High-Speed Rail and Interscalar Coordinated Development from a Multidisciplinary Comparative Perspective: Hotspots, Features, and Future Directions

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Abstract: Achieving interscalar coordinated development along with the fast expanding high-speed rail (HSR) networks poses a challenge in multidisciplinary research and planning practice. This paper goes beyond existing scholarship by adopting a comparative approach that covers the fields of planning, geography, economics, and transportation. We employ CiteSpace, a knowledge mapping software, to analyze the hotspots, characteristics, and current gaps in HSR studies found in the Chinese core journals over the past 20 years. The results reveal four common characteristics across these disciplines: a shifting emphasis from efficiency enhancement to pursuing multiple values; research design that are sensitive to different developmental stages, with a pro-growth orientation within internal disciplinary frameworks; the gradual deepening of research, accompanied by academic debates in the normalization stage; and the exploration of research methods and the refinement of research data. Due to limitations in research chronology, analytical scale, disciplinary background, and knowledge systems, the integration of these four disciplines remains insufficient, hindering the formation of a comprehensive research paradigm on the sustainable development of high-speed rail and regional development. In response, the paper proposes four theoretical research directions and five practical research directions to facilitate the integration of interdisciplinary studies.

Keywords: multidisciplinary comparison; literature review; high-speed rail; interscalar coordinated development

After the construction of various types of development zones and new cities, the integrated development of high-speed rail stations and surrounding areas has become another new form of spatial expansion to promote urbanization and urban development in China. Currently, with the basic completion of the "Eight Vertical and Eight Horizontal" main high-speed rail network, China has fully entered the "High-Speed Rail Era." High-speed rail new cities and new districts are under construction in various "high-speed rail cities," which is quite different from the model in Western countries of upgrading existing urban railway stations to high-speed rail stations. How to reasonably plan, construct, and guide the implementation of high-speed rail station areas, new cities, and new districts, and promote the positive interaction between high-speed rail as new regional infrastructure and cross-scale regional coordinated development①, is one of the key issues of concern for local governments and the planning community. With a large number of high-speed rail new cities, new districts, and station areas in China, and great regional differences, depending on the varying levels of urban capacity—this study includes cities at the prefectural level or above for a complete count. By the end of 2022, 26% of cities in China explicitly proposed the development of high-speed rail new cities and new districts, and 46% of cities explicitly proposed the development of multi-scale areas related to high-speed rail②. Recognizing the development laws of these areas is the premise for scientific planning and implementation, and is the practical need for the construction of high-speed rail and the sustainable development of cross-scale regions. At the same time, China's national conditions and development stage differ greatly from high-speed rail pioneer countries like Europe and Japan. A review of more local

academic research to clarify the factors and driving mechanisms influencing the development of China's high-speed rail station areas will better help learn international experiences selectively and conduct targeted practices in China. Transportation is one of the key factors continuously reshaping regional economic and geographical conditions. The high-speed rail network and its economic benefits are multi-scale and regional, so research in this field inherently involves the complexity of cross-scale spatial interaction mechanisms. Different disciplines provide multi-dimensional analytical perspectives for this field. The task of urban planning is to follow the laws and provide scientific guidance for the coordinated development of high-speed rail related regions. Geography focuses on the geographical distribution, diffusion, changes, and the formation and development laws of regional structures related to high-speed rail. Economics focuses on the development laws of the economic benefits brought by high-speed rail and the return on investment in high-speed rail. Transportation studies focus on the occurrence, development, and operation laws of high-speed rail transportation, as well as transportation planning, design, and management. These four disciplines have their own characteristics and advantages in analyzing, explaining, predicting, and intervening in the real world, and they differ greatly in research ideas, methods, scales, and scopes. Based on the comparative perspectives of the four disciplines, this paper reviews the progress and discoveries of research related to high-speed rail and urban regional spatial development, forming a two-way feedback between prospective and retrospective disciplines. By establishing an interactive bridge between practical and theoretical disciplines, it helps urban planning and transportation studies absorb research ideas and results from geography and economics at different scales, enhancing the scientific planning and construction of high-speed rail and related cross-scale regional development. Understanding the needs and issues of regional planning and construction practice under the background of high-speed rail construction also contributes to the further deepening of research in geography and economics, thus jointly promoting the healthy and coordinated development of multi-scale high-speed rail urban regions.

1 Analysis of Research Topic Changes

1.1 Data and Methods

The literature sources selected from CNKI include CSCD, CSSCI, and core journals. Foreign journals were not included due to the scarcity of research on China's planning discipline and the fact that key papers in disciplines like transportation, geography, and economics share similar content, authors, and conclusions with core Chinese journals. Therefore, foreign journals were excluded from the analysis. To clarify the research landscape and trends of high-speed rail (HSR) and cross-scale studies in China, no starting year was set for the search, and the end date was April 31, 2022. Based on this, a professional search query was constructed for "title" searching, and irrelevant materials were manually removed, resulting in 591 valid documents. Through visual analysis, the distribution of research outcomes in various disciplines over the years was compared with the cumulative map of HSR operation mileage to display development dynamics (Figure 1). Using bibliometric tools like CiteSpace, keyword clustering and emergent word detection were performed to generate information maps for various disciplines (Figure 2), revealing the trends in the four disciplinary fields of HSR and urban region research.

1.2 The Total Volume and Theme Changes of Research Hotspots

A time-sequenced map of hot topics and development speed was created, showing that

academic research on HSR and urban space has been on the rise across all disciplines (Figure 2). From 2003 to 2010, research on HSR and urban regional spatial development was in its early stages, with very few results, limited to speculations on the promising prospects of HSR, accessibility improvements, and topics such as the early-opening Beijing-Shanghai, Wuhan-Guangzhou HSRs. From 2011 to 2015, with the continuous increase in attention, research themes and topics flourished. In addition to deepening the topics from the previous phase, more specific content such as spatial patterns (structures), influencing factors, transfers and urban traffic, HSR effects, etc., were addressed. For example, theoretical discussions, policy considerations, and planning cases emerged on multi-scale, multi-level spatial phenomena related to new HSR cities, HSR stations, station areas, and HSR hubs. Since 2016, the number of related results has accelerated, and the research content has tended to focus on subdividing vertical fields. A large number of hot topics such as economic links, passenger flow distribution, industrial agglomeration, urban and regional innovation, total factor productivity, spatial effects, and land use have emerged. Besides supplementing the existing literature system, this also reflects to some extent the transformation of national policies and development values.

1.3 Alignment of Research Hotspots with Macroeconomic Policies

Research hotspots in various disciplines are significantly influenced by the macro background and policy focus, exhibiting distinct era characteristics. The change in the keyword heat corresponding to each discipline over time can be clearly identified in the research time-zone map (Figure 2), which, combined with the policy directions at the corresponding time, shows: In 2004, the "National Medium and Long-term Railway Network Plan" was first released, and it was revised in 2008 and 2016, proposing the goal of building a "Four Vertical and Four Horizontal" and "Eight Vertical and Eight Horizontal" network. After these three time points, related research surged, and the research topics became closely linked to the construction process, expanding from the earlier opened Beijing-Shanghai, Beijing-Guangzhou (Wuhan-Guangzhou) HSRs located in China's central and eastern regions to national trunk channels connecting various regions, such as the Harbin-Dalian and Harbin-Qiqihar HSR in the northeast, the Chengdu-Chongqing HSR in the southwest, and the Lanzhou-Xinjiang HSR in the northwest, extending to the entire national HSR network. In 2014, the "National New-type Urbanization Plan" was released, and the national urbanization goals shifted to a development model led by central cities and urban agglomerations. Major city clusters began to propose "rail-based city clusters," and the research on urban agglomerations and HSR regional spatial structure and connections started to enrich. In 2018, the four ministries jointly issued the "Guiding Opinions on Promoting the Rational Development and Construction of Areas Around HSR Stations," and with more than a decade of development, there have been few successful cases of new cities around HSR stations. Reflective research on this field gradually increased, such as topics on station-area hierarchy structures, land use and related spatial effects, urban differences, influencing factors, and mechanisms. Overall, the research content reflects a shift from single to diverse themes, and the analysis perspectives from simple to complex.

