

# Can the Opening of China-European Railway Express Enhance Technical Sophistication of Export from Chinese Cities?

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**Abstract:** The China-Europe Class Train (CR-Express) is an effective channel connecting China with the international market, which provides new opportunities for the economic development of cities along the route. Using a multi-period DID model, this paper investigates the impact of the opening of the CR-Express on the export technical sophistication of cities and its impact mechanisms. The study shows that: the opening of the CR-Express has a positive promotion effect on export technical sophistication, and the basic findings remain robust after considering parallel trend tests and placebo tests; the mechanism test finds that the enhancement effect of the opening of the CR-Express on export technical sophistication is mainly realized through two paths: innovation-driven and industrial upgrading. The policy implication is how to increase the frequency and routes of the CR-Express in the future to radiate a larger range of enterprises and continuously optimize the transportation organization, and how to effectively dovetail China's innovation-advantaged industries facing transformation with the economic development gaps of the countries along the route, to achieve a "win-win" situation of innovation-driven, industrial upgrading in the opening cities and improved welfare levels in the countries along the route. The future development direction of CR-Express is to promote the continuous improvement of the technical sophistication of exports.

**Keywords:** CR-Express; export technical sophistication; double difference; innovation drive; industrial upgrading

**JEL Classification:** E61; F23; F36

## 1. Introduction

As China's "One Belt, One Road" international cooperation continues to grow, CR-Express has developed rapidly as a new vehicle and channel for international railway cargo transport cooperation. Since 2011, when the first "YUXINOU" train was launched in Chongqing, China, the number of CR-Express (CR-Express) has doubled every year. In recent years, China has put forward the issue of high-quality development, which includes not only the growth of trade scale but also the optimization and upgrading of trade structure. export technical sophistication, as an important indicator of the structure, technology, and production efficiency of export commodities, provides a good analytical tool for studying the international division of labor and the international competitiveness of a country or region.

At this critical period when China's economy is shifting from high growth to high-quality development, it is important for China to further improve export technical sophistication to transform China's foreign trade from "quantitative" growth to "qualitative" development and to realize its strategy of becoming a strong trading nation and transforming its economy. This is of great significance to China's strategy of becoming a strong trading nation and its economic transformation.

Numerous studies have shown that CR-Express has positively contributed to regional trade growth, industrial structure, and innovation efficiency in the cities where it operates. So, has the launch of CR-Express also increased the technological technical sophistication of cities' export? What are the mechanisms and pathways through which they work? This has not been systematically and critically discussed in the existing literature. Based on this, this paper systematically explains the mechanism of the impact of the operation of the CR-Express on export technical sophistication and constructs a corresponding econometric model to empirically examine the effect and mechanism of the operation of the CR-Express on the export technical sophistication, to provide a basis for China to effectively improve the export technical sophistication and achieve the goal of a strong trade country and high-quality economic development.

## 2. Influence Mechanisms and Theoretical Hypotheses

### *2.1 Effect of the Opening of the CR-Express on the Export Technical Sophistication*

Since the opening of the first train, the CR-Express has shown a vigorous development trend. With the advantages of time efficiency and price to optimize the division of international transportation by sea, land, and air, it has greatly optimized the global production division of labor layout, while realizing the coastal development of Chinese mainland cities. On the one hand, due to the opening of the CR-Express, local import and export enterprises can obtain international market information more efficiently and constantly adjust their production strategies so that they can carry out the international division of labor with other countries through intermediate product trade, focus on their comparative advantages and continuously improve their production efficiency, thus improving the technical content of product production, which in turn leads to the improvement of the city's export technical sophistication. On the other hand, aside from maritime and air transportation, CR-Express provides a new means of organizing international land transport between China and Europe. Compared with traditional sea-rail transport, CR-Express can save 8-20% of the comprehensive logistics costs and has comparative advantages in meeting specific logistics needs such as high added value and strong timeliness. In addition, as a newly emerging and promising development, CR-Express is currently being heavily subsidized by the government to a large extent, which further reduces the direct logistics costs of CR-Express, and this can lead to significant increases in export technical sophistication (Liu, 2022).

