Research on the China' Production Capacity Cooperation Potential of Mechanical and Electrical Equipment Products with the Countries along the "Belt and Road"

Hongbing You [1, 2], Zou Yan [1]

[1] School of Economics and Management, Nanjing University of Science and Technology, Nanjing, China

[2] Research Center for International Economic and Trade Issues, Nanjing, China

Abstract. Promoting international production capacity cooperation of equipment manufacturing can improve both the quality and efficiency of China's economy. The "One Belt and One Road"(OBOR) initiative has provided an important opportunity for China's mechanical and electrical equipment to "go global". Based on the panel data of 51 countries along the OBOR from 2004 to 2019, a stochastic frontier gravity model is constructed to estimate the production capacity cooperation of China's mechanical and electrical equipment products in those representative countries along the OBOR. The study found that the production capacity cooperation of mechanical and electrical equipment between China and those countries along the OBOR has continued to deepen since the OBOR initiative has been put forward and there is still great potential; however, the production capacity cooperation potential is differences in regions. When promoting the production capacity cooperation of mechanical and electrical equipment between China and those countries along the OBOR, it is very crucial to select scientific and reasonable countermeasures, they are as follows: to scientifically identify the factors affecting the production capacity cooperation, to reasonably select cooperation partners with greater potential, and choose scientific and rational strategic layout to the develop the production capacity cooperation.

Keywords: OBOR; Mechanical and Electrical Equipment Products; Production Capacity Cooperation; Random Frontier.

1. Introduction

After decades of development, including mechanical and electrical equipment, including China's equipment manufacturing industry in recent years, there is a more serious problem of overcapacity, and it is difficult to solve by stimulating domestic demand. As a new type of international economic cooperation mode of mutual benefit and win-win situation, production capacity cooperation can not only solve China's overcapacity of mechanical and electrical equipment, but also can realize complementary advantages with the countries participating in the production capacity cooperation and drive the industrial upgrading of both sides. [1] It can also realize complementary advantages with participating countries and drive the industrial upgrading of both sides. There are usually two paths for capacity cooperation: one is to complete capacity displacement through export trade; the other is to implement industrial transfer through foreign direct investment.[2] One is to complete capacity displacement through export trade; the other is to implement industrial transfer through outward direct investment. In view of the fact that at the present stage, the form of capacity cooperation between China and the countries along the "Belt and Road" is still dominated by export trade, and drawing on the existing literature to measure the potential of capacity cooperation, we choose to take the unrealized trade potential of mechanical and electrical equipment as a substitute indicator due to the existence of trade resistance, and then use the unrealized potential of mechanical and electrical equipment as a substitute indicator for capacity cooperation. In this paper, we choose to use the unrealized trade potential of mechanical and electrical equipment as a proxy indicator for capacity cooperation.[3] In this paper, the trade potential of unrealized mechanical and electrical equipment is chosen as a proxy indicator for capacity cooperation.

Although mechanical and electrical equipment products are one of the important subjects of the equipment manufacturing industry, the national economic industry division (GB/T 4754-2017) does not have a special explanation for them. Drawing on the classification method of Xu Qiang (2022), and taking into account the availability of data, this paper limits the mechanical and electrical equipment products to the means of production in the equipment manufacturing industry. In summary, the scope of the "mechanical and electrical equipment" industry in this paper does not include the following two categories in the equipment manufacturing industry, i.e., the metal products industry and the communication equipment, computer and other electronic equipment manufacturing industry.

Table 1. Classification of mechanical and electrical equipment and its SITC.

subcategories	means of transportation		robots			electrical power
subcategory	motor vehicles	Other transportation equipment	metal processing	Specialized machines	electric motor apparatus	electrical power
SITC code	78	79	73	72	771	71+773

Specifically, the product categories involved in the mechanical and electrical equipment studied in this paper are divided and their corresponding SITC classification codes are shown in Table 1, which are mainly divided into three subcategories of transportation, machines, and electronics, and their specific compositions are as follows: the major category of transportation includes automobiles (SITC 78) and other transportation equipment such as ships, railroads, and aerospace (SITC 79), etc.; the major category of machines includes metalworking (SITC 73), special machines (SITC 72), and electric machines (SITC 73); and the major category of machines includes metal processing (SITC 73), special-purpose machinery (SITC 72) and electric machinery (SITC 771) three subcategories; power subcategory includes generation equipment (SITC 71) and transmission equipment (SITC 773) two SITC codes summed up, this major category under the subcategories are no longer distinguished.[4] The subcategories are no longer distinguished under this major category.