1.4 Response of Research Hotspots to Practical Applications

In recent years, the speed at which related topics and hotspots have emerged has accelerated. The research hotspots in the four disciplines are closely related to their respective research objects and practical applications. Figure 3 compares the distribution of emerging keywords in each discipline, where the red line represents the period when a certain keyword became a

research hotspot. "Beijing-Shanghai High-Speed Railway" appeared as the first hotspot keyword in 2006 in the field of transportation studies, reflecting the strong application-oriented characteristics of transportation engineering research. Between 2010 and 2015, 22 new emerging keywords appeared, indicating that related research was increasingly receiving academic attention. During this period, planning studies contributed the most hotspot keywords, reflecting the forward-looking characteristics of planning studies that serve and guide practice. From 2016 to 2022, a new set of 23 hotspots emerged, with geography and economics each contributing 7 keywords, reflecting the long-term and delayed effects of transportation infrastructure on geographical and economic elements and space. A series of milestone achievements have pushed the continuous enrichment of research spatial layers, characterized by the differentiation of research objects, vertical deepening, and various focal points.

2 Analysis of Research Content Characteristics

Since CiteSpace software analysis can only present the abstract characteristics, it is necessary to manually read and summarize the specific research content, conclusions, methods, contributions, and other information based on the key literature shown by the software. This section systematically summarizes existing research from the perspective of comparing the four disciplines.

2.1 Change in Ideas: From Focusing on Efficiency Improvement to Balancing Multidimensional Values

Research in transportation and planning often follows practical issues. The primary motivation for high-speed rail development in various countries has been to address the insufficient capacity of traditional rail passenger transport. Early studies in transportation mainly focused on investigating high-speed rail travel demand [1]. After high-speed rail construction, the issue of integrating high-speed rail stations with urban transportation emerged, with integration efficiency [2] becoming a key focus. Later, research began to focus on passenger satisfaction [3] and travel service experiences [4], responding actively to the rise of experiential consumption preferences in China in recent years. From the perspective of planning, high-speed rail station areas, as the interface where regional high-speed rail systems directly interact with urban space, have been one of the main research topics. In European countries, high-speed rail stations are often located within urban areas, and the introduction of high-speed rail is often accompanied by the issue of upgrading existing station areas. In this regard, Bertolini's "Node-Place" analysis model [5], which advocates balancing the transport node value and urban place value of station areas, has become an important turning point in the research on value transformation. In China, most high-speed rail stations are located outside urban areas but face similar value-balancing issues—local governments' operational intentions have led to over-ambitious planning for station areas, with many developments not performing well [6], leading to reflexive studies that measure the imbalance between human-environment relationships in new high-speed rail cities.

The shift in economic and geographical research is related to China's major transformation in economic development and the national flow of elements brought about by the high-speed rail network. The global financial crisis of 2008 and the European debt crisis of 2011 forced China to adopt an investment-driven model, with high-speed rail as one of the major infrastructures supporting this investment. Initially, the core of economic research focused on whether high-speed rail construction promoted economic growth, with empirical studies showing that

high-speed rail did not have an immediate regional economic stimulation effect [7]. Later, with the new urbanization strategy and the Party's 19th National Congress defining China's primary contradiction as the issue of "imbalance and insufficient development," the core demands shifted to "people-centered" urbanization and balanced regional development. Economic and geographical research gradually incorporated issues such as the imbalance between urban and rural areas or regional development [8]. In recent years, under the backdrop of innovation-driven development and the ecological civilization strategy, the role of high-speed rail in urban regional innovation development [9] and carbon emissions [10] has become new hotspots. With the full completion of China's "Four Verticals and Four Horizontals" high-speed rail network, reshaping the economic-geographical structure, the economic impact of high-speed rail network effects [10] has become an objective reality, and the medium- and long-term benefits of high-speed rail have begun to emerge.

2.2 Content System: Research Topics Based on the Research Frameworks of Each Discipline during the Growth-Oriented Historical Period

Research on high-speed rail and urban regional space has gradually formed a preliminary system, with different disciplines refining their content in parallel, and the core content becoming clearer. Academic research serves the basic logic of the socio-economic goals at specific stages, which lays the groundwork for the sub-goals of research in four disciplines: planning, transportation, economics, and geography. Each discipline has deepened its research in areas such as incremental development, interconnectivity, economic growth, and spatial segmentation, establishing analytical approaches based on their respective theoretical frameworks. By using the mature research paradigms of each discipline, they explore the new spatial and temporal phenomena and issues triggered by high-speed rail (Figure 4 left).

The task of urban planning is to follow the spatial development laws to the greatest extent and scientifically guide the future development of high-speed rail-related spaces. Due to its forward-looking nature, one side of planning practice follows the logic of planning and design experience and "imported theories." For example, in practice, the "three development zones" layered structure of Schutz is commonly used as the ideal model for spatial layout around high-speed rail stations [7]. On the other hand, based on existing paradigms within the discipline, planning scholars have summarized the framework for analyzing the spatial impact of high-speed rail station areas [11]. Although the areas around high-speed rail stations are still in the early stages of development and the research cannot yet systematically summarize objective laws, the research system already covers core dimensions of "incremental development" in planning, such as hub construction [12], spatial structure, functional positioning, land use layout, intensity, and height [13].

Transportation studies focus on the occurrence, development, and operational laws of high-speed rail transport itself, as well as the theories and methods of transportation planning, design, and management operations. Under the broad context of "interconnectivity" [8], most of the research is centered on the theme of high-speed rail accessibility [14]. In addition, continuing the tradition of transportation research, many studies have explored transportation facility planning [15], travel behavior [16], transfer connections [17], the competition and cooperation relationship between high-speed rail and other modes [18], the reliability of high-speed rail transportation networks [19], and other aspects related to the physical environment supply, usage characteristics, and safety resilience.

Economics focuses on the development laws of the economic effects brought by high-speed rail and the issues of high-speed rail investment recovery. The traditional economic research in China includes five main themes: economic growth, monetary policy, total factor productivity, international economics, and corporate finance, with economic growth always being the key focus [20]. High-speed rail research in economics follows this tradition, starting with explaining the causes of China's economic growth in the era of high-speed rail. For example, from the perspective of decomposing and calculating the contribution rate of high-speed rail elements, studies have emerged in regional economics [21], industrial structure [22], spatial spillover [10], and other topics. In recent years, other popular economic topics, such as total factor productivity and corporate finance, have also started to be extensively reflected in high-speed rail research [23].

Geography focuses on the geographical distribution, diffusion, and changes of phenomena related to high-speed rail, as well as the formation and development rules of regional structures (Human Geography). Since its inception, geography has maintained a tradition of regional research and spatial studies, with a continued focus on regional research. Further subdivision of human geography includes settlement geography, economic geography, and tourism geography, forming the "three pillars" of the discipline, while population geography, cultural geography, and political geography occupy peripheral areas [9]. From the research on high-speed rail in the field of geography, the author identifies regional spatial research topics related to spatial structure [24], hierarchical systems [25], and passenger catchment areas [26], with other high-speed rail-related studies also concentrating on the "three pillars," such as urban systems [27], accessibility and economic connections [28], and tourism market patterns [29]. However, related research mainly focuses on summarizing static cross-sectional characteristics and rules.

2.3 Controversies: Normalized Development Stage Leading to Widespread Academic Debate

The result of these debates has deepened the research on related issues (Figure 4, right). As research deepens, studies related to high-speed rail in urban planning have begun to reflect a "learning while doing" approach. They have started focusing on practical issues arising from the development of new cities, districts, and station areas over the years, exploring topics such as planning implementation [30], station-city integration [31], land use intensification [6], and evolutionary patterns [32]. For example, after about 10 years of the opening of high-speed rail lines such as Beijing-Shanghai and Beijing-Guangzhou, comparisons of the development status of station areas with planning expectations show that most city station areas have an overestimated functional positioning, with core functions not yet manifested, completion rates below 20%, and development progress far behind expectations [30]. Establishing stations in suburban areas has exacerbated land use and high-speed rail-driven development, even leading to "exclave models" and "dual-city models" [6]. Based on these various issues, some scholars aim for station-city integration, and based on retrospectives of the current situation, they explore the location selection for high-speed rail stations in China [31], and provide guidance for planning practices through the study of the long-term spatial evolution of high-speed rail station areas [32]. Ignoring the objective laws of the city’s development stage and the spatial growth of station areas, and lacking scientific control and guidance over the spatial development timeline of station areas, often leads to the easy breaking of the constraints imposed by planning [13]. Therefore, long-term attention to issues related to the dynamics of spatial development is required.

