Does the "Belt & Road" Initiative Promote Total Factor Productivity in Provinces along the Route?

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Abstract—This paper empirically investigates the impact of the impact of "Belt & Road" initiative on total factor productivity (TFP) in provinces along the route. The DEA-Malmquist method is used to calculate TFP. Utilizing a quasi-natural experimental design, this paper finds that the "Belt & Road" Initiative has a significant positive effect on TFP in provinces along the route. The influencing mechanism is found to be increased foreign direct investment (FDI). Based on this, the paper suggests that China should further open up. Meanwhile, provinces along the route should improve infrastructure and attract more FDI. The governments should constantly enhance technological innovation.

1 Introduction

The "Belt & Road" Initiative was proposed in September 2013 by President Xi in his speech in Kazakhstan. In October of the same year, President Xi proposed the "maritime Silk Road of the twenty-first Century" in Indonesia Parliament. Since then, the "Belt & Road" Initiative has played an increasingly important role in promoting international exchanges and cooperation. It aims to build a mutually beneficial and open economy. According to official statistics, total imports and exports totaled US $6 trillion and 469 billion 190 million by the end of 2018 in participating countries, creating 244 thousand jobs for the local government. As the host country, China has signed 170 intergovernmental cooperation documents with 122 countries and 29 international organizations, built 82 overseas economic and trade cooperation zones, and made more than 80 billion US dollars in foreign investment. the "Belt & Road" Initiative is estimated to provide more platform for participating countries to seek cooperation.

A great deal of research pertains to the impact of the "Belt & Road" Initiative, but almost all of them focus on economic growth of participating countries, or trade volume, while its impact on provinces along the route, particularly the impact on total factor productivity (TFP) is scanty. This paper empirically investigates the impact of the impact of "Belt & Road" initiative on total factor productivity (TFP) in provinces along the route.

2 Empirical Research

This paper adopts a quasi-natural experimental design. Provinces along the route is classified as the treatment group, while provinces not on the route are classified as the control group. The econometric specification, ideally, is of the following difference-in-differences (DID) form.

$$TFP_{it} = \beta_0 + \beta_1 treated_{it} + \beta_2 year_{it} + \beta_3 treated_{it} \times year_{it} + \beta_4 X_{it} + \varepsilon_{it} \quad (1)$$

in which TFP_{it} is total factor productivity, $treated_{it}$ is a dummy variable that takes the value of 1 if the province is on the route, and 0 otherwise. $year_{it}$ is a dummy variable that takes the value of 1 if the year is after 2013 when the "Belt & Road" Initiative was implemented, and 0 otherwise. $treated_{it} \times year_{it}$ is the impact of the "Belt & Road" Initiative on TFP. Its coefficient β_3 is the main concern. X_{it} represents a vector of control variables that might influence TFP. ε_{it} represents unobserved terms.

This paper uses the propensity score matching method (PSM) to reduce the "self-selection bias". This paper selects control variables, foreign direct investment, scientific research and experimental development, education level, science and technology, capital, import and export volume, fiscal expenditure, fiscal surplus, and income. Through logit model, this paper regress the policy variable on multiple covariates, so as to get a propensity score. The PSM-DID model can eliminate systematic differences among provinces, avoid the bias of sample selection, and eliminate endogeneity, so as to accurately estimate the impact of the "Belt & Road" Initiative on TFP of provinces on the route.

