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# Impact of Transport Infrastructure on Trade: Evidence from the Chinese Inland Provinces under "One Belt, One Road"

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## Abstract

This paper discusses the impact of transport infrastructure on trades in the Chinese provinces directly affecting by "One Belt, One Road" initiative. That is why infrastructure is of significance in "One Belt, One Road" initiative and one of important purpose for initiative is to promote the unimpeded trade in China. In this paper, authors analyzed the impact of railways and highways which are the key elements of transport infrastructure on total value of exports and imports in the Chinese inland provinces directly affecting by "One Belt, One Road" and correlations between individual elements of transport infrastructure based on data from National Bureau of Statistics of China and from some articles related to "One Belt, One Road" and correlation and regression analysis methods. The conclusion is that railways, highways, and port have strong correlation with Gross Regional Products, and effects of elements of transport infrastructure are different among inland provinces affected by "One Belt, One Road" and this needs rational management of transport infrastructure in promoting trade according to provinces.

## Keywords

Transport Infrastructure (TI), Trade, Total Value of Exports and Imports (TVEI), "One Belt, One Road" (OBOR), Chinese Economy

## 1. Introduction

In 2013, what is important in "One Belt, One Road" (OBOR) initiative proposed by China is the Land Road "Silk Road Economic Belt". The OBOR initiative aims to increase the integration among countries in Asia as well as in Africa and Europe, and this will be accompanied by trade promotion in China [1]. The key element in OBOR initiative is the infrastructural connectivity, and transport infrastructure such as railways, roads, ports, and airports will be a particular focus in inland provinces [2]. These infrastructural elements will stimulate the economic growth in China and affect the majority of the Chinese provinces. Furthermore, some of the Chinese provinces will be directly affected by the initiative, since the New Silk Roads will go through the provinces. However, there exists many studies on effects of infrastructure on the Chinese economy, but it is seen that there is a few studies in quantitative studies on the impact of infrastructural projects according to OBOR on trade. Some scholars mentioned the impact of infrastructure on foreign trade. Under OBOR, transport infrastructure (TI) affects positively in promoting the foreign trade in states along the line [2]. Infrastructure will likely play a fundamental role in fostering regional cooperation and development, especially at the early stage of the Initiative. A large number of projects are already being considered to connect various sub-regions, including high-speed railroads, oil and gas pipelines and telecom and electricity links [3]. In his/her study, Ylander [4] discussed various variables representing the impact of OBOR, and analyzed their effects on GRP (Gross Regional Products) in the Chinese provinces directly affected by OBOR. However, the variables such as labor productivity, unemployment rate, and exports included in his/her study are all related to infrastructure. Also, he/she did not study the impact of infrastructure on trade considering the features of economic development in specific provinces, and furthermore, did not discuss the impact of correlations between elements of infrastructure on trade. From the limitations of previous studies, we raise the research problems as follows: 1) Are there correlations of individual elements of TI such as railways and highways with total value of exports and imports (TVEI), 2) If so, how do TI's elements affect the TVEI according to provinces, and 3) what is the correlation between TI's elements. Our study is based on that what is of significant in OBOR is infrastructural connectivity and infrastructure has its effect on trade. This will probably give the significant implications for strategic management in infrastructural investment under OBOR. From research problems and reasons, the paper aims to analyze the impact of specific elements of TI on trade in the Chinese inland provinces directly affected by OBOR as well as the impact of correlations between elements of TI. Based on research purpose, our papers are organized as follows.

In first section, authors discuss the successes of previous studies which analyzed the impact of infrastructure on economic growth and trade. Second section analyzes the correlation of individual elements of TI such as railways and highways with total value of exports and imports (TVEI) and constructs the regression models and conducts forecasts using the data from 2009 to 2017 and regression analysis method. The rest of paper discusses the results, discussions, conclusion, limitations and future research.

## 2. Previous Study on Impact of Infrastructure on Economic Growth and Trade

Many scholars studied the impact of infrastructural investment on economic growth based on premise that economic growth and trade are correlated. Previous researchers demonstrated the effects of infrastructural investment on economic performance in different regions and countries using long-term time series data and production function. For example, discussing the impact of public investment in infrastructure on economic performance. Aschauer [5] estimated that elasticity of output with respect to public investment in infrastructure is between 0.34 and 0.39. Some authors proved the strong positive impact of public capital in international or regional level using the production function approach [6] [7] [8] [9], and others demonstrated the productivity of infrastructural investment using the cost function approach [10] [11]. On the other hand, some authors judged the positive impact of public capital on output in different countries using VAR (Vector Auto Regression) approach [12] [13].

In some studies, the impact of the individual elements of infrastructure on economy was illustrated. For example, some researchers demonstrated the positive impact of energy infrastructure on output/growth [14] [15] and others tried to analyze the impact of water and sanitation on economy in various aspects [16] [17]. In addition, researchers analyzed the positive impact of telecommunication infrastructure on economic growth [18] [19] (for example, Zhan-Wei Qiang & Pitt 2004; Chakraborty & Nandi 2011) and investigated the impact of transport infrastructure on economy in various aspects [20] [21] [22]. Pereira & Andraz [23] summarized the positive impact of infrastructure investment on economic growth through the survey of previous studies on impact of infrastructure.