After most high-speed rail stations in the country are interconnected, transportation studies have

shifted focus to optimizing operations. Research now centers on transportation planning evaluation and benefit analysis, such as passenger satisfaction [3], competition with air travel [33], or multimodal transport [34], as well as traffic-related issues such as noise, pollution, and other transportation-related nuisances [35]. Although most studies have empirically confirmed that high-speed rail has a time-space compression effect, some studies have found that high-speed rail does not necessarily improve efficiency and experience. Due to the significant compression of travel time within the train (travel time on high-speed rail), passengers become more sensitive to out-of-train travel time (waiting, security checks, walking, queuing, etc.), resulting in "relative time-space distortion" [10]. Studies also discuss the competitive distance, competition, and differentiation features between high-speed rail and civil aviation. Some studies suggest that the competitive advantage distance for high-speed rail is between 500 and 900 km [33], while other studies confirm the competitive advantage range is between 800 and 1500 km [36], which reflects the transition from corridor development to a networked system. These discrepancies push for future research and practice to focus on the staged development of high-speed rail, the dynamic changes in existing findings, and the differences across various dimensions.

Economics-related research on high-speed rail is influenced by external environments, with the goal of achieving economic stability, focusing on issues such as factor flow, balanced development, urban innovation, and production efficiency. Research conclusions on these topics often vary. For example, there is some disagreement on whether high-speed rail promotes regional balanced development: "It increases the economic gap between provincial capitals, but has little effect on general cities" [37] vs. "It exacerbates urban disparities and regional economic imbalance" [8]. In addition, regarding the emerging topic of whether high-speed rail promotes urban innovation, due to differing understandings of technological innovation, varying measurement indicators, and different selections of control variables, consensus has not been reached on the methods, content, and conclusions. Some studies suggest that "the opening of high-speed rail significantly enhances the technological innovation level of megacities, large cities, and super-large cities" [9], while others claim that "high-speed rail significantly boosts the technological innovation level of general prefecture-level cities, but has no significant effect on provincial capitals, municipalities, and sub-provincial cities" [38]. These conclusions are in direct opposition, making it difficult to reach a consensus in the short term. These debates have prompted scholars to conduct long-term follow-up research, delve deeper into heterogeneity studies, and systematically organize existing findings on key issues for practical reference.

Geography research has gradually shifted from static spatial characteristics to dynamic patterns based on "flow spaces," focusing on spatial differentiation, urban networks, and other dynamic effects. During the corridor stage of high-speed rail, regional spatial forms exhibit clear axial connections and traffic orientations, such as linear economic and industrial belts (e.g., the Yangtze River Delta "1-hour" economic circle) [39]. In the network stage, the space gradually becomes more balanced with the release of the "diffusion effect," and its form evolves into a multi-center, multi-layered, and contiguous structure optimization model. For example, the national urban hierarchy evolved from the initial "rank-size" sequence to a multi-level and community-type sequence during the network stage [40]. From 2015 to 2016, the national high-speed rail network presented a "tree-shaped" structure, while the train schedules showed characteristics of "scale-free" and "small-world" networks [19], indicating lower resilience.

Through multi-period simulations, it was found that the national high-speed rail network in 2015-2020 was characterized by regional connectivity and global integration, leading to a short-term decrease in overall network resilience due to large-scale regional connections. However, from 2020 to 2030, with local aggregation and improved convenience, the network's resilience will improve in the medium to long term with full coverage and layout downward penetration [41].

2.4 Methodological Deepening: Expansion of Research Types and Refinement of Research Data

The deepening of research methods plays an important role in further analyzing research questions. Descriptive studies have evolved from macro-level descriptions to micro-level descriptions and then to evaluative descriptions. Descriptive research focuses on geography, urban planning, and transportation studies and can be divided into two categories: value-neutral descriptive characteristics (such as 1 to 4) and evaluation-based descriptions based on specific values (such as 5)〇II.

Accessibility. From accessibility coefficients based on train timetable data [42] to the shortest weighted distance based on raster analysis [43], and finally to accessibility index methods integrating multiple disciplines [44].

Spatial layout. From describing urban system patterns [27] and tourism market patterns [29] using macro-level accessibility methods, to describing station area industrial spatial patterns using micro-level enterprise data, POI data, Ripley’s K-function method, kernel density method, and industrial index method [45].

Land development. From describing station location and surrounding development characteristics using distance index methods [46], to refining using buffer analysis, fan analysis, skyline analysis to describe total development, proportion, density, and time-sequence characteristics around the station [13], and further describing the dynamic evolution of the relationship between station development and station-city location using spatial evolution diagrams and timeline diagrams [32].

Travel behavior. From using survey data to describe passengers' social attributes and intercity commuting behavior characteristics [47], to combining ticket data to describe passenger flow structure and spatiotemporal distribution characteristics [3-4, 16].

Evaluation studies. Evaluating the realization of planning around high-speed rail stations based on planning implementation effects [13, 30], evaluating the node-place functions under the station-city integration concept [48], and evaluating the stability of the high-speed rail network under the service reliability principle [19].

Explanatory research has evolved from correlations to causal relationships and then to the deepening of causal chains. Explanatory research aims to explore the causes and processes behind phenomena, identifying influencing factors and establishing relationships between them. Most of this research comes from economics, which, due to systematic econometric training, considers both causal relationships and causal chains. For example, using GLS and FE models to study the correlation between high-speed rail and population flow [49], the PSM-DID model to study the causal mechanism of high-speed rail’s impact on regional economic growth [21], and the mediation effect model to examine the transmission mechanism of high-speed rail on innovation [50]. In contrast, research in urban planning, geography, and transportation focuses on correlations, such as using logit regression to identify factors influencing intercity commuting choices [47], multiple regression to identify the factors influencing spatial development

characteristics around high-speed rail stations [51], and multinomial logit models to study the factors affecting passenger transfer preferences [52].

Data Granularity Refinement and Extension of Research Periods: Geography and economics paradigms traditionally use multi-period data for explanatory research, and the improvement in data accuracy primarily comes from the refinement of data granularity. For example, in economics, the core explanatory variable "high-speed rail" has evolved from a dummy variable (such as whether there is a high-speed rail station [8]) to a continuous variable (such as the centrality of the high-speed rail network [22]). Other variables have evolved from using provincial and city statistical data to district and county-level statistical data, and even to nighttime lights, company registration addresses, and so on. In planning disciplines, which mainly focus on characteristic studies, satellite imagery data combined with field surveys are commonly used, with no obvious refinement in data granularity, but the research period has been further extended. For instance, from using one period of data (end of 2016) to analyze the station areas along the Beijing-Shanghai and Beijing-Guangzhou high-speed rail lines [30], to using two periods of data (2004 and 2014 for Beijing-Shanghai high-speed rail, and 2006 and 2014 for Beijing-Guangzhou high-speed rail data and 2014), followed by year-by-year data (2012 to 2019) to track the development process of multiple high-speed rail station surrounding areas over a decade [32].

