Discussion on the Motivation and Influencing Factors of High-Speed Railway Development in Various Countries

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ABSTRACT

The main research content of this paper is to compare the causes and possible influencing factors of the development of high-speed railway construction in various countries. This paper collates the high-speed rail development data of the top 50 countries in operation and construction mileage in 2019. This paper summarizes the original intention of building the first high-speed railway in some countries, studies the possible influence of different national political systems on the development of high-speed railway, and selects 25 countries with high-speed railway operating mileage for comparison and regression of some large indicators. The study found that total population had a significant positive relationship with the miles of high-speed rail, and land area had a significant negative impact, which may be caused by some difficult-to-quantify factors such as differences in land ownership in different countries. GDP has a positive relationship, but it is not statistically significant, which may be caused by the fact that countries are competing for the high-speed rail market by sending high-speed rail projects to other developing countries. This paper will provide some reference for the choice of the timing of high-speed railway construction in some countries.

Keywords: High-speed rail development, Political system, Motivation, International comparison.

1. INTRODUCTION

Since the opening of the Shinkansen between Tokyo and Osaka in Japan on October 1, 1964, a large number of countries began to invest in the construction of high-speed rail, and the high-speed rail industry began to flourish. By the end of 2019, 27 countries (regions) in the world had high-speed trains in operation, and more than 50 countries had high-speed rails under construction or in operation, with top speeds ranging from 200 km/h to 350 km/h (as shown in Table 1). China's high-speed rail service has reached 31,000 kilometers, ranking first in the world.

A large number of literatures have conducted a multi-dimensional in-depth study on the impact of high-speed rail on cities. For example, Zong Gang (2020) pointed out that the opening of high-speed railway significantly promoted the high-quality economic development by improving the technical efficiency on the whole[1]. Du Xingqiang (2017) pointed out that the opening of high-speed railway enhanced the attractiveness of cities by expanding the market scale, and promoted the increase of doctoral and senior talents in non-state-owned listed enterprises[2]. Tang Yihong et al. (2019) found that enterprises in cities with high-speed railway increased their exports by 12.7% by reducing fixed trade costs[3].

However, few articles have studied the influencing factors of countries choosing to build high-speed railways. What kind of country would choose to build high-speed rail? What is their original intention of building the high-speed railway? Based on this, this paper conducts an in-depth study in order to provide some guidance for other countries to choose the right time for the construction of high-speed rail and some ideas for future studies in this direction.

Table 1. The top 50 countries in high-speed rail mileage under construction or in operation in 2019

Ranking	Countries (Regions)	Under Construction (km)	In Operation (km)	Total (km)	Maximum Operating Speed (km/h)
1	China	7207	31000	38207	350
2	European Union	8064	17190	25254	320
3	Spain	2285	3240	5525	310
4	Turkey	3798	1213	5011	250
5	France	570	3300	3870	320
6	Germany	550	3046	3596	300
7	Japan	657	2765	3422	320
8	Sweden	710	1706	2416	205
9	United States	2007	55	2062	240
10	Russian Federation	1181	845	2026	250
11	United Kingdom	620	1377	1997	300
12	Thailand	1876	0	1876	300
13	Italy	505	1192	1697	300
14	Korea, Rep.	376	1105	1481	305
15	Saudi Arabia	663	453	1116	300
16	Australia	1098	0	1098	350
17	Finland	95	944	1039	220
18	Egypt, Arab Rep.	900	0	900	300
19	Uzbekistan	0	741	741	250
20	Greece	0	700	700	200
21	United Arab Emirates	684	0	684	220
22	Portugal	0	624	624	220
23	Austria	208	352	560	250
24	India	508	0	508	320
25	Romania	497	0	497	250
26	Poland	322	143	465	200
27	Switzerland	311	137	448	250
28	Iran, Islamic Rep.	410	0	410	300
29	Norway	270	104	374	210
30	Taiwan	0	345	345	300
31	Malaysia	335	0	335	350
32	Belgium	0	326	326	300
33	Morocco	137	186	323	320
34	Oman	306	0	306	220
35	Latvia	303	0	303	240
36	Denmark	229	65	294	250
37	Lithuania	286	0	286	240
38	Qatar	283	0	283	220
39	Ireland	266	0	266	225
40	Estonia	235	0	235	240
41	Bangladesh	230	0	230	250
42	Netherlands	35	175	210	210
43	Serbia	184	0	184	200
44	Hungary	152	0	152	200
45	Bulgaria	150	0	150	200
46	Kuwait	145	0	145	220
47	Indonesia	142	0	142	250
48	Vietnam	139	0	139	350
49	Iceland	49	0	49	250
50	Bahrain	36	0	36	220

