

Article

Differential Influences of High-Speed Railway Stations on the Surrounding Construction Land Expansion and Institutional Analysis: The Case of Taiwan and Hainan

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Abstract: The purpose of this paper is to compare the differential impact of Taiwan High-speed Railway (T-HSR) and Hainan East Ring High-speed Railway (HER-HSR) stations on the surrounding construction land expansion, reveal the underlying institutional reasons, and then provide policy recommendations for coordinating the rational development of land resources and ecological environment protection around high-speed railway (HSR) stations. The research methods include the Institutional Analysis and Development (IAD) framework, buffer analysis, and GIS spatial analysis. The results show that (1) The spillover impact of HSR stations on the surrounding construction land expansion is the result of the game between different actors around the development and protection of land around HSR stations under the action scenarios of various external factors. The surrounding construction land of 12 stations of T-HSR increased by 269.98 km² within the study scope and period, while the surrounding area of 10 stations in HER-HSR increased by 187.61 km². (2) There are nine stations in T-HSR that affect the expansion of surrounding construction land within 1.0–3.0 km and lead to the expansion of construction land of 22.44 km², while there are six stations in HER-HSR that affect the expansion of construction land within 1.5–3.5 km and lead to the expansion of construction land of 24.20 km². Other stations cannot effectively identify their areas of influence due to other reasons. (3) Each station of HER-HSR has a stronger influence intensity and degree on the expansion of surrounding construction land than that of T-HSR, which is closely related to institutional factors such as land planning, land property rights, public participation, and other basic systems will lead to differences in the expansion of surrounding construction land for HSR stations. This research aims to provide institutional adjustment suggestions to achieve coordinated economic development and ecological protection around HSR stations in two Chinese islands with different institutional environments.

Keywords: high-speed railway stations; construction land expansion; IAD framework; institutional factors; Taiwan high-speed railway; Hainan East ring high-speed railway



Citation: Zhou, B.; Hu, X.; Xiong, C. Differential Influences of High-Speed Railway Stations on the Surrounding Construction Land Expansion and Institutional Analysis: The Case of Taiwan and Hainan. *Land* **2024**, *13*, 10. <https://doi.org/10.3390/land13010010>

Academic Editor: Thomas Panagopoulos

Received: 29 September 2023

Revised: 16 November 2023

Accepted: 16 November 2023

Published: 19 December 2023



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1. Introduction

After over a decade of development, China has built the world's largest high-speed railway (HSR) network. Behind this accomplishment lies not only the pursuit of modern and green transportation but also the important role that HSR plays in promoting regional economic development. Among them, HSR stations are important hubs for transportation and economic nodes, and their construction and operation not only directly drive fixed asset investment and job growth [1] but also produce a “time-space compression” effect [2], accelerating the gathering and cross-regional flow of production factors [3] and driving economic development in the surrounding areas of the station [4]. However, the negative impact of

HSR stations on the surrounding resources and environment cannot be ignored, especially the impact on social and economic development, which can lead to drastic changes in land use and construction land expansion [5], further causing ecological and environmental problems such as habitat destruction and soil erosion [6], thereby exacerbating the tension between people and the environment. In 2018, the National Development and Reform Commission, together with the Ministry of Natural Resources, the Ministry of Housing and Urban–Rural Development, and China State Railway Group, issued the “Guiding Opinions on Promoting the Rational Development and Construction of High-Speed Railway Station Surrounding Areas” [7], aiming to promote the rational development and construction of the surrounding areas of HSR stations via planning guidance and government regulation, rational determination of site selection and scale, and strict conservation and intensive land use. Against the backdrop of China’s continued acceleration of the “Eight Vertical and Eight Horizontal” HSR network and ecological civilization construction, how to achieve the coordination between HSR station land development and ecological protection in the surrounding areas has become an important practical issue.

Currently, academia has conducted related research on the results and restricting factors of construction land expansion around high-speed railway stations. Regarding the results, the mainstream approach is to use remote sensing (RS) technology to monitor the distribution of construction land around HSR stations over a long time period and reveal the impact of HSR stations on construction land expansion via the comparison of differences before and after construction [8]. Some studies also use counterfactual analysis framework and quantitative methods such as difference-in-difference, spatial panel regression, and Future Land Use Simulation (FLUS) models to assess the performance and regional differences in HSR stations in promoting urban or regional construction land expansion [9,10]. As for restricting factors, most of them are identified via econometric regression or case comparison [11], and it is found that the location conditions of high-speed railway stations [12], whether they are connected to other public transportation in the city [13], population density, social and economic development level of the surrounding area [14], topography, climate, and other natural environment factors [15] are the main reasons affecting the impact of HSR stations on construction land expansion. However, these studies have overlooked the deep-level role of institutional factors, and problems with institutional management have been exposed in practice. For example, local governments have excessively invested in infrastructure construction in “political competitions” [16] and have neglected the actual development needs by blindly launching projects or developing new areas around HSR stations [5], using inadequate planning authority [17], ambiguous land ownership rights [18], and replacing “public participation” with “leadership decision-making” in institutional arrangements [19]. Thus, land inefficiency and disorderly urban sprawl have resulted. In theory, the land expansion around HSR stations is essentially the result of conflicts, trade-offs, and negotiations between different entities for land resource development and utilization [20], and institutional factors such as land planning, land ownership, and public participation can achieve the purpose of benefit distribution by coordinating and restraining entity behavior [21]. Obviously, institutional factors play an important role in the land expansion process around HSR stations, and whether there are differences in the external impact of infrastructure such as HSR stations on construction land expansion in different countries or regions with different institutional environments is worth attention. The major distinction of this study from previous research lies in its contribution to filling the gap in research on the correlation between land use changes around high-speed railway stations and the institutional environment. In real life, under different institutional arrangements, people’s behavior of land development will be different, which is inevitable. However, as mentioned above, few scholars measured the specific outcomes stemming from the expansion of construction land around HSR stations operating within distinct institutional contexts. We deem it crucial to uncover these effects. Consequently, we opted to employ two HSR lines with different institutional environments for comparative study in order to fill this research gap. We are confident that

our research can offer a fresh perspective on institutional adaptation for achieving both land development and preservation in the vicinity of high-speed railway stations.