3. Dilemma: Reasons and Impacts of Insufficient Discipline Integration

I have outlined the content and keywords of four disciplines and their intersectional fields (Figure 5), finding that existing disciplinary integration is primarily limited to pairwise combinations, lacking comprehensive and systematic deep integration across disciplines. The root cause of insufficient interdisciplinary integration in past research lies in immature objective conditions, reflected in aspects such as research sequencing, analysis scales, disciplinary roles, and knowledge systems. First, in terms of sequencing, the core task of planning disciplines is to proactively formulate and implement planning schemes, which first triggered the research boom on high-speed rail. However, economics and geography have mainly focused on mechanism studies, with a large portion of the research occurring after planning studies, resulting in an inversion in sequence, where the discovery of mechanisms and processes has not been fully reflected in planning decision-making. Second, in terms of scale, the four disciplines do not align with one another. Planning studies are often conducted at the station and district scale, while economics and geography mainly focus on the city and regional scale, and transportation studies tend to concentrate on the scale of stations, station buildings, and tracks. Although each discipline understands the scale and research content of the others, they do not fully grasp the essential conclusions of each other’s key issues and mechanisms, making it difficult to apply the research findings of other disciplines. Third, in terms of disciplinary roles, planning, being the most comprehensive and practice-oriented discipline of the four, should have more in-depth thinking about bridging existing laws with practical issues. However, the reality is that scholars from planning backgrounds tend to focus more on urban studies and less on planning studies in relation to high-speed rail. Fourth, in terms of knowledge systems, over the past period, each discipline has gone through stages of emergence, exploration, and maturity. Although related research has flourished and gradually become more refined, the internal systematic coherence within each discipline has been weak, and the real conditions for large-scale disciplinary

integration have long been immature. Insufficient interdisciplinary integration has led to an incomplete understanding of high-speed rail and the coordinated development of cross-scale regions, and insufficient grasp of the interactions between various elements and intrinsic laws of the disciplines. As time has passed, problems encountered in high-speed rail projects have gradually accumulated, and the research system within each discipline concerning high-speed rail has gradually matured. At this point, the objective conditions for large-scale disciplinary integration have now matured.

4. Future Research Directions for Promoting Coordinated Development of High-Speed Rail and Cross-Scale Regions

4.1 Theoretical Research Innovation from the Perspective of Multidisciplinary Integration

Based on the previous discussion, four "progressive" theoretical research directions are proposed for reference to promote the construction of a systematic theoretical framework for coordinated development of high-speed rail and cross-scale regions.

First, it is necessary to deeply understand the existing theories and carefully examine their nature, form, content, and boundaries of application in order to extend and expand the existing theories (Table 1). Current theoretical research has the following shortcomings: First, foreign theories cannot fully explain the Chinese reality. For example, the station-city integration theory from Japan and the node-place theory from the Netherlands were proposed in the context of old city renewal, and both consider the ideal goal of perfect integration of transportation and urban functions, with multiple market participants in the development process⑫. Foreign experience is only applicable to developed urban agglomerations and nodal cities in China, while many high-speed rail stations in China are new stations located in non-nodal cities, and not all of them need to implement the "station-is-city" or "station-city integration" model. The unique characteristics of passenger flow—"more, longer, larger, and fewer"—are also unique to China. The allocation of related resources cannot be fully carried out according to market principles, and these special features are difficult to explain using foreign theories⑬-⑭. Second, there is a tendency to relax the assumptions and expand the scope of application of theories. For example, because regional transportation carries higher functional levels, it is still debatable whether the TOD theory, which is applicable to urban bus stops, can be directly applied to intercity railways [53]. Similarly, applying the node-place theory, originating from the Netherlands, in non-central small cities in China, or even proposing this ideal model (ideal model)⑮ as a strategy for achieving balance in non-central stations through strategic interventions, believing that all unbalanced stations must achieve the node-place balance, is fundamentally impossible to achieve according to systems theory. Furthermore, there is little adaptation, expansion, or improvement of theories, and little research on fundamental laws. For example, in foreign studies on the classic node-place model, besides applying it to station evaluation and classification, corresponding prediction models, development mechanism explanation models, and systematic integration and platform development have been developed. However, domestic research is mostly limited to simple quantitative empirical applications of the classic model [54].

Second, using the scale of high-speed rail new districts as an entry point, a "multi-time—multi-disciplinary" analytical framework is proposed to identify the sequence of key problems in coordinating high-speed rail and cross-scale regions under different temporal granularities. Time serves as a bridge for interdisciplinary interaction. Economic and geographical laws of "flow," as

well as production and consumption relationships, will be reflected in the physical environment of transportation and planning over a certain period of time. The extent to which the advanced deployment of spatial resources can be realized depends on understanding long-term economic laws. Currently, research in the four major disciplines involves the intersection of different time granularities, but a theoretical framework for coordination based on multi-time granularities has not yet been established. Specific problems only become key problems at appropriate time granularities. The idea of "three years to form a trend, five years to build a city" breaks the basic rule that the development of new cities should be considered on a timescale of several decades. What problems and risks arise at different time granularities, such as daily, weekly, annually, every three to five years, every five to ten years, and several decades? Which problems and risks are more urgent at specific time granularities? What is the sequence of these problems and risks? Using the scale of high-speed rail new districts as an entry point, a "multi-time—multi-disciplinary" two-dimensional framework is proposed, which balances both short-term and long-term perspectives, clarifies the sequence of key issues in coordinating high-speed rail and cross-scale regions, identifies the key issues in specific periods, and then studies their characteristics and regularities. This represents a breakthrough theoretical innovation in this field. The multi-time perspective also provides an effective path to explore the relationship between non-spatial laws and their spatial manifestation⑯.

Third, using the high-speed rail new district as the skeleton, a "multi-time—multi-scale—multi-disciplinary" theoretical framework is constructed to study the interactions between high-speed rail and regional, urban, new district, and station-area systems. It focuses on multiple concurrent mechanisms and the multi-element mixed characteristics of good development paths. The coordination of high-speed rail and cross-scale regions is a typical multi-scale spatial reorganization problem, and each discipline involves the need for upward reorganization, downward reorganization, and outward reorganization across scales. The definition of related scientific issues in each discipline must return to the following fundamental questions: Which elements and path combinations can effectively promote the overall performance of high-speed rail construction? Which development path is better, rather than which one? What elements contribute to the good development path? In the past, various disciplines have not fully grasped each other's key issues and mechanisms, and existing findings cannot effectively engage in dialogue, resulting in a lack of overall focus on the multiple concurrent mechanisms and multi-element mixed characteristics of good development paths in development practice in this field. Compared with other scales, the high-speed rail new district scale has strong dynamism and substantial intervention ability in policy supply and administrative authority⑰. It is also the key scale for linking the city, station area, and surrounding regions. By taking the new district as the core, a comprehensive analysis framework of multi-time, multi-scale, and multi-disciplinary dimensions can be constructed. By analyzing the key issues and mechanisms within each scale, further exploration of how these key mechanisms interact with the new district scale is a potential breakthrough for integrated theoretical innovation in this field.

Fourth, taking the high-speed rail new district as the entry point, a comparison analysis approach of institutional and non-institutional environments is constructed, focusing on the adaptability between good development paths and governance contexts. Institutional incentives determine the choice of spatial governance tools. Previous research in various disciplines has often focused on the non-institutional environment while neglecting the institutional environment. Beyond the

measurement models, the combination of influencing factors and mechanisms and how they work in different contexts needs in-depth analysis of the institutional environment. In the field of high-speed rail, European academia has recently called for greater attention to institutional environments [58]. Future research, through constructing a comparative framework of institutional and non-institutional environments, holds multidimensional theoretical value. On one hand, it can expand the explanatory scope of existing theories for objective facts. Existing research has often discussed the divergent phenomena under the influence of the non-institutional environment, explaining the causes of phenomena like accessibility differentiation [44], tourism pattern differentiation [29], and the different levels of planning function achievement at various high-speed rail station areas [13, 30]. However, it cannot explain why newly developed and later-developed high-speed rail new districts generally have overly high planning orientations, with most planning goals poorly achieved, reflecting convergence phenomena [19]. On the other hand, comparative studies help establish a systematic framework for the coordinated development of high-speed rail and cross-scale regions from the perspective of high-speed rail new districts. Current research on new districts often focuses on nationally significant new districts, which are quite different from high-speed rail new districts. These districts are highly flexible in terms of functions and types, including industrial new cities, urban sub-centers, residential-led developments, and education/research-driven districts [30, 45]; in terms of administrative management, high-speed rail new districts generally fall under the jurisdiction of local governments without national or provincial-level unified management. Furthermore, the context has changed significantly, with many high-speed rail new districts being constructed after economic development model transformations, involving numerous ongoing or planned projects, as well as institutional changes such as departmental restructuring and system reforms [20]. These factors have posed new demands for the innovation of theories and governance tools related to high-speed rail new districts. Through comparative research, we can gain a deeper understanding of the internal logic, evolutionary trajectories, and structural forces between China’s various new districts and high-speed rail new districts, transcending quantitative and single-case narratives, thus offering a larger space for theoretical innovation.

