

# A synthetic difference-in-differences model for the influence of CR Express on Chongqing's economy

CR Express's  
influence on  
Chongqing's  
economy

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## Abstract

**Purpose** – The China–Europe Railway Express (CR Express) in Chongqing has operated regularly and undergone large-scale development. Its impact on Chongqing's economic growth has become increasingly evident, necessitating further research in this field.

**Design/methodology/approach** – This study employs the opening of CR Express as a quasi-natural experiment, designating Chongqing, which inaugurated the CR Express in 2011, as the treatment group. 13 provinces and cities that had not yet opened the CR Express until 2017 were selected as the control group. Utilizing panel data from 14 provinces across China spanning from 2006 to 2017, the synthetic control method (SCM) is employed to synthetically construct Chongqing. To quantify the difference in economic development levels between Chongqing with the operation of the CR express and Chongqing without its operation. Key metrics such as gross domestic product (GDP), per capita GDP, total retail sales of consumer goods, import and export value and the proportions of the secondary and tertiary industries are employed to measure urban economic development capabilities. Chongqing is designated as the experimental group, and a double-difference model is constructed to regress the operation of the CR Express against economic development capabilities. Robustness tests are conducted to validate the analytical results.

**Findings** – The results indicate that, compared to provinces without the operation of the CR Express, the initiation of the CR Express in Chongqing significantly enhances the economic development level of the city. The opening of the CR Express exhibits a pronounced positive impact on Chongqing's economic development, and these findings remain robust and effective even after parallel trend tests and placebo tests.

**Originality/value** – The study represents an expansion of the theoretical framework. In contrast to previous studies that relied on a single indicator such as GDP, this study selects six indicators from the dimensions of economy, trade and industry to measure regional economic development capabilities. Furthermore, employing the grey relational analysis method, the study screens these indicators, thereby providing a theoretical basis for the selection of indicators for measuring regional economic development capabilities.

**Keywords** CR Express, Regional economic development, Synthetic model, Difference-in-differences method

**Paper type** Research paper

## 1. Introduction

The China–Europe Railway Express (CR Express) has revolutionized the international trade transport landscape traditionally dominated by sea and air transport. It advances the reform and development of global supply chains and plays a crucial role in facilitating import and



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export trade and international economic cooperation between cities where it operates and other countries worldwide. Government subsidies have reduced the freight costs of CR Express by 60%, providing them with a significant competitive advantage over maritime shipping in terms of cost. Specifically, this advantage is more pronounced in the category of information technology (IT) products within CR Express service (Jiang, Shen, Peng, & Yu, 2018). CR Express stimulates greater trade growth in the cities of origin and destination than in the cities along its route (Liu & Li, 2020). Since its opening, CR Express (Chongqing) has experienced substantial growth, with an increasing number and frequency of train trips. Achieving a two-way balance, the volume of loaded containers has consistently risen, and the quality of CR Express operations has improved continuously. Moreover, there has been a gradual diversification in the types of goods being transported. The CR Express (Chongqing) catalyzes the transformation and upgrading of Chongqing's transport, foreign trade growth and industrial structure changes. It stands as an important initiative towards accelerating this city's quest to become a pacesetter for opening-up in China's inland areas.

Following CR Express's opening, various studies have shed light on its impacts on import and export trade, production factors and industrial structure. Most studies typically analyze China's trade relations and outward foreign direct investment with countries along the "Belt and Road" through the construction of classical gravity models or multiple difference models (Lu, Dong, & Ye, 2020; Julia, Mathilde, & Anthony, 2020). CR Express significantly promoted my country's export trade to the regions along the "Belt and Road" through the two intermediary mechanisms of trade cost effect and policy subsidy effect (Yang & Li, 2023). Based on the difference-in-differences (DID) method, study reveals that CR Express operations have a significant impact on enhancing trade opening-up extent in the western regions and large cities of China. However, they did not yield a significant impact on the eastern and central regions and small and medium-sized cities (Fang, Lu, & Wei, 2020). The opening of CR Express has significantly enhanced the bilateral trade potential between countries along the routes and China (Huang, 2021) and has a particularly significant impact on industrial upgrading in the central and western regions of China. CR Express, with its reliance on central areas, transport corridors and inland free trade zones amplifies its effect on industrial upgrading (Li, Wen, & Wang, 2021). Through research on the total factor productivity of exporting enterprises, Fang and Zhao (2022), Xie and Fang (2022) and Xie (2021) concluded that the opening of the CR Express has increased the productivity of exporting enterprises and significantly enhanced the total factor productivity of the cities where they operate. The Belt and Road Initiative can drive the upgrading of the urban industrial structure by leveraging the technological promotion effect, industrial transfer effect and tertiary industry development effect (Fang & Zhao, 2021) and can promote enterprise upgrading through research and development innovation, and enterprise upgrading is also a micro-level manifestation of industrial structural upgrading. Therefore, this indirectly demonstrates that the Belt and Road Initiative can influence industrial structural upgrading (Wang & Lu, 2019).

