

Does “the belt & road” initiative promote the trade potential of participating countries? ——A “Quasi-natural” experiment design based on PPML model

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Abstract. The “Belt & Road” Initiative (B&R) is China’s international cooperation initiative proposed in 2013, which aims to promote regional economic development and common prosperity. Not only is B&R important for economic development, but also it helps to adjust and improve relevant policies. The trade potential of 100 B&R countries between 2008-2017 countries is analysed by using the PPML model. This paper finds that B&R has brought trade advantages participating countries. It has significantly promoted the trade potential of participating countries through influencing tariff levels, infrastructure and natural environment, economic scale, urbanization level and unemployment rate. B&R should be further promoted to better develop the policy advantages. More countries can be induced to participate in B&R by reducing trade frictions and promote cooperation.

1 Introduction

China has put forward B&R in the new situation of global regional economic integration. Today, many participating countries have formed cooperation with China, and constantly formulate reasonable, scientific, and efficient development strategies and trade strategies to promote common development and achieve common prosperity. The study of the impact of the B&R on the trade potential of participating countries is of great significance in promoting the economic and trade development of the countries and the construction of the B&R per se. The study can provide effective recommendations for policy implementers and guide the future development of international trade.

The trade between China and participating countries is affected by many factors. Most previous studies only investigate some of the participating countries. In this paper, the trade data between China and 100 countries from 2008 to 2017 are explored, which not only includes most of the participating countries, but also 24 non-coastal countries which rank high in the world GDP. After descriptive statistics of the relevant explanatory variables, this paper constructs the regression equation and conducts test on the import and export trade data. The PSM-DID model, based on a “Quasi-natural experiment”, is then used to test whether B&R promotes the trade potential of participating countries. A placebo test is conducted to verify the robustness. After that, the paper explores the mechanism by which B&R affects the trade potential by influencing the explanatory variables, and calculates the trade potential of participating countries based on the PPML model. This paper evaluates the effect of the policy implementation and

puts forward corresponding policy recommendations to promote the sound development of trade in China and participating countries.

This paper provides marginal contribution in the following three aspects: First, when the trade flow is zero, the stochastic frontier gravity model is invalid. This paper uses the pseudo-Poisson maximum likelihood estimation (PPML) model to measure the trade efficiency and potential. Second, the PSM-DID model is used to compare the trade volume among participating countries and non-participating countries. Third, this paper identifies the influencing mechanisms of B&R on trade potential, and puts forward policy recommendations accordingly.

2 Related Literature

China’s trade relations with participating countries have become closer. A great deal of research pertains to the multilateral trade relations and potential in this context. On the one hand, previous research has positive predictions about the trade potential of China and participating countries^[1,2], for example, Gao et al.^[3] uses social network analysis and finds that trade among participating countries is becoming more frequent and China is playing a more important role. Pan^[4] analyses China and participating countries’ agricultural trade data and finds that agricultural products still have great trade potential. On the other hand, previous research has also investigated the characteristics of trade markets between China and participating countries^[5,6]. He^[7] uses a stochastic frontier model and finds that multilateral trade is highly dependent on the GDP of the trading countries,

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and influenced by international organizations of population, language, and participation. However, empirical studies on the trade between China and non-participating countries are scanty [8-12].

This paper uses the PPML model and the PSM-DID method to evaluate the B&R from the perspectives of the trade potential between countries. The PPML model used in this paper can effectively deal with the regression impact brought by the zero-trade flow [13]; at the same time, the paper selects the trade data before and after the B&R, so the regression results can be more objectively compared. In addition, this paper also studies the influencing mechanism, and puts forward reasonable policy recommendations. It is an important task of this paper to get China's trade potential with other countries through multi-model, multi-aspect, and multi-angle analysis, and to make an analysis of its differences, to put forward practical suggestions at the strategic level.