4.2 Application Research and Practical Innovation from a Multidisciplinary Integration Perspective

Five research directions related to practical application are proposed for reference, complementing the aforementioned four theoretical research directions.

First, integrating multi-source data from different disciplines to build a database that corresponds to the key problem sequence established in the previous theoretical research. China’s high-speed rail practices have accumulated a vast amount of factual and empirical data. After clarifying the key problem sequence regarding the coordinated development of high-speed rail and cross-scale regions in theoretical research, establishing a database corresponding to the problem sequence is essential for delving into empirical characteristics, exploring objective facts, and understanding the spatial, economic, and social interaction laws of cities and regions in the high-speed rail era. China’s high-speed rail network has a significant global advantage in scale, with an abundance of policy and regulatory data, administrative management data, economic and social statistical survey data, real estate price data, geographical monitoring big data, land use big data, spatial location big data, individual behavior big data, and real-time monitoring data. Previously, different disciplines mainly focused on data within their own domain, while lacking

understanding of data from other fields. Future research should comprehensively and deeply combine data from various sources in response to key problem sequences.

Second, transcending existing disciplinary research paradigms to form a methodological flow guided by key problem sequences, promoting a more application-oriented shift in academic research. Historically, under disciplinary divisions, research paradigms have clear boundaries: geography emphasizes descriptive and correlation-based explanatory research, economics focuses on deep causal and correlation-based explanatory studies, planning emphasizes spatial descriptive research and spatial policy research, and transportation studies, while encompassing descriptive research and correlation/causal explanation, primarily focus on transportation itself. Complexity theory posits that the sum of disciplinary divisions is far less than the true real-world issues [20]. Furthermore, previous research overly focused on quantitative studies, abstracting some general laws, but qualitative research has been insufficient. Few qualitative studies have focused on the investment decision-making process of high-speed rail transport planning [77] or the formulation of planning schemes [78], without involving practices such as policy formulation and implementation, particularly in contexts of negotiation, and most research has been limited to central or flagship cities. Future studies urgently need to build a technology flow that transcends disciplinary boundaries, integrating both qualitative and quantitative research paradigms, combining descriptive research, evaluative research, correlation and causality explanations, and application strategies and governance context studies to gain a deeper understanding of the underlying laws and mechanisms in this field.

Third, by using meta-analysis to summarize consensus laws and their reliability in addressing current hot issues, the practice can be guided. Planners and policy practitioners often express skepticism about academic research conclusions, believing that the findings of one or two quantitative studies cannot directly be used for practical guidance because quantitative research generally has strict assumptions and conclusions that are only probabilistic events within a certain confidence interval. However, when the conclusions drawn from dozens or even hundreds of papers on a particular issue are highly consistent, they can be regarded as a relatively reliable general law to guide practice. Two prerequisites are necessary to achieve this: first, there must be more than 30 key quantitative papers accumulated on a research issue, and second, there must be a scientific method to systematically compare and analyze the details of these articles to obtain consensus knowledge. Currently, the four major disciplines have accumulated a large amount of empirical evidence on some hot issues, and the meta-analysis method can clarify whether there is highly evidence-based public knowledge in existing studies. This applied research direction will form an important support for guiding practical work.

Fourth, strategy research needs to go beyond relative group ranking and focus on the individual life cycle and development dynamics. The node-place model is widely used in various disciplines, often for site classification, evaluation, and strategic guidance. The specific method is to find a sample of high-speed railway stations (high-speed corridors, within the same province or urban agglomerations), collect cross-sectional data including transportation and place function measurements, and then classify the large sample group according to a clustering model. Each subtype represents a different equilibrium state, and strategies are proposed for different types to guide the station area toward the best equilibrium state. The mathematical nature of this approach is group-relative ranking. The flaw of this approach is that group-relative ranking cannot guide individual practice: firstly, the classification of a station area entirely depends on the

group it belongs to, and within a group of basketball players, there will certainly be shorter individuals; secondly, individual development is dynamic, meaning even if cross-sectional data show poor current development, it is unclear what the future trend of development will be, making it impossible to judge whether intervention is needed and what strategy should be used; thirdly, individuals have unique life cycles, and due to differences in the opening time of stations, life stages, and growth speeds, applying group-relative ranking and strategic guidance is inappropriate. The author believes that using the relative ranking results of the node-place model to study regional comparative advantages is acceptable, but applying it for individual strategy guidance is clearly an abuse (see Table 1). Future research should place more emphasis on the individual life cycle and development dynamics of high-speed railway stations and surrounding areas, integrating multidisciplinary technological methods from the perspective of urban science, combining years of data and survival analysis, measuring individual dynamic indicators, focusing on the evolution between different individual development states, and providing a scientific basis for strategic guidance.

Fifth, taking smart technology as an opportunity to promote the scenarization of high-speed railway and cross-scale regional coordinated development applications. Computer-aided technology, urban quantitative evaluation technology, urban dynamic simulation technology, and urban intelligent interaction technology all possess advantages such as thorough perception, deep integration, interconnectivity, and innovative applications, providing a feasible path for promoting the scenarization integration of multidisciplinary technologies. Typical scenarized applications related to high-speed rail and cross-scale regional coordinated development include (but are not limited to): station-city integration scenarios at the core station area scale, digital empowerment scenarios for high-speed rail-related spatial planning and implementation, and policy simulation and performance modeling scenarios for high-speed rail and cross-scale regional development. In 2023, Shanghai East Station (East Hub) began constructing the scenarization applications driven by smart technology for station-city integration, considering the goals of station-city integration at various scales including station areas, stations, and station buildings. The relevant digital empowerment work includes digital design, digital construction, and digital operation and maintenance. Typical sub-application scenarios include "human" time-space collaborative planning, "land" time-space saving and intensive use, green low-carbon and smart transportation, as well as dynamic monitoring, public opinion warnings, integrated decision-making, and scheme optimization. This work represents the frontier of interdisciplinary practice in this field, and future research should further address key challenges in smart technology scenarization applications and explore more typical application scenarios.

5 Conclusion

The search for answers to questions raised by a discipline may require the combined efforts of multiple disciplines. The core argument of this article is that, in order to truly harness the positive effects of high-speed rail (HSR) and achieve coordinated development between HSR and cross-scale regions, it is necessary to combine interdisciplinary research and promote cross-disciplinary cooperation. From the perspective of the goal of coordinated development between HSR and cross-scale regions, issues in urban planning, geography, transportation, economics, and those related to HSR at different scales are all relevant to this goal. However, current research often constructs academic topics based on specific issues encountered in the

development process or the frameworks of individual disciplines, and may even blindly chase academic hot topics due to changes in policy trends. The difference between this article and other HSR-related review articles is that it “transcends the existing paths and scope of topic construction,” standing from a more macro perspective and beyond specific issues, examining the progress and deficiencies of current related research. It uses a comparative analysis of four disciplines—urban planning, geography, economics, and transportation—as the main line, sorting out the development context of research in each discipline, summarizing the consensus achieved in each field and the hot topics currently under discussion. It compares the characteristics and differences of technical methods in different disciplines. Based on this, by analyzing the reasons for the insufficient integration of these four disciplines and the academic limitations resulting from this, it proposes four theoretical research directions and five practical research directions that are expected to achieve innovation after breaking through disciplinary divisions. The focus of this article is to reflect on the limitations of constructing academic topics and problems under the current disciplinary division model, reconsidering possible paths to achieve coordinated development between HSR and cross-scale regions, and aiming to provide inspiration and guidance for future research, rather than merely expanding or supplementing it. The specific research content evaluation in this article is based on key papers under corresponding topics, and the number of referenced achievements is limited. Due to space constraints, this article has not been able to conduct targeted discussions on planning responses from an interdisciplinary perspective, which requires further research in the future.

