries. Coal consumption, industrial electricity use and the annual mean concentration of fine particulate matter smaller than 2.5 micrometres describe their energy structure and environmental burden. Industrial exhaust emissions, wastewater discharge, the utilisation of industrial solid waste and total carbon dioxide emissions are also included.

On this basis, the assessment system contains two primary indices, three broad dimensions, 17 subdimensions and 28 individual indicators (Table 1).

Table 1. Indicator system for the transition from traditional to emerging growth drivers

Level 1 indicator	Level 2 indicator	Level 3 indicator	Level 4 indicator
Emerging(NI)	Inputs	Investment	R&D expenditure intensity of high-technology manufacturing (%)
			Science and technology expenditure / local general public budget expenditure (%)
		Capital	Total value of green-bond issuance (CNY 100 million)
			Fixed-asset investment (CNY 100 million)
		Technology	Industrial robot penetration (%)
			Internet penetration (thousand subscriptions per 10,000 people)
		Human Resource	Employees in strategic emerging industries (persons)
			Students enrolled in regular higher education institutions (10,000 persons)
	Industry	Structure	Nationally recognised high-technology enterprises (number)
			Output value of strategic emerging industries (CNY 100 million)
	Green Development	Resources	Clean-energy consumption (10,000 tonnes of standard coal equivalent)
		Environment	Share of days with good air quality (%)

			Green coverage of built-up areas (%)
Traditional(OI)	Inputs	Investment	Investment in environmental pollution control (CNY 100 million)
		Capital	Total fixed assets of industrial enterprises above designated size (CNY 10,000)
			Total liabilities of industrial enterprises above designated size (CNY 10,000)
		Technology	Traditional industrialisation level (%)
		Human Resource	Manufacturing employment (10,000 persons)
			Students enrolled in secondary vocational schools (persons)
	Industry	Structure	Gross industrial output of enterprises above designated size / service-sector value added (CNY 10,000)
			Industrial enterprises above designated size (number)
	Green Development	Resources	Coal consumption (tonnes)
			Industrial electricity consumption (10,000 kWh)
		Environment	Annual mean PM2.5 concentration (µg/m³)
			Industrial exhaust-gas emission intensity (%)
			Industrial wastewater discharge (10,000 tonnes)
			Comprehensive utilisation rate of industrial solid waste (%)
			Total carbon dioxide emissions (tonnes)

2.1.1. Modified coupling coordination degree model

Following Wang et al. (2021), an modified coupling-coordination model links transition speed to the manufacturing output of industrial enterprises above the designated size, a Chinese statistical category covering firms above the official revenue threshold. The model combines a coupling measure, a coordination measure and a composite coordination index. It is used to assess whether the expansion of emerging growth drivers is accompanied by an improvement in industrial performance and whether the restructured growth base is compatible with the scale and foundations of local manufacturing. This compatibility is termed “transition effectiveness” and is calculated as follows:

$$E_{TNO} = \sqrt{\left(2 \times \sqrt{\frac{S_{TNO} \times V_{Manf.}}{(S_{TNO} + V_{Manf.})^2}} \right) \times (\alpha \times S_{TNO} + \beta \times V_{Manf.})} \quad (1.1)$$

In equation (1.1), E_{TNO} denotes transition effectiveness, S_{TNO} denotes transition speed by entropy

weight method and $V_{Manf.}$ denotes the manufacturing output of industrial enterprises above the designated size. The weights α and β are both set to 0.5 so that the two components contribute equally.

2.1.2.Spatial correlation analysis

Global Moran' s I is used to test whether the transition level is spatially correlated across cities. It is calculated as follows:

$$I = \frac{\sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{S^2 \sum_{i=1}^n \sum_{j=1}^n w_{ij}} \quad (1.2)$$

In equation (1.2), x_i and x_j are observations for spatial units i and j , $\bar{x}$ is the sample mean, w_{ij} is the spatial weight, S^2 is the sample variance and n is the number of prefecture-level cities in the Yangtze River Economic Belt.

Local Moran's I is then used to identify local spatial clusters. It is calculated as follows:

$$I = \frac{x_i - \bar{x}}{S^2} \sum w_{ij} (x_j - \bar{x}) \quad (1.3)$$

In equation (1.3), A positive local Moran' s I indicates that a city resembles its neighbours, producing either a high – high or a low – low cluster. A negative value indicates dissimilarity, producing either a high – low or a low – high cluster.