3 Empirical Analysis

This paper selects the trade situation between China and 76 countries along the “Belt & Road” and 24 countries not along the “Belt & Road” during the ten years from 2008 to 2017 as the research object. It carries out regression analysis of trade data between China and 100 countries and substitutes them in PPML model for operational analysis.

3.1 Variables and descriptive statistics

Table 1. Variables and their definitions

Variables	Definitions
EX_{jit}	Total amount of imports and exports from country i to country j at time t. And because this paper studies China's trade with countries along the “Belt & Road”, country i is China and country j is the countries along the “Belt & Road”.
IM_{jit}	At time t, the total amount of goods and services imported by country i from country j. Country i is China.
GDP_{it}	At time t, the GDP of China is gross domestic product
GDP_{jt}	The time t for countries along the “Belt & Road” or countries not along the line, where j is used to represent the gross domestic product of a single country, that is, the gross domestic product of each country.
D_{ij}	The geographic distance between country i and country j, which is not time-varying. In the general gravity model, distance is considered as the trade cost in the trade process. The larger the distance, the higher the trade cost
CSO_{nj}	Coastal or no, indicating whether country j is a coastline country. If country j is a landlocked country, the value of this variable will be 0, if it is a non-landlocked country, it will be 1, and then regression will be carried in to obtain a corresponding significant result.

$APEC_j$	Whether this country has joined APEC (Asia-Pacific Economic Cooperation). This paper only considers reciprocal trade agreements in APEC. When country i and country j are both in APEC, the value is 1, otherwise 0.
V_{ijt}	Variables that influence this regression result satisfy a normal distribution and can be classified as random errors and external shocks. Ξ_{ijt} is an inefficient term in this regression, assuming that it is greater than or equal to zero and that it satisfies the conditions of normal distribution.
INF	Infrastructure Description: Transportation, Electricity and Communications, which include three modes of transportation, land, air, sea, power consumption and the percentage of Internet user communications. By calculating a total facility score for the three data, the larger the number, the better its construction will be.
NRS	Description of Natural Resources: The Export of Industrial Raw Materials as a Percentage of Total Export of Commodities in Trading Countries.
GDP	Description of market size: gross domestic product of the trading country in the current year.
UNE	Unemployment rate description: the proportion of unemployed people in the trading countries in their countries
TAR	Tariff level: $(V_{max}-V_1)/(V_{max}-V_{min}) \times 10$, $V_{max}=15\%$, $V_{min}=0\%$, V_1 indicates the average tariff rate. A lower value indicates a higher tariff rate.
URB	Urbanization level: the proportion of urban population in trading countries.
GEO_dis	Geographic Distance: Distance between China's capital and trading countries (kilometres)

Descriptive statistics for continuous variables are shown in Table 2.

Table 2. Descriptive statistics

Variab le	Name	Mean	SD	Min	Max
CC	Corruption	2.266	0.695	1	4.5
INF	Infrastructure	0.22	0.152	0.003	0.699
NRS	Natural resources	0.278	0.313	0	1.047
GDP	Market size	25.215	1.442	22.291	28.463
UNE	Unemployment rate	0.072	0.052	0.001	0.24
TAR	Tariff level	4.298	0.926	0	7.2
GEO_DIS	Geographic distance	5435.599	1734.495	1172.047	7722.639
URB	Urbanization level	0.591	0.213	0.168	1
HOFS TEDE	Psychological distance	1.735	1.117	0.103	5.861

3.2 Model specification

This paper selects the volume of import and export trade between each country and China, mainly explaining the

GDP of each country, the distance from China, whether coastal countries or not, whether join APEC or not, and then uses PPML method to study the trade potential and efficiency of China and countries along the "Belt & Road" through empirical analysis.

To study whether the trade potential of countries along lines of "the Belt & Road" Initiative has been enhanced, this paper uses dummy variable to measure the impact of this initiative. The dummy variable DID is defined as follows: 76 countries along the Belt & Road have a value of 1 for the year and after in which they joined, and 0 for the year before.