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According to the endogenous growth theory, when human capital and material capital cannot be further improved, the role of external forces in promoting economic growth is relatively limited, and endogenous technological progress has become an important factor in promoting economic development. The “Belt & Road” Initiative advocated the five links, will deepen cooperation between the region along with other countries along the route, and expand regional opening by increasing opening up, increasing investment in infrastructure construction and attracting foreign investment. In theory, industrial agglomeration has the characteristics of external economy and scale economy (Krugman, 1991). The emergence of agglomeration will be accompanied by the introduction of high-tech, high-end talents and new knowledge, which will promote the technological progress of a region, thus driving the development of total factor productivity in the region. From the perspective of space, if the industrial cluster is formed, the technology and knowledge innovation of a region will spill over to the surrounding areas, which will have a positive impact on the technology innovation of the surrounding areas, and promote the development of the total factor productivity of the surrounding

DEA is a nonparametric mathematical programming method for frontier estimation, which is more efficient than a nonparametric piecewise surface constructed by linear programming. This index was first proposed by Malmquist (1953) as a consumption index, and then applied to measure productivity change by caves et al. (1982). According to the summary of Chen (2019), in order to calculate Malmquist productivity index, it is necessary to define the distance function.

Set the profuction function as $P^{t}(x,y)=\{(x,y|t\ period,x\ and\ produce\ y)\}$, and the output distance function is

$$d^{t}(x,y)=min_{\theta}\{\theta:(x,\frac{y}{\theta}\dot{o}\,p^{t}(x,y),\theta>0\} \quad (2)$$

If t period is the base period, then the productivity index can be set as

$$M^{t}=\frac{d^{t}\left(x^{t+1},y^{t+1}\right)}{d^{t}\left(x^{t},y^{t}\right)} \quad (3)$$

If t+1 period is the base period，then productivity index is

$$M^{t+1}=\frac{d^{t+1}\left(x^{t+1},y^{t+1}\right)}{d^{t+1}\left(x^{t},y^{t}\right)} \quad (1)$$

Following Fisher Index, utilize the exponential average of the two periods to define Malmquist TFP, i.e.,

$$\mathrm{M}\left(x^{t+1},y^{t+1},x^{t},y^{t}\right)=\left\{\frac{d^{t+1}\left(x^{t+1},y^{t+1}\right)}{d^{t+1}\left(x^{t},y^{t}\right)}\frac{d^{t}\left(x^{t+1},y^{t+1}\right)}{d^{t}\left(x^{t},y^{t}\right)}\right\}^{\frac{1}{2}} \quad (2)$$

According to the vision and action for jointly building the Silk Road Economic Belt and the 21st century Maritime Silk Road jointly issued by the national development and Reform Commission, the Ministry of foreign affairs and the Ministry of Commerce, "the Silk Road Economic Belt" is delineated as 13 provinces, including Xinjiang, Shaanxi, Gansu, Ningxia, Qinghai, Inner Mongolia, Heilongjiang, Jilin, Liaoning, Guangxi, Yunnan, Tibet and Chongqing. The 21st century maritime silk road is divided into five provinces and cities, namely Shanghai, Fujian, Guangdong, Zhejiang and Hainan.

Table I summarizes all variables and provides descriptive statistics.

TABLE I. DESCRIPTIVE STATISTICS

Variable	Denotation	Mean	Std. Dev.	Minimum	Maximum
Total Factor Productivity	TFP	2.33	0.127	2.102	2.801
outward foreign direct investment	ofdi	0.019	0.03	0	0.247
research and development	rd	0.009	0.005	0	0.022
average education attainment	edu	0.041	0.023	0.018	0.173
scientific technology	scitech	0.004	0.003	0.001	0.014
fixed asset investment	capital	3.418	0.985	1.511	6.756
import & export volume	eximp	0.287	0.341	0.017	1.698
fiscal expenditure	fiscalex	0.265	0.201	0.087	1.379
fiscal balance	fibalance	2.889	1.09	1.279	7.575

average income per capita	income	0.41	0.066	0.249	0.613

The data are gathered from China Statistical Yearbook of the National Bureau of statistics. All continuous variables are winsorized so as to control outliers.

Table II shows the regression results. Both the DID model and the PSM-DID model show that the coefficient of treatyear are statistically significant. This indicates that the implementation of the "Belt & Road" Initiative can increase TFP of provinces on the route.