Meanwhile, based on the background of the "Belt and Road" initiative, combined with the task of China's mechanical and electrical equipment "going out", and with capacity cooperation as the research object, the BC95 model is constructed to measure the optimal potential of capacity cooperation between China and the mechanical and electrical equipment of the countries along the route on the "frontier", so as to provide guidance for promoting the capacity cooperation between China and the countries along the route. By constructing the BC95 model, we measure the optimal potential of capacity cooperation between China and the countries along the route in terms of mechanical and electrical equipment on the "frontier", so as to provide guidance for promoting the capacity cooperation between China and the countries along the route in terms of mechanical and electrical equipment.

2. Literature review

2.1. Study on capacity cooperation

The concept of "international production capacity cooperation" was first put forward by Premier Li Keqiang and President Nazarbayev of Kazakhstan during their talks in December 2014, and since then, although Sino-foreign international production capacity cooperation has attracted the attention of some foreign scholars, it is mainly dominated by domestic scholars, and the research has mainly been carried out from the following two aspects:

First, research based on the perspective of China and specific countries or regions. Based on the data of 54 countries along the "Belt and Road" from 2005 to 2017, Liu Bing (2021) utilized a time-varying stochastic frontier model to study the efficiency of production capacity cooperation between China and countries along the "Belt and Road" from the perspective of Chinese cultural dissemination abroad, and found that there is still much room for expanding the potential of production capacity

cooperation between China and countries along the belt and road. Efficiency, and found that there is still much room for expanding the potential of production capacity cooperation between China and the countries along the Belt and Road.[5] It is found that there is still much room for expanding the potential of capacity cooperation between China and countries along the Belt and Road. Sun Fang et al. (2021) found that China and Russia have a strong foundation for production capacity cooperation and have carried out production capacity cooperation in the fields of petroleum processing, automobile manufacturing, pharmaceutical manufacturing, and so on.[6] Li Daojun et al. Li Daojun et al. (2021) studied the Sino-Harbinese production capacity cooperation from the perspective of industrial gradient differences, and found that China's capital-intensive and capital-technology-intensive industries are more competitive and have a further upward trend, while the labor-intensive industries are very competitive but show a downward trend.[7] The labor-intensive industries are very competitive but showing a decreasing trend.

Second, research based on a specific industry. Liu Dong (2020) studied the production capacity cooperation in the field of manufacturing between China and Egypt, pointing out that Egypt has potential comparative advantages in the development of manufacturing industry, but China-Egypt manufacturing production capacity cooperation is still in the initial stage.[8] ; Shijian (2020) found that the agricultural production capacity in Central Asia is low, but the potential for the development of agricultural resources and livestock resources is huge, and there is a large potential for production capacity cooperation[9] Yan and Li Zhipeng (2017) studied the production capacity cooperation between China and the Philippines in the iron and steel industry, pointing out that the Philippines is rich in mineral deposits, rich in human resources, high labor quality and low cost, and there is a strong potential for production capacity cooperation with China[10] .

2.2. Study on the trade potential of countries along the “Belt and Road”

The proposal of the “Belt and Road” initiative has created a favorable environment for the study of the trade potential between China and the countries along the “Belt and Road”, arousing more and more scholars' interest in the study and forming a series of related research results.

First, a number of research results on cooperation in the field of trade have been produced. Zou Jialing et al. (2015) studied and pointed out that the trade dependence between China and the countries along the “Belt and Road” has a tendency to deepen and shows significant asymmetry; Sun Jin et al. (2016) pointed out that the construction of infrastructure is a key factor in reducing the cost of trade between China and the countries along the route; Li Jing et al. (2017) innovatively chose the network analysis method, integrated density and centrality research and found that the trade complementarity between the “Belt and Road” countries is greater than competition. (2017) innovatively chose the network analysis method, comprehensive density and centrality research found that the trade complementarity between the countries along the “Belt and Road” is greater than the competition; Li Huiling et al. (2016) from the three effects of the demand-induced, industrial structure, price competition, the impact of China-India, China-Pakistan export growth research, and found that China can make adjustments based on these three perspectives in order to promote exports.

The second is that researchers select explanatory variables from multiple perspectives. Liu Jingxing et al. (2019) chose the stochastic frontier gravity model to study the potential of steel production capacity cooperation between China and the “Belt and Road” countries, and in the process of the study, based on the panel data of 57 countries for the period of 2000-2016, they selected China's GDP, host country GDP, China's per capita GDP, host country's per capita GDP, geographical distance, common language, and common border as explanatory variables, and selected economic distance, institutional distance, and cultural distance as explanatory variables for non-trade efficiency [11] . For the latter, the selection is based on the concept of “five links” put forward by the “Belt and Road” initiative: policy linkage, facility linkage, trade linkage, capital linkage and people's heart linkage. In the study of China's construction machinery export potential and export efficiency, for the selection of explanatory variables, Yin Hua (2020) believes that not only should consider the common factors common to the export of tangible commodities, but also must be closely integrated with the