The regression equation used in this model is as follows:

$$\ln(ex) | \ln(im) | \ln(\text{total ex} + im) = \alpha + \beta_1 DID_{it-1} + \partial_0 + \partial_1 \ln GDP_{it} + \partial_2 \ln GDP_{jt} + \partial_3 \ln D_{ij} + \partial_4 CSON_j + \partial_5 APEC_j + \beta_4 \text{tar}_{it-1} + \beta_5 \text{inf}_{it-1} + \beta_6 \text{nr}_{it-1} + \beta_7 \text{gdp}_{it-1} + \beta_8 \text{urb}_{it-1} + \beta_9 \text{une}_{it-1} + \beta_{10} \text{cc}_{it-1} + \beta_{11} \text{dis}_{it-1} + \beta_{12} \text{hof}_{it-1} + \beta_{13} \text{tsr}_{it-1} + \beta_{14} \text{ran}_{it-1} + \beta_{15} \text{expen}_{it-1} + \varepsilon_{it} \forall_{ijt} - \exists_{ijt} > 0 \quad (1)$$

This paper uses PSM-DID model based on "quasi-natural" experiment design to test whether "the Belt & Road" Initiative promotes trade potential of countries along the line. Prior to that, PSM balance test should be carried out on the sum of import trade, export trade and import and export trade to judge whether explanatory variables are balanced according to the results.

Table 3. PSM-DID model suitability test

	(1)	(2)	(3)	(4)	(5)
	Common trend test	Random test of policy implement time	Control group not affected by the policy	Uniqueness test of policy	Group random test
DID	0.1065836** (0.013)	0.0368219 (0.510)	0.053971 (0.350)	0.1393198 (0.357)	2.517255*** (0.005)
Control variable	Y	Y	Y	Y	Y
Individual FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

Notes. *Significant at 10%, **5%, ***1%

According to the results in the table, under the standard deviation, the explanatory variables of import, export and total import and export trade are balanced, and the regression results are significant. From the observation of regression results, the DID is still significant in the common trend test, and DID of other tests are not significant, so the regression is not affected

by the interactive terms, so the equation has a parallel trend. After ensuring that a series of pre-tests have passed, regression is carried out on imports, exports and total imports and exports under the stable condition, and regression analysis of PSM-DID part is started, and the results in the table below are obtained.

Table 4. Import and export DID regression and PSM-DID regression results

Variable	DID		
	Import	Export	Total import and export
DID	0.367*** (3.03)	0.367*** (3.03)	0.259* (1.93)
LnGDP	0.0589345** (0.036)	0.0726279** (0.039)	0.316*** (0.015)
LnDistance	-0.6128772*** (0.004)	-0.622566*** (0.003)	-0.0413 (0.133)
Costalorno	0.5250967** (0.043)	0.5910908** (0.040)	0.602*** (0.002)
APEC	0.6838715** (0.042)	0.6980404** (0.031)	1.057*** (0.005)
Infrastructure	1.102*** (5.07)	1.102*** (5.07)	0.519** (2.49)
Natural Resources	0.584*** (4.28)	0.584*** (4.28)	0.919*** (6.25)
GDP	0.237***	0.237***	0.840***