2.1.3.Geographically and temporally weighted regression

$$y_i = \beta_0(\mu_i, \nu_i, t_i) + \sum_{k=1}^{\rho} \beta_k(\mu_i, \nu_i, t_i) x_{ik} + \varepsilon_i \quad (1.4)$$

In equation (1.4), y_i is the transition level, ρ is the number of explanatory variables, x_{ik} is explanatory variable k for city i , (μ_i, ν_i, t_i) gives the city' s spatial and temporal coordinates, $\beta_0(\mu_i, \nu_i, t_i)$ denotes the value of the function $\beta_k(\mu_i, \nu_i, t_i)$ at the spatio-temporal location of prefecture-level city i , β_0 and β_k is coefficient, and ε_i is the random error term.

2.2.Selection of explanatory variables

Four explanatory variables are selected on the basis of previous research and the development conditions of the Yangtze River Economic Belt: transport accessibility (Du and Li 2022), government intervention (Zhao et al. 2023), city size (Sun and Zhou 2024) and market size (Wang, 2016). Transport accessibility is measured as the ratio of motorway length in kilometres to administrative land area in square kilometres. Government intervention is measured as local general-budget expenditure divided by gross domestic product. City size is represented by the urbanisation rate, and market size by urban economic density.

2.3.Measuring the transition level

The measurement proceeds in two stages. First, entropy weighting and the Technique for Order

Preference by Similarity to Ideal Solution are used to calculate an emerging-driver index (NI) and a traditional-driver index (OI). Second, these indices are combined in a two-dimensional framework. Transition speed S_{TNO} is the relative weight of the emerging-driver index in the overall growth-driver structure. A higher value means that production factors and industrial structure are moving more rapidly from traditional towards emerging activities. Transition effectiveness (E_{TNO}) is obtained from equation (1.1). A city with high speed but low effectiveness is expanding emerging activities rapidly without embedding them successfully in the local economy. A city with moderate speed but high effectiveness is changing more gradually but achieving a stronger fit with its industrial base. The final transition level (L_{TNO}) combines these two dimensions.

2.4.Data sources

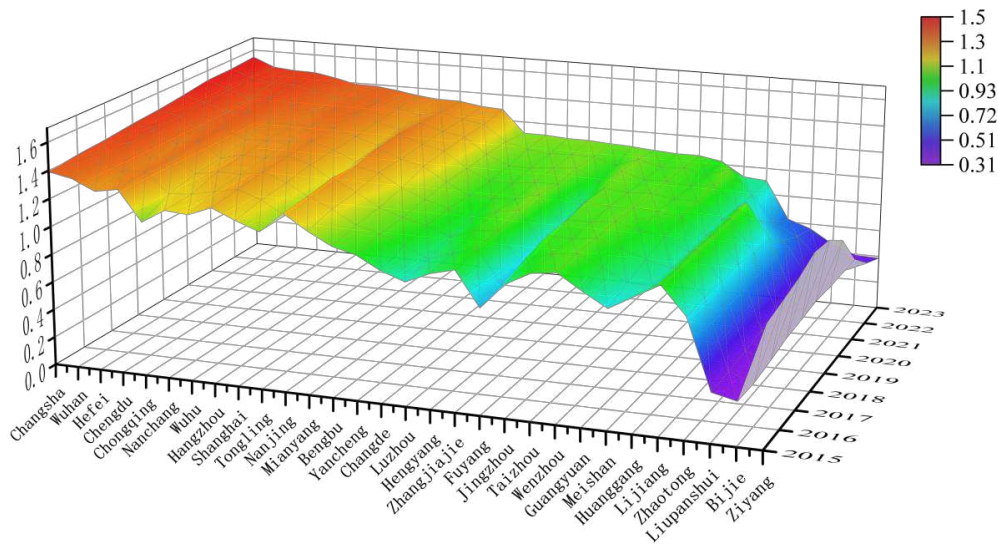
The panel covers 2015–2023. Data used to construct the two growth-driver indices come from the China Statistical Yearbook on Science and Technology, China Energy Statistical Yearbook, Almanac of China's Finance and Banking, China Industry Statistical Yearbook and China Statistical Yearbook of the Tertiary Industry. City-level variables are drawn from the China City Statistical Yearbook, China Statistical Yearbook and provincial statistical yearbooks. Administrative boundaries come from the 1:1,000,000 National Fundamental Geographic Information Database maintained by the National Geomatics Center of China. A small number of missing observations are filled by interpolation.