On the other hand, there exist few studies of impact of infrastructure on international trade in international level. Typically, Nordås and Piermartini [24] studied the correlation between infrastructure and trade. They studied the impact of quality of infrastructure on country's performance of trade, and analyzed its effect in total bilateral trade and in automobiles, clothing, and textile sectors. Improving the TI has positive effect in bilateral trade by reducing trade cost [25] And TI investment enables to reduce the business cost according to distance and to improve the ability of firms to compete in world markets [26] Lawrence and Martin [27] investigated the quality of infrastructure on export, focusing on Sub-Sahara Africa. According to him/her, improving the quality of infrastructure has positive impact on export by lowering the transport cost faced by exporter. Discussing the close interrelations between infrastructure and trade, Behrens [28] demonstrated that countries with better infrastructure and larger volumes of interregional trade may experience a more balanced spatial development. Discussing the relation between infrastructure, trade cost, distance, and transport cost, some scholars demonstrated that TI has the positive and significant impact on trade by reducing the transport distance and cost [29] [30] [31] [32] [33]. Besides, other scholars demonstrated that Belt and Road economies located along the corridors where infrastructure projects are built experience the largest gains, and shipment times along these corridors decline by up to 11.9 percent and trade costs by up to 10.2 percent [34].

Some Chinese scholars studied the impact of infrastructure on economic growth and trade in China.

In typical, Ni [35] analyzed the impact of transport infrastructure on economic growth in China. He studied the effect of investment in transport infrastructure on China's economic growth and demonstrated that there is long-term stable equilibrium relationship between infrastructure investment in economic growth, and the transportation infrastructure's positive spillovers to economic growth using data from the year 1978 to 2011. Yingying *et al.* [36] investigated the relationship between infrastructure capital and China's regional economic growth for the period 1990-2013 and using a vector error correction model, found mixed support across time period and region for the contribution of infrastructure investment to economic development.

Based on the C-D production function model, Xinmin *et al.* [37] explored the influence of China's TI investment on economic growth with the aggregation data and panel data, and showed that China's investment in TI construction has a long-term and stable effect on economic growth with contribution rate of 12%. Ylander [4] conducted the regression analysis including various variables such as railways, highways, unemployment rate, labor productivity, and exports which affect the GRP (Gross Regional Products) in order to prove that OBOR and its infrastructural projects influence the GRP in China. According to him/her, OBOR has the positive effect on GRP in selected Chinese provinces.

Also, there exists a few studies of impact of TI on foreign trade under OBOR. According to Xiaodan [38], TI projects promote the efficiencies of export and total trade, and states and regions along the line reduce the cost of bilateral trade, push ahead the exchange among regions, and enhance their export efficiency and efficiency of exports and imports among through participation in TI projects under OBOR. Zaiyong, *et al.* [39] demonstrates that three infrastructures such as energy, transport, and communication network and their interaction have positive effects on imports and exports of countries along the line and intraregional bilateral trade. In China, TI, export, labor productivity, and employment rate have positive effects on economic growth [4].

As seen from analysis on previous studies, infrastructure has positive effects on economic growth and trade. However, it cannot be seen that in terms of individual province, TI has positive effect on trade. It is our review that there are various factors affecting the trade due to features of economic development in individual provinces, and thus, promotion of trade does not entirely depend on individual TI.

This paper focuses on analyzing the impact of infrastructural projects under OBOR on regional TVEI, and thus, discusses the influences of TI on region's TVEI in the Chinese provinces directly affected by OBOR.

# 3. Material and Methods

## 3.1. Data Description

According to National Development and Reform Commission *et al.* [1], the initiate roads of economic corridors will have a direct effect on five Chinese inland provinces since the route will go through these provinces. The inland route will go through Shaanxi, Gansu, Ningxia Autonomous Region (Hereafter, Ningxia), Qinghai, and Xinjiang Uygur Autonomous Region (Hereafter, Xinjiang). Therefore, authors conduct the analysis based on data from year 2009 to 2017 for five Chinese inland provinces. Data are from the National Bureau of Statistics of China and various articles. Important elements of TI under study are railways and highways in terms of physical measurements. The reasons of selecting the data for period of 2009-2017 are concerned to facts that in general, many studies were conducted based on data before 2009, and 2009 is the postperiod of 2008 world financial crisis. Also, the reason of selecting the railways and highways as important elements of TI is concerned to facts that infrastructural elements are very complicated and diverse, and data of infrastructure related investment, in particular, data of infrastructural investment under OBOR are limited. Furthermore, considering that infrastructural investment is not basis for economic development in given period due to lags, using the data of physical infrastructure is acceptable.

Under above premise on data collection, authors collected the data regarding TVEI, length of railways, and length of highways for five Chinese inland provinces directly affecting by OBOR as follows (See **Table 1**).