characteristics of the industry of construction machinery and the implementation of the Belt and Road Initiative, and ultimately, he chose the GDP per capita, geographic distance, exchange rate and common borders as the explanatory variables, and the trade inefficiency model. then chose five elements such as infrastructure conditions, policy effects, economic conditions, trade facilitation and government expenditure level[12] ; Diao Li (2017) studied China's export potential and export efficiency to the countries along the Silk Road Economic Belt based on the trade complementarity and competition between China and the countries along the belt, and for the explanatory variables, GDP per capita, population size, geographic distance, common borders, and whether or not the importing country is landlocked were selected, and for the trade inefficiency term, the explanatory variables of the RTAs, infrastructure, and government efficiency were selected, trade freedom, financial freedom and monetary freedom; Liu Chunyan (2022) et al. studied the impact of the national facilities connectivity perspective on the efficiency of China's outward FDI. In terms of the selection of infrastructure connectivity indicators for the “Belt and Road” countries, the sum of the freight volume of air and railroads is selected to characterize the level of transportation infrastructure connectivity in each country, the average value of the number of fixed-line telephone subscribers, mobile telephone subscribers and Internet subscribers per 100 people is selected to characterize the level of network infrastructure connectivity in each country, and the average value of renewable energy consumption as a percentage of total final energy consumption is selected to characterize the level of network infrastructure connectivity in each country. energy consumption as a share of total final energy consumption to measure the level of energy infrastructure connectivity in each country, and the share of population with access to basic sanitation as a share of total population to characterize the level of public service infrastructure connectivity in each country.[13] The level of public service infrastructure connectivity is characterized by the share of the population with access to basic sanitation in the total population.

2.3. Study on the export potential of the mechanical and electrical equipment industry

Although mechanical and electrical equipment belongs to the equipment manufacturing industry from the point of view of the major industries, the equipment manufacturing industry itself is a relatively unique concept in China's industrial research and economic management.

Pengfei Chu (2020), in an empirical study of China's exports of equipment manufacturing products to countries along the Belt and Road from 2006 to 2018, selected seven variables as explanatory variables for the trade inefficiency term, namely, institutional environment, trade openness, trade agreements, tariff levels, and infrastructure, and found that signing FTAs with trading partner countries, increasing trade openness, and developing infrastructure levels significantly increase China's trade level, while increasing tariff levels decrease trade efficiency. It was found that signing FTAs with trading partner countries, increasing trade openness, and developing infrastructure level can significantly improve China's trade level, while increasing tariff level will reduce trade efficiency.

In addition, a number of studies on the export efficiency and export potential of China's equipment manufacturing products have been produced, representative of which is Li Xiaozhong's (2019) study on the export potential and export efficiency of China's equipment manufacturing products. He innovatively chose to use the Internet penetration rate to measure the Internet development level of the host country, and selected three indicators of liner shipping connectivity index, trade and transport-related infrastructure and liner shipping connectivity to measure the infrastructure convenience of the host country, the paper utilized the stochastic frontier gravity model, and selected data from 62 countries along the routes from 2007-2015 to carry out empirical analyses, and the results found that The results found that the implementation of the “Belt and Road” initiative, the improvement of the level of Internet development, and the improvement of trade and transportation infrastructure can promote the efficiency of export trade, and put forward targeted recommendations.[14] Yin Hua (2019) empirically studied the factors affecting China's exports of electrical equipment manufacturing products to the “Belt and Road” countries, export potential and export efficiency, and selected explanatory variables from the economic conditions, institutional

environment, infrastructure and trade facilitation of trade partner countries in terms of trade inefficiency, trade freedom and monetary freedom to measure the economic conditions of trade partner countries, and trade facilitation. freedom and monetary freedom to measure economic conditions, political stability index as a proxy variable for institutional environment, information, infrastructure index and liner shipping index under infrastructure conditions are used to reflect information and communication, land transportation and sea transportation respectively, and trade facilitation is measured by the dummy variables of China-Europe liner and tariff level.