3.Spatial and temporal patterns

3.1.Temporal evolution analysis

At the city level (see Figure 1), nearly 90% of the 110 cities recorded a sustained increase in the transition level. Changsha ranked first and Wuhan second, while Hefei and Chengdu alternated between third and fourth. Fuyang recorded the fastest increase, at 44.24%. Two policy developments help explain this rise. The Development Plan for the Huai River Ecological Economic Belt, issued in 2018, directed Fuyang away from resource-dependent activities towards processing and innovation. The 2021 Implementation Plan for Industrial Transfer Clusters in Northern Anhui then included the city in a regional platform for electronic information, advanced transport equipment and intelligent manufacturing. This enabled Fuyang to absorb medium- and high-end manufacturing activities spilling over from the Yangtze River Delta, together with new technologies, equipment and management practices. Twelve cities—Taizhou, Huanggang, Nanjing, Zhangjiajie, Jingzhou, Yancheng, Wenzhou, Guangyuan, Meishan, Zhaotong, Lijiang and Ziyang—followed a rise-then-fall pattern. Ziyang showed the largest fluctuation, at 54.78%. Between 2015 and 2019, subsidies for high-technology firms, industrial projects, technological upgrading and innovation platforms helped local food processing and vehicle-parts manufacturers renew equipment and improve production processes. After this policy ended, deeper integration within the Chengdu – Chongqing Economic Circle concentrated key industrial-chain functions, research resources and headquarters activity more strongly in Chengdu. Ziyang

increasingly specialised in supporting production and lower-value manufacturing, which limited the local accumulation of emerging growth drivers.



Note: To save space, only selected years are shown.

Figure 1. Transition levels across cities in the Yangtze River Economic Belt, 2015 – 2023

Figure 2 shows a steady rise in all three parts of the economic belt between 2015 and 2023, with the downstream area consistently ahead of the midstream area and the midstream area ahead of the upstream area. This pattern mirrors regional differences in economic development, resource-allocation efficiency and openness. The downstream area benefited from an earlier start, more complete industrial chains and greater openness. The midstream area improved rapidly by receiving manufacturing activities from the coast and linking education and research more closely to industry. The upstream area advanced as transport links improved and green-development policies were implemented, although its overall rise was slower. In 2023, 20 downstream cities, 14 midstream cities and 22 upstream cities were above their respective subregional averages. The corresponding numbers were 20, 13 and 21 in 2019, and 21, 11 and 20 in 2015. The large number of above-average cities in both the downstream and upstream areas shows that location within the broad river gradient does not by itself determine transition performance.

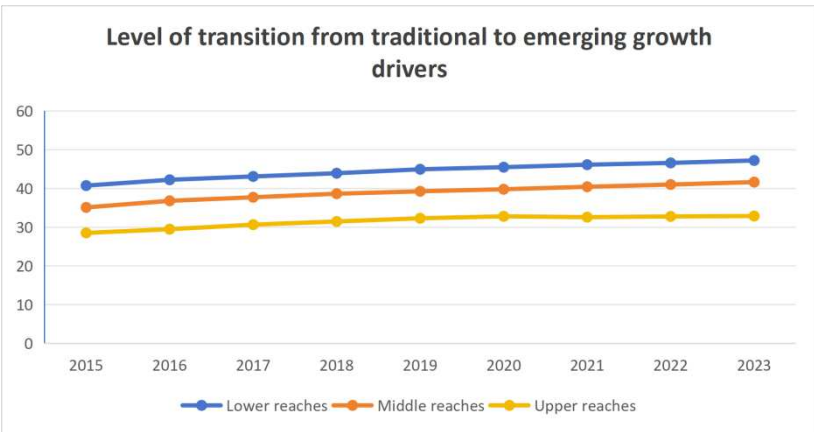
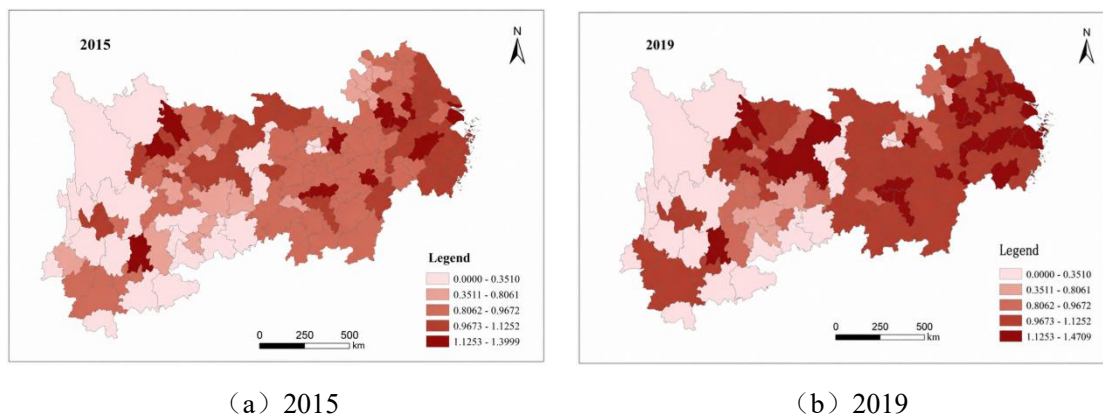