Over the past decade, CR Express (Chongqing) has operated regularly and undergone large-scale development. Its impact on Chongqing's economic growth has become increasingly evident, necessitating further research in this field. Considering the changes in Chongqing's economic growth following the opening of the CR Express (Chongqing), both the synthetic control method (SCM) and DID method are used to quantitatively analyze the contribution of CR Express (Chongqing) to the city's economic growth. The relationship between its opening and the city's economic development is examined. Additionally, a placebo test is conducted to demonstrate the robustness of the study conclusions. This paper aims to verify the positive impact of CR Express (Chongqing) on the regional economic development of this city, specifically in the context of China–Europe connectivity under the Belt and Road Initiative. While previous studies have primarily focused on foreign trade, this

study expands on the existing theories by broadening the scope of the study. In terms of study methods, this study employs a combination of the SCM and the DID method. In terms of the selection of explained variables, previous studies often relied on a single indicator, such as gross domestic product (GDP) or GDP per capita. In contrast, this study utilizes a set of six indicators concerning the economy, trade and industry to comprehensively measure the regional economic development capacity. Moreover, grey relation analysis is utilized to filter and select the indicators, providing a theoretical basis for choosing indicators that measure the index of regional economic development capacity.

## **2. Mechanism underlying the impacts of CR Express operations on regional economic development capacity**

Following the operation of the first train in Chongqing in 2011, many cities embraced CR Express operations, resulting in a positive trend of growth. The number and density of trips have increased, while the quality of operations has steadily improved. Therefore, the impact of CR Express on the regional economy has gradually become evident. It serves as a new platform for the trade development of China, facilitating the opening-up of inland cities in China. It is closely intertwined with the economic progress of the cities.

The regular operations of CR Express have promoted the economic and trade development of cities where it operates. Moreover, CR Express has expanded China's network of international trade transport services while effectively reducing transport costs for both inland and border ports. Compared to sea transport, CR Express offers notable advantages in terms of timeliness and service stability. It is particularly efficient in transporting time-sensitive goods with high added value. Furthermore, CR Express's timeliness benefits enterprises by reducing inventory and minimizing tie-up capital. This, in turn, improves capital turnover. In addition, CR Express presents a cost advantage compared to air transport. The regular operations of CR Express can enhance logistics services in CR Express operating areas and facilitate regional business clusters, enabling enterprises involved to intensively participate in the global industrial chain. As a result, it accelerates the division of labor and cooperation among enterprises, reducing unnecessary links and costs in the industrial chain. This will lead to economies of scale, intensive utilization of resources and the production of more cost-effective products, thereby promoting a well-structured industrial development in cities where CR Express operates.

Figure 1 illustrates the theoretical framework of economic development in areas under the impact of CR Express.

This paper posits that the opening of CR Express can enhance regional economic development.

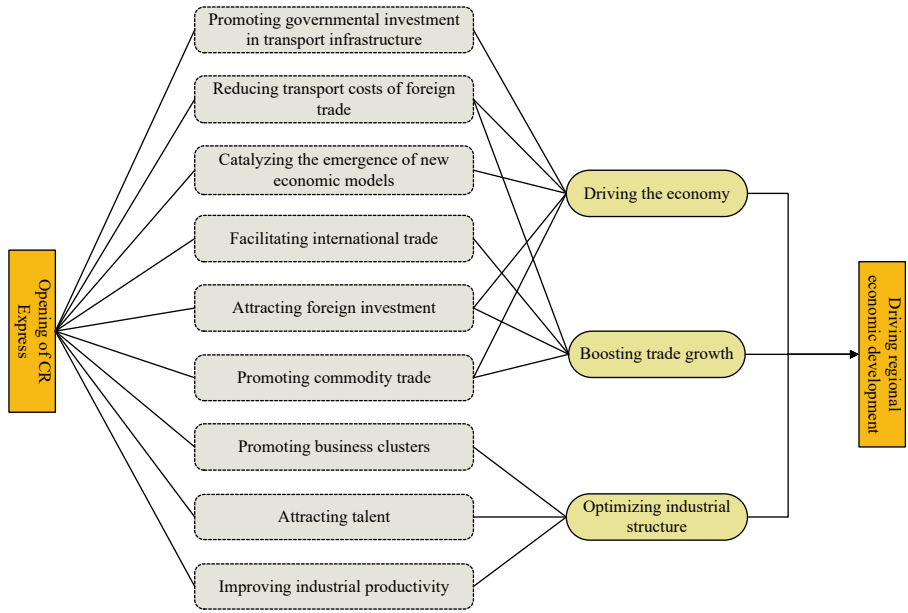
## **3. Measurement and analysis of index of regional economic development capacity**

### *3.1 Indicator establishment*

Regional economic development capacity serves as a comprehensive measure of regional economic development. Based on the principles of diversity, measurability and independence, 11 indicators are selected from three fields, i.e. economy, trade and industry, to establish the index of regional economic development capacity through weighted addition. See Table 1 for details.

### *3.2 Indicator screening and weight determination*

Since CR officially launched the family brand "CHINA RAILWAY Express" on June 8, 2016, Chongqing, Chengdu, Xi'an, Zhengzhou and Urumqi have operated a large number of CR