In conclusion, taking the Taiwan High-speed Railway (T-HSR) and the Hainan East Ring High-speed Railway (HER-HSR) in China as comparative cases are justified for the following reasons: (1) Due to historical reasons, the two islands of Taiwan and Hainan, which both are Chinese, have significant differences in fundamental institutions such as land planning, land property rights, and public participation (see Table 1; (2) Two high-speed railways pass through the coastal plains of their respective islands, and the areas connected by T-HSR in the western corridor of Taiwan and the eastern coastal region linked by HER-HSR are the most active areas for regional economic activity and have the highest population size in the two islands. Therefore, the similarity of the natural and socio-economic environments and the difference in institutional environments of the two high-speed railways provide an ideal research material for focusing on the role of institutional factors in the impact of HSR stations on changes in surrounding construction land use.

Table 1. Comparing institutional differences and their impact on HSR stations' vicinity land between Taiwan and Hainan.

Fundamental Institutions		Taiwan		Hainan
Type of Institution	Specific Name and Brief Explanation	The Game of Each Actor and Its Impact	Specific Name and Brief Explanation	The Game of Each Actor and Its Impact
Land planning institution	◆ Spatial Planning Act ◆ Land strict division and the clear function Strict land use control has the force of law after examination and approval	Local governments and land developers face significant planning obstacles in developing the areas around HSR stations, leading to a lower probability of agricultural land conversion to construction land and a concentration of socio-economic activities within the impact range of the high-speed rail station.	◆ Land Management Law ◆ Strictly protect agricultural land and carry out national spatial development and protection Adjustments and changes will be made in various names during the implementation process	Local governments can make moderate adjustments or changes to the plan in the name of public interest or economic development, which can increase the probability of agricultural land in the HSR station impact area being converted to construction land and accelerate the expansion of social and economic activities.
	◆ Forward-looking Infrastructure Development Program ◆ Projects following planning	The strict adherence to land planning by the local government and land developers in participating in infrastructure projects, such as the T-HSR, results in a lesser impact on the construction land changes in the HSR station's surrounding area.	◆ Medium and Long-term Railway Network Planning ◆ Fair and efficiency are the key points, and both economic and social benefits planning following projects	Local governments are more likely to induce the transformation of agricultural land into construction land in the vicinity of HSR stations by adjusting land use planning according to infrastructure construction projects, such as the HER-HSR.
Land property rights institution	◆ Equal Land Rights ◆ Ownership of agricultural land belongs to farmers privately	Farmers have absolute discourse power, which hinders the expropriation process and the expansion of construction land around HSR stations, as local governments cannot efficiently and massively expropriate land from farmers.	◆ Public Ownership of Land ◆ Ownership of agricultural land belongs to collective economic organizations	The unclear internal power structure and ambiguous property rights of rural collectives have resulted in a powerlessness predicament for individual farmers, making it difficult to resist land expropriation by local governments, thereby accelerating the expansion of construction land around HSR stations.

Table 1. Cont.

Fundamental Institutions		Taiwan	Hainan	
Type of Institution	Specific Name and Brief Explanation	The Game of Each Actor and Its Impact	Specific Name and Brief Explanation	The Game of Each Actor and Its Impact
Land property rights institution	◆ Private Resource ✧ Low competition between local governments and farmers High exclusivity of farmers	Farmers who have land ownership have the power to decide whether their land should be expropriated, thus eliminating the risk of their own interests being harmed. On the other hand, local governments face the dilemma of “anti-public land tragedy”.	◆ Common Pool Resource ✧ High competition between local governments and farmers Low exclusivity of farmers or collective organizations	Local governments, in pursuit of economic benefits, expropriate farmland for development and construction, leaving farmers suffering from property rights deprivation.
Public participation institution	◆ Act for Promotion of Private Participation in Infrastructure Projects ✧ Encourage and mobilize the public to participate in the construction process of infrastructure and allow for legislative protection	Taiwan’s legislation guarantees the right of public participation, forming a resistance to government-planned and implemented land expropriation, further restraining the expansion of construction land around HSR stations.	◆ / ✧ No typical law or policy temporarily	The government often solicits public opinions in a “top-down” manner during decision-making processes, but the public’s interests cannot be effectively implemented, which puts them in a disadvantaged position during development and leads to the rapid expansion of construction land around HSR stations.

Source: collected by the author.

This research aimed to provide institutional adjustment suggestions to achieve co-ordinated development and protection of land resources around HSR stations in two Chinese islands with different institutional environments. To reveal how each station of the two HSRs differentially impacts the expansion of surrounding construction land use, RS monitoring and GIS analysis were used. To analyze the specific role of the HSR station’s own attributes, social and economic conditions, and institutional environment, the IAD analysis framework was used. The findings of this study might provide a new idea of institutional adjustment for sustainable development around HSR stations. The rest of this article is organized as follows. Section 2 sets up the analysis framework and lays the foundation for the subsequent empirical research. Section 3 introduces the data and methods, and Section 4 shows the results, including the differences in the scope and intensity of the impact of various HSR stations on construction land expansion in the two lines. Section 5 discusses the influence of the institutional environment on land use around HSR stations. Section 6 concludes.

2. Analysis Framework Construction and Analysis of the Scope of Influence

2.1. Analysis Framework of the Impact of HSR Stations on the Expansion of Surrounding Construction Land

Using the IAD analytical framework [22], this paragraph clarifies the underlying factors and relationships that drive the expansion of construction land around HSR stations [23,24] (see Figure 1).