**Table 1.** Province- and year-specific TVEI, length of railways, and length of highways.

| Province | Indicator | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| Shaanxi | TVEI[a] (1000 USD) | 8,405,392 | 12,101,680 | 14,647,271 | 14,799,030 | 20,128,062 | 27,364,485 | 30,498,504 | 29,947,223 | 40,202,798 |
| | Length of railways in operation[b] (km) | 3300 | 4100 | 4100 | 4100 | 4400 | 4500 | 4500 | 4600 | 5000 |
| | Length of highways (km) | 144,100 | 147,500 | 152,000 | 161,400 | 165,200 | 167,100 | 170,100 | 172,500 | 174,400 |
| Gansu | TVEI (1000 USD) | 3,865,554 | 7,402,953 | 8,728,579 | 8,900,750 | 10,236,106 | 8,640,615 | 7,952,016 | 6,832,980 | 4,826,333 |
| | Length of railways in operation (km) | 2400 | 2400 | 2400 | 2500 | 2600 | 3400 | 3800 | 4100 | 4700 |
| | Length of highways (km) | 114,000 | 118,900 | 123,700 | 131,200 | 133,600 | 138,100 | 140,100 | 143,000 | 142,300 |
| Qinghai | TVEI (1000 USD) | 586,785 | 788,961 | 923,817 | 1,157,470 | 1,402,742 | 1,717,888 | 1,934,472 | 1,529,204 | 655,751 |
| | Length of railways in operation (km) | 1700 | 1900 | 1900 | 1900 | 1900 | 2100 | 2300 | 2300 | 2300 |
| | Length of highways (km) | 60,100 | 62,200 | 64,300 | 66,000 | 70,100 | 72,700 | 75,600 | 78,600 | 80,900 |

Continued

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ningxia | TVEI (1000 USD) | 1,202,479 | 1,959,989 | 2,285,746 | 2,216,710 | 3,217,686 | 5,435,212 | 3,739,255 | 3,252,489 | 5,039,517 |
| | Length of railways in operation (km) | 900 | 1200 | 1300 | 1300 | 1300 | 1300 | 1300 | 1300 | 1400 |
| | Length of highways (km) | 21,800 | 22,500 | 24,500 | 26,500 | 28,600 | 31,300 | 33,200 | 33,900 | 34,600 |
| Xinjiang | TVEI (1000 USD) | 13,947,831 | 17,130,110 | 22,819,672 | 25,170,060 | 27,561,391 | 27,672,315 | 19,669,397 | 17,637,744 | 20,568,530 |
| | Length of railways in operation (km) | 3700 | 4200 | 4300 | 4700 | 4700 | 5500 | 5900 | 5900 | 5900 |
| | Length of highways (km) | 150,700 | 152,800 | 155,200 | 165,900 | 170,200 | 175,500 | 178,300 | 182,100 | 185,300 |

Source: National Bureau of Statistics of China [40]. Note: [a]Data of import and export data are from the general administration of customs. Data of 1978 were from the Ministry of Foreign Trade, and data since 1980 are from Customs statistics. [b]Length of Railways in Operation refers to the total length of the trunk line for passenger and freight transportation in full operation or temporary operation calculated the actual length of the period between the two stations. Any full or partial lane and above lines, in calculated in the actual length of the first line; tracks, station lines, segments, branch lines and special purpose lines and does not calculate shipping connecting lines of business mileage.

These data show the specific features according to provinces. In other words, inland provinces include three data. That is why under OBOR land roads are linked through the railways and highways.

Putting these into graphs, features according to provinces seem to be more apparent, and thus, it can conclude that the specifics of individual provinces must consider rightfully under study.

Picturing the relationship between TVEI and lengths of railways and highways, it is as follows (**Figures 1-5**).

Graphic description indicates the features of trade development in the Chinese inland provinces directly affecting by OBOR more clearly. It shows that there are few differences between growths of TEVI, length of railways in operation, and length of highways according to provinces under study over period from 2009 to 2017.

For comparative consideration, calculating the province- and indicator-specific averages and putting them into graph, it is as follows (**Figure 6**).

It shows that all infrastructural elements grow, but the growth of TVEI is not proportional to them. In other words, while some provinces indicate the proportional relation, others—reverse relation. This enables us to analyze the impact of TI on TVEI in provinces under study.

### 3.2. Methods

Section 3.1 indicates that interrelations between three indicators emerge differently according to provinces as a result of description. This study aims to reveal the influences of TI's elements on TVEI according to provinces, and thus, it is important to analyze the influences of railways and highways on TVEI in line with province-specific features and to reveal the interrelation between two elements of TI.

