

Research on the Impact of CR-express Train on Enterprise Innovation

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Abstract—As an important carrier of the “Belt and Road” initiative, the CR-express train has promoted the interconnection between China and countries along the route, thereby providing new opportunities for China to promote an open economy and innovation-driven development. This article takes the opening of CR-express train as a quasi-natural experiment, selects China’s A-share listed manufacturing companies from 2010 to 2017 as a sample, and uses a multi-time point DID model to empirically test the impact of the launch of CR-express train on corporate innovation. The research finds that: The opening of the CR-express train significantly promotes corporate innovation, and the conclusion is still valid after the parallel trend test. This article reveals the role of CR-express trains in promoting enterprise innovation and its influence mechanism, which has a certain enlightenment for the construction of CR-express trains’ interconnection.

Keywords—the CR-express train; enterprise innovation; multi-time point DID model.

I. INTRODUCTION

In 2020, the two sessions of the National People’s Congress proposed that China should promote cooperation in science and technology innovation in the construction of the “Belt and Road” and promote the positive interaction between domestic and international cycles. The CR-express train, as an important infrastructure construction of the “Belt and Road”, greatly promotes the economic and trade cooperation between China and the countries along the “Belt and Road” (Wei and Gu, 2020; Li et al., 2020), thus promote the flow of technology between countries along the international trade and thus influence the level of innovation of enterprises (Grossman and Helpman, 1990). So how does the opening of CR-express train affect firm innovation? And through what channels? An accurate study of the impact of CR-express train on enterprise innovation is of great theoretical and practical significance for deepening the “Belt and Road” initiative, accelerating infrastructure interconnection, strengthening innovation capacity opening and cooperation, and forming an opening pattern with internal and external linkage between land and sea, and mutual benefit between east and west.

Based on this, this paper tries to study the micro effects of CR-express train on enterprises from the perspective of enterprise innovation. The CR-express train opening can be seen as a quasi-natural experiment, and since the CR-express train opening time varies from city to city, this paper adopts a multi-temporal double difference approach (DID). Therefore, with the quasi-natural experimental environment formed by the opening of CR-express train, this paper analyzes the impact of CR-express train on Chinese firms’ innovation based on the data of Chinese A-share listed companies from 2010-2017 and using a multi-temporal DID model.

This paper is expected to contribute to two aspects: first, it examines the economic effects of the CR-express train, an important vehicle of the Belt and Road, from the micro perspective of enterprise innovation. This paper enriches the literature on CR-express train and reveals the innovative effect of promoting infrastructure connectivity on corporate entities. Secondly, this paper enriches the study of macroscopic factors

influencing enterprise innovation and provides a new perspective for the study of innovation theory.

II. THEORETICAL ANALYSIS

Analysis from the “going out” perspective. It is widely accepted in the existing literature that the improvement of a country’s infrastructure level has a significant positive impact on the introduction of foreign investment (Cheng and Kwan, 2000). CR-express, as a transportation infrastructure, promotes the spatial flow of economic factors and helps to promote trade development, while the level of trade facilitation can indirectly promote direct foreign investment. It has been argued that OFDI can significantly increase the innovation level of firms (Mao and Xu, 2014). This is because CR-express sells enterprises’ products to overseas markets, which is conducive to diluting product costs, realizing economies of scale in enterprise production and sales, producing significant improvement effects on enterprises’ business conditions, and promoting enterprise innovation (Wang and Bu, 2019).

Analysis from the perspective of “introduction”. The goods transported by CR-express are mostly products with high added value, and their export destinations are mostly developed markets, which are more likely to become important intermediate products in the international division of labor, thus enabling the producers of these products to introduce advanced technologies in international trade through agreement purchase and imitation learning. At the same time, they gain the opportunity to learn from competitors and customers (Li et al., 2016). This facilitates the acquisition of technological spillover effects while participating in international trade.