Notes

① "Coordinated development across scales" refers to achieving coordinated development between different spatial scales within a region, involving the coordination of measures and policies between these scales, reducing conflicts, optimizing resource allocation, and achieving sustainable development goals. In this paper, it specifically refers to effectively utilizing high-speed rail construction and development to promote the coordinated and sustainable development of multiple spatial scales, such as stations, station areas, new districts/areas, cities, and regions.

② The author has conducted a full-scale analysis of cities at the prefecture level and above that have included the concept of "high-speed rail new city, new district" in their municipal government work reports over the past nearly 20 years since the "11th Five-Year Plan." By 2022, 85 cities had included this concept, mentioning it 482 times across 262 municipal government work reports, covering 26% of all cities at the prefecture level and above in China. If we count different spatial concepts related to "high-speed rail" (high-speed rail new city, high-speed rail new district, high-speed rail area, high-speed rail cluster, high-speed rail station area, high-speed rail economic zone, etc.), a total of 149 cities have mentioned them, accounting for 46% of all cities. Generally speaking, work included in government work reports represents the government’s key areas of focus.

③ With the goal of coordinating high-speed rail and cross-scale regional development, issues related to urban planning, geography, transportation, economics, and high-speed rail research at various scales are all relevant to this goal. This paper, from a perspective that comprehensively compares existing research across disciplines, proposes future research directions to promote coordinated development, and thus does not limit itself to papers that directly study coordinated

development as the research object.

④ Search strategy for the designated title: TI (Title) = (high-speed rail + high-speed railway) AND TI (Title) = (region + international + intercity + metropolitan + city + urban + rural + town + village + station + station area + space + network + country + province + city + district + county + town + village + land + real estate + industry). Select titles that contain "high-speed rail / high-speed railway" and "city / region," and manually exclude irrelevant literature.

⑤ The author also used CiteSpace to map research institutions and author collaboration networks, but due to space constraints, they are not included. The study found that these high-speed rail lines, shown as hot topics in Figure 2, are not only related to the order of their opening times but also to the fact that they are located in regions with four representative universities or research institutes in these disciplines. Scholars tend to study the high-speed rail lines in their own regions.

⑥ This paper, combining numerous cases and data, provides a detailed summary of the characteristics, causes, and strategies of China's high-speed rail new city "ghost city" phenomenon. See: ZHAO S, MA D. Ghost city phenomenon along China's high-speed railway grid[J]. Int J Sustainable Society, 2017, 9(3): 210-225.

⑦ Expanding the three development zone theories into the "high-speed rail new city zone theory," even related misconceptions appeared in real exam questions, see: High-speed rail new city, the new favorite of the college entrance exam [EB/OL]. (2023-04-24) [2024-04-23]. http://www.360doc.com/content/23/0424/10/54793027_1077913082.shtml

⑧ The "Infrastructure Connectivity" plan in the 2016 B20 Policy Recommendation Report is China's effort to promote global infrastructure connectivity. Moreover, in global rankings, institutions such as the World Bank, the World Economic Forum, and the United Nations have included "infrastructure connectivity levels" as one of the assessment criteria. See: KANAI J M, SCHINDLER S. Infrastructure-led development and the peri-urban question: furthering crossover comparisons[J]. Urban Studies, 2022, 59(8): 1597-1617.

⑨ According to the second edition of Human Geography edited by Chen Huilin, the main branches of human geography include: economic geography, population geography, settlement geography, cultural geography, tourism geography, and political geography. The core and peripheral divisions of each branch are discussed in: FAN JIE. 70 Years of Innovation and Academic Characteristics of Human Geography in China[J]. Science China: Earth Sciences, 2019, 49(11): 1697-1719.

⑩ "Relative spatiotemporal distortion," see: Wang Jixian. World-class hubs [M]. Hong Kong: Commercial Press, 2019: 98-101.

⑪ The first category, value-neutral descriptive characteristics, refers to descriptions of objective facts that do not vary based on the researcher's knowledge background or personal preferences. The second category, value-based evaluative descriptions, although also describing objective facts, requires the researcher to make a value choice before conducting the research, such as evaluating the transfer efficiency of high-speed rail stations, which implicitly assumes that higher transfer efficiency is better.

⑫ "Station-city integration design guidelines," see: Ministry of Land, Infrastructure, Transport and Tourism of Japan. Xu Chang et al. (trans.). Station-city integration design guidelines [EB/OL]. (2022-01-14) [2024-04-23]. http://www.360doc.com/content/22/0114/09/38506261_1013190670.shtml

⑬ The author’s research found that the ownership of high-speed rail station buildings and track land belongs to the railway department. Station building designs are generally led by design institutes under the railway department, typically focusing on integrating the station building and the small adjacent surrounding areas. Land beyond the station building and surrounding areas belongs to local governments.

⑭ "Many, long, large, few" refers to many passengers, long waiting times, large passenger flow, and limited space. See: Cheng Taining. The importance of concepts: "Station-city integrated development" exploration [EB/OL]. (2023-04-25) [2024-04-23]. https://www.sohu.com/a/670176114_121123726

⑮ Bertolini emphasizes its ideal-type (ideal type) and analytical tool (analytical tool) attributes, rather than theoretical (theory) attributes, meaning that the "node-place" equilibrium referred to by the model does not necessarily occur at any station in reality. See: Reference [5].

⑯ For example, planning practices often arrange the second ring layer surrounding a station as a residential cluster. Geographic evidence shows that actual construction in the second ring layer exhibits a "fault phenomenon"—i.e., the first and third ring layers have been constructed, but the second ring layer is vacant. The economic explanation is that "holding vacant land has physical option value," and the timing of construction depends on developers' initial investment size and government subsidy or stimulation policies. In this example, time is the important link connecting knowledge across disciplines. See: LU CL, LIAO WC, PENG CW. Developers' perspectives on timing to build: evidence from microdata of land acquisition and development[J]. Journal of Housing Economics, 2020, 49:101709.

⑰ Regarding the arrangement of responsibilities, the overall planning of high-speed rail new areas and stations, other related policy formulation, and demolition relocation are often directly managed by the High-Speed Rail New Area Management Committee or the local district government where the new area is located. In many cities, the high-speed rail new areas are located within the scope of national-level new areas such as high-tech zones and economic development zones, and may also be managed by the national-level new area management committees. The district-level governments have strong agency and intervention capabilities in the top-level design and institutional arrangements for high-speed rail and cross-scale regional coordinated development.

⑱ Institutional environment refers to a series of political, social, and legal basic rules used to establish the foundation for production, exchange, and distribution. It drives organizations (such as local governments) to make decisions based on the logic of gaining legitimacy and social reputation, such as compliance with regulations, environmental friendliness, etc.; the non-institutional environment (technical environment) requires organizations to make decisions based on the logic of efficiency optimization, such as shortening construction periods and improving transportation accessibility. Institutional mechanisms and non-institutional mechanisms may cooperate but are usually divergent, so it is necessary to conduct comparative analysis in the governance context.

⑲ According to John Meyer’s new institutionalism theory, non-institutional factors require the pursuit of efficiency optimization, leading to differentiation among individuals; while institutional factors require satisfying social reputation, leading to convergence among individuals. JOHN W MEYER, BRIAN ROWAN. Institutionalized organizations: formal structure as myth and ceremony[J]. American Journal of Sociology, 1977, 83(2): 340-363.

⑳ For example, in the past five years, high-speed rail (new city) industrial guidance funds have become a new policy tool for governments to promote industrial development, which was not present in the development of new cities in the past. The government industrial guidance funds mostly operate in the "fund-of-funds" model, co-investing with social capital in market-oriented private funds. The government can later exit through equity, unlike subsidies, which are "one-way and non-recoverable."