In summary, the opening of the CR-Express will improve regional cooperation and exchange, reduce trade costs, assist opening cities in improving the technical content of their

export products, and enable the opening cities to transport their competitive high-value-added products with high logistics timeliness to the European market at lower logistics costs, enhancing their export technical sophistication. Based on these findings, the paper presents the following hypothesis.

H1: The CR-Express can significantly increase the export technical sophistication from the cities where it operates.

## *2.2. The Intermediary Role of the Innovation Drive in the Process of Promoting Export Technical Sophistication*

The opening of the CR-Express may have a catalytic effect on the improvement of the regional innovation level. On the one hand, CR-Express opened to bring trade activities from different regions into a unified framework, promote cross-regional exchanges of knowledge and technology, and increase the level of regional technological innovation (Zhang et al., 2019). Moreover, by establishing direct links with developed Western economies via CR-Express, the exchange and cooperation of innovation factors and R&D resources can be made easier. This pathway offers new impetus to the technological and scientific upgrading of the source region. The "reverse transfer" pathway provides new impetus to the technological upgrading of the cargo source. (Ma, 2018). Meanwhile, at the other end of the CR-Express lies the developed economies of Europe, where many of the world's leading companies are located. By using CR-Express, Chinese companies can gain direct access to and effectively cooperate with technology leaders in developed countries, as well as bring their advanced management experience and technology to the opening cities at a lower cost.

The increase in innovation in a region can directly improve the competitiveness of local products in the international arena, increasing both the variety and the number of exported products, thereby increasing the technical sophistication of export (Gu et al., 2013). Import trade liberalization contributes significantly to the technical sophistication of export through the enhancement of corporate R&D innovation. (Sheng et al., 2017). The degree of autonomous innovation and R&D not only translates directly into production technology, but also enhances the manufacturing industry's ability to absorb technological spillovers from intermediate goods (Han, 2018), and technological innovation contributes to an increase in R&D investment, which in turn can lead to a greater degree of technological technical sophistication in export. (Arora et al, 2001). Additionally, it has been shown that companies with advanced technologies can reduce their R&D and learning costs, as well as achieve technological spillovers through investment and trade. Such technological spillovers contribute to the export of technical sophistication from technologically relatively backward countries or cities (Coe & Helpman, 1995; Wang et al., 2010).

In summary, the opening of the CR-Express can reduce the flow costs of innovation factors, bring advanced technology and experience to the opening city, and raise the level of science and technology innovation in the opening city. The improvement of the regional innovation level can in turn enhance the technical sophistication of the city's export through

channels such as R&D investment and technology spillover. Accordingly, this paper puts forward the following hypothesis.

H2: CR-Express can improve the export technical sophistication from the opening cities through technological innovation.

### *2.3. The Role of Industrial Upgrading as an Intermediary in the Process of Promoting Export Technical Sophistication*

The opening of the CR-Express has greatly promoted the cross-regional flow of factors and realized regional industrial upgrading. On the one hand, the "transport cost effect" suggests that transport infrastructure enables the optimal allocation of factors by reducing transport costs, which creates the conditions for industrial upgrading. The opening of the CR-Express will enhance industrial upgrading through the optimization of the allocation of high-end factors (Zhang et al., 2019). The CR-Express enables Chinese enterprises to cooperate with enterprises in developed European countries "against the gradient", which realizes the two-way flow of production factors and achieves industrial upgrading by further optimizing the allocation of high-end factors in the cities where the CR-Express operates. On the other hand, CR-Express is divided into three major corridors: East, Central, and West, and each node city within the different corridors follows a similar route planning, policy orientation, and cargo source pattern. (Li, 2021). Enhancing the absorption and transformation capacity of factors between diffusion and inflow areas will increase incentives to take over overflowing production factors to transform them into local industrial upgrades.