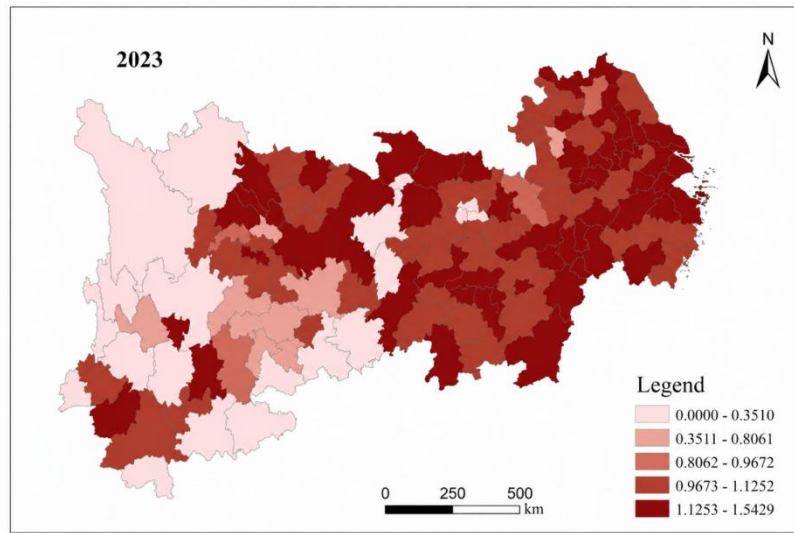
Figure 2. Transition levels in the downstream, midstream and upstream areas, 2015–2023

3.2.Spatial evolution analysis

The overall pattern declined from the coastal downstream area through the midstream interior to the south-western upstream area, while levels rose across the economic belt as a whole. Natural-break classification and frequency analysis in ArcGIS were used to map the transition levels in 2015, 2019 and 2023. The resulting pattern can be summarised as a concentration of high values along the eastern river and coast, a continued rise in midstream urban regions and the emergence of several stronger nodes in the south-west (Figure 3). Shanghai, Nanjing, Wuxi, Hangzhou and Ningbo formed the main high-value core and the pattern extended inland in a south-westerly band. Their period means were 1.2667, 1.3045, 1.1004, 1.3158 and 1.1359, respectively, all above the overall mean. By contrast, Suqian, Huainan, Anqing and Lu'an remained below the mean, with values of 0.8773, 0.7169, 0.9588 and 0.9501. In the south-western interior, Chongqing, Chengdu and Kunming remained above the overall mean, at 1.2747, 1.3844 and 1.2113. Liupanshui, Zunyi, Qujing, Zhaotong and Ziyang remained below it, at 0.4045, 0.5453, 0.8236, 0.7389 and 0.7340.

The number of cities in the low and lower-level groups fell markedly. The share below the medium level declined from 58.18% in 2015 to 10.91% in 2023, while the share at the upper-medium level or above rose from 22.73% to 70.91%. A broad north-east – south-west divide remained. High-level cities were concentrated along the main Yangtze corridor and the coastal port belt in a point-and-axis pattern. Compared with other cities, they had stronger infrastructure and public services and were better able to attract capital and skilled labour. Upper-medium and medium-level cities often appeared in rings around core cities, especially in Hubei, with its strong scientific and technological base, and Hunan, with its active financial sector and human-capital advantages. Cities at or below the medium level were more widely distributed upstream, where weaker transport connections and constrained resources increased the risk of persistent low development.





(c) 2023

Note: Values of 0.0000 – 0.3510 indicate a low level; 0.3511 – 0.8061, a relatively low level; 0.8062 – 0.9672, a moderate level; 0.9673 – 1.1252, a relatively high level; and 1.1253 – 1.5429, a high level.

Figure 3. Spatial distribution of transition levels in 2015, 2019 and 2023

4. Empirical analysis of transition drivers in the Yangtze River Economic Belt

4.1. Analysis of spatial autocorrelation

4.1.1. Global spatial autocorrelation

A contiguity-based spatial weight matrix is used to estimate global Moran's I. As shown in Table 2, the statistic is positive and statistically significant in every year from 2015 to 2023. Transition levels are therefore not randomly distributed across space; cities with similar levels tend to be located near one another.