While the international trade formed by the opening of CR-express adheres to the laws of the market, the government also plays an indispensable role in it. The government has provided a series of preferential policies (such as subsidies per liner, etc.) measures. So that those who can not afford overseas direct investment or bear the cost of traditional transport mode, but have a certain uniqueness and international competitiveness of the enterprise to the international market. In turn, they will be rewarded and

support their own innovative behavior. Therefore, the opening of CR-express has the potential to promote corporate innovation.

In summary, this paper proposes research hypothesis H1:CR-express opening can promote corporate innovation.

III. SAMPLE SELECTION AND STUDY DESIGN

A. Sample selection and data sources

Based on the types of goods transported by CR-express trade are mainly manufacturing industries, this paper selects A-share listed manufacturing companies from 2010-2017 as research objects to examine the impact of CR-express opening on enterprise innovation. The data were also screened according to the following criteria: (1) excluding manufacturing enterprises listed after 2008; (2) excluding samples that were ST, PT, and *ST during the sample period; (3) excluding samples with missing main variables. Finally, 17,184 sample observations were obtained from 179 enterprises. The data in this paper are mainly obtained from iFind database and CSMAR database. CR-express information is taken from the website of China Railway Container Transportation Co., Ltd, local railroad bureaus and local official media, etc. In addition, robust standard error estimation is used in all subsequent regressions in this paper as a way to mitigate possible heteroskedasticity and serial correlation problems.

B. Model and variable definitions

In this paper, a two-way fixed-effect multi-period DID method is used for identification (Li et al., 2020). Specifically, based on the first version of the CR-express operating schedule of China Railway Container Lines, the enterprises located in the 11 regular operating cities of Chongqing, Chengdu, Zhengzhou, Wuhan, Suzhou, Jinhua, Changsha, Hefei, Dongguan, Tianjin, and Changchun are assigned to the treatment group, and the remaining enterprises are assigned to the control group. In this paper, we also include firm and time fixed effects in the model to control for differences in some unobservable factors between firms and years in the treatment and control groups after the opening of CR-express. Drawing on Beck et al. (2010), the model is set up as follows:

$$Y_{it} = \alpha + \beta D_{it} + \delta X_{it} + A_i + B_t + \varepsilon_{it} \quad (1)$$

where Y_{it} measures firm innovation (where i and t denote firm and year, respectively, hereafter). D_{it} is a policy dummy variable. It takes the value of 1 for firms in cities that are in the CR-express opening and in the year after the opening, and 0 otherwise. The coefficient β indicates the difference in the effect of CR-express opening on the treatment and control groups. β is significantly positive if CR-express opening promotes firm innovation. X_{it} is a set of firm-level control variables. A_i and B_t are firm and year fixed effects, respectively, and ε_{it} is a random disturbance term.

Explanatory variable: enterprise innovation

In this paper, the number of patent applications (patent) is selected to measure the change of enterprise innovation level after the opening of CR-express, which takes into account the

quality of innovation and the timeliness of data to a certain extent.

Core explanatory variables: CR-express opening

D is the city of the enterprise after the opening of CR-express and takes the value of 1 in the year after the opening, otherwise it is 0.

Control variables: Including gearing ratio (lev); fixed asset ratio (PPE); capital intensity (fa); cash holding level (cash); return on total assets (ROA); firm size (size); state is a regional dummy variable, if the firm is registered in the east, then state=1, otherwise state=0.

C. Descriptive Statistics

Table 1 shows the descriptive statistics of the main variables in this paper. Among them, the mean value of the number of enterprise patent applications (PATENT) is 142.831, the maximum value is 6867, the minimum value is 1, and the standard deviation is 430.5678, which indicates that there are large differences in innovation efficiency among different manufacturing enterprises. The maximum value of size is 26.6507 and the minimum value is 19.9727, which indicates that the sample size selected in this paper is relatively balanced. And the maximum value of ROA is 119.8838 and the minimum value is -54.5897, which indicates that there is a large difference in the return on total assets of the selected sample enterprises, which may affect the innovation of enterprises.

TABLE I. Descriptive statistics of main variables

Variables	Observation	Mean	Standard deviation	Maximum	Minimum
patent	1432	142.831	430.5678	6867	1
D	1432	0.0691	0.2534	1	0
Lev	1432	0.5041	0.2275	4.8079	0.0557
PPE	1432	0.2467	0.1320	0.8098	0.0138
fa	1432	12.5670	0.8185	15.0879	9.6496
cash	1432	0.1653	0.1106	0.9148	0.0029
ROA	1432	6.0938	7.3559	119.8838	-54.5897
Age	1432	22.2123	3.6796	31	13
size	1432	22.6660	1.1959	26.6507	19.9727
state	1432	0.6201	0.4855	0	1

IV. EMPIRICAL RESULTS AND ROBUSTNESS TESTS

A. DID test results

Table 2 presents the results of the tests on whether CR-express opening affects firm innovation. Column (1) shows the results of the panel fixed effects test without controlling for the characteristics of each firm, and column (2) shows the results of the panel fixed effects test with controlling for the characteristics of the firms. The results show that the estimated coefficients are 63.5547 and 50.6055, respectively, and are significant at the 5% and 10% significance levels, respectively. It indicates that CR-express opening increases firm innovation and proves hypothesis H1.

TABLE 2. Impact of CR-express opening on corporate innovation.

Variables	Patent (1)	Patent (2)
D	63.5547** (2.1155)	50.6055* (1.7987)
lev		-58.9569*** (-2.8006)

PPE		75.5348 (0.4887)
Cash		-63.9012 (-0.8588)
ROA		-0.1379 (-0.2187)
fa		-0.0001* (-1.9563)
Size		110.2371*** (4.3614)
Constant	154.9548*** (9.2978)	-2.3e+03*** (-3.9818)
Id	Y	Y
year	Y	Y
N	1432	1432
R-squared	0.0343	0.2018

Note: *, ** and *** indicate significance levels at 10%, 5% and 1%, respectively. Values in parentheses are robust t-statistics corrected for heteroskedasticity.

B. Parallel trend test

In this paper, we refer to the practice of previous literature and use event analysis method to conduct the test. The specific settings are as follows:

$$Y_{it} = \beta_0 + \sum_{\alpha \geq -5} \beta_{\alpha} D_{it}^{\alpha} + \beta \sum X_{it} + \gamma_i + \theta_t + \varepsilon_{it} \quad (2)$$

where D_{it}^{α} is a dummy variable for the current period of CR-express opening. If α is less than 0, it indicates the first α years of CR-express opening. If α is greater than 0, it indicates the α th year after the opening of CR-express. In this paper, we take the year of CR-express opening as the base period, and set 5 periods before and after. β_{α} is the direction of influence on enterprise innovation before and after CR-express opening. When α is less than 0, β_{α} is not significantly different from 0, then the assumption of parallel trend is satisfied. Fig. 1 shows the results of the parallel trend test for CR-express opening and firm innovation, presenting the estimated value of regression coefficient β_{α} and 95% confidence interval. Where, the vertical axis is the value of the regression parameter of β_{α} and the horizontal axis is the value of the year from the opening of CR-express. It can be found that the original hypothesis that the regression coefficient β_{α} cannot be rejected as 0 before the opening of CR-express, which verifies the parallel trend hypothesis.

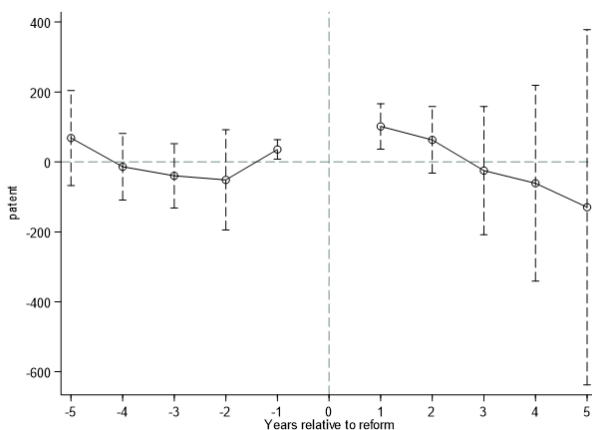


Fig. 1. Parallel trend test.

C. Placebo test

Corporate innovation may not be correlated with CR-express opening, and to exclude this effect, this paper constructs a placebo test for spurious opening years. This is done by setting dummy variables for the opening period of each region 1 year earlier (past1, taking the year before the opening period of each city as 1, otherwise 0), 2 years later (past2), and 1 year later (after1, since Changchun only became a regular city in 2017, the city is excluded) and 2 years later (after2), and using these "pseudo-opening" time for the placebo test. The coefficients in columns (1)-(4) of Table 3 are insignificant, thus eliminating the possibility of pseudo-regressions, indicating that the setting of "policy effects" in this paper is reasonable and confirming the reliability of the benchmark results.

TABLE 3. Placebo test.

Variables	patent			
	past1 (1)	past2 (2)	after1 (3)	After2 (4)
Dpast1	14.2705 (0.3924)			
Dpast2		7.3538 (0.1534)		
Dafter1			32.5097 (0.9541)	
Dafter2				39.4902 (1.1140)
Constant	-1344.163 ** (-2.1442)	-1350.358** (-2.1591)	-1329.448** (-2.1247)	-1320.227** (-2.1065)
Controls	Y	Y	Y	Y
id	Y	Y	Y	Y
year	Y	Y	Y	Y
N	1424	1424	1424	1424
R-squared	0.0429	0.0431	0.0557	0.0558

V. IMPACT MECHANISM TEST

This paper continues to explore the channels through which CR-express affects enterprise innovation. Through the above analysis, enterprises have improved their profitability and competitiveness by "going out" and "coming in", and government subsidies and bank credit policies have provided a large amount of financial support, which is conducive to timely replenishment of liquidity. In addition, government subsidies and bank credit policies provide a lot of financial support, which helps enterprises to replenish liquidity in a timely manner, and the "identity" of CR-express local enterprises releases the signal of having the government's "invisible guarantee" to the outside world, thus alleviating the level of financing constraints of enterprises and thus enhancing their innovation ability. In order to test this channel, we refer to Hadlock and Pierce (2010) to measure the financing constraint by the SA index and multiply it with D to test the moderating effect. Table 4 reports the regression results. The coefficient of $D \times SA$ is 13.3244 and is significant at the 5% level of significance. This result indicates that the opening of CR-express has promoted innovation by alleviating the financing constraints of firms.

TABLE 4. Impact mechanism test.

Variables	patent
D×SA	13.3244** (2.3312)
Constant	-2064.101 *** (-3.6207)
Controls	Y
id	Y
year	Y
N	1432
R-squared	0.19

VI. CONCLUSIONS AND POLICY IMPLICATIONS

This paper takes CR-express opening as an entry point and uses data from Chinese A-share listed manufacturing firms from 2010-2017 as a sample. A two-way fixed-effects multi-period DID model is used to examine the impact of CR-express opening on firm innovation. It is found that CR-express opening significantly improves firms' innovation ability, and the finding remains robust to parallel trend tests. The mechanism test found that CR-express promotes innovation by increasing the profitability of enterprises through "going out" and "coming in", and by easing the financing constraints of enterprises through the role of government and financial intermediaries.

Combined with the research findings, this paper puts forward the following policy recommendations. Different cities should take advantage of the situation and seize the development opportunity of CR-express. For cities that have not opened CR-express, they should make full use of their existing resource endowments and advantageous industries to actively join the transportation of CR-express, seize the opportunity to attract the influx of innovation factors and improve their own innovation capacity. The government should provide confidence and institutional security to participants in this market, including businesses, investors, banks and consumers, to improve the trade environment for businesses.

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