TABLE II. MAINLINE REGRESSION

	(1)	(2)
	DID	PSM-DID
treat×year	0.0230***	0.0264**
	(3.19)	(2.60)
ofdi	-0.289*	-0.644***
	(-1.78)	(-3.76)
rd	-3.955***	-2.682
	(-9.35)	(-1.43)
edu	1.776***	-0.333
	(3.22)	(-0.78)
scitech	-3.418*	5.938**
	(-1.84)	(2.31)
capital	0.000199	-0.0294***
	(0.03)	(-4.25)
eximp	-0.0912***	-0.00250
	(-4.47)	(-0.04)
fiscalexp	-0.208***	0.0898
	(-3.26)	(0.70)
fibalance	-0.0658***	-0.0290**
	(-9.02)	(-2.39)
income	0.194***	-0.0473
	(3.40)	(-0.57)
_cons	-2.150***	-2.096***
	(-66.87)	(-59.43)
Individual & Year Fixed Effect	Yes	Yes
N	310	271
R^2	0.875	0.844

Note: t statistics in parentheses. *p< .1, **p< .05, ***p< .01.

Table III presents tests on influencing mechanism.

The regression results show that the provincial economic unit's outward FDI, fixed assets investment, import and export, fiscal revenue and expenditure and per capita income have a significant positive impact on TFP, while R&D and technology factors show a significant negative impact.

The "Belt & Road" Initiative is a source of financial revenue. According to Liang and Zhang (2017), fiscal expenditure and taxation are conducive to the growth of local TFP [14]. From the enterprise level, the improvement of TFP of the provinces along the route is mainly due to the reverse technology spillover effect of foreign investment.Through FDI,

TABLE III. INFLUENCING MECHANIS

	(1)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	ofdi	**edu**	**scitech**	**capital**	**eximp**	**fiscalexp**	**fibalance**	**income**
t×y	0.00565***	0.000532	-0.000838***	0.141***	0.0214***	0.0181**	0.301***	0.00831*
	(2.18)	(0.69)	(-5.77)	(3.51)	(3.98)	(2.34)	(5.40)	(1.79)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

N	310	310	310	310	310	310	310	310
R^2	0.190	0.066	0.037	0.328	0.010	0.088	0.096	0.048

Note: t statistics in parentheses. *p< .1, **p< .05, ***p< .01.

provinces along the route can learn from the advanced , gather local information and talent resources, and then aply to the related R&D, thus promoting the technological progress [15] and TFP of the related industries. The “Belt & Road” Initiative promotes closer ties and more convenient economic exchanges, and the import and export of fixed assets and the investment in fixed assets between countries have been significantly improved. According to statistics, in 2017 alone, the new contract signed by Chinese enterprises and China's cross-border infrastructure projects reached 430 billion RMB (700 million US dollars), and continued to grow steadily. The construction and improvement of fixed assets, represented by infrastructure, provides a good environment for long-term economic development, thus providing a strong driving force for the improvement of TFP. [16] From the human resource perspective, the “Belt & Road” Initiative has created a large number of jobs for the provinces along the route, thus effectively raising the per capita income of the local people, and providing sufficient human capital for the improvement of TFP.

The impact of the “Belt & Road” Initiative on research and development (R&D) and technology has lagged behind. Most of the scientific research work itself has a certain time span, which ranges from one month to several decades, or even longer. Therefore, in scientific research activities, research results or outputs are not only related to the current scientific research input, but also related to the input of the previous and subsequent periods, and lag refers to the output of achievements after a certain period of input, that is, the output of R&D achievements lags behind the input of R&D resources. [17] The impact on R&D and technology is reflected in the related elements such as capital input, while the output of R&D and scientific and technological achievements lag behind the factor input period. Therefore, in the short term, the “Belt & Road” initiative has negative correlation with R&D and technology.