**Figure 1.** Mechanism underlying CR express’s impact on promoting regional economic development

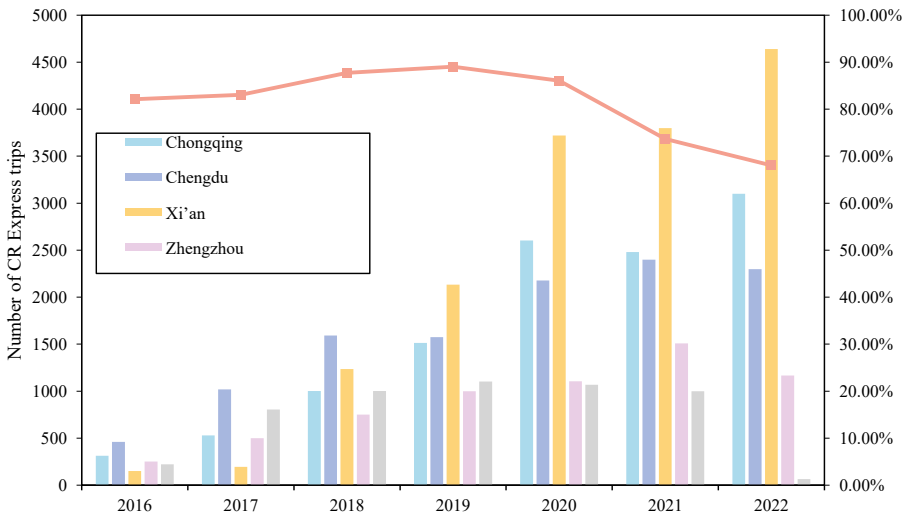
Source(s): Authors’ own

Type of variables	Field	Indicator	Unit
Regional economic development capacity	Economy	Regional GDP	RMB 100 million yuan
		Regional GDP per capita	RMB yuan
		Fixed asset investment	RMB 10,000 yuan
		General public budget revenue	RMB 10,000 yuan
	Trade	Total retail sales of consumer goods	RMB 100 million yuan
		Total import and export value	RMB 100 million yuan
		Amount of foreign direct investment	USD 100 million
	Industry	Share of the secondary industry	%
		Share of the tertiary industry	%
		Railway freight volume	10,000t
Operating length of railway		10,000km	

**Table 1.** Indicators of regional economic development capacity

Source(s): Authors’ own

Express trains (See Figure 2 for details). During the 2016–2022 period, the total number of CR Express trips of these five cities averagely accounted for 81.4% of the annual total number (See Table 2 for details). In 2020, these representative cities were listed as CR Express hub demonstration cities. Therefore, the five cities mentioned above are used as the objects of this study.



**Figure 2.** Number and share of CR express trips of five hubs in 2016–2022

Source(s): Authors' own

Year	Chongqing	Chengdu	Xi'an	Zhengzhou	Urumqi	Number of CR express trips	Share of CR express trips of five hubs (%)
2016	313	460	151	251	223	1,702	82.14
2017	530	1,020	194	501	806	3,673	83.07
2018	1,002	1,591	1,235	752	1,002	6,363	87.73
2019	1,513	1,576	2,133	1,000	1,102	8,225	89.05
2020	2,604	2,177	3,720	1,106	1,068	12,406	86.05
2021	2,480	2,398	3,800	1,508	1,000	15,183	73.67
2022	3,101	2,297	4,639	1,167	65	1,6562	68.04

**Table 2.** Number of CR express trips of the five hubs in 2016–2022

Source(s): <https://www.crexpress.cn/#/home> and statistical communique of Zhengzhou over these years

After factors with impacts on regional economic development capacity are qualitatively analyzed, the impact extent and significance of each factor need to be quantitatively analyzed. The grey relation analysis is employed to assess the relation degree between the number of CR Express trips and each economic indicator to indicate the intensity of CR Express's impacts on all aspects of the regional economy. The calculation steps are described below:

Step 1: Determine the reference sequence and comparison sequence. The number of CR Express trips is used as the reference sequence and economic indicators are used as the comparative sequence. The sequence  $x_n = (x_{(0)}, x_{(1)}, \dots, x_{(11)})$  ( $n = 0, 1, \dots, 11$ ) is given.

Step 2: Non-dimensionalize each indicator with the normalization method:

$$x'_n = \frac{x_n - x_{min}}{x_{max} - x_{min}} \quad (1)$$

After the sequence dimension difference is processed, the value of each variable sequence is within [0, 1].

Step 3: Calculate the coefficient of grey relation between factors:

$$\xi_{ik} = \frac{\min_{ik} |x_0(k)' - x_i(k)'| + \rho \times \max_{ik} |x_0(k)' - x_i(k)'|}{|x_0(k)' - x_i(k)'| + \rho \times \max_{ik} |x_0(k)' - x_i(k)'|} \quad (2)$$

where,  $\xi_{ik}$  represents the coefficient of the relation between the number of CR Express trips and the  $i$  th indicator at time  $k$ . In general, the larger the resolution coefficient  $\rho$  is, the greater the resolution will be; the smaller  $\rho$  is, the smaller the resolution will be.  $\rho$  is within (0, 1) and is set to 0.5 in this study.

Step 4: Calculate the grey relation degree:

$$y_{0i} = \frac{1}{n} \sum_k \xi_{ik} \quad (3)$$

where,  $y_{0i}$  represents the grey relation degree between the number of CR Express trips and the  $i$  th indicator, indicating the degree of the impact of CR Express on the urban economy.

Use the MATLAB tool to perform relevant operations of grey relation analysis and work out the values of the relation degree between CR Express and economic indicators. The results are given in Table 3 below.

According to the results above, the indicators with an average relation degree of less than 0.6 are excluded. The SPSS software is used to check the multicollinearity of the remaining indicators, including the regional GDP, regional GDP per capita, total retail sales of consumer goods, total import and export value, share of the secondary industry, share of the tertiary industry and railway freight volume indicators. The number of CR Express trips of each province/municipality represents the regression variable. The variance inflation factors (VIFs) of the regional GDP, regional GDP per capita, share of the secondary industry and share of the tertiary industry are all greater than 10. This indicates that the multicollinearity of the model is serious, so the regional GDP per capita is excluded. As products from the manufacturing sector constitute the majority of the CR Express freight, the share of the tertiary industry is excluded. Then, the model is regressed again. The VIFs of all the variables are less than 10, indicating that the multicollinearity of the model is fully eliminated.