In terms of external factors, the characteristics of the HSR station, such as its size and the volume of trains arriving and departing [25], which affect the extent of its impact on the surrounding areas. The social and economic conditions of the city or county where the HSR station is located mainly include per capita GDP and population size [26], which affect the operation and passenger transport scale of the HSR station [27]. The institutional environment is the key rule that provides incentives or punishments for different actors in the development and protection of land resources, usually including land planning institutions, land property rights institutions, and public participation institutions. For

example, the decision to convert land near the HSR station into construction land depends not only on planning compliance but also on land acquisition and ownership changes, often involving public participation issues [28,29].

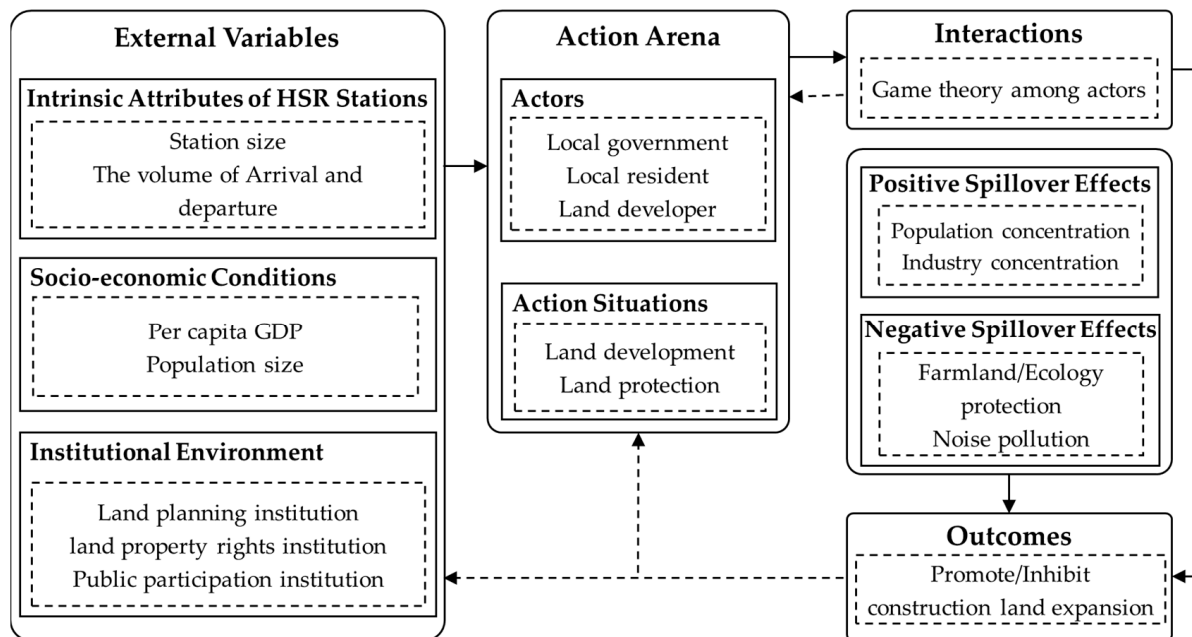


Figure 1. IAD framework for construction land expansion around HSR stations.

In the action arena, the above factors directly influence the behavior of local governments, land developers, and local residents in developing and protecting land resources around HSR stations. Land developers often pursue economic benefits and choose to develop land resources around HSR stations. Local residents will choose to protect land (especially farmland) resources for their own interests. Local governments will balance economic, agricultural, and ecological benefits when deciding on land development and protection.

Different actors make different behavioral decisions in different action situations, ultimately resulting in the spillover effects of HSR stations on the expansion of surrounding construction land, which can have both positive and negative [30]. On the one hand, as a transportation hub, HSR stations converge a large number of people and production factors, tempting local governments and land developers to engage in commercial and service industries, factory construction, and real estate development, resulting in the continuous expansion of construction land. On the other hand, HSR stations are often located in areas with high-quality farmland or ecological protection zones, where landowners or users have certain demands for farmland protection. Policies related to farmland or ecological protection can restrict land development behaviors. Additionally, noise pollution from HSR operations may disrupt normal production and living in the surrounding areas [31], which can inhibit the expansion of construction land to some extent.

However, numerous empirical studies have shown that the impact of high-speed rail stations on the expansion of surrounding construction land is usually dominated by positive spillover effects, leading to the continuous expansion of construction land around HSR stations [32–34].

2.2. Analysis of the Influence Scope of HSR Stations on the Expansion of Surrounding Construction Land

Further combining the location theory, the spillover effect of HSR stations (point O in Figure 2) on the expansion of surrounding construction land will gradually decrease as the distance increases (segment AB in Figure 2). Meanwhile, the expansion of construction

land around HSR stations will also be affected by other exogenous shocks [35,36] (point O' in Figure 2, such as CBD, municipal centers, etc.), and also follow the distance attenuation law (segments CB and CD in Figure 2). Therefore, with the increase in distance, the expansion of construction land around HSR stations will follow the basic trend of “first decrease, then increase, and then decrease”, that is, the ideal curve. Among them, the expansion of construction land in segment AB is mainly affected by the HSR station, while the expansion of construction land in segments BC and CD is mainly affected by other exogenous shocks. This paper regards segment AB as the maximum influence range of HSR stations on the expansion of surrounding construction land and will also judge the maximum influence range of different HSR stations on the expansion of surrounding construction land according to the ideal curve in later sections.