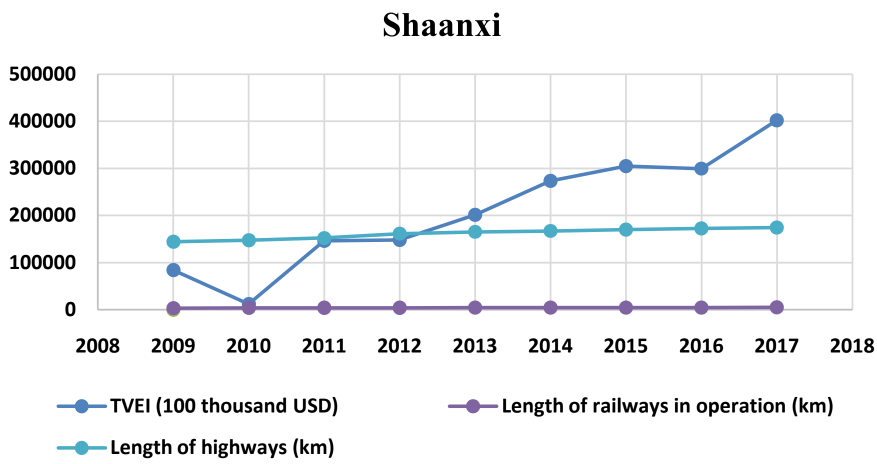


**Figure 1.** Relationship between TVEI and lengths of railways and highways (Shaanxi). Source: Own elaboration.

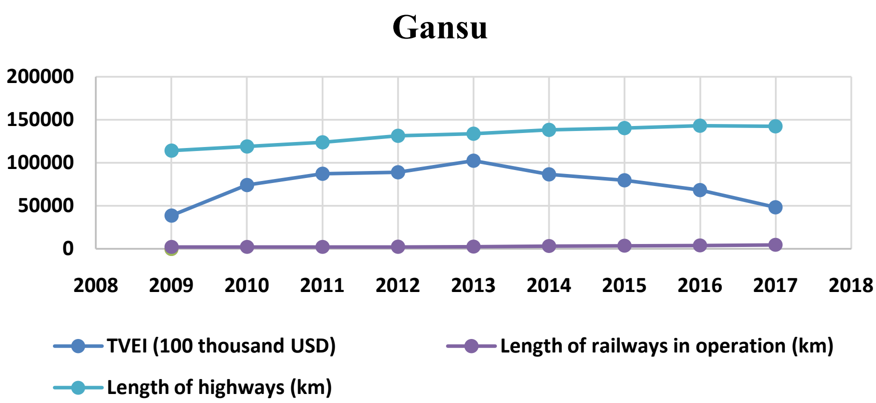


**Figure 2.** Relationship between TVEI and lengths of railways and highways (Gansu). Source: Own elaboration.

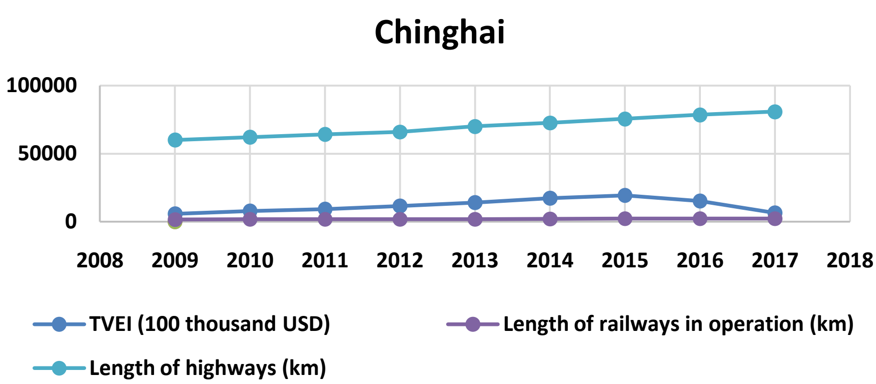


**Figure 3.** Relationship between TVEI and lengths of railways and highways (Chinghai). Source: Own elaboration.

For this, first of all, it is important to understand the variation of individual values compared to average values according to provinces and indicators. That is why primary data and putting them into graphs only indicate the general features in interrelations between three indicators but not concrete features. Therefore,

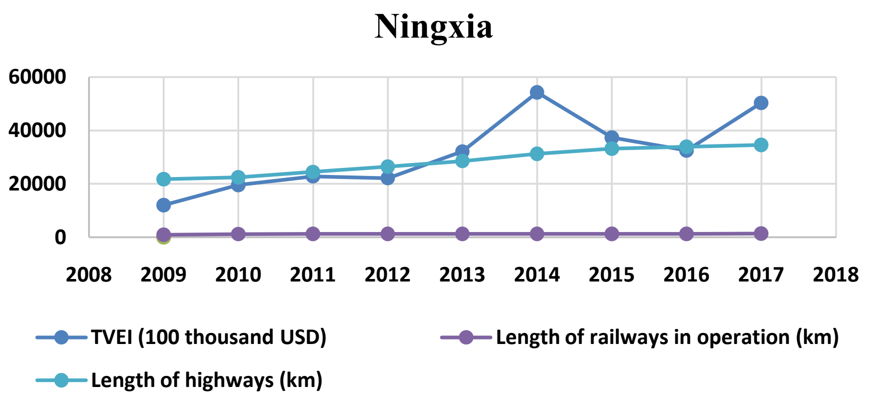


Figure 4. Relationship between TVEI and lengths of railways and highways (Ningxia). Source: Own elaboration.