2.4. Literature review

To summarize, on the issue of trade cooperation between China and the countries along the “Belt and Road”, scholars have carried out extensive research and produced a number of representative research results, which provide strong theoretical guidance and forward-looking methodology for this study. However, scholars' research on production capacity cooperation is mostly based on the overall production capacity cooperation, and mainly selects the manufacturing industry as the research object in the industry selection, and even less on the equipment manufacturing industry, especially the mechanical and electrical equipment products. In this paper, we will use the export data of China's mechanical and electrical equipment industry to the countries along the “Belt and Road” from the macro level, use the BC95 model to empirically study the factors affecting the trade scale, and add the inefficiency term in the stochastic frontier model, and introduce the trade resistance factors into the model which were originally put into the stochastic interference term, and through the “one-step method”, we will study the trade resistance factors in the “Belt and Road” and the “One-step method”. In addition, the inefficiency term is added to the stochastic frontier model, the trade resistance factor is introduced into the model, and estimated by the “one-step method”, and finally the trade efficiency and trade potential are measured, so as to better guide the production capacity cooperation of China's mechanical and electrical equipment.

3. Overview of China's exports of mechanical and electrical equipment to countries along the “Belt and Road” route

3.1. Scale of exports Expanding but fluctuating

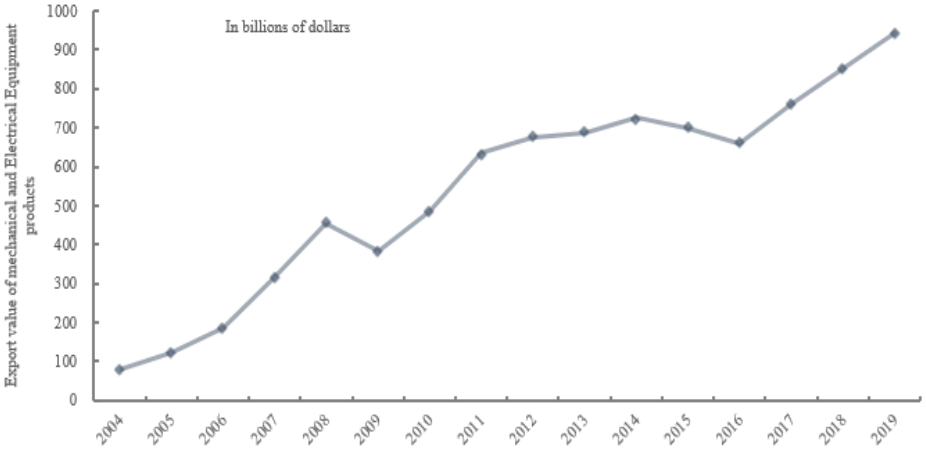

Fig 1. China's exports of mechanical and electrical equipment to countries along the “Belt and Road”, 2004-2019.

Under the “Belt and Road” initiative, the mechanical and electrical equipment industry, as a key area of China's equipment manufacturing industry, is not only one of the important pillars of China's industrial growth, but also an industry with high relevance to “facility connectivity” and “trade connectivity”. It is also an industry with high relevance to “facility connectivity” and “trade connectivity”. The “Belt and Road” initiative not only stimulates China's exports to the countries along the “Belt and Road” and enhances bilateral economic and trade exchanges, but also adds a

"going out" feasible path for China's mechanical and electrical equipment industry. "A feasible path. China Customs statistics show that in 2004, China's exports of mechanical and electrical equipment products amounted to 44.506 billion U.S. dollars, and in 2019, exports reached 307.887 billion U.S. dollars, with an average annual growth rate of 12.85%, which is a very rapid growth. In recent years, although affected by the new crown pneumonia epidemic, China's equipment manufacturing industry has recovered strongly, and helped the growth of China's exports of equipment manufacturing industry. 2022 1-6 value added of equipment manufacturing industry increased by 4.3% year-on-year. 2004 to 2019 16 years, China's exports of mechanical and electrical equipment to countries along the "Belt and Road" showed a significant upward climb. During the 16-year period from 2004 to 2019, China's exports of mechanical and electrical equipment products to countries along the "Belt and Road" showed an obvious upward trend (Figure 1), rising from 8.202 billion U.S. dollars in 2004 to 94.500 billion U.S. dollars in 2019, with an average annual growth rate of 16.50%.

Table 2. Percentage of China's exports of mechanical and electrical equipment to countries along the "Belt and Road", 2004-2019 (unit: %).

vintages	in China's exports of mechanical and electrical equipment products	in China's total exports
2004	18.43	8.84
2005	20.42	9.64
2006	22.44	10.54
2007	27.01	12.51
2008	29.38	14.29
2009	30.21	14.41
2010	27.74	14.09
2011	29.14	14.82
2012	29.98	14.35
2013	30.32	12.98
2014	30.06	12.23
2015	29.67	12.38
2016	30.42	12.36
2017	27.92	13.04
2018	28.25	13.13
2019	30.69	13.53

According to the proportion of China's exports of mechanical and electrical equipment to countries along the Belt and Road from 2004 to 2019 (Table 2), it can be found that in recent years, the proportion of China's exports of mechanical and electrical equipment to