㉑ The macro perspectives such as international and domestic balance, tax-sharing system, promotion incentives, housing and land marketization, land finance and land banking, institutional preferential policies, etc., are often used to explain the institutional logic behind past new city and new area developments. These institutional incentives are closely linked to the historical tasks of the country at specific periods.

㉒ In all complex systems, the whole is greater than the sum of its parts. A complex system refers to a type of interaction model: open, continuously developing, unpredictable, yet adaptive and self-sustaining. Urban environments are typical complex systems. See: THEISE N. Notes on complexity: a scientific theory of connection, consciousness, and being [M]. New York: Spiegel and Grau, 2023: 1628.

㉓ Some scholars have used urban science methods to observe 1,627 high-speed rail stations in 533 cities in China and Europe, exploring the relationship between location and urban form, which is pioneering. See: LOO B P Y, HUANG Z. Location matters: high-speed railway (HSR) stations in city evolution [J]. Cities, 2023, 139: 104380.

㉔ State refers to observable and identifiable conditions, situations, characteristics, etc. The structure, state, characteristics, behavior, and functions in a system evolve over time, and this process is called system evolution. In the long run, any system belongs to an evolutionary system. The coordination between high-speed rail stations and surrounding area development is also a slow evolutionary process. The evolutionary process involves dynamic changes in system structure, characteristics, and functions, thereby affecting the different states presented by the system.

㉕ Different types of intelligent planning technologies, see: Gan Wei. Research on the types and characteristics of intelligent planning technologies in urban areas at home and abroad [J]. International Urban Planning, 2018, 33(3): 105-111.

㉖ Based on the author's participation in the project "Digital Empowerment of Shanghai East Station Top-Level Planning," completed in 2023 by Tongji University, China Railway Science Research Institute Group Co., Ltd., and China Railway Fourth Survey and Design Institute Group Co., Ltd.

[1] GIVONI M, DOBRUSZKES F, Zhang Siyang. Substitution of Travel Modes and Induced Traffic Demand after the Opening of High-Speed Rail: An Empirical Summary [J]. Urban Transport, 2015, 13(2): 78-94.

[2] Ye Yuling, Chen Junjing, Liu Xiaoya. Study on Transfer Connections between High-Speed Rail Stations and Urban Public Transport [J]. Urban Rail Transit Research, 2017, 20(11): 45-49.
[3] Zhang Tao. Optimization of High-Speed Rail Train Operations Based on Passenger Satisfaction [J]. Railway Transport and Economy, 2022, 44(3): 7-14.
[4] Wang Lingyan. Optimization of High-Speed Rail Passenger Service Experience [J]. Railway Transport and Economy, 2020, 42(10): 43-48.
[5] BERTOLINI L. Spatial Development Patterns and Public Transport: The Application of an Analytical Model in the Netherlands [J]. Planning Practice and Research, 1999, 14(2): 199-210.
[6] Xiao Chiwei, Liu Ying, Li Peng, et al. Study on High-Speed Rail New Towns Based on Urban Spatial Expansion and Population Growth Coordination [J]. Journal of Natural Resources, 2016, 31(9): 1440-1451.
[7] Wang Yao, Nian Meng. Does High-Speed Rail Promote Regional Economic Development? [J]. Shanghai Economic Research, 2014(2): 82-91.
[8] Lu Wanbo, Jia Jing. High-Speed Rail, Urban Development, and Regional Economic Inequality: Empirical Data from China [J]. East China Economic Management, 2018, 32(2): 5-14.
[9] Shi Minjun, Zhang Xue. Urban Heterogeneity and the Role of High-Speed Rail in Urban Innovation: Based on Data from 264 Prefecture-Level Cities [J]. Economic Review, 2020(2): 15-22.
[10] Deng Rongrong, Zhang Aoxiang, Chen Ming. High-Speed Rail Network, Urban Carbon Emission Intensity, and Spatial Spillover Effects: Evidence from the Yangtze River Delta Region [J]. Technology and Economics, 2022, 41(1): 43-52.
[11] Wang Lan. A study framework on the impact of high-speed rail on urban space [J]. Planner, 2011, 27(7): 13-19.
[12] Duan Jin. National large-scale infrastructure construction and urban space development response: A case study of high-speed rail and intercity integrated transportation hubs [J]. Urban Planning Journal, 2009(1): 33-37.
[13] Xu Wenbo, Wang Xingping. Study on the spatial development characteristics of high-speed rail station areas: Empirical analysis based on the Beijing-Shanghai high-speed rail corridor [J]. Urban Planning Journal, 2016(1): 72-79.
[14] Jiang Haibing, Zhang Wenzhong, Qi Yi, et al. National land accessibility analysis under the impact of high-speed rail and travel costs [J]. Geographical Research, 2015, 34(6): 1015-1028.
[15] Zhang Benyong, Zheng Meng, She Shiying. Site selection of Wuhan high-speed rail hub and optimization of overall railway layout [J]. Urban Transport, 2015, 13(6): 37-45.
[16] Ji Chen, Zou Xiaolei, Xu Ruihua. Study on passenger travel behavior and passenger flow spatial-temporal distribution characteristics of the Beijing-Shanghai high-speed rail [J]. Railway Transportation and Economics, 2020, 42(S1): 74-80.
[17] Li Lihui, Zhu Jiansheng, Shi Feng, et al. Research on high-speed rail transfer demand statistical algorithms [J]. Journal of Railway Science and Engineering, 2018, 15(5): 1111-1117.
[18] Zhang Xu, Luan Weixin, Zhao Bingru. Study on the competition between the Wuhan-Guangzhou high-speed rail and civil aviation based on non-aggregated models [J]. Journal of Transportation Systems Engineering and Information, 2012, 12(6): 17-21.
[19] Zhang Lanxia, Qin Yong, Wang Li. Weighted complex network analysis of high-speed rail [J]. Railway Science and Engineering Journal, 2016, 13(2): 201-209.
[20] Hong Yongmiao, Wang Shouyang. Mathematics, models, and economic thinking [J]. Management World, 2020, 36(10): 15-27.

[21] Niu Fei, Wu Xiaofeng. Research on the impact of high-speed rail on regional economic growth: An empirical analysis based on the PSM-DID method [J]. Price Theory and Practice, 2021(9): 185-188.
[22] Wang Qunrong, Wang Xibei. The impact of high-speed rail networks on regional industrial structure: An analysis based on social network and spatial econometric models [J]. Modern Economic Exploration, 2021(5): 82-91.
[23] Wang Keliang, Pang Suqin, Zhang Fuqin. Can high-speed rail improve urban green total factor productivity? [J]. Industrial Economics Research, 2021(3): 112-127.
[24] Fang Dachun, Sun Mingyue. Spatial structure reconstruction of the Yangtze River Delta urban agglomeration in the high-speed rail era: Based on social network analysis [J]. Economic Geography, 2015, 35(10): 50-56.
[25] Wu Fenglian, Hao Lisha, Wang Xiaoge, et al. The potential development pattern of the service industry in eastern China cities based on high-speed rail links: A social network analysis perspective [J]. Economic Geography, 2020, 40(4): 145-154.
[26] Dong Yao, Meng Xiaocheng. Research on the scope and structure of the high-speed rail station hinterland along the Beijing-Guangzhou line [J]. Progress in Geography, 2014, 33(12): 1684-1691.
[27] Chu Nancheng, Jiang Bo, Zhao Yinghui, et al. The impact and optimization of intercity high-speed rail on the spatial pattern of future Harbin's urban system [J]. Economic Geography, 2016, 36(4): 78-83.
[28] Wang Hui, Zhang Mei Qing. The impact of high-speed rail on accessibility and economic ties in the Beijing-Tianjin-Hebei region [J]. Geographical Sciences, 2021, 41(9): 1615-1624.
[29] Wang Degeng, Qian Jia, Niu Yu. The spatial pattern and evolution of urban tourism field strength in China under high-speed rail networks [J]. Acta Geographica Sinica, 2016, 71(10): 1784-1800.
[24] Fang Dachun, Sun Mingyue. Reconstruction of the Spatial Structure of the Yangtze River Delta Urban Agglomeration in the Era of High-Speed Rail: Based on Social Network Analysis [J]. Economic Geography, 2015, 35(10): 50-56.
[25] Wu Fenglian, Hao Lisha, Wang Xiaoge, et al. Potential Pattern of Service Industry Development in Eastern China’s Cities Based on High-Speed Rail Connections: A Social Network Analysis Perspective [J]. Economic Geography, 2020, 40(4): 145-154.
[26] Dong Yao, Meng Xiaocheng. Study on the Scope and Structure of the Hinterland of High-Speed Rail Stations along the Beijing-Guangzhou Railway [J]. Progress in Geography, 2014, 33(12): 1684-1691.
[27] Chu Nancheng, Jiang Bo, Zhao Yinghui, et al. The Impact and Optimization of Intercity High-Speed Rail on the Spatial Pattern of the Urban System in Heilongjiang Province [J]. Economic Geography, 2016, 36(4): 78-83.
[28] Wang Hui, Zhang Meiqing. The Impact of High-Speed Rail on Accessibility and Economic Connections in the Beijing-Tianjin-Hebei Region [J]. Geographical Science, 2021, 41(9): 1615-1624.
[29] Wang Degeng, Qian Jia, Niu Yu. The Spatial Pattern and Evolution of Urban Tourism in China under the High-Speed Rail Network [J]. Acta Geographica Sinica, 2016, 71(10): 1784-1800.
[30] Zou Zhuojun. Research on Land Use Development in High-Speed Rail Station Areas and Its Achievement in Urban Center Functions: Empirical Analysis Based on Beijing-Shanghai and