Indicator\operating province/ municipality	Hebei	Chongqing	Sichuan	Shaanxi	Xinjiang	Average relation degree
Regional GDP	0.6612	0.7532	0.7122	0.8542	0.6496	0.7261
Regional GDP per capita	0.6772	0.6212	0.6857	0.7542	0.6496	0.6776
Fixed asset investment	0.5017	0.5844	0.5219	0.4511	0.5623	0.5243
General public budget revenue	0.4304	0.5331	0.5711	0.4256	0.5211	0.4963
Total retail sales of consumer goods	0.6987	0.6118	0.6624	0.6792	0.6747	0.6654
Total import and export value	0.7573	0.8852	0.8008	0.8144	0.8756	0.8267
Amount of foreign direct investment	0.5366	0.5867	0.5921	0.5304	0.4211	0.5334
Share of the secondary industry	0.8124	0.8641	0.8011	0.7895	0.6417	0.7818
Share of the tertiary industry	0.7211	0.6241	0.6351	0.7117	0.6842	0.6752
Railway freight volume	0.7851	0.8624	0.8103	0.7941	0.8213	0.8146
Length of operating railways	0.4622	0.7104	0.6512	0.4851	0.4311	0.5480

Source(s): Authors' own

**Table 3.**  
Relation degree  
between CR express  
and economic  
indicators

To enhance the robustness of assessment results, the entropy method is used to determine the weight of each indicator of regional economic development capacity. Results of the weights of regional economic development capacity indicators are given in Table 4.

### 3.3 Measurement model for index of regional economic development capability

A weighted regression model for the index of regional economic development capacity is established as follows:

$$Y_{it} = \theta_1 X_{i1t} + \theta_2 X_{i2t} + \theta_3 X_{i3t} + \theta_4 X_{i4t} + \theta_5 X_{i5t} \quad (4)$$

where,  $Y_{it}$  ( $i = 1, 2, \dots, 14; t = 2006, 2007, \dots, 2017$ ) represents the index of regional economic development capacity of the  $i$  th region in the  $t$  year;  $\theta_j$  ( $j = 1, 2, \dots, 5$ ) represents the weight of five indicators of regional economic development capacity;  $X_{ijt}$  ( $j = 1, 2, \dots, 5$ ) represents the value of the  $j$  th indicator in the  $i$  th region in the  $t$  th year.

## 4. Model settings and data description

### 4.1 Model settings

According to the natural experiment concept, to study the impact of CR Express on Chongqing's economic development, it is necessary to control the impact of other factors. Based on the SCM proposed by Abadie and Gardeazabal (2003), the economic situation of Chongqing before the opening of CR Express is fitted through the weighted synthesis of 13 provinces without CR Express operations before 2017. The results are used for comparison. The model is as follows:

$$\Delta_{it} = Y_{it}^a - Y_{it}^b \quad (5)$$

where,  $\Delta_{it}$  represents the change in regional economic development capacity of the  $i$  th province within time  $t$  resulting from CR Express's opening;  $Y_{it}^a$  represents the change in regional economic development capacity of the  $i$  th province with CR Express operations within time  $t$ ;  $Y_{it}^b$  represents the change in regional economic development capacity of the  $i$  th province without CR Express operations within time  $t$ .

For the provinces with CR Express operations, the  $Y_{it}^a$  can be observed but  $Y_{it}^b$  cannot be observed. Therefore, the factor model is used to estimate  $Y_{it}^b$  in this study.

$$Y_{it}^b = \delta_t + \theta_i Z_i + \beta_i \mu_i + \varepsilon_{it} \quad (6)$$

where,  $\delta_t$  represents the time fixed effect of economic factors influencing all the provinces.  $\varepsilon_{it}$  represents unobservable short-term impacts (a zero mean at the regional level is assumed).  $Z_i$  represents the variable not subject to the control of CR Express operations and  $\theta_i$  represents an unknown parameter vector.  $\mu_i$  represents the unobservable province fixed effect.  $\beta_i$  represents the unobservable common factor vector.

Indicator	Weight
Regional GDP ( $X_1$ )	0.22
Total retail sales of consumer goods ( $X_2$ )	0.18
Total import and export value ( $X_3$ )	0.25
Share of the secondary industry ( $X_4$ )	0.20
Railway freight volume ( $X_5$ )	0.15

Source(s): Authors' own

**Table 4.**  
Measurement indicator  
system for regional  
economic development  
capacity

The “Synthetic Chongqing” obtained by weighting the data of provinces without CR Express operations can be used to simulate how Chongqing’s economy would develop without CR Express (Chongqing) operations. The difference in regional economic development capacity between “Synthetic Chongqing” and Chongqing with CR Express (Chongqing) operations represents the impact of CR Express (Chongqing) operations on the regional economic development capacity of this city.