Table 2. Global Moran's I for the transition level

Year	Moran's I	Z value	P value	Year	Moran's I	Z value	P value
2015	0.356***	5.627	0.000	2020	0.332***	5.293	0.000
2016	0.378***	5.983	0.000	2021	0.285***	4.550	0.000
2017	0.386***	6.124	0.000	2022	0.239***	3.836	0.000
2018	0.380***	6.022	0.000	2023	0.221***	3.565	0.000
2019	0.367***	5.829	0.000				

4.1.2. Local spatial autocorrelation

Figure 4 presents the local indicators of spatial association. In 2015, high–high clusters were concentrated in and around the core of the Yangtze River Delta: Taizhou, Zhenjiang, Changzhou, Wuxi, Huzhou, Jiaxing, Hangzhou, Shaoxing and Ningbo. Low–low clusters appeared mainly in Yunnan and Guizhou and included Kunming, Yuxi, Chuxiong, Honghe, Pu'er, Lincang, Zhaotong, Bijie and Lu'an. By

2023, high–high clustering still covered part of the Yangtze River Delta but had also extended into central Jiangxi, including Changzhou, Wuxi, Huzhou, Jiaxing, Yichun and Fuzhou. Low–low clustering was then confined mainly to Guizhou and neighbouring areas, including Dazhou, Guiyang, Liupanshui, Anshun, Qianxinan, Qiannan and Qiandongnan. Overall, high-value clustering remained relatively stable downstream, new high-value nodes emerged midstream and low-value clustering contracted upstream. The contraction from much of Yunnan and Guizhou to a smaller part of Guizhou indicates improvement in the south-west, although some places still face a weak industrial base and limited innovation resources. The appearance of high–high clusters in Yichun and Fuzhou suggests stronger capacity to absorb industrial transfer and innovation inputs in the midstream area. Persistent clustering in the Yangtze River Delta reflects its strong industrial base, dense innovation resources, advanced digital economy and close regional coordination.

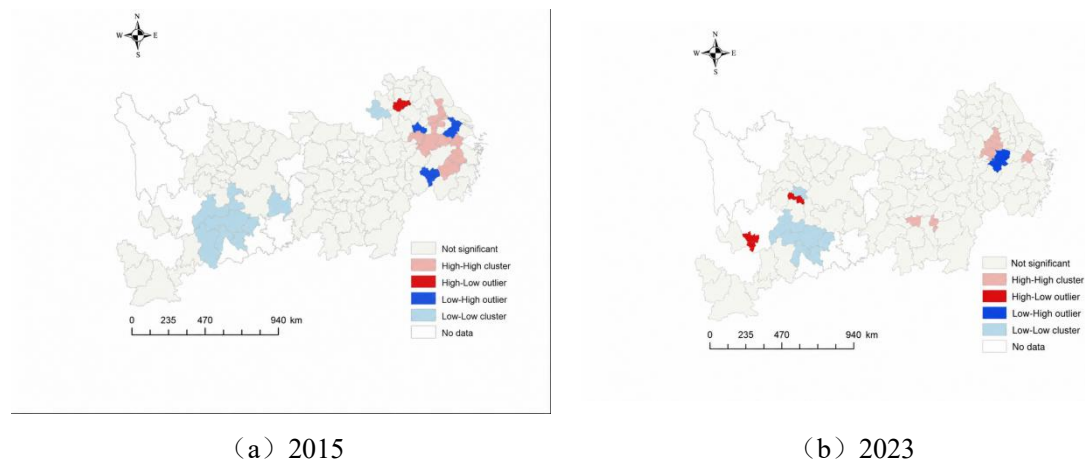


Figure 4. Local indicators of spatial association for the transition level in 2015 and 2023

4.2. Analysis of transition drivers in the Yangtze River Economic Belt

The geographically and temporally weighted regression coefficients are classified using natural breaks in ArcGIS and mapped in Figure 5. The maps show how the direction and strength of each driver changed across cities between 2015 and 2023.

The effect of transport accessibility changed from negative to positive. The spatial pattern moved from “more negative in the east and less negative in the west” to “more positive in the east and less positive in the west”. In 2015, coefficients were negative overall, with the strongest negative values in the downstream Yangtze River Delta. In areas where transport infrastructure was already extensive, a further increase in motorway density offered limited marginal benefit and could even hinder transition through land use, resource misallocation and dependence on established patterns of factor movement. By 2023, the coefficients were positive, ranging from 0.2219 to 2.7723, with the highest values again in the Yangtze River Delta. As integrated transport networks, metropolitan commuting systems and regional integration improved, accessibility increasingly supported the concentration of innovation resources, industrial specialisation and the spread of digital activity. The 2016 Yangtze River Economic Belt Development Plan and the 2019 Outline for Building China into a Transport Power accelerated links among motorways, high-speed rail, ports and