The upgrading of industrial structure can generate industrial spillover effects from high-tech industries, which have a correlative effect on other industries, enabling other industries to improve their technological level and management efficiency and promoting the technological technical sophistication of regional export. (Li, 2011). Researchers have examined the role that industrial upgrading plays in increasing export technical sophistication from the perspective of penetration of high technology industries, arguing that this penetration effect can contribute to industrial institutional innovation, and institutional innovation, especially contractual systems and property rights protection systems, can affect the production costs of products and improve the production efficiency of urban industries, which in turn can affect the export structure of the trade sector and shift a country's export structure and production structure towards complex products, and increase the city's export technical sophistication. (Zhang, 2017)

In summary, the opening of CR-Express can promote industrial upgrading by reducing transport costs and optimizing the allocation of high-end factors. In turn, upgrading the industrial structure can improve the production efficiency of enterprises through the effects of industrial spillovers and the penetration of high-tech industries, which can enhance export technical sophistication. Accordingly, this paper puts forward the following hypothesis.

H3: CR-Express can improve the export technical sophistication from the opening cities through industrial upgrading.

### 3. Methodology

#### 3.1. Construction of an Economic Model

Double difference (DID) is an important concept in empirical research and is widely used in policy evaluation studies, especially when evaluating progressive policy reforms that are demonstrating good fitting effects. To validate the train launch effect, it is necessary to compare the change in the cities in the study group before and after the CR-Express launch to evaluate the role of the CR-Express launch in enhancing export technical sophistication. Since this could also be a natural effect over time, it is necessary to introduce a change in the results of the cities in the control group before and after the train launch to eliminate the time effect within this group. We introduce a multi-temporal DID model to evaluate the effect of this shock, with the baseline econometric model being set as follows.

$$ets_{c,t} = \beta_0 + \beta_1 CRR_{c,t} + \beta_2 X_{c,t} + \gamma_c + v_t + \varepsilon_{c,t} \quad (1)$$

$$CRR_{c,t} = post_{c,t} \times treat_c \quad (2)$$

In model (1), the explanatory variable  $ets_{c,t}$  is the export technical sophistication in the  $t$  year of city  $c$ .  $treat_c$  is a policy dummy variable with a value of 1 for cities in the treatment group and a value of 0 for cities in the control group.  $post_{c,t}$  is a time dummy variable that takes the value of 1 for the year in which a city starts the CR-Express and beyond, and 0 for the rest of the years.  $X_{c,t}$  is a series of control variables.  $\gamma_c$  and  $v_t$  are city and year fixed effects, and  $\varepsilon_{c,t}$  are the random disturbance terms of the model. Based on the characteristics of the study, the baseline regression section focuses on the  $\beta_1$ .

#### 3.2. Variables and Data Sources

Explained Variable: Export technical sophistication

Current scholarly approaches to measuring export technical sophistication are generally based on the CA theory and the RCA index proposed by Hausmann et al. (2007). By using the ratio between a country's total export of a product to the total export of all countries exporting that product as the weight, this method produces a weighted average of all the technology-level indicators. Due to data limitations, this method is only suitable for measuring the export technical sophistication at the national level and cannot be broken down to the regions of a country. Xu and Lu (2009) improved this method by using GDP per capita and urban import/export data instead of national-level data, compensating for the shortcomings of Hausmann's (2007) method, and has been widely used in the academic community. Zhou et al. (2019) extends the application of export technical sophistication to the city level by utilizing industry-level data. Based on the above methodologies and the characteristics of the research subject, the measurement of the export technical sophistication of cities is carried out in two steps.

In the first step, the export technical sophistication of a high-tech product is determined using the methodology of Xu and Lu (2009).

$$PROD_k = \sum_{i=1}^n \frac{x_{ik}/x_i}{\sum_{i=1}^n x_{ik}/x_i} * y_i \quad (3)$$

In the formula, the  $x_{ik}$  denotes  $i$  country's export value of  $k$  product,  $x_i$  denotes the total export value of national products, and  $y_i$  denotes the  $i$  country's GNP per capita.

In the second step, referring to the measurement method proposed by Zhou et al. (2019), after obtaining the product-level data, it is summed to the city level with the product export value as the weight, thus obtaining the export technical sophistication for each Chinese city (ets).

$$ets_c = \sum_{k=1}^n \frac{x_{ck}}{x_c} * PROD_k \quad (4)$$

where  $x_{ck}$  denotes the  $c$  city's export value of  $k$  product,  $x_c$  is the total export value of city  $c$ , and  $ets_c$  is the export technical sophistication of city  $c$ . The logarithmic export technical sophistication value is taken as the explanatory variable.