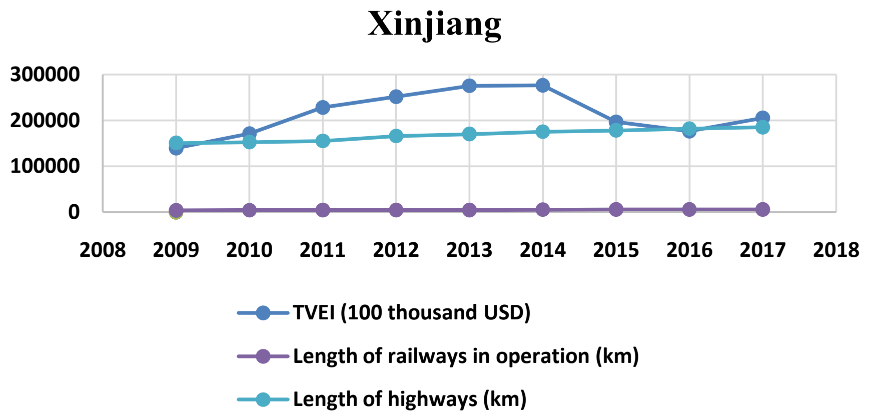


Figure 5. Relationship between TVEI and lengths of railways and highways (Xinjiang). Source: Own elaboration.

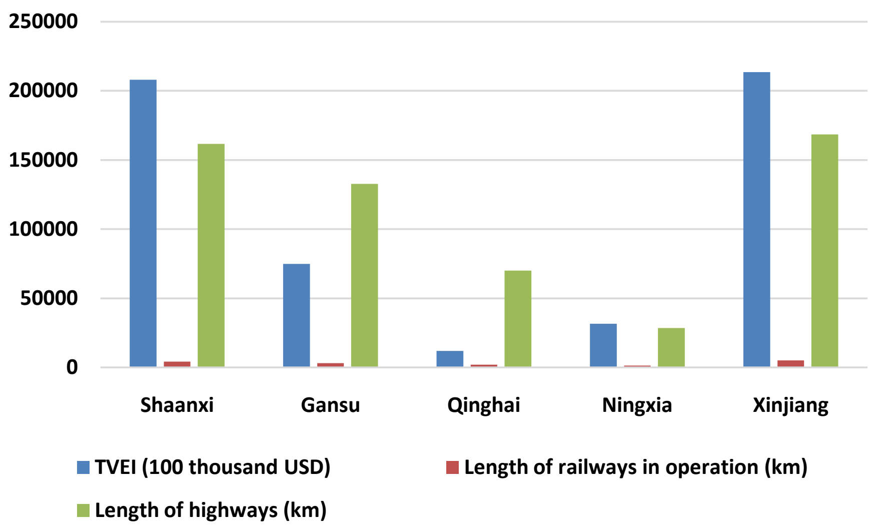


Figure 6. Comparison of province- and indicator-specific averages. Source: Own elaboration.

we calculate descriptive statistics such as maximum, minimum, mean, and standard deviation of each indicator according to provinces. Next, we calculate the correlation coefficients to reveal the correlation between three indicators. This is significant procedure in revealing what degree of correlation between three indicators there exist. As a result of correlation analysis, correlation degree of factor indicators with result indicator and correlation between two factor indicators are revealed. Finally, in order to analyze the influences of TI elements on TVEI in provinces under study, we conduct the linear multiple regression analysis and use the statistical package SPSS. Conducting the linear multiple regression analysis is based on assumption that TVEI and diverse TI elements are in linear relation and these elements affect the TVEI diversely. Also, the degree of changes in TVEI according to changes of diverse TI elements can easily be estimated by drawing regression models through regression analysis. SPSS enables us to conduct regression analysis by treating large panel data conveniently.

As seen above, considering the features of economic development in provinces under study, regression analysis is conducted according to provinces, and based on them, regression equations are constructed. For regression analysis, correlation matrix and regression models are constructed, and in turn, statistical forecasts can be conducted. TVEI is selected as dependent variable and length of railways and length of highways are selected as independent variables.

#### 3.2.1. Calculation of Descriptive Statistics and Correlation Coefficients

First of all, let's calculate the descriptive statistics and correlation coefficients regarding each province, respectively using SPSS. Descriptive statistics represent major features of every independent variables and dependent variable, and correlation coefficients enable to reveal the influences of each independent variable on TVEI and correlation between independent variables.

Descriptive statistics and correlations regarding inland provinces are as follows (See **Table 2** and **Table 3**).

**Table 2.** Descriptive statistics.

| Province[a] | Variable | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|---|
| Shaanxi | Length of railways in operation (km) | 3300 | 5000 | 4333.33 | 471.699 |
| | Length of highways (km) | 144,100 | 174,400 | 1.62E5 | 11,154.421 |
| | TVEI (100 thousand USD) | 12102 | 402028 | 2.08E5 | 122,932.946 |
| Gansu | Length of railways in operation (km) | 2400 | 4700 | 3144.44 | 880.499 |
| | Length of highways (km) | 1.14E5 | 1.43E5 | 1.3166E5 | 10,586.20696 |
| | TVEI (100 thousand USD) | 38,656 | 102,361 | 7.49E4 | 20,394.143 |
| Qinghai | Length of railways in operation (km) | 1700 | 2300 | 2033.33 | 223.607 |
| | Length of highways (km) | 60,100.00 | 80,900.00 | 7.01E4 | 7405.5918 |
| | TVEI (100 thousand USD) | 5868 | 19345 | 1.19E4 | 4841.537 |