Data Source: Public information collation

2. MOTIVATIONS TO BUILD HIGH-SPEED RAILS

The motivations for high-speed rail are never exactly the same in each country. At the same time, as each country chooses to build high-speed railways out of different considerations, the different original intention also leads to different choices of high-speed railway development paths, such as construction mode, operation mode and type of high-speed train in different countries, which ultimately has an impact on high-speed railway line length, railway operating speed and other indicators.

China, for example, is building high-speed trains mainly to strengthen inter-city links, develop regional economies, relieve pressure on passenger demand and free up rail freight capacity. However, there are also some railway lines to underdeveloped and sparsely populated remote areas, such as the Qinghai-Tibet Railway. Its purpose is not only to promote the economic development of the central and western regions, but also to strengthen the connection between cities and the national center for geopolitical considerations

Japan's high-speed rails was originally built to reduce travel time and distance between big cities [4]. Because Japan previously built narrow tracks and the new high-speed network is based on standard tracks, the two networks are completely independent, with the two types of trains running on both types of tracks.

France's was originally built to reduce traffic congestion. Most of the railways were connected to Paris to ensure passenger flow, thus ensuring the economic viability of the high-speed rail projects. As a result, the French railway network formed a star-shaped form with the capital as the core. France has chosen a hybrid high-speed rail infrastructure system, which reduces the construction cost to a certain extent, but part of the high-speed rail operation speed must be limited.

In order to promote economic development and political cohesion in the poor areas of Spain, the first railway was chosen to connect the capital, Madrid, with Seville. At the same time, due to the interoperability with other European countries, Spain also chose to build a separate railway system, because Spain's regular network is basically narrow gauge, so Spain's high-speed rail only runs on the high-speed tracks based on standard gauge. However, Spain has also developed a railway vehicle adaptive technology, TALOGO train, which can be operated on conventional tracks or high-speed tracks, saving a certain amount of purchase cost and increasing flexibility.

Germany's motivation is to boost shipments from its northern ports to its industrial south. Germany's terrain is complex and mountainous, so the construction and operation costs of high-speed rail are relatively high. At the same time, because it mainly serves freight, Germany has opted for a mix of passengers and goods, thus bringing with its higher maintenance costs. Its high-speed trains are also heavier, have more space, but are more flexible than those in other countries [5].

Some countries have made the choice of railway construction under the promotion of China's "One Belt and One Road" strategy, such as the Moksha high-speed railway promoted by China, Mongolia and Russia, and the China-Thailand railway. Such projects are not only a way for China to export its high-speed railway technology, standards and equipment, but also an important path for China to consolidate international trade routes, deepen international cooperation and promote high-quality economic development of all countries.

3. INFLUENCING FACTORS OF HIGH-SPEED RAILWAY DEVELOPMENT

There are many factors affecting the development of high-speed railways in different countries, but few scholars have made in-depth discussions on this. As for China's high-speed rail, some scholars pointed out that the reason why China's high-speed rail can be so efficient to build such a large scale high-speed rail cannot be separated from the country's institutional advantage of "concentrating power to do big things", vast market, appropriate land system and talent training system, etc..

This paper takes several countries' state system as an example to carry on the horizontal comparison and the discussion. The French rail system, for example, was originally dominated by six major private sectors, but were all under strict government supervision, and the government intervened heavily in the construction of railways to avoid vicious competition with other modes of transport. Later, after the nationalization of private railway enterprises, the state has also secured the financial and competitive base of the National Railway Company, allowing France to invest in high-speed rail for a long period of time and to concentrate on high-speed trains. However, the American government gave great discretion to local governments, and gave little administrative intervention, which made private railway companies excessively competitive and resulted in a large number of parallel and redundant lines in conventional railway construction. Later on, due to a car booming, private railway companies go bust. The government made the final choice to nationalize the railways, established Amtrak National Railway

Passenger Transport Company, but still not paid great attention to the construction of railways. So, Amtrak's tasks are only to maintain of existing and developing of railways and has no ability and incentive to do research and development of high-speed railway.