The “Synthetic Chongqing” obtained by SCM serves as the control group for further study by DID. The model is established as follows:

$$Y_{it} = \beta_0 + \beta_1 \times du_i + \beta_2 \times dt_i + \beta_3 \times du_i \times dt_i + \theta_j \times X_{it} + \varepsilon_t \quad (7)$$

where,  $Y_{it}$  represent the explained variable, i.e. the regional economic development capacity of provinces/municipalities with CR Express operations;  $du_i$  represents the region dummy variable,  $du_i = 1$  represents the experimental group and  $du_i = 0$  represents the control group;  $dt_i$  represents the time dummy variable and  $dt_i = 1$  represents after CR Express’s opening and  $dt_i = 0$  represents before CR Express’s opening;  $du_i \times dt_i$  represents the cross-term of region dummy variable and time dummy variable;  $X_{it}$  represents the control variable, including railway freight volume, government intervention, per capita disposable income and per capita consumption expenditure; coefficient  $\theta_j$  represents the regression coefficient of control variable; coefficient  $\beta_0$  represents a constant term of the control group before CR Express’s opening; coefficient  $\beta_1$  represents the difference between the experimental group and the control group before CR Express’s opening; coefficient  $\beta_2$  represents the difference in the control group before and after CR Express’s opening; coefficient  $\beta_3$  represents the policy effect of CR Express’s opening, i.e. the impact of CR Express’s opening on the economic development of the province;  $\varepsilon_t$  represents the model residual term.

#### 4.2 Data sources

The data of the model are sourced from the statistical yearbooks of the provinces and municipalities of the corresponding years and the website of the National Bureau of Statistics. Due to the significant rise in the number of provinces with CR Express operations after 2017, excluding these provinces from the analysis would make the sample data too little. This decrease in sample size may impact the robustness and validity of the experiment. Therefore, the data from the 12 years of 2006–2017 are used for the study.

CR Express’s opening years in various provinces and municipalities are listed in [Table 5](#).

The provinces without CR Express operations before 2017 constitute the control group for Chongqing. However, certain provinces are excluded from the control group for two reasons: (1) These provinces had already opened CR Express operations before 2017; (2) Xizang, Hong Kong, Macao and Taiwan have limited or missing data.

#### 4.3 Description of variables

##### (1) Explained variable

The explained variable refers to the indicator system established in Chapter 2, and the index of regional economic development capacity ( $Y_{it}$ ) serves as the explained variable.

##### (2) Explanatory variables

$dt_i$ : time dummy variable. It is set to 1 after CR Express’s opening, or 0 otherwise; for Chongqing,  $dt_1 = 0$  represents before 2011 and  $dt_1 = 1$  represents after 2011.

$du_i$ : region dummy variable.  $du_i = 1$  represents the experimental group (Chongqing with CR Express operations);  $du_i = 0$  represents the control group (provinces without CR Express operations).

Province/municipality	Opening year	Province/municipality	Opening year
Beijing	–	Henan	2014
Tianjin	2017	Hubei	2015
Hebei	2016	Hunan	2013
Shanxi	2017	Guangdong	2017
Inner Mongolia	2017	Guangxi	–
Liaoning	2015	Hainan	–
Jilin	2016	Chongqing	2011
Heilongjiang	2016	Sichuan	2013
Shanghai	–	Guizhou	–
Jiangsu	2014	Yunnan	2016
Zhejiang	2015	Shaanxi	2015
Anhui	2015	Gansu	2016
Fujian	2016	Qinghai	2017
Jiangxi	–	Ningxia	–
Shandong	2017	Xinjiang	2016
		Xizang	–

**Table 5.**  
CR express's opening  
years in provinces and  
municipalities

Source(s): <https://www.imsilkroad.com/>

$du_i \times dt_i$ : CR Express utility variable, i.e. the cross-term of region dummy variable and time dummy variable.

### (3) Control variables

With reference to the results of previous studies, the endogenous problems caused by missing variables of the model are alleviated as much as possible. Finally, the railway freight volume (*railway*), government intervention (*gov*), per capita disposable income (*pdi*) and per capita consumption expenditure (*crb*) are selected as control variables. Among them, government intervention (*gov*) is measured by the ratio of fiscal revenue to regional GDP.

The data in this study undergo logarithmic value processing to establish the six indicators for the regional economic development capacity. In this way, the measurement problems caused by different dimensions of data are eliminated. Additionally, the data are weighted using the entropy value method based on predetermined weights. This process determines the indicator data for the regional economic development capacity of each province in each year. Furthermore, to eliminate potential heteroscedasticity, the explained variable and the control variable undergo logarithmic transformations in the empirical study. Refer to Table 6 for the descriptive statistical results.

	Variable	Mean value	Standard deviation	Minimum value	Maximum value
Explained variable	$Y_{it}$	6.01456	0.9780979	3.8444	7.9501
Explanatory variable	$dt_i$	0.5833333	0.4944805	0	1
Explanatory variable	$du_i$	0.0714286	0.2583093	0	1
Core explanatory variables	$du_i \times dt_i$	0.0416667	0.2004237	0	1
Control variable	$\ln railway$	8.651606	1.351971	6.1334	11.2894
	$\ln gov$	-1.812568	0.5485251	-2.6443	-0.1567
	$\ln pdi$	9.330802	0.5529073	8.0577	10.5914
	$\ln crb$	9.685325	0.5640076	8.298	10.9851

**Table 6.**  
Descriptive statistical  
results of variables

Source(s): Authors' own

**5. Empirical study**

*5.1 Analysis of empirical results*

(1) SCM

The opening of CR Express (Chongqing) is considered a natural experiment and 13 provinces of the control group are weighted to form “Synthetic Chongqing”. Fitting is performed to acquire the regional economic development capacity in the case of Chongqing without CR Express operations. The result serves as the control group for Chongqing to investigate the impact of CR Express operations (Chongqing-Xinjiang-Europe) on Chongqing’s regional economic development capacity. The weight components of “Synthetic Chongqing” are given in Table 7.