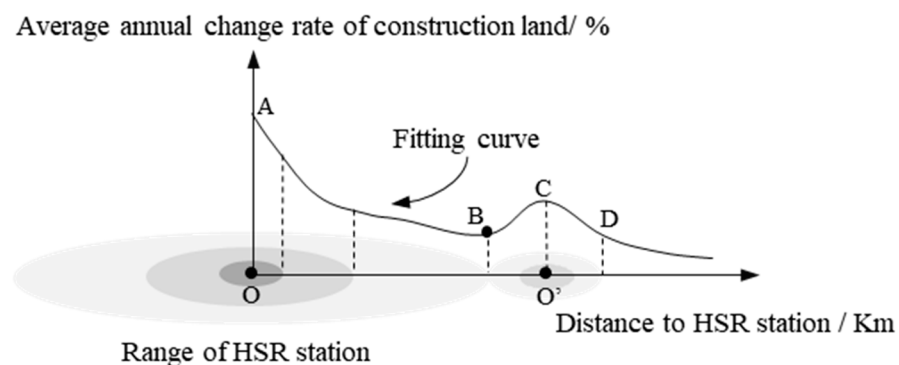


Figure 2. The ideal curve for the construction land expansion around HSR stations.

3. Data and Methods

3.1. Cases of HSR

The Taiwan High Speed Railway (T-HSR) runs from Taipei to Kaohsiung, has a total length of 349.5 km, was designed with a speed of 300 km/h, and has 12 stations. It was built in March 2000 and officially opened for operation in March 2007. The Hainan Eastern Ring High-Speed Railway (HER-HSR) runs from Haikou to Sanya, which has a total length of 308.1 km, was designed with a speed of 250 km/h and has 10 stations. It was built in September 2007 and officially opened for operation in December 2010 (Figure 3).

The article compares the 12 stations of the T-HSR and the 10 stations of the HER-HSR. The study period for the T-HSR stations was set from 1999 to 2018, while that for the HER-HSR stations was set from 2006 to 2018, with 1999 and 2006 reflecting the situations of the stations before the start of construction for the two high-speed railways, respectively. Additionally, referring to the existing literature on the spillover effect caused by HSR stations [37], the study adopts the principle of maximizing impact and takes a 7 km buffer zone outside the boundaries of each HSR station as the study area and the potential maximum range of impact.

3.2. Basic Data and Preprocessing

The basic data include two parts: spatial data and socio-economic data. The former are used to monitor the dynamic changes in construction land around HSR stations, including (1) Global Artificial Impervious Area (GAIA), which was derived from the database of scientific research Resources of the Department of Earth System Sciences, Tsinghua University; (2) Landsat historical remote sensing images from the United States Geological Survey (USGS); and (3) the administrative boundary data of Taiwan and Hainan and the vector data of HSR were derived from the Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences. The latter are used to describe the socio-economic attributes of the region where HSR stations are located, including GDP, population size, station area, passenger flow, and other factors, respectively, from Taiwan Provincial Executive Yuan and Hainan Provincial Bureau of Statistics.

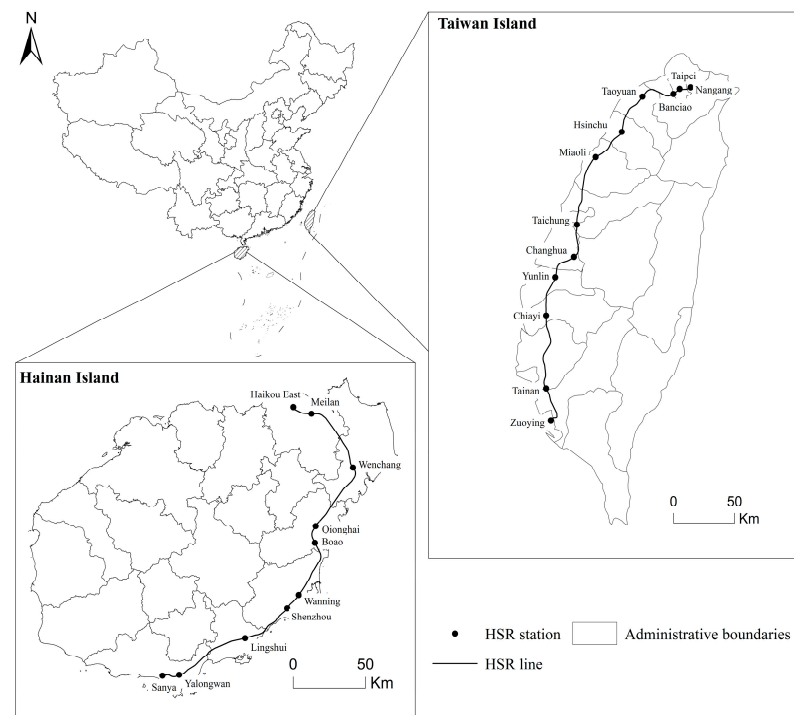


Figure 3. Location map of HER-HSR and T-HSR and its stations.

The above spatial data were projected and transformed to ensure the consistency of spatial position information. Meanwhile, with the help of high-resolution remote sensing images (such as Sentinel) and manual visual interpretation, the boundary range (platform, station building, front square, and supporting infrastructure) of each station along T-HSR and HER-HSR is determined, which is taken as the scope of HSR station itself.

3.3. GAIA Data Correction Based on Spectral Index

The spatial resolution of GAIA data is 30 m and the temporal resolution is 1 year, with an overall accuracy of more than 90% over multiple years [38]. However, GAIA data had minor deviations in local areas, such as the unrecognition of some construction land in the central part of the T-HSR corridor and along the HER-HSR line. We selected Landsat images with less than 5% cloud cover for Taiwan in 1999 and 2018 and for Hainan in 2006 and 2018. The Normalized Difference Impervious Surface Index (NDISI) was used to correct the local areas in the coverage of GAIA data, which is detailed in the relevant literature [39]. Finally, for the corrected construction land cover data in the Taiwan and Hainan HSR study areas, approximately 600 random samples were selected, and accuracy validation was conducted using contemporaneous high-resolution remote sensing images (such as Sentinel). The overall accuracy was above 90%, indicating strong data reliability.