Beijing-Guangzhou High-Speed Rail [J]. Urban Planning Journal, 2018(4): 49-55.
[31] Duan Yang, He Zhenzi, Yang Jiawen. Challenges of Integrating Transportation and Land Use in the High-Speed Rail Era: Analysis of High-Speed Rail Station Location Issues in China [J]. Journal of Western Human Settlements Environment, 2021, 36(4): 29-35.
[32] Cao Yang, Yu Li, Li Songtao. Spatial Evolution of High-Speed Rail Station Areas and Planning Responses [J]. Urban Planning, 2020, 44(11): 88-96.
[33] Ding Jinxue, Jin Fengjun, Wang Jiaoe, et al. Competition and Spatial Effects between High-Speed Rail and Civil Aviation: A Case Study of Beijing-Shanghai High-Speed Rail [J]. Economic Geography, 2013, 33(5): 104-110.
[34] Zhao Pengjun, Lü Di, Hu Haoyu, et al. Research on Modern Integrated Transportation Systems Adapted to Population Development [J]. Acta Geographica Sinica, 2020, 75(12): 2699-2715.
[35] Zhu Yong, Yang Rui, Li Desheng, et al. Comprehensive Evaluation of the Regional Environmental Impact of Beijing-Shanghai High-Speed Rail Construction Project [J]. Journal of Railway Science and Engineering, 2015, 37(11): 117-121.
[36] Li Xin, Guo Jinli, Zhang Yu. Comparative Analysis of High-Speed Rail Network Characteristics of Three Major Urban Clusters Based on Complex Network Perspective [J]. Resource Development and Market, 2016, 32(6): 703-707.
[37] Bian Yuanchao, Wu Liwei, Bai Junhong. High-Speed Rail Opening, Element Flow, and Regional Economic Disparities [J]. Journal of Finance and Trade Economics, 2018, 39(6): 147-161.
[38] Yang Siying, Li Zheng. High-Speed Rail Opening and Urban Innovation [J]. Financial Science, 2019(1): 87-99.
[39] Sun Yang, Yao Shimu, Zhang Luocheng. "Spatial Flow" Hierarchical Functional Structure of the Yangtze River Delta Urban Agglomeration: Based on High-Speed Rail Passenger Data Analysis [J]. Progress in Geography, 2016, 35(11): 1381-1387.
[40] Jiao Jingjuan, Wang Jiaoe, Jin Fengjun, et al. Research on the Impact of High-Speed Rail on Urban Network Structure: Based on Railway Passenger Train Schedule Analysis [J]. Acta Geographica Sinica, 2016, 71(2): 265-280.
[41] Yu Bao, Feng Chun, Zhu Qian, et al. Vulnerability Analysis of China’s High-Speed Rail Network [J]. Journal of Safety Science and Technology, 2017, 27(9): 110-115.
[42] Yang Jinhua. The Impact of High-Speed Rail on the Accessibility of Hunan Urban Cluster [J]. Human Geography, 2014, 29(2): 108-112.
[43] Li Xianwen, Bai Jianjun, Tang Shanghong. The Impact of High-Speed Rail Network Construction on Accessibility Spatial Pattern in Shaanxi Province [J]. Economic Geography, 2019, 39(2): 82-92.
[44] Li Tao, Ma Wei, Gao Xingchuan, et al. Comprehensive evaluation of the accessibility effect of the Xiamen-Shenzhen high-speed railway based on the Super-DEA model and spatial differentiation [J]. Economic geography, 2017, 37(8): 67-76.
[45] Wang Shaojian, Mo Huimin, Lü Huini, et al. The impact of locational factors on the industrial structure characteristics of high-speed railway station areas: Empirical analysis based on POI data [J]. Acta Geographica Sinica, 2021, 76(8): 2016-2031.
[46] Zhao Qian, Chen Guowei. Research on the impact of high-speed railway station location on the development of surrounding areas: Empirical analysis based on the Beijing-Shanghai and Wuhan-Guangzhou lines [J]. Urban planning, 2015, 39(7): 50-55.

[47] Lin Xiongbin, Lu Yuan. Study on cross-regional commuting characteristics and influencing factors in metropolitan areas: A case study of the Beijing-Tianjin intercity high-speed railway [J]. Urban planning, 2021, 45(12): 104-113.
[48] Chen Xiaojun, Lin Xiaoyan. Evaluation of the development value of high-speed railway stations in the Beijing-Tianjin-Hebei region: Based on the node-place model [J]. Technological Economics, 2018, 37(12): 82-93.
[49] Zhang Mingzhi, Yu Donghua, Sun Yuanyuan. Study on the reshaping effect of high-speed railway opening on urban population distribution pattern [J]. Chinese Population Science, 2018(5): 94-108.
[50] Wang Yufei, Ni Pengfei, Zhao Jiahan, et al. Transportation distance, commuting frequency, and enterprise innovation: A perspective from spatial association with central cities after the opening of high-speed rail [J]. Finance and Trade Economics, 2021, 42(12): 150-165.
[51] Wang Lan, Wang Can, Chen Chen, et al. Development and planning of areas around high-speed railway stations: Empirical analysis based on the Beijing-Shanghai high-speed railway [J]. Urban planning journal, 2014(4): 31-37.
[52] Chi Ming, Huo Yamin, Liu Guangwu, et al. Analysis of passenger transfer choices at high-speed railway stations based on the Logit model [J]. Railway transportation and economics, 2021, 43(5): 31-37.
[53] Huang Jianzhong, Cao Zhejing, Wan Ge. Development of TOD theory and research prospects in the new technological environment [J]. Urban planning journal, 2023(2): 40-46.
[54] Yang Xian, Yu Yang, Zhou Rui. Research progress and implications of the international node-place model: Application, extension, and systematic development [J]. International Urban Planning, 2022(7): 1-17.
[55] PETER M J P. The economic impact of the high-speed train on urban regions [C/OL]. European Regional Science Association, ERSA conference papers, 2003-08, ERSA03: 397. https://ideas.repec.org/p/wiw/wiwrsa/ersa03p397.html
[56] PEEK G J, HAGEN M V. Creating synergy in and around stations: three strategies for adding value [J]. Transportation Research Record, 2002, 1793(1): 1-6.
[57] CALTHORPE R. The next American metropolis: ecology, community and the American dream [M]. New York: Princeton Architectural Press, 1993.
[58] WENNER F, THIERSTEIN A. High-speed rail as an urban generator? An analysis of land use change around European stations [J]. European Planning Studies, 2022, 30(2): 227-250.