Table 8 gives the mean values of all relevant variables of “Synthetic Chongqing” and Chongqing before the opening of CR Express (Chongqing-Xinjiang-Europe) (referred to as “before intervention”). It can be seen that their deviations are very small (within 8%). Furthermore, the mean square prediction error (MSPE) before intervention is very small, only 0.111716. All these indicate a good fitting effect, so “Synthetic Chongqing” is a suitable control group for Chongqing.

Figure 3 illustrates the curve fitting of Chongqing and “Synthetic Chongqing”. It is evident that before 2011, namely, before the opening of CR Express (Chongqing), the solid line representing Chongqing and the dotted line representing “Synthetic Chongqing” exhibited a similar upward trend. This suggests that the “Synthetic Chongqing” successfully fitted with Chongqing before CR Express’s opening. So, “Synthetic Chongqing” is a suitable control group for Chongqing.

In early 2011 (the data in 2010 can be deemed as data of early 2011 due to their year-end aggregation), a gap started to emerge between the solid line and the dotted line. The solid line representing Chongqing rises at a much higher rate, and the gap between Chongqing and “Synthetic Chongqing” continues to widen. This shows that compared with “Synthetic Chongqing”, Chongqing’s regional economic development improved rapidly after the opening of CR Express (Chongqing), demonstrating that the opening can promote the regional economic development capacity of this city.

Figure 4 shows the impact of CR Express (Chongqing-Xinjiang-Europe) on Chongqing’s regional economic development capacity, i.e. the difference between the real export value and

**Table 7.**  
Weight components of  
“synthetic Chongqing”

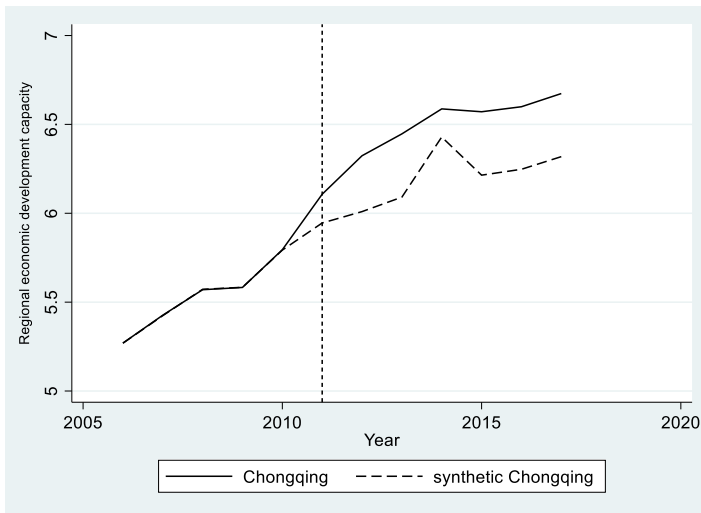
Province/municipality	Jiangxi	Beijing	Ningxia	Qinghai
Weight	0.563	0.223	0.136	0.078

**Source(s):** Authors’ own

**Table 8.**  
Comparison of mean  
values of variables  
between Chongqing  
and “synthetic  
Chongqing”

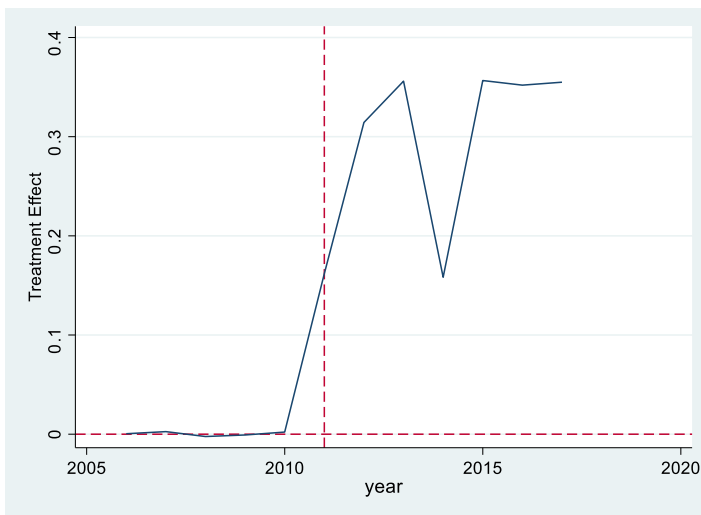
Variable	Chongqing	“Synthetic Chongqing”	Deviation (%)
$\ln railway$	7.66	8.27	8.02
$\ln gov$	-1.43	-1.49	3.86
$\ln pdi$	8.85	8.92	0.72
$\ln Ur$	9.58	9.21	-3.84
$Y_{it}$ (2006)	5.27	5.27	-0.01
$Y_{it}$ (2008)	5.57	5.57	0.04
$Y_{it}$ (2010)	5.79	5.79	-0.04

**Source(s):** Authors’ own



Source(s): Authors' own

**Figure 3.**  
Curve fitting of  
Chongqing and  
"synthetic Chongqing"



Source(s): Authors' own

**Figure 4.**  
Differences in regional  
economic development  
capacity between  
Chongqing and  
"synthetic Chongqing"

the synthetic export value. It can be seen that before 2011, the economic development gap between Chongqing and "Synthetic Chongqing" fluctuated around the zero axis within a range of plus or minus 0.5. However, after 2011, the impact broke through the zero axis and experienced a sharp rise. It reached a value of 3.5 at the end of the sample period.

Figures 3 and 4 reveal that there existed a gap between the actual value and the synthetic value of Chongqing's regional development capacity before the opening of CR Express. However, this gap remained within a certain range. Following the official opening of CR Express (Chongqing), the gap widened noticeably. This suggests that the opening of CR

Express has significantly enhanced the economic development capacity of the city and contributed to the economy.