	(3.15)	(3.15)	(11.32)
Urbanization	1.080***	1.080***	1.218***
	(4.26)	(4.26)	(5.95)
Unemployment	-1.229**	-1.229**	2.970***
	(-2.51)	(-2.51)	(4.84)
Corruption Perception	-0.398***	-0.398***	-0.675***
	(-7.15)	(-7.15)	(-11.72)
Ldistance	-1.910***	-1.910***	-1.379***
	(-12.53)	(-12.53)	(-10.33)
Hofstede	-0.0609***	-0.0609***	-0.0539***
	(-6.04)	(-6.04)	(-3.21)
cons	-5.696***	7.452***	12.22***
N	857	857	857
R ²	0.703	0.711	0.642
PSM-DID			
Variable	Import	Export	Total import and export
DID	0.389***	0.375***	0.259*
	(2.97)	(3.05)	(1.93)
LnGDP	0.0672896**	0.0727355**	0.321***
	(0.037)	(0.041)	(0.013)
LnDistance	-0.6435671***	-0.628428***	-0.0427
	(0.005)	(0.004)	(0.128)
Costalorno	0.5023783**	0.5915705**	0.641***
	(0.039)	(0.051)	(0.004)
APEC	0.7123739**	0.6992633**	1.062***
	(0.039)	(0.037)	(0.002)
Infrastructure	1.096***	1.110***	0.507**
	(4.98)	(5.12)	(2.38)
Natural Resources	0.603***	0.595***	0.899***
	(4.17)	(4.34)	(6.02)
GDP	0.245***	0.291***	0.901***
	(3.14)	(3.20)	(10.49)
Urbanization	1.104***	1.095***	1.227***
	(4.18)	(4.28)	(6.02)
Unemployment	-1.304**	-1.211**	2.898***
	(-2.63)	(-2.63)	(4.95)
Corruption Perception	-0.413***	-0.415***	-0.696***
	(-6.97)	(-7.19)	(-10.98)
Ldistance	-1.87***	-1.957***	-1.385***
	(-12.07)	(-12.68)	(-10.47)
Hofstede	-0.0627***	-0.0677***	-0.0532***
	(-5.47)	(-6.12)	(-3.34)
cons	-6.142***	7.405***	12.41***
N	767	767	767
R ²	0.684	0.705	0.632

Notes. *Significant at 10%, **5%, ***1%

The coefficients of DID regression results in import and export trade are positive and significant. Combined with PSM-DID method, it can be concluded that the “Belt & Road” Initiative has brought positive impact on trade between China and other countries. In comparison between member countries and non-member countries, trade volume of member countries has been significantly improved after joining the “Belt & Road” initiative, but the change of trade volume of non-member countries is less obvious. The other explanatory variables are also consistent with the previous trade regression results. All the explanatory variables are significant. The

international trade in current world is no longer mainly affected by geographical distance, but determined by the economic size of the trading country, whether it is a coastal country and whether it has joined the reciprocal trade organization.

The analysis of the regression results is as follows: in the model, the coefficients of each explanatory variable are greater than zero, which indicates that China mainly plays the role of exporter in international trade with trading countries. Secondly, the regression coefficient of tariff level is positive and significant, which indicates that tariff is an important factor affecting net export. It is

necessary to control a stable tariff for trade between countries. The coefficients of infrastructure and natural environmental resources are positive and the regression results are significant, which shows that these two factors are the key points in trade, and the investment of governments in infrastructure and natural environmental resources has a positive role in promoting international trade. In addition, other explanatory variables such as the economic size (GDP) and urbanization level (URB) of

trading countries are positively correlated and significant, indicating that the economic size and urbanization level of a country have a positive impact on international trade. Geographic distance (GEO_DIS) and the unemployment rate (UNE) are negatively correlated, indicating that close distance between trading countries is more conducive to international trade, and the high unemployment rate is not beneficial for international trade.

Table 5. Impact of trade potential: placebo test

DID			
	Import	Export	Total import and export
DID	-0.007 (-1.11)	-0.004 (-0.78)	-0.004 (-0.77)
_cons	2.194*** (103.77)	1.931*** (70.82)	2.046*** (71.11)
Control variables	Y	Y	Y
Individual FE	N	N	Y
Year FE	N	N	N
N	310	310	310
R ²	0.820	0.854	0.774
PSM-DID			
	Import	Export	Total import and export
DID	-0.006 (-1.26)	-0.005 (-0.69)	-0.005 (-0.71)
_cons	2.298*** (110.13)	2.034*** (80.88)	1.997*** (81.32)
Control variables	Y	Y	Y
Individual FE	N	Y	Y
Year FE	N	N	Y
N	310	310	310
R ²	0.852	0.832	0.769

Notes. *Significant at 10%, **5%, ***1%

In the regression of testing the randomness of policy intervention time, the results in Table 5 show that the coefficient of DID is negative and not significant, so the placebo effect of DID is excluded. Based on the results, the coefficients of DID are not significant in 2011 and 2012. But it shows that the “Belt & Road” initiative has played a real role in promoting trade between the countries since 2013. This fully illustrates that the “Belt & Road” initiative has played a significant positive role in promoting the trade potential of countries along the line under the condition of passing the placebo test.