**Continued**

| | | | | | |
|---|---|---|---|---|---|
| | Length of railways in operation (km) | 900 | 1400 | 1255.56 | 142.400 |
| Ningxia | Length of highways (km) | 21,800.00 | 34,600.00 | 2.8544E4 | 4964.653 |
| | TVEI (100 thousand USD) | 12025 | 54352 | 3.15E4 | 14,134.048 |
| | Length of railways in operation (km) | 3700 | 5900 | 4977.78 | 842.285 |
| Xinjiang | Length of highways (km) | 150,700 | 185,300 | 1.68E5 | 13,048.382 |
| | TVEI (100 thousand USD) | 139,478 | 276,723 | 2.14E5 | 48,104.223 |

Note: [a]number of observations = 9, Source: Own calculation.

**Table 3.** Correlation coefficients[a].

| Province[b] | Independent / Dependent | Length of railways in operation (km) | Length of highways (km) | Correlation between independent variables |
|---|---|---|---|---|
| Shaanxi | TVEI (100 thousand USD) | 0.823** | 0.928** | 0.893** |
| Gansu | TVEI (100 thousand USD) | −0.330 | 0.205 | 0.837** |
| Qinghai | TVEI (100 thousand USD) | 0.517 | 0.469 | 0.943** |
| Ningxia | TVEI (100 thousand USD) | 0.675* | 0.833** | 0.691* |
| Xinjiang | TVEI (100 thousand USD) | 0.203 | 0.285 | 0.966** |

Note: **Correlation is significant at the 0.01 level (2-tailed). [a]Pearson Correlation, [b]number of observations = 9, Source: Own calculation.

Diverse descriptive statistics and correlations show the features in impacts of individual elements of infrastructure on TVEI according to provinces. In other words, in general, railways in operation and highways have different correlations with TVEI in all inland provinces. For example, Shaanxi has the highest correlations of railways and highways with TVEI (0.823 and 0.928), Gansu—the lowest correlation of railways (−0.03), and Xinjiang has lower correlations of two independent variables with TVEI. Correlation coefficients are statistically significant at the one percent.

### 3.2.2. Construction and Analysis of Regression Models

Given that correlations of TI elements with TVEI are revealed, linear regression models are constructed and analyzed in provinces under study.

Construction and analysis of regression models are conducted according to each province, considering province-specific features. Results of construction and analysis are presented in Appendix. As a result of regression analysis, significance and availability of regression models were tested, and thus, based on them, influences of TI elements on TVEI according to provinces can be analyzed, and province-specific TVEIs are estimated.

As a result, regression equations according to provinces can be described as follows.

*Inland provinces*

Shaanxi:

$$y = -1.457\text{E}6 - 6.998x_1 + 10.488x_2;$$

Gansu:

$$y = -209921.285 - 38.688x_1 + 3.087x_2;$$

Qinghai:

$$y = -10163.314 + 14.578x_1 - 0.108x_2;$$

Ningxia:

$$y = -49228.595 + 18.885x_1 + 1.997x_2;$$

Xinjiang:

$$y = -310552.721 - 62.760x_1 + 0.150x_2;$$

where $x_1$ —length of railways in operation (km).

$x_2$ —length of highways (km).

$y$ —TVEI (100 thousand USD).

Constructing the regression models, significance provability, contribution degree, and standard error of estimate are calculated, and they are meaningful values. For example, for Shaanxi, significance provability is 0.03, contribution degree ($R^2$)—0.861, and standard error of estimate −53,001.881 respectively. This shows that regression equation is significant and statistically meaningful, $x_1$ and $x_2$ explain 86.1% of changes in TVEI, and error interval of TVEI is in ±53,001.881 (100 thousand USD).

## 4. Results and Discussion

We gathered primary data in terms of TVEI, length of railways, and length of highways according to provinces under study and put them into graphs. As a result, we found the general features of interrelations between three indicators according to provinces. From **Figures 1-6**, we found that while railways and highways grew systematically in all provinces and growth of highways is faster than those of railways, growth of TVEI is different among provinces. However, we cannot understand how railways and highways affect the TVEI with such graphic description. Therefore, we calculated descriptive statistics and correlation coefficients of each indicator according to provinces. According to calculation of descriptive statistics, it is revealed that variations of individual indicators compared to average values in terms of standard deviation are very different according to provinces and indicators. In detail, while Shaanxi has the largest variation, Qinghai—the smallest in terms of TVEI. On the other hand, Gansu has the largest variations and Ningxia—the smallest in terms of both railways and highways. This shows that there are differences in growth according to provinces and indicators. At the same time, these may be indirect marks of correlations between three indicators. We calculated the correlation coefficients in order to reveal correlations of railways and highways. As a result, railways in operation and highways have different correlations with TVEI in all inland provinces. For example, Shaanxi has the highest correlations of railways and highways with TVEI (0.823 and 0.928), Gansu—the lowest correlation of railways (−0.03), and Xinjiang has lower correlations of railways and highways with TVEI.