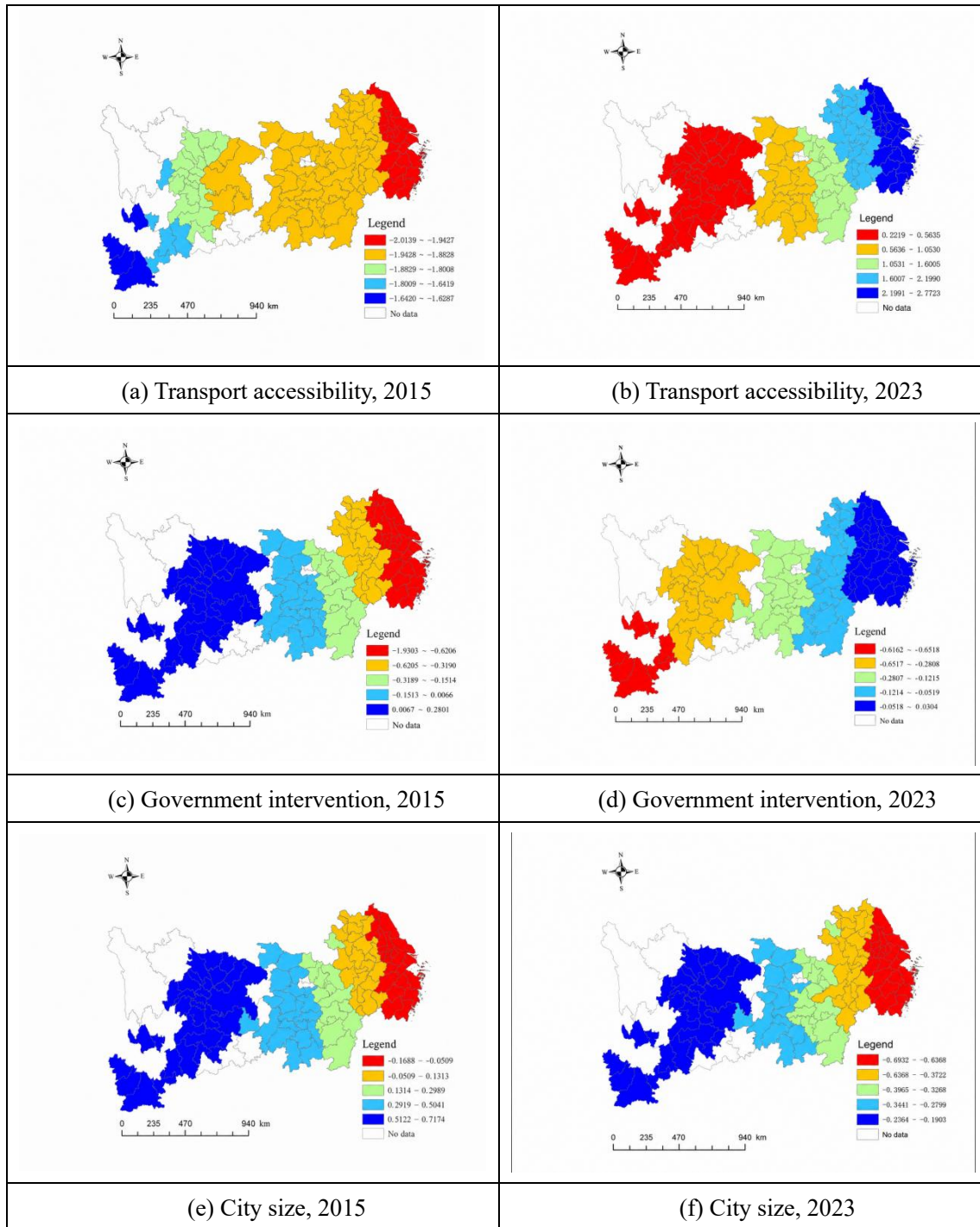
urban transport systems. Integration in the Yangtze River Delta further increased the efficiency of cross-regional factor flows. Transport accessibility thus changed from a basic enabling condition into a more active driver of growth-driver transition.