3.3 Policy mechanism

In order to further analyse how the “Belt & Road” initiative ultimately affects the mechanism of trade potential by affecting various explanatory variables, table 6 shows the results of the mechanism of the “Belt & Road” initiative affecting the trade potential of countries along the line.

Table 6. Mechanism research on the impact of “Belt & Road” initiative on trade potential

	TAR	INF	CC	URB	UNE
DID	0.0275*** (8.24)	0.00131*** (5.37)	0.00118 (0.96)	0.005*** (3.40)	-1.190*** (14.13)
Control variables	Y	Y	Y	Y	Y
N	310	310	310	310	310
R ²	0.196	0.094	0.126	0.040	0.418
	GDP	GEO_DIS	NRS	HOFSTEDE	
DID	0.024 (1.20)	-0.046*** (8.92)	0.760*** (12.72)	0.00997 (1.32)	
Control	Y	Y	Y	Y	

variables				
N	310	310	310	310
R ²	0.061	0.222	0.368	0.123

Notes. *Significant at 10%, **5%, ***1%

In Table 6, this paper focuses on the observation of the interactive items, representing the impact of the “Belt & Road” initiative on the driving factors of the trade potential of the neighbouring countries along the line. According to the regression results, the coefficients of tariff level (TAR), infrastructure (INF), natural environment (NRS), economic scale (GDP) and urbanization level (URB) are mostly significantly positive. The geographic distance between trading countries (GEO_DIS) and unemployment rate (UNE) are significantly negative. It can be concluded that the “Belt & Road” initiative significantly affects the trade potential of countries along the line through tariff level (TAR), infrastructure (INF), natural environment (NRS) and urbanization level (URB).

3.4 Estimation of trade potential

Based on the PSM-DID regression analysis of PPML model, this paper estimates the trade potential value of the countries along the line. The calculation method is as follows:

$$\text{Trade potential} = \frac{\text{Trade value of sample}}{\text{Trade value estimated by regression equation}} \quad (2)$$

Based on the import and export trade value, distance, GDP, whether it is a land locked country and whether it has joined the APEC Trade Organization, corresponding import and export regression value is obtained, and the trade potential value of 76 countries along the line is calculated, and the possible reasons for the resulting value are analysed.

According to classification methods by Boyd ^[14], the trade potential value can be divided into 3 categories: potential regeneration type, potential development type and potential huge type. Details are shown in Table 7^a.

After that, by using the average value of the potential value of export trade between China and countries along the line in 2008-2017, due to the lack of time variability, we calculated the average value, and obtained the space for the increase of trade potential and made the corresponding analysis. The following formula is the specific calculation method of the space for the increase of trade potential:

$$\text{Room for improvement} = 1 - \text{trade potential value} \quad (3)$$

Looking at all the export potential values and development space of the “Belt & Road” initiative, most of the countries have a small gap and a large development space. China's exports have certain similarities to the markets of other countries along the “Belt & Road”, but further development is required to achieve the improvement of trade value according to different national conditions. All the countries along the

“Belt & Road” have a trade potential value of less than 1.2, and except Singapore, most of the Asian countries along the “Belt & Road” have a potential value of less than 0.8, which belong to potential huge type, and has great potential for development. This shows that after becoming the countries along the “Belt & Road”, their export trade with China still has great potential and great prospects for development in the future. Further, each trading country has its own characteristics. Within the scope of all countries along the belt and road, the top 2 countries in terms of export trade potential improvement are Saudi Arabia and Vietnam, with the former potential value of 84.6% and the latter of 80.8%, both greater than 0.8 and less than 1.2, which are potential development type, indicating that after the “Belt & Road” initiative was launched in 2013, the export trade market between these two countries and China is not fully saturated, and there is still more than 10% room for development. However, China still has more room for development for the markets exported to other countries, with the values of less than 0.8, the vast majority or even less than 0.5, indicating that it has great room for development, China needs to focus on developing new trade policies to promote development when exporting to these countries.