We conducted the regression analysis in order to analyze the influences of individual TI elements and to estimate future TVEI in the Chinese inland provinces directly affecting by OBOR. As a result, it is seen that contributions of TI elements to TVEI are diverse and standard errors of estimate are relatively large in inland provinces. Results of regression analysis are given in **Appendix A**. Interpretations on results of regression analysis in provinces under study were discussed in subsection 3.2.2.

## 5. Conclusions

This study aims to analyze and forecast the influences of individual TI elements such as railways and highways on TVEI in the Chinese inland provinces directly affecting by OBOR, and to help in rational management related to infrastructural investment under execution of OBOR initiative. Therefore, authors conducted the correlation and regression analysis using panel data of TI elements from 2009 to 2017 according to provinces. Its conclusion is that TI elements contribute in promoting trade in some extend under OBOR, and these contributions are differ among individual inland province. Another conclusion is that individual TI elements affect TVEI differently according to correlations between them. This study can contribute to making decision of ways of investment in infrastructure for ensuring purposeful TVEI in future under execution of OBOR.

Our study has some limitations. First, we conducted analysis using data regarding some elements of infrastructure, that is, railways and highways due to limit of data. Second, we did not ensure the correctness in analysis enough due to catching analysis period of 9 years. Finally, comparability of data is not ensured. This means that scales of infrastructural elements and TVEI rely on populations and areas of provinces. From this, in future research, it is necessary to select data regarding all elements of infrastructure, take long-term analysis period as possible, and ensure the comparability of data in various aspects. Also, it is desirable to analyze based on standardization of data of dependent and independent variables in order to ensure comparability. Such analysis can enhance the correctness and reliability of analysis and help in practical decision-making.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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## Appendix A: Results of Regression Analysis

**Table A1.** Contribution of independent variables to dependent variable[b].

| Model | R | $R^2$ | Adjusted $R^2$ | Standard error of estimate |
|---|---|---|---|---|
| Shaanxi | 0.928[a] | 0.861 | 0.814 | 53,001.881 |
| Gansu | 0.938[a] | 0.880 | 0.840 | 8164.055 |
| Qinghai | 0.520[a] | 0.270 | 0.027 | 4775.666 |
| Ningxia | 0.844[a] | 0.713 | 0.617 | 8744.134 |
| Xinjiang | 0.402[a] | 0.162 | −0.118 | 50,856.252 |

Note: [a]Predictors: (Constant), length of highways (km), length of railways in operation (km); [b]Dependent Variable: TVEI (100 thousand USD). Source: Compiled by author.

**Table A2.** Test of significance[b].

| Model | | Sum of Squares | Degree of freedom | Mean Square | F | Significance |
|---|---|---|---|---|---|---|
| Shaanxi | Regression | 1.040E11 | 2 | 5.202E10 | 18.519 | 0.003[a] |
| | Residual | 1.686E10 | 6 | 2.809E9 | | |
| | Total | 1.209E11 | 8 | | | |
| Gansu | Regression | 2.927E9 | 2 | 1.464E9 | 21.961 | 0.002[a] |
| | Residual | 3.999E8 | 6 | 6.665E7 | | |
| | Total | 3.327E9 | 8 | | | |
| Qinghai | Regression | 5.068E7 | 2 | 2.534E7 | 1.111 | 0.389[a] |
| | Residual | 1.368E8 | 6 | 2.281E7 | | |
| | Total | 1.875E8 | 8 | | | |
| Ningxia | Regression | 1.139E9 | 2 | 5.697E8 | 7.451 | 0.024[a] |
| | Residual | 4.588E8 | 6 | 7.646E7 | | |
| | Total | 1.598E9 | 8 | | | |
| Xinjiang | Regression | 2.994E9 | 2 | 1.497E9 | 0.579 | 0.589[a] |
| | Residual | 1.552E10 | 6 | 2.586E9 | | |
| | Total | 1.851E10 | 8 | | | |

Note: [a]Predictors: (Constant), length of highways (km), length of railways in operation (km); [b]Dependent Variable: TVEI (100 thousand USD). Source: Compiled by author.

**Table A3.** Regression coefficients[a].

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Significance | 95% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Standard Error | Beta | | | Lower Bound | Upper Bound |
| Shaanxi | (Constant) | −1.457E6 | 315,898.881 | | −4.611 | 0.004 | −2.230E6 | −683,735.040 |
| | length of highways (km) | −6.998 | 87.929 | −0.027 | −0.080 | 0.939 | −222.154 | 208.157 |
| | length of railways in operation (km) | 10.488 | 3.728 | 0.952 | 2.814 | 0.031 | 1.367 | 19.609 |
| Gansu | (Constant) | −209,921.285 | 50,903.989 | | −4.124 | 0.006 | −334,478.858 | 85,363.712 |
| | length of highways (km) | −38.688 | 5.983 | −1.670 | −6.467 | 0.001 | −53.326 | −24.049 |
| | length of railways in operation (km) | 3.087 | 0.498 | 1.602 | 6.204 | 0.001 | 1.870 | 4.305 |