3.4. Multiple Buffer Analysis

The multiple buffer analysis was adopted to reveal the trend of construction land expansion around the HSR stations with the increasing distance from the stations. Firstly, drawing on existing literature [40], believe that land development within 0.5 km of a certain geographical object will have an important impact on the surrounding area, and other scholars have shown via relevant empirical studies that the development and construction activities around HSR stations have obvious circle structure [41]. Therefore, a buffer zone was established every 0.5 km with each HSR station boundary as the center, generating a total of 14 buffer rings. Secondly, considering the different areas of each buffer ring and the difference in the operating time of the HSR stations in Taiwan and Hainan, the average annual construction land change rate was summarized and statistically analyzed for each

buffer. Then, the change rate data were plotted on a coordinate system to obtain the curve of construction land expansion with the increasing distance from the HSR stations. Finally, combined with the theoretical analysis in the previous sections, the influence range of each HSR station was identified based on the basic trend of the curve.

4. Results and Analysis

4.1. Analysis of Construction Land Expansion around HSR Stations

During the research period, there was a significant expansion of construction land around the stations of both T-HSR and HER-HSR, with some differences observed among the stations (Figure 4). From 1999 to 2018, the 12 stations of T-HSR resulted in a total increase of 269.98 km² in construction land within the study area, with an annual average increase of 1.12 km² per station. Among them, Taoyuan Station and Taichung Station had the largest relative increase in construction land, reaching 43.45 km² and 36.50 km², respectively. Nangang Station had the smallest increase of only 11.60 km². From 2006 to 2018, the 10 stations of HER-HSR resulted in a total increase of 187.61 km² in construction land within the study area, with an annual average increase of 1.44 km² per station. Among them, Haikou East Station and Sanya Station had the largest relative increase in construction land, reaching 44.36 km² and 34.27 km², respectively, while Boao Station had the smallest increase of only 2.44 km². Obviously, the total amount of newly added construction land around T-HSR stations was larger, which is related to its larger number of HSR stations, while HER-HSR had relatively higher annual growth rates and expansion rates per station.

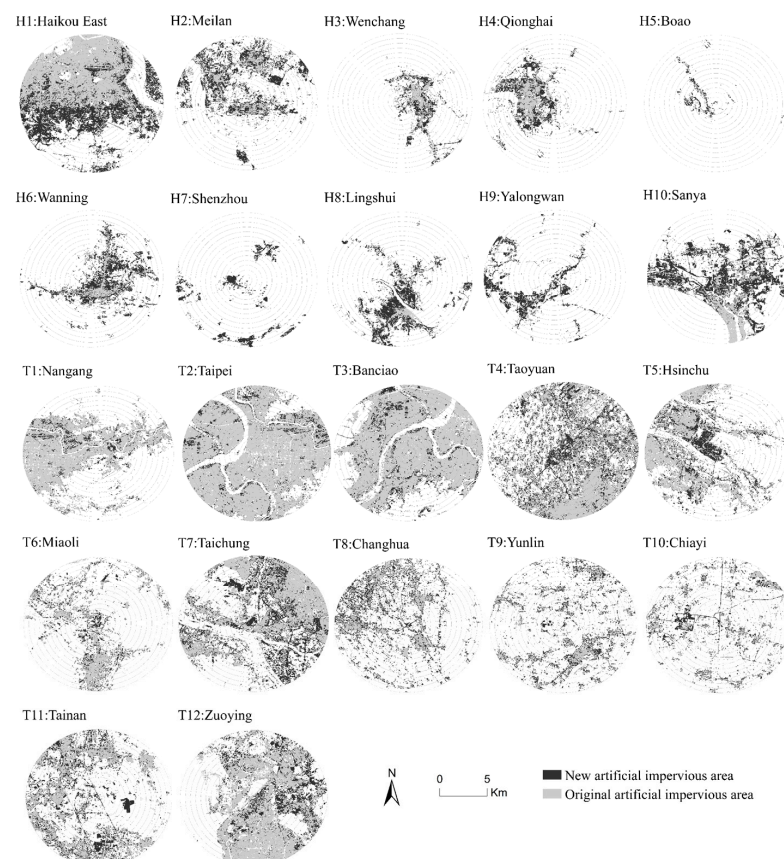


Figure 4. Distribution of construction land expansion around T-HSR and HER-HSR stations.

4.2. Analysis of Influence Scope of HSR Station on Surrounding Construction Land Expansion

The buffer analysis results showed that nine of the HSR stations in Taiwan and six of the HSR stations in Hainan's Eastern Ring Rail had land use changes around them that followed the ideal curve (Figure 5). The turning point of the ideal curve, which

shows a downward trend followed by an upward trend, was used to determine the range of influence. For T-HSR, T6 (Miaoli Station) had the largest range of influence, which was 3.0 km, because it is located in the middle of Miaoli City and Houlong Township, and its construction created a new urban pattern in Miaoli City while developing the surrounding areas, resulting in a relatively larger impact on the expansion of construction land. The ranges of influence for the other HSR stations were 1.0 km, 1.5 km, and 2.5 km for five stations (T7, T8, T9, T10, and T11), two stations (T5 and T12), and one station (T4), respectively. For HER-HSR, H8 (Lingshui Station) had the largest range of influence, which was 3.5 km, while the ranges of influence for the other HSR stations were 1.5 km and 2.0 km for three stations (H4, H6, and H9) and two stations (H3 and H10), respectively.