The mainline regression only provides the average effect of the “Belt & Road” Initiative on TFP. This paper conducts further research on the dynamic effect of the “Belt & Road” Initiative. The econometric specification is of the following form.

$$TFP_{it} = \alpha_0 + \sum_{n=2014}^{2017} \lambda_n treated_{it} \times T_n + \alpha_1 X_{it} + \mu_i + \varepsilon_{it} \quad (3)$$

in which is the year dummy. The results indicate that the “Belt & Road” Initiative did not have significant effect in 2014 and 2015, but the effect is observed starting from 2016.

TABLE IV. DYNAMIC EFFECT OF REGRESSION RESULTS

	(1)
$treat \times T_{2014}$	0.00907 (1.27)
$treat \times T_{2015}$	-0.00964 (-1.08)
$treat \times T_{2016}$	0.0180* (-1.79)
$treat \times T_{2017}$	0.0322*** (-2.62)
Control	Yes
N	310
R^2	0.877

Note: t statistics in parentheses. *p< .1, **p< .05, ***p< .01.

For robustness check, this paper sets 2014 as the year in which the “Belt & Road” Initiative was implemented. The regression result is presented in Table V.

Table V. Robustness Check

	(1)
treyear	0.0113**
	(2.29)
rd	-4.472***
	(-9.39)
edu	1.963***
	(3.50)
scitech	-3.783*
	(-1.90)
capital	0.00251
	(0.50)
eximp	-0.105***
	(-6.13)

Although the “Belt & Road” Initiative was proposed in 2013, it came into full execution in 2014. As can be seen in Table V, after the event year was redefined, the impact of the “Belt & Road” Initiative still has a significant positive impact on TFP.

This paper also implements a placebo test. It creates a falsified policy variable which takes the value of 1 if the year is after 2011. It can be observed that the falsified variable is statistically insignificant. It provides more evidence that the “Belt & Road” Initiative indeed promotes TFP.

TABLE VI PLACEBO TEST

	(1)
treat×year	0.0000791
	(0.00)
ofdi	-0.507***
	(-4.16)
rd	-4.899***
	(-13.68)
edu	1.613***
	(2.83)
scitech	-4.369**
	(-2.28)
capital	-0.0122**
	(-2.37)
eximp	-0.0868***
	(-4.73)
fiscalexp	-0.184***
	(-2.97)
fibalance	-0.0662***
	(-8.87)
income	0.179***
	(3.14)
_cons	-2.105***
	(-62.65)
Control	Yes
N	310
R^2	0.866

Note: t statistics in parentheses. *p< .1, **p< .05, ***p< .01.

3 Conclusion

The empirical results of this paper indicate that the “Belt & Road” Initiative can indeed increase the TFP of the provinces along the route. The influencing mechanism is also further analyzed, and concludes that the implementation of the “Belt & Road” Initiative has a significant positive impact on the outward FDI, fixed assets investment, import and export, fiscal revenue and expenditure, and per capita income. At the same time, it has a significant negative impact on R&D and science and technology factors, which may be due to the strong lag of R&D and science and technology factors.

Based on the results of this paper and the regression results of related influencing factors, this paper puts forward the following suggestions:

First, China should further promote the “Belt & Road” Initiative, and encourage China's enterprises to "go out" to invest and build factories in participating countries. It will better learn the local advanced science and technology, absorb the local excellent technicians and advanced management experience, and feed the country and promote the technological progress and innovation of the related industries in China.

Besides, the “Belt & Road” Initiative, China should pay attention to the construction of infrastructure. Improving the infrastructure represented one by one is conducive to the participating countries. It provides a prerequisite for further deepening the initiative and closer ties between countries, and also creating a good external environment for technological development, innovation and entrepreneurship, and promoting the development of high quality economy in all parts of the country.

Finally, the “Belt & Road” Initiative is a strong driving force behind the development of TFP. Therefore, local governments should insist on, or even appropriately increase, investment in science and technology, research and development, and provide sufficient financial support and basic guarantee for technological innovation.

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