**Continued**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Qinghai | (Constant) | −10,163.314 | 16,075.344 | | −0.632 | 0.551 | −49,498.264 | 29,171.636 |
| | length of highways (km) | 14.578 | 22.703 | 0.673 | 0.642 | 0.545 | −40.974 | 70.131 |
| | length of railways in operation (km) | −0.108 | 0.686 | −0.166 | −0.158 | 0.880 | −1.786 | 1.569 |
| Ningxia | (Constant) | −49,228.595 | 27,452.731 | | −1.793 | 0.123 | −116,403.008 | 17,945.817 |
| | length of highways (km) | 18.885 | 30.031 | 0.190 | 0.629 | 0.553 | −54.600 | 92.369 |
| | length of railways in operation (km) | 1.997 | 0.861 | 0.702 | 2.319 | 0.060 | −0.110 | 4.105 |
| Xinjiang | (Constant) | −310,552.721 | 513,292.556 | | −0.605 | 0.567 | −1.567E6 | 945,428.917 |
| | length of highways (km) | −62.760 | 82.767 | −1.099 | −0.758 | 0.477 | −265.283 | 139.762 |
| | length of railways in operation (km) | 0.150 | 0.056 | 0.909 | 0.929 | 0.388 | −8.107 | 18.039 |

[a]Dependent Variable: TVEI (100 thousand USD). Source: Compiled by author.

**Table A4.** Estimation of TVEI using regression equation[a].

| Province | Indicator | Case Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Shaanxi | Standard residual | 0.992 | −0.933 | 0.712 | −1.120 | −0.827 | 0.176 | 0.173 | −0.392 | 1.220 |
| | TVEI (100 thousand USD) | 84,054 | 12,102 | 146,473 | 147,990 | 201,281 | 273,645 | 304,985 | 299,472 | 402,028 |
| | Predicted value | 31,501.90 | 61,562.14 | 108,757.74 | 207,344.12 | 245,098.68 | 264,325.88 | 295,789.62 | 320,260.78 | 337,388.48 |
| | Residual | 5.255E4 | −4.946E4 | 3.771E4 | −5.935E4 | −4.382E4 | 9.319E3 | 9.195E3 | −2.079E4 | 6.464E4 |
| Gansu | Standard residual | −1.288 | 1.192 | 1.001 | −1.150 | 0.052 | 0.187 | 0.483 | −0.563 | 0.087 |
| | TVEI (100 thousand USD) | 38656 | 74030 | 87286 | 89008 | 102361 | 86406 | 79520 | 68330 | 48263 |
| | Predicted value | 49,167.93 | 64,295.14 | 79,113.64 | 98,398.79 | 101,939.28 | 84,881.60 | 75,580.96 | 72,927.54 | 47,553.99 |
| | Residual | −1.051E4 | 9.734E3 | 8.172E3 | −9.391E3 | 421.777 | 1.525E3 | 3.939E3 | −4.598E3 | 709.343 |
| Qinghai | Standard residual | −0.469 | −0.608 | −0.278 | 0.250 | 0.857 | 0.965 | 0.874 | 0.093 | −1.684 |
| | TVEI (100 thousand USD) | 5868 | 7890 | 9238 | 11,575 | 14,027 | 17,179 | 19,345 | 15,292 | 6558 |
| | Predicted value | 8105.34 | 10,793.39 | 10,565.75 | 10,381.48 | 9937.05 | 12,570.90 | 15,172.23 | 14,847.04 | 14,597.73 |
| | Residual | −2.237E3 | −2.904E3 | −1.328E3 | 1.193E3 | 4.090E3 | 4.608E3 | 4.172E3 | 444.999 | −8.040E3 |
| Ningxia | Standard residual | 0.081 | 0.140 | −0.160 | −0.696 | −0.031 | 1.888 | −0.485 | −1.202 | 0.466 |
| | TVEI (100 thousand USD) | 12,025 | 19,600 | 22,857 | 22,167 | 32,177 | 54,352 | 37,393 | 32,525 | 50,395 |
| | Predicted value | 11,312.58 | 18,376.17 | 24,259.59 | 28,254.55 | 32,449.26 | 37,842.47 | 41,637.68 | 43,035.92 | 46,322.61 |
| | Residual | 712.210 | 1.224E3 | −1.402E3 | −6.087E3 | −272.404 | 1.651E4 | −4.245E3 | −1.051E4 | 4.073E3 |
| Xinjiang | Standard residual | −1.300 | −.263 | 0.745 | 0.656 | 0.707 | 1.198 | −0.155 | −0.926 | −0.662 |
| | TVEI (100 thousand USD) | 139,478 | 171,301 | 228,197 | 251,701 | 275,614 | 276,723 | 196,694 | 176,377 | 205,685 |
| | Predicted value | 205,605.43 | 184,653.82 | 190,296.11 | 218,327.84 | 239,681.50 | 215,792.90 | 204,593.49 | 223,464.16 | 239,355.26 |
| | Residual | −6.613E4 | −1.335E4 | 3.790E4 | 3.337E4 | 3.593E4 | 6.093E4 | −7.900E3 | −4.709E4 | −3.367E4 |

[a]Dependent Variable: TVEI (100 thousand USD). Source: Compiled by author.