In addition, there are still seven HSR stations in both Taiwan and Hainan whose land use changes around them do not follow the ideal curve. The main reasons are: (1) The HSR station is located in the original city center, and the changes in the surrounding land use are more influenced by the city's own expansion. The representative stations are H1, T1, T2, and T3. Among them, although T3 has a clear “first decreases and then increases” curve trend and the turning point location can be identified, due to the significant influence of other geographic factors, it is considered that the HSR station does not follow the ideal curve; (2) The HSR station is adjacent to other large infrastructure, and the trend of land use change is more affected by the latter, such as H2, which is located under the Haikou Meilan International Airport, and its land use change pattern is more affected by the airport; (3) The city where the HSR station is located is too small in scale, the public transportation connections are not convenient, and the development around the station is limited, such as H7 and H5.

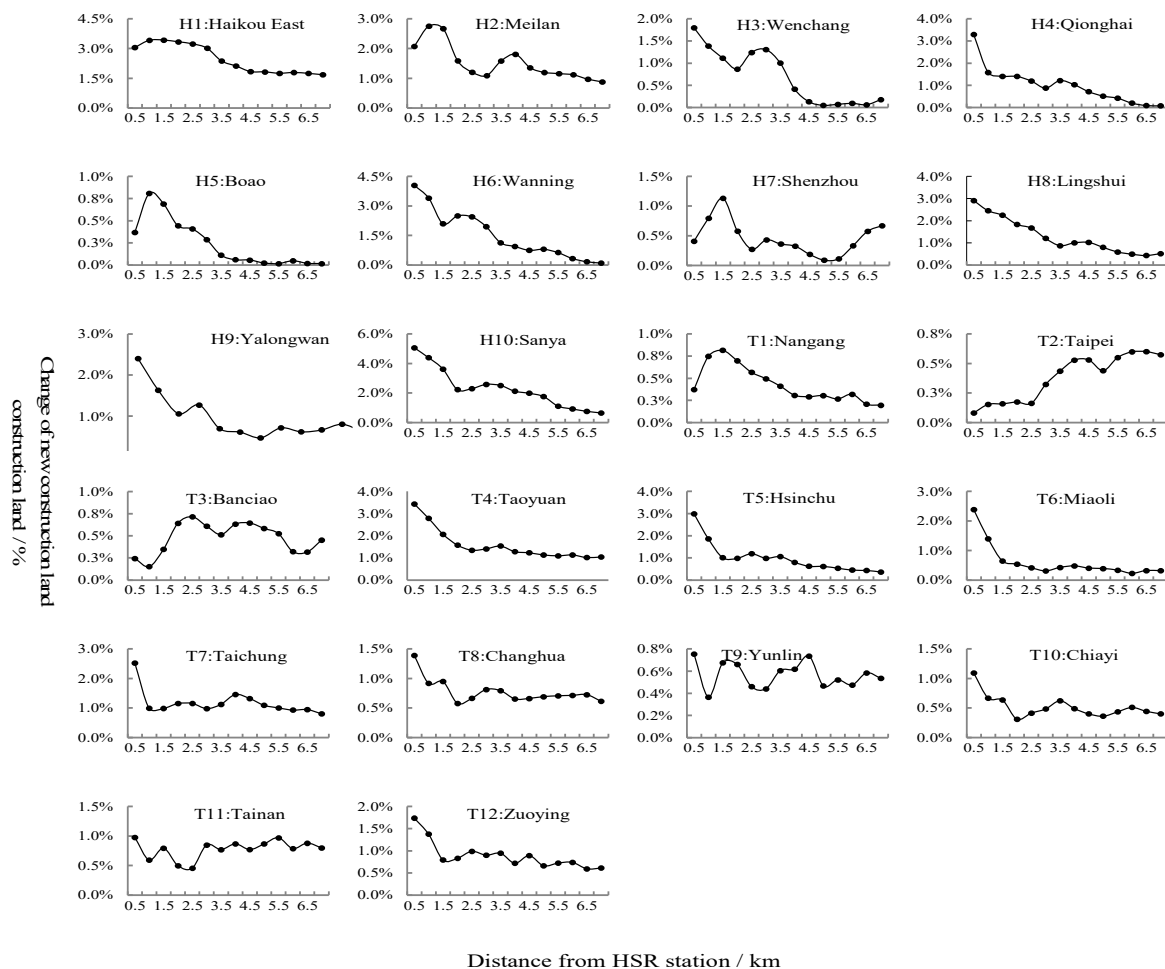


Figure 5. Curves of construction land changes around T-HSR and HER-HSR stations.

4.3. Comparison of the Difference Influence of T-HSR and HER-HSR Stations on the Expansion of Surrounding Construction Land

According to the comparison analysis of the impact of station development on surrounding construction land expansion between T-HSR and HER-HSR stations that conform to the ideal curve (Figure 6), it can be seen that the impact range of nine HSR stations in Taiwan on the expansion of surrounding construction land is between 1.0 and 3.0 km, with an average impact range of 1.6 km. The six stations of the HER-HSR have an impact range of 1.5–3.5 km, with an average impact range of 2.0 km. In terms of expansion scale, within their respective impact ranges, the nine T-HSR stations led to an increase of 22.44 km² in the expansion of surrounding construction land, with an average increase of 2.49 km² per station, while the six stations of the HER-HSR led to an increase of 24.20 km² in the expansion of surrounding construction land, with an average increase of 4.03 km² per station. In terms of the annual average change rate of construction land within their respective impact ranges, among the nine T-HSR stations, only one had an annual average change rate exceeding 10%, and six had an annual average change rate below 5.0%. Among the six HER-HSR stations, two had an annual average change rate exceeding 10%, and the other four had an annual average change rate greater than 5%. Obviously, the overall impact range and degree of the HER-HSR stations on the expansion of surrounding construction land are significantly higher than those of T-HSR stations.