In China, due to the political system of "upward responsibility" combined with the institutional arrangement of decentralization, local governments have horizontal competition in economic development. Therefore, they all hope to promote local economic development and improve their political achievements by building high-speed railways, which is one of the key factors affecting China's high-speed railway construction. At the same time, compared with Russia, although the latter also adopts the policy of decentralization, once the local government's income increases, the central government will reduce the transfer payment to the local government, so actually the local ones do not get an independent financial status. This institutional arrangement inhibits the effective supply incentive of public goods by the local government.

4. DATA SOURCES AND MODEL ESTABLISHMENT

Due to the risk of delay or cancelation in the construction stage of the project, this article only considered the countries with high-speed rails in operation. At the same time, in order to improve the comparability, this paper remove the two regions, Taiwan and the EU, from sample city. Eventually, we take 25 countries as sample cities to do comparison and analysis. Their development indicators are shown in Table 2.

Table 2. Descriptive statistics of development indicators of nations with high-speed rails in operation

VARIABLES	N	mean	sd	min	max	skewness	kurtosis
High-speed rail	25	2,232	6,080	55	31,000	4.485	21.76
Employment to population ratio, 15+, total (%)	25	54.69	7.134	39.87	66.52	-0.457	2.258
GDP per person employed	25	78,840	29,489	13,275	130,505	-0.584	2.972
Population density (people per sq. km of land area)	25	164.2	144.6	8.822	529.4	1.271	3.792
Rural population (% of total population)	25	23.57	11.82	1.999	49.52	0.417	2.535
GDP (current US$)(million)	25	2.55E+06	4.88E+06	57,921	2.14E+07	2.995	11.12
Population, total	25	1.08E+08	2.77E+08	5.35E+06	1.40E+09	4.279	20.35
Land area	23	92,380	174,766	7,898	802,054	3.28	13.3

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highspeedr~l |    Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

   landarea1 | -121.7978   17.18458   -7.09   0.000    -157.7655   -85.83007
 population1 |  .2415596   .0087852   27.50   0.000      .223172    .2599472
       lngdp |  392.7083   234.7451    1.67   0.111    -98.61892    884.0355
       _cons | -4733.192   3139.316   -1.51   0.148    -11303.85    1837.472
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Figure 1 Regression analysis results of influencing factors of high-speed railway mileage.

In this paper, the operating mileage of high-speed trains in each country in 2019 is taken as the explained variable. The data are collected from online public information. The total population, GDP and land area of each country were selected as explanatory variables, and all data were obtained from the Database of the World Bank.

In this paper, the following model is constructed:

$$highspeedrail = \beta_1 + \beta_2 population + \beta_3 lngdp + \beta_4 landarea + u \tag{1}$$

5. STATISTICAL RESULTS AND ANALYSIS

In this paper, OLS regression analysis was carried out by STATA. The regression analysis results are shown in Figure 1.

From the statistical results, it can be found that the total population, GDP and land area of each country can explain nearly 97.8% of the high-speed railway mileage. Among them, land area is negatively correlated. For example, although the United States and Russia have a larger land area, they have fewer high-speed railway miles, while Germany and France have a higher mileage, which may be affected by other factors such as the national system that is difficult to quantify. At the same time, there is a significant positive correlation between the population and the number of miles of high-speed rail, because in many countries, it is the demand market that creates the incentive to build high-speed rail and ensures the economic viability of high-speed rail. Although GDP is not statistically significant, from the perspective of coefficient, it is positively correlated with the mileage, and cities with better economic development are more likely to build high-speed rail. However, due to China's "One Belt, One Road" policy, high-speed rail is also exported to some nearby countries with less developed economies, which may result that GDP is not so significant in the 25 small samples.

6. CONCLUSION

Overall, this paper summarizes and compares the causes and possible influencing factors of the development of high-speed railway construction in various countries, and then draws a conclusion through an OLS regression that there is a significant positive correlation between the population and the number of

miles of high-speed rail, while land area is negatively correlated. Because a large enough demand market is very important for the sustainable development of HSR operation.

However, the factors that influence the motivation of high-speed railway construction are very complex, and many indicators such as political motivation and land system may be difficult to quantify. This paper has only made a preliminary exploration of the possible influencing factors of high-speed railway construction. In the future, a more comprehensive index system and more comprehensive panel data can be established to compare the timing and national development background of high-speed railway construction in different countries.

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