### Explanatory and Control Variables

Explanatory variable "The Opening of CR-Express (CRR)" is the interaction term between the policy dummy variable and the time dummy variable to indicate the launch of CR-Express in a city. Using the end of 2019 as the time point, cities that have launched CR-Express before then are used as the treatment group, otherwise, the control group is 0. If a city has launched a CR-Express by the end of each year, the value is 1 for that year, otherwise it is 0.

Control variables: (1) level of economic development of the city (Ineco) (2) level of human capital (Inhum). (3) level of informatization (Ininf). (4) Level of infrastructure development (fac). (5) Level of government intervention (gov).

### Data Sources

In this paper, the data about 273 prefecture-level cities in China from 2009-2019 are used as a sample to study the impact of the opening of CR-Express on the technical complexity of exports. The relevant data are derived from the China City Statistical Yearbook, Wind database, and provincial statistical yearbooks. The results of descriptive statistics of each variable are shown below.

Table 1. Descriptive statistics of variables

Variables	Sample Size	Mean	Std. dev.	Min	Max
Inets	3,003	10.67	0.382	9.487	11.40
Ineco	3,003	16.98	1.083	13.88	20.37
Inhum	3,003	5.851	0.686	3.137	8.047
Ininf	3,003	6.557	0.778	2.480	10.32
fac	3,003	16.34	6.272	1.370	35.78
gov	3,003	0.229	0.0486	0.0750	0.418

## 4. Results

### 4.1. Baseline Regression

Table 2 shows the results of the baseline regression. The same city-fixed effects and time-fixed effects were controlled for in the regression process to exclude the effect of city-level time trends on the test results, and five control variables were gradually added to observe

the change in the coefficients of the explanatory variables. The results show that with the increasing number of control variables, the coefficients  $\beta_1$  are always positive and reach statistical significance, implying that the enhancement effect of the CR-Express on the technological technical sophistication of city export is significant, even when controlling for individual factors, time effects, and various other factors.

Table 2. Baseline regression results

Variable name	(1) <i>lnets</i>	(2) <i>lnets</i>	(3) <i>lnets</i>	(4) <i>lnets</i>	(5) <i>lnets</i>	(6) <i>lnets</i>
CRR	0.302*** (17.63)	0.299*** (17.52)	0.294*** (17.19)	0.293*** (17.22)	0.290*** (16.97)	0.290*** (16.93)
Ineco		0.013*** (2.90)	0.013*** (2.83)	0.012*** (2.66)	0.012*** (2.71)	0.012*** (2.66)
Inhum			0.158*** (4.11)	0.148*** (3.87)	0.147*** (3.84)	0.146*** (3.74)
Ininf				-0.028*** (-3.57)	-0.029*** (-3.61)	-0.029*** (-3.58)
fac					-0.003** (-2.51)	-0.004** (-2.51)
gov						0.051 (0.34)
cons	10.188*** (1022.36)	9.956*** (123.61)	9.041*** (38.18)	9.290*** (37.71)	9.333*** (37.83)	9.336*** (37.82)
observations	3,003	3,003	3,003	3,003	3,003	3,003
R <sup>2</sup>	0.464	0.465	0.391	0.410	0.406	0.407
Urban fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES

Note: \*, \*\*, \*\*\* denote significance at the 1%, 5%, and 10% levels, respectively, with standard errors for clustering to the city level in parentheses.

#### 4.2. Parallel Trend Test

The double difference method is based on the assumption of parallel trends. The trend of change in export technical sophistication in the treatment and control groups should remain parallel before the opening of the CR-Express. This paper uses the event analysis method to examine this assumption, and the model estimated is shown below.

$$lnets_{c,t} = \sum_{m=1}^3 \lambda_m First_{c,t-m} + \sum_{n=0}^3 \lambda_n First_{c,t+n} + \lambda_2 X_{c,t} + \lambda_3 \tau_t + v_t + \varepsilon_{c,t} \quad (5)$$

In model (3),  $First_{c,t}$  is a dummy variable, which is taken to be 1 if a city is the first to open the CR-Express in year  $t$ , and 0 if the opposite is true.  $First_{c,t-m}$  denotes the period  $m$  before the opening of city  $c$ .  $First_{c,t+n}$  denotes the period  $n$  after the opening. The distinction between the antecedent and the consequent variables is used here to test the assumption of a parallel trend in the effect of the launch of the train.

According to Figure 1, the results indicate that the impact of CR-Express on the increase in the export of technical sophistication to the city was significant. As can be seen, the coefficient

estimates for the  $t < 0$  intervals are not significant at bilateral 95% confidence intervals, indicating that the trend of change in export technical sophistication does not differ significantly between the experimental and control groups before the launch of the CR-Express. Further, the  $t > 0$  interval coefficient estimates are significantly positive and increasing overall, indicating that the opening of the CR-Express positively influenced the export technical sophistication from Chinese cities and that the assumption of parallel trends is satisfied.

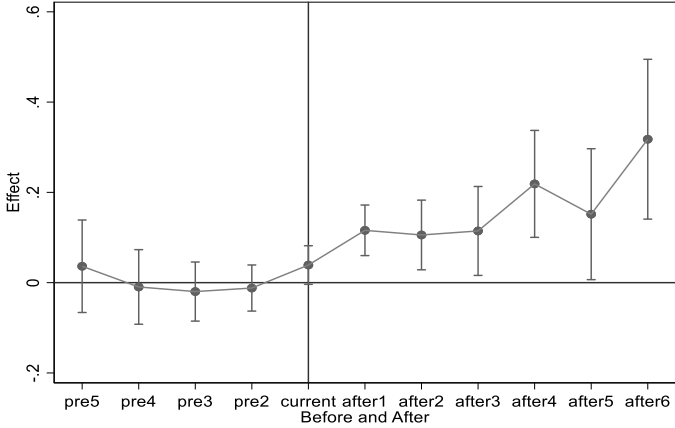


Figure 1. Parallel trend test

4.3. Placebo Test

To ensure that the increase in the technical sophistication of city export is solely caused by the opening of the CR-Express, this paper constructs a placebo test, in which the policy shock associated with the opening of the CR-Express is randomly selected among the treatment groups and then treated based on model (1). As a result, the reliability of the findings is measured by the probability of obtaining baseline results from a spurious experiment. The benchmark regression is conducted by randomly generating treatment groups from a sample of 273 prefecture-level cities, repeating this process 1,000 times, and plotting the distribution of spurious estimates of interaction term coefficients (Figure 2). The true regression results in Table 1 are on the right-hand side of the normal curve and do not intersect the normal curve, suggesting that other unobservable factors do not significantly impact the main estimates.

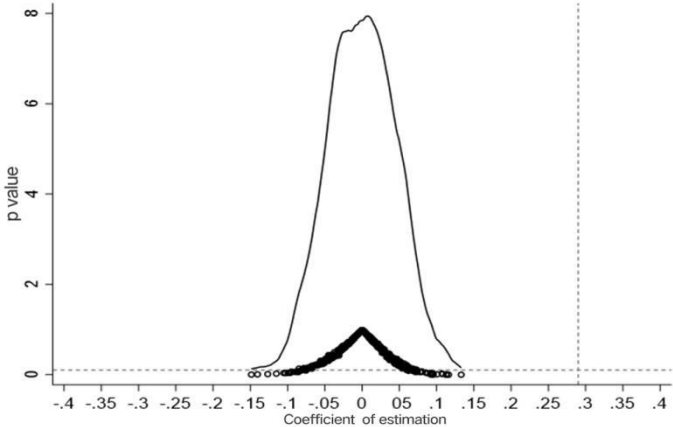


Figure 2. Placebo test



#### 4.4. Mechanism Testing

Using the theoretical analysis presented in the previous paper, as well as the study of Wen et al. (2004), this paper proposes a mediation model.

$$IM_{c,t} = \beta_0 + \beta_1 CRR_{c,t} + \beta_2 X_{c,t} + \gamma_c + v_t + \varepsilon_{c,t} \quad (6)$$

$$lnets_{c,t} = \beta_0 + CRR_{c,t} + IM_{c,t} + \beta_2 X_{c,t} + \gamma_c + v_t + \varepsilon_{c,t} \quad (7)$$

In the above equation, *IM* is the mechanism variable, the other variables are set as in the baseline regression model, and the control variables are denoted by *X*. First, referring to the study by Bian et al. (2019), this paper measures the level of innovation in terms of the number of patents granted after logarithmization. Columns 1 and 2 of Table 3 show that the coefficients of the policy variables are significantly positive at the 1% level, indicating that the opening of the CR-Express significantly contributes to the level of regional innovation. At the same time, the coefficient on the policy dummy variable is significantly positive, suggesting that the launch of the CR-Express can improve the technological technical sophistication of the exporting cities by increasing the level of innovation and hence the export technical sophistication of the launching cities. Referring to Sheng Bin's (2005) study, this paper uses the share of tertiary industry value added to GDP as a proxy variable for regional industrial upgrading. The results in columns 3 and 4 of Table 4 show that the operation of the CR-Express significantly contributes to the upgrading of regional industries, suggesting that the CR-Express, as a bridge and link between China and the countries along its route, creates more opportunities and conditions for industrial upgrading, which in turn increases the export technical sophistication.

Table 3. Results of the analysis of the impact mechanism

Variables	Innovation driven		Industrial upgrading	
	<i>patent</i> (1)	<i>lnets</i> (2)	<i>update</i> (3)	<i>lnets</i> (4)
CRR	0.224*** (15.21)	0.301*** (7.21)	0.041*** (4.21)	0.145*** (3.45)
paten = t		0.082*** (5.78)		
update				0.075** (3.11)
X	YES	YES	YES	YES
Province FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R <sup>2</sup>	0.322	0.355	0.407	0.418

Note: \*, \*\*, \*\*\* denote significance at the 1%, 5%, and 10% levels, respectively, with standard errors for clustering to the city level in parentheses.

#### 5. Conclusion

The launch of the China-Europe Classical Train (CR-Express) has strengthened the connectivity between China and European countries. In this context, this paper examines the effect of the CR-Express on the export technical sophistication from China's opening cities and investigates the mechanism by which the opening of the CR-Express increases the export

technical sophistication through both the "innovation level" and "industrial structure" factors. The findings are as follows.

Firstly, the opening of the CR-Express has a positive effect on the export technical sophistication, suggesting that the opening of the CR-Express is an important factor contributing to the increase in the export technical sophistication. This result passes both the parallel trend and placebo tests, which further supports its robustness. Secondly, the innovation drive mediates the relationship between the launch of CR-Express and the export technical sophistication, with the launch of CR-Express promoting the export technical sophistication in the launch cities through the improvement of regional innovation levels. Thirdly, the industrial structure mediates the relationship between the launch of the trains and the export technical sophistication, with the launch of the trains promoting the upgrading of the industrial structure to drive up the export technical sophistication. Therefore, we should increase the frequency and routes of the CR-Express to radiate a wider range of enterprises, continue to optimize the transport organization, vigorously expand the sources of return cargo, promote the intensive and efficient use of transport resources, and promote the continuous improvement of the export technical sophistication. On the other hand, we will continue to deepen our opening up to the outside world, adhere to the "going out" strategy, strengthen the consensus on cooperation with countries along the "Belt and Road", and, against the background of the continuous improvement of transport infrastructure such as the CR-Express, effectively match the industries with innovative advantages and facing transformation with the economic development gaps of countries along the route. In the context of the continuous improvement of the CR-Express and other transport infrastructures, China's innovative and transforming industries will be effectively dovetailed with the economic development gaps of the countries along the route, to achieve a "win-win" situation of opening up the city for innovation-driven and industrial upgrading and improving the welfare of the countries along the route.

Conflict of interest: none.

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