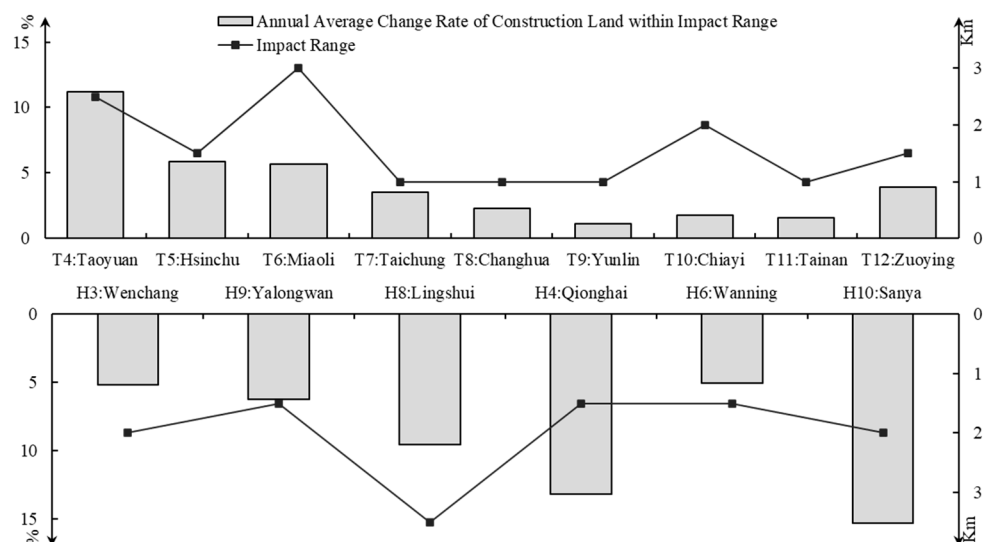


Figure 6. Comparison of the impact scope and extent of surrounding construction land expansion between T-HSR and HER-HSR stations.

5. Discussion

5.1. Institutional Environment Is the Key Factor That Causes the Difference in Construction Land Expansion around HSR Stations

Continuing the analysis framework constructed earlier, a comparison analysis of the stations of T-HSR and HER-HSR is further conducted (Table 2). The average size of T-HSR stations and the number of trains departing and arriving per day are much higher than those of HER-HSR. The per capita GDP of the western cities in which the T-HSR stations are located is 3.29 times higher than that of the eastern cities in which the HER-HSR stations are located. The average population size of the cities in which the T-HSR stations are located is 1.88 million, which is much higher than the average of 0.92 million for the cities in which the HER-HSR stations are located. Obviously, without considering institutional factors, the attributes of T-HSR stations and the socio-economic conditions in the areas where they are located are superior to those of HER-HSR. Therefore, the impact of T-HSR on the expansion of construction land in the surrounding areas should be higher than that of HER-HSR.

However, the empirical study mentioned above shows that the former's impact on the expansion of construction land in the surrounding areas is significantly lower than that of the latter. The reason for this result is likely to be closely related to the fundamental institutional differences in land planning, land property rights, and public participation between Taiwan and Hainan (Table 1).

Table 2. Comparison of relevant attributes between T-HSR and HER-HSR stations.

Comparison of Attributes of HSR Station		T-HSR		HER-HSR	
		Actual Value or Characteristic Description	Influence Degree of Construction Land Expansion Theoretically	Actual Value or Characteristic Description	Influence Degree of Construction Land Expansion Theoretically
Intrinsic Attributes of HSR Stations	Average station size (m ²)	78,292	++	56,567	+
	Average number of trains arriving and leaving	159	+++	51	+
Socio-economic Conditions	Per capita GDP (Yuan)	165,376	++++	53,756	+
	Population size (Million)	181	++	75	+
Institutional Environment	Land planning institution	Project following the plan	—	Plan following the project	+
	Land property rights institution	Private ownership	—	Public ownership	+
	Public participation institution	Substantive public participation	—	Formal public participation	+
The actual influence degree of HSR stations on surrounding construction land expansion		+		++	

Note: “+” and “—” represent positive and negative impact levels, with more symbols indicating a greater impact level. Due to space limitations, the table only lists the average data for 2018.

First is the land planning system. In Taiwan, the Spatial Planning Act divides the land into two categories, urban planning areas and non-urban planning areas, and specifies the specific use of each land block. Once approved, the plan is strictly enforced and has legal effects. The unauthorized or illegal alteration of the designated use of non-urban planning area land, such as the conversion of agricultural land into construction land, will result in fines, imprisonment, or even imprisonment [42,43]. The Forward-looking Infrastructure Development Program clearly lists the high-speed rail construction projects involved in the “railway construction” and emphasizes “planning before projects”. Therefore, the land planning system in Taiwan has the characteristic of “projects following planning”, which means that all types of construction projects must strictly comply with the planning before development is allowed. Even the construction of HSR cannot change the land use zoning [44]. This planning characteristic will result in greater planning obstacles for local governments or land developers when developing land around HSR stations, thereby constraining the expansion of construction land. In Hainan, land planning is strictly implemented in accordance with the Land Management Law. However, when faced with the need for infrastructure construction or local socio-economic development, local governments often adjust or change the scope of planning in the name of public interests or safeguarding economic development, such as the HSR new area and logistics park area that has been re-planned around newly built HSR stations. The Medium and Long-term Railway Network Planning states that railway development laws should be followed while considering efficiency and fairness, which also indicates that economic and social benefits are still more important at present. Therefore, the land planning system in Hainan has the implicit feature of “planning following projects”, which provides local governments or land developers with greater operational space when developing land around HSR stations. This implicit feature will lead to different actors blindly pursuing the maximization of economic benefits of land around high-speed rail stations and accelerating the expansion of construction land.