(2) DID method – investigating the impact of CR Express (Chongqing) from the perspective of statistics

A DID model is created to assess the impact of CR Express on Chongqing’s economic development. “Synthetic Chongqing” serves as the control group and Chongqing as the experimental group for DID analysis. Table 9 shows the results based on empirical model (3).

According to the regression results, the SCM-DID policy treatment effect of CR Express (Chongqing) is 0.32298. It shows that compared with provinces and municipalities without CR Express operations, the index of regional economic development capacity of Chongqing has increased by 0.32298 after the opening of CR Express. The specific effect is shown in Figure 5. The core explanatory variable  $du_i \times dt_i$  of this experiment exerts a positive significant effect at the significance level of 1%, indicating that the opening of CR Express (Chongqing) has significantly promoted Chongqing’s regional economic development capacity.

5.2 Robustness tests

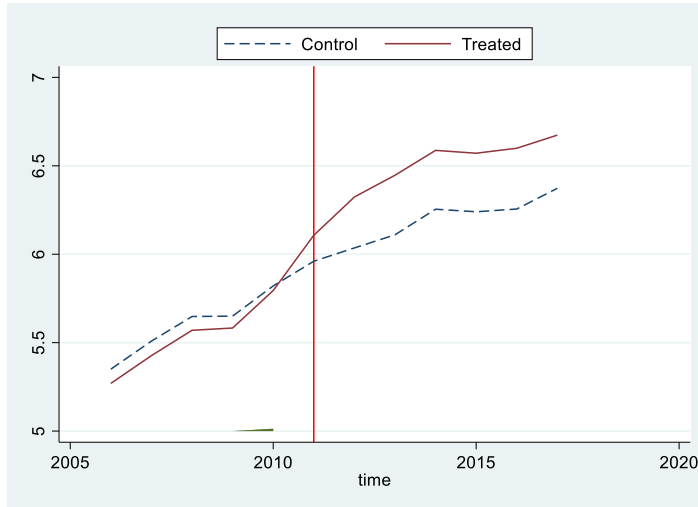
(1) Parallel trend test

A parallel trend test is conducted on the DID model for “Synthetic Chongqing” fitted by SCM. The results of the parallel trend test are shown in Figure 6. It can be seen that Chongqing and

**Table 9.**  
DID analysis results of  
“synthetic Chongqing”  
and Chongqing

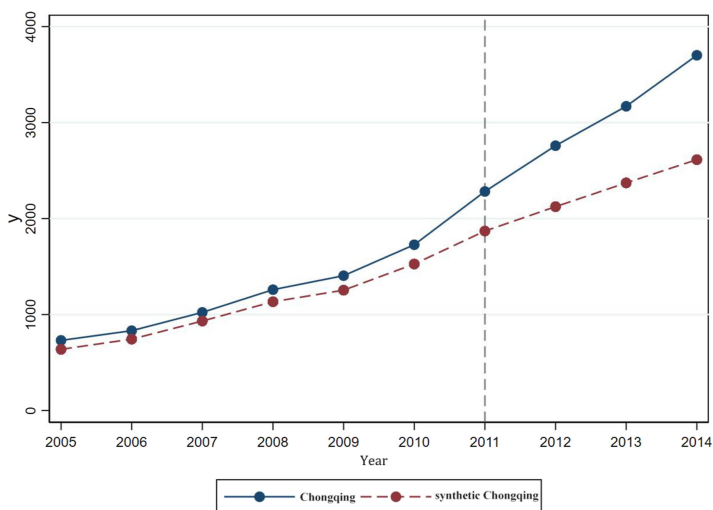
$Y_{it}$	ATT	Std. Err	t	$p> t $	[95%Conf.Interval]
$du_i \times dt_i$	0.32298	0.09721	3.32	0.001	0.13246 0.51350

Source(s): Authors’ own



**Figure 5.**  
Treatment effect of  
SCM-DID model

Source(s): Authors’ own

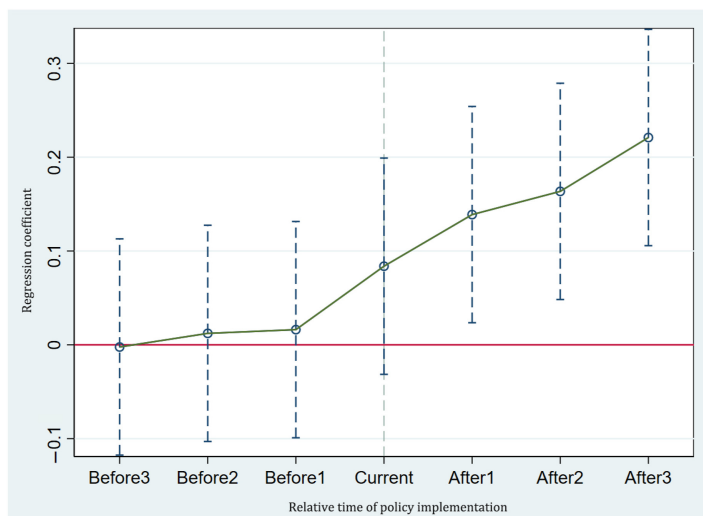


Source(s): Authors' own

Figure 6.  
Parallel trend test of  
SCM-DID model

“Synthetic Chongqing” exhibited the same development trend before 2011, and the result passed the parallel trend test.