The effect of government intervention changed from locally positive to negative overall, although the strength of the negative effect varied spatially. In 2015, coefficients ranged from -0.8830 to 0.2661 . Positive values were concentrated in upstream Yunnan, Guizhou, Sichuan and Chongqing, where fiscal investment, industrial support and public services could partly compensate for weak markets and support both established and emerging activities. Negative values were found in the more market-oriented and industrially mature Yangtze River Delta, where strong direct intervention could reduce the efficiency of market allocation. By 2023, coefficients were negative across the economic belt. The negative effect was strongest upstream and weaker downstream. This shift suggests that transition increasingly depended on market mechanisms, firm-level innovation and freer factor movement, while the marginal return to direct public investment and administrative promotion declined. It also coincided with stronger market integration, progress towards a unified national market and a gradual change in local-government functions from direct intervention towards public services, institutional provision and improvement of the business environment. In some upstream areas, however, fiscal dependence, poorly targeted support and inefficient resource allocation may still create crowding-out effects.

The effect of city size also changed from locally positive to negative overall. In 2015, coefficients ranged from -0.1868 to 0.7174 . Positive values were concentrated upstream, where moderate urban expansion could increase the concentration of labour and industry, enlarge consumer markets and improve public services. Negative values appeared in the already large and densely populated downstream cities, where further expansion could increase congestion, land constraints, environmental pressure and inefficiency. By 2023, all coefficients were negative, ranging from -0.4692 to -0.1809 , and the negative effect became stronger from upstream to downstream. The results indicate that, as the economic belt moved towards higher-quality development, expanding population and urban land became less important than innovation, industrial upgrading, digitalisation and more efficient factor allocation. The broader shift from quantity-led to quality-led urbanisation reduced the marginal benefit of city expansion, especially where population pressure, development intensity and demand for public resources were already high.

The effect of market size changed from locally positive to positive overall. In 2015, the strongest positive coefficients were found in the downstream Yangtze River Delta, where high incomes, strong consumer demand and a complete industrial system provided a stable market for new industries and business forms. Coefficients were negative in upstream Yunnan, Guizhou, Sichuan and Chongqing, where limited market capacity and weaker industrial support reduced the effect of demand expansion. By 2023, all coefficients were positive, ranging from 0.0132 to 0.0348 , and the highest values had shifted upstream. Growing consumer potential, urban-region development and larger internal markets strengthened the role of demand in the west. The effect remained positive but weaker in the Yangtze River Delta, where further

market expansion yielded smaller marginal gains and transition depended more on technology, industrial upgrading and high-level inputs. The change was supported by national policies to expand domestic demand, closer market links along the economic belt and the development of upstream growth poles such as the Chengdu–Chongqing Economic Circle and the central Guizhou and central Yunnan urban regions.



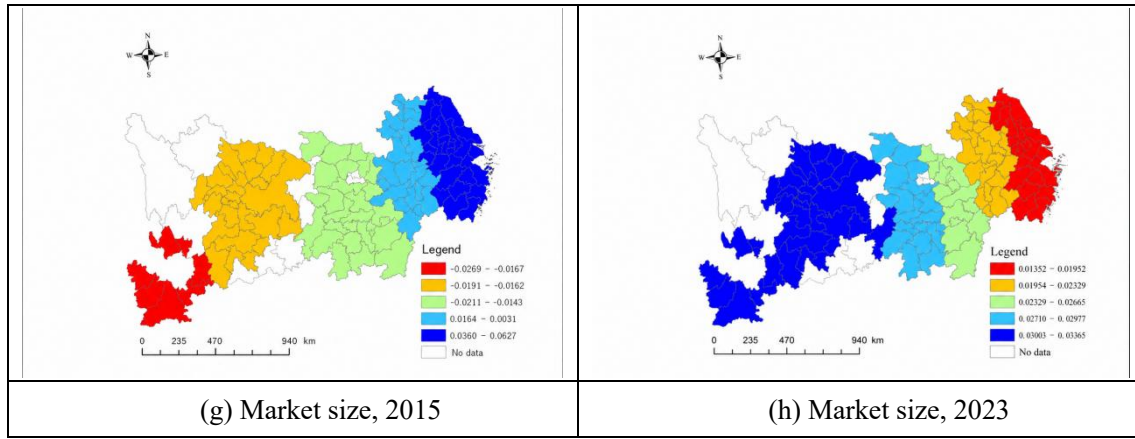


Figure 5. Spatial and temporal variation in the regression coefficients of the four drivers

5. Conclusions and recommendations

5.1. Conclusions

Using panel data for 110 prefecture-level cities from 2015 to 2023, this study treats growth-driver transition as a combined process of expanding emerging activities, upgrading established industries and rebuilding the fit between them and the local industrial system. The two-dimensional framework combines transition speed with transition effectiveness and is analysed using entropy-weighted ideal-solution ranking, an improved coupling-coordination model, Moran's I and geographically and temporally weighted regression. Three conclusions follow.