By observing all the potential value and development space of the import trade along the “Belt & Road”, it is found that the development space of the import market in many countries is greater than 0.5, which is different from the export trade, and the import trade has more potential. China's import development from the countries along the “Belt & Road” needs to be improved, which is also closely related to China's status as an export country. All the countries along the “Belt & Road” have a trade promotion space value of less than 1.2, indicating that they are not potential regeneration type, and most of the values are less than 0.8. Although the number of countries along the “Belt & Road” with huge potential is less than exports, it still accounts for the majority. Countries along the “Belt & Road”, including other continents, have great development prospects and broad space for import development.

4 Policy suggestions and conclusions

This paper evaluates whether the “Belt & Road” initiative affects the trade potential of countries along the “Belt & Road” and explores the impact mechanism. The empirical study found that the “Belt & Road” initiative has a significant effect on promoting the trade potential of countries along the “Belt & Road”. The “Belt & Road” has a positive impact on the international trade potential by influencing factors such as tariff level, infrastructure and natural environment, economic scale, urbanization level and unemployment rate, while the geographical distance between trade countries has a negative impact on international trade. Based on the conclusions, the following policy recommendations are proposed:

^a Due to space limit, all appendices can be found on <https://www.jianguoyun.com/p/DfzJOdoQ38HrCbi26OkD>

(1) To create a stable environment and promote the development of mutually beneficial trade agreements with members of the “Belt & Road”: according to the previous article, the independent variable regression results such as whether to join the Asia Pacific Economic Cooperation (APEC) are significant and the coefficient is greater than zero, indicating that when a trading country joins the trade mutually beneficial organization, lower tariffs and favourable trade terms make international trade more effective, the efficiency value TE is higher. Therefore, China should strengthen the role of multilateral cooperation mechanisms such as the Asia Pacific Economic Cooperation Organization, the Asia Europe conference, and the Shanghai cooperation organization, and make multilateral trade develop well in a relatively stable trading environment by drafting new free trade agreements and promoting the establishment of new free trade zones.

(2) Reduce trade frictions and promote more countries to join the “Belt & Road”: this paper found that the “Belt & Road” initiative did play a positive role in promoting trade between China and countries along the “Belt & Road”, so the cooperation between national governments on the macro level is particularly crucial, so as to strengthen in-depth cooperation with overseas countries, which is beneficial to reduce trade frictions and promote China international trade with countries in order to reach a new stage. However, there are still many countries in the world that have not joined the project, so the focus of China's future work is to further improve and implement the "Belt and Road" initiative, deepen the degree of mutual benefit with the member countries and attract more countries outside the initiative to join, which is the key to promote the sound development of China's economy and improve the status quo of various international regions.

(3) To promote the deepening of cooperation among member countries and implement the "Belt & Road" initiative: as a member of the “Belt & Road” initiative, the level of tariffs, the economic scale of trading countries, the level of urbanization, the level of environment and infrastructure and other explanatory variables are positively related to international trade; at the same time, the calculation results of trade potential show that the potential of many member states is still huge. Therefore, China should comprehensively consider the advantages of resources of each member state, adapt to local conditions, and achieve localization and efficiency of policies. At the same time, we will implement the cooperation objectives of facility connection, trade smooth, and financing, promote the economic development and related infrastructure construction of member states, and promote the establishment of emerging pilot free trade zones, so as to play the positive radiation role of the "Belt & Road" initiative to seek benefits for member states and further deepen cooperation among countries.

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