A hypothetical opening year is defined. This allows for the grouping of three years before the opening, the year of opening and three years after the opening as the policy implementation years for the treatment group. Seven indicator variables are then established: Before3, Before2, Before1, Current, After1, After2 and After3. A regression analysis is conducted using the DID model. This involves performing separate regressions each year. Figure 7 presents the coefficient regression results of the



Source(s): Authors' own

Figure 7.  
Results of parallel  
trend test of SCM-  
DID model

parallel trend test of the DID model. It can be seen that the regression coefficient of the first three years before the policy implementation is not significant, indicating that the result passes the placebo test. This demonstrates that the policy effect previously identified is reliable. However, the regression coefficient became significant immediately after 2011, indicating that the opening of CR Express has significantly promoted Chongqing's economy.

(2) Placebo test

The placebo test primarily aims to examine whether changes in the impacted objects are only related to the policy implementation. Following the practices of [Eliana, Alberto, and Suzanne \(2012\)](#) and [Li, Lu, and Jin \(2016\)](#) a hypothetical treatment group is defined, an interaction term  $du_i \times dt_i$  is randomly sampled and then incorporated into the DID model for regression. Finally, the reliability of the results is assessed according to the probability of the baseline regression estimated coefficient of the false experiment. To enhance the robustness of the results, the process described above is repeated 500 times to get the estimated coefficient distribution of the coefficient  $du_i \times dt_i$ .

Based on the experiment above, an assessment is conducted on whether Chongqing's economic development is under the impacts other than the opening of CR Express. If the estimated coefficients of  $du_i \times dt_i$  upon random treatment are distributed around 0, it indicates that the impact effect in the baseline analysis is indeed a result of the opening of CR Express. It can be seen from the estimated coefficient distribution shown in [Figure 8](#) that the estimated coefficients of the DID term in the random process concentrate around 0, indicating that there is no serious missing variable problem in model settings and the core conclusion remains robust.

6. Conclusion

In this study, the opening of CR Express (Chongqing) is deemed as an exogenous impact. The panel data in 2006–2017 of several provinces and Chongqing Municipality are utilized

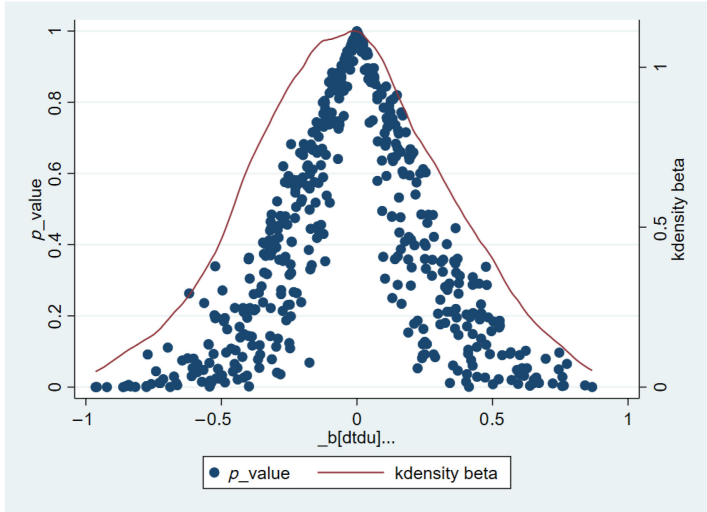


Figure 8.  
Placebo test

Source(s): Authors' own

to establish a panel regression model employing the SCM and DID methods. Regression analysis is performed on the opening of CR Express (Chongqing) and Chongqing's economic development capacity. The data of 14 provinces and municipalities are used for the study. The "whether CR Express opens" variable is treated as a dummy variable and deemed as the core explanatory variable. The regression results demonstrate that the opening of CR Express significantly promotes the regional economic development capacity. Then, a parallel trend test and a placebo test are conducted on the regression results, thereby validating the robustness of the study conclusions. Therefore, it is essential for Chongqing to continue vigorously implementing the Belt and Road Initiative in the following aspects:

- (1) Chongqing, being located in southwest China without convenient sea transport channels like coastal cities, can still leverage its geographical advantage in terms of connectivity between Asia and Europe. Inland cities are comparatively closer to new trade partners, presenting a significant opportunity. The following efforts should be undertaken: (1) Enhancing CR Express improvement and expanding the construction of supporting facilities for CR Express guided by the comprehensive top-level design and reasonable arrangement of the government; (2) Increasing the freight volume and the number of train trips of CR Express; (3) Continuously increasing the volume of import and export trade; (4) Attracting international direct investment; (5) Implementing a reasonable industrial distribution plan and promoting business clusters, thus enhancing the economic development capacity of Chongqing.
- (2) Chongqing should leverage the capital flow effect and regional innovation effect of CR Express to boost its industrial upgrading and enhance its comprehensive competitiveness. The opening of CR Express will stimulate enterprises to increase investment in scientific research and innovation. Additionally, the improved connectivity with the European market enables Chongqing to access high-end technology and management expertise at a reduced cost, thereby facilitating industrial upgrading and enhancing regional economic strength.
- (3) Chongqing should enhance the advantages of CR Express and develop it into a well-established international freight channel. CR Express services are more suited for time-sensitive products with high added value. Therefore, Chongqing should capitalize on the unique advantages of CR Express as a distinct third transportation option, different from sea and air transport. By consistently securing freight orders for such products and generating continuous value and profit, Chongqing should leverage CR Express to reap benefits for its development. Consequently, CR Express will evolve into an independent and mature international transport brand.

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