First, the transition strengthened across the Yangtze River Economic Belt, but regional differences remained pronounced. Most cities improved and the number below the medium level fell sharply, indicating that new technologies, emerging industries and greener inputs became more widely embedded in regional economies. Nevertheless, the downstream–midstream–upstream gradient persisted. Existing industrial foundations, innovation resources, openness and the capacity to allocate factors therefore continued to shape the process. Differences within each subregion were also substantial. Geographical location alone did not determine performance; what mattered was whether a city could convert its resources into industrial-upgrading capability. The economic belt is consequently experiencing overall progress alongside local divergence rather than uniform convergence.

Second, the spatial pattern is changing from a stable east–west divide towards a layered structure in which downstream cities lead, midstream cities absorb industry and innovation, and upstream cities gradually catch up. Positive global Moran's I values show that transition is spatially dependent: industrial links, technological diffusion, capital flows and market connections transmit change between cities. Persistent high–high clustering in the Yangtze River Delta reflects the cumulative advantages of complete industrial chains, dense innovation networks and an integrated market. The emergence of midstream high-value nodes indicates that industrial transfer increasingly includes technology, skills and organisational capability rather than production capacity alone. The contraction of low–low clusters upstream suggests that better

infrastructure, greener development and regional growth poles are weakening earlier patterns of low-level lock-in. The remaining asymmetry between the outward influence of core cities and the capacity of peripheral cities to absorb that influence, however, limits wider convergence.

Third, the effects of the four drivers vary markedly across space and time. Transport accessibility changed from a negative to a positive influence as networks and regional integration improved the movement of factors. Government intervention changed from locally positive to negative overall, indicating greater dependence on market allocation and firm-level innovation. City size also changed from locally positive to negative overall, showing that the benefits of simple urban expansion have declined. Market size became positive throughout the economic belt, with its strongest effects shifting upstream as domestic demand and western growth poles developed.

5.2.Recommendations

Based on the above findings, this study proposes the following recommendations.

First, regional policy should recognise different starting conditions rather than impose a single transition path. The downstream area should use the Yangtze River Delta's influence to strengthen basic research, technology transfer and high-value industrial-chain functions in fields such as the digital economy, green finance, intelligent manufacturing and life sciences. Its objective should be to turn concentration advantages into wider spillovers. The midstream area should use Wuhan, Changsha and Nanchang as hubs for receiving industrial and technological spillovers and for combining advanced manufacturing and modern services with local capabilities. The upstream area should build on ecological assets, energy resources and distinctive industries, prioritising green manufacturing, clean energy, nature-based tourism and higher-value processing of agricultural products rather than copying the downstream development model.

Second, transport and digital infrastructure should be developed as connected systems that support cross-regional flows. The positive effect of accessibility in the later period indicates that infrastructure now matters not only by shortening distance but also by enabling industrial coordination and innovation diffusion. Priorities include better links among motorways, high-speed rail, ports, airports and urban transport, especially where midstream and upstream bottlenecks isolate peripheral cities from major hubs. Fifth-generation mobile networks, industrial internet platforms, data centres and intelligent logistics should also extend further inland. Downstream investment should be coordinated with industrial and innovation chains rather than focused on road density alone. In the midstream and upstream areas, better physical and digital connections should be converted into stronger capacity to receive and upgrade transferred industries.

Third, government should shift from direct allocation and project support towards stable rules, effective public services and better governance. In highly market-oriented downstream areas, unnecessary administrative intervention should be reduced and policy should focus on intellectual-property protection, a predictable business environment and the commercialisation of research. Midstream industrial policy should target missing or weak links in competitive industrial chains and avoid low-level duplication. Upstream

governments should improve the efficiency of fiscal spending and direct scarce resources towards public services, vocational education, transport and logistics, digital infrastructure and ecological governance. Across the economic belt, the main public role should be to provide strategic direction and reliable institutions that enable firms to invest in emerging growth drivers.

Fourth, urban policy should move from expansion towards quality and should use domestic demand more effectively. Large downstream cities need to manage land, environmental and transport pressures and encourage a balanced distribution of people, industry and public resources across metropolitan areas. Midstream cities should improve their capacity to support people and firms through stronger urban-region coordination, better integration of employment and housing, and more attractive conditions for skilled workers, capital and innovation. Upstream cities should avoid expansion for its own sake and improve urban quality through distinctive and green industries and stronger everyday services. At the same time, multilevel consumer markets, higher household incomes, digital consumption and locally distinctive products can help turn market demand into sustained support for new industries and business forms, especially in the Chengdu–Chongqing, central Guizhou and central Yunnan growth poles.

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