Second, the land property rights institution. In Taiwan, land property rights emphasize “equal land rights”, where the ownership of agricultural land belongs to farmers and is considered a private resource. This gives farmers the absolute right to dispose of their land, making it easy for them to exclude situations where their interests are harmed. This also creates the problem of “anti-public land tragedy” for local governments when promoting land development around HSR stations, as it is difficult to efficiently and massively expropriate land from farmers, thereby impeding the expropriation process and the expansion of construction land. In Hainan, the ownership of agricultural land belongs to collective economic organizations and is considered a common pool resource. However, due to the ambiguity of property rights within the collective [45], farmers face a powerlessness situation, making it difficult to exclude local government expropriation actions [46]. This characteristic makes it easier for HSR station land (especially agricultural land) to be expropriated for development by local governments pursuing economic interests, thereby accelerating the expansion of construction land.

Third, the public participation institution. Taiwan established the “Act for Promotion of Private Participation in Infrastructure Projects”, which encourages and mobilizes public participation in infrastructure construction, including project proposals and suggestions for improvement [47], with the participation of various social organizations and news media. The greater the public participation, the greater the public’s voice, which can create resistance to local government planning and land acquisition in the process of developing land around HSR stations, protecting farmers’ rights to land ownership (use rights), and forming a certain restraining effect on the expansion of construction land. In contrast, in Hainan, when soliciting public opinions, a “top-down” approach is often adopted, especially when farmers are limited by their own cognitive level and feedback information from administrative agencies is not smooth. This weakens the collective participation, information, and supervision rights of farmers in the planning and land acquisition around HSR stations and fails to form a balance against local governments or land developers blindly pursuing economic benefits and implementing land development, resulting in rapid expansion of construction land around HSR stations.

5.2. Policy Implications

The land resources around HSR stations face a dilemma between development and protection. How to design corresponding institutions or policies to resolve this issue should be determined according to the current or long-term development goals of the region. If pursuing current economic benefits and expanding the positive spillover effect of HSR stations or infrastructure in the socio-economic aspect as much as possible, the corresponding land planning, land property rights, and public participation institution arrangements can consider benchmarking the institutional environment in China’s Hainan province. However, the conflicting interests between development and resource and environmental protection should be coordinated. If prioritizing the long-term ecological value and minimizing the negative spillover effect of HSR stations or infrastructure in the ecological resource aspect as much as possible, the corresponding land planning, land property rights, and public participation institution arrangements can be learned from Taiwan’s institutional arrangements. However, the relationship between economic development and environmental protection should also be balanced.

As for China’s current goal of pursuing sustainable development around HSR stations, in terms of land planning, the government should introduce supporting policies and implementation details to maintain the seriousness of the planning, strengthen the execution of the planning, and impose rigid constraints, while also adapting to local socio-economic development and environmental protection. With regard to land ownership, land rights should be clearly defined for specific rights holders via the implementation of land ownership certification for agricultural land, and the speech rights of farmers or collectives should be guaranteed. Regarding public participation, legislation, and policymaking should be accelerated to ensure public participation in infrastructure construction, with a particular

focus on the information, participation, and supervision rights of farmers so that this vulnerable group's speech rights in the land planning and land acquisition process are legally protected.

6. Conclusions

This article constructs an analysis framework for the impact of HSR stations on the expansion of surrounding construction land and compares and analyzes the differences in the impact and institutional causes of the T-HSR and HER-HSR. The main findings are as follows: (1) The spillover effect of HSR stations on the expansion of surrounding construction land is the result of different actors weighing and playing around the development and protection of land around HSR stations under the influence of external factors such as the attributes of HSR stations, the social and economic conditions of HSR stations, and the institutional environment in which they are located. (2) Both T-HSR and HER-HSR have caused the expansion of surrounding construction land, but the scope and degree of the former are weaker than those of the latter. There are nine stations of the former with an impact range of 1.0–3.0 km, which have cumulatively caused 22.44 km² of construction land expansion within their respective impact ranges, while there are six stations of the latter with an impact range of 1.5–3.5 km, which have caused a total of 24.20 km² of construction land expansion. (3) The institutional environment is a key factor leading to the differential impact of T-HSR and HER-HSR stations on the expansion of surrounding construction land. Under the institutional environment of “planning following the project,” public ownership of land rights design, and formal public participation in Hainan, agricultural land around the HER-HSR station is more likely to be converted into construction land. However, under the institutional environment of “project following the plan,” private ownership of land rights design, and substantive public participation in Taiwan, the expansion of construction land around T-HSR stations is more constrained or hindered, resulting in less encroachment on land resources, but also hindering the social and economic development around HSR stations in Taiwan.

This study reveals the differences and reasons for the impact of HSR stations on the expansion of construction land in the surrounding areas under different institutional environments and expands the content of policy and institutional research in the field of HSR spillover effects. It can provide effective policy suggestions for the rational development and protection of land resources around HSR stations. However, there are limitations in this study. It only qualitatively compares the differences in the basic institutions of the HSR stations in Taiwan and Hainan and lacks in-depth research and empirical analysis of different actors and institutional factors. Therefore, in the next step, it can be considered to introduce behavioral economics experiments and multi-agent models in the field of computational social sciences. By simulating policies and comparing the results, the performance and differences in different institutional factors and actors in triggering the expansion of construction land around HSR stations can be quantitatively evaluated.

Author Contributions: Validation, X.H.; Writing—original draft, B.Z.; Writing—review & editing, C.X.; Funding acquisition, C.X. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by [Humanities and Social Science Fund of Ministry of Education of China] grant number [20XJCZH009], [Hainan Provincial Natural Science Foundation of China] grant number [720QN241], [National Natural Science Foundation of China] grant number [72004049,42361039], [Hainan University research start-up fund project] grant number [kyqd(sk)2021].

Data Availability Statement: Due to data privacy protection, it is not publicly available.

Conflicts of Interest: The authors declare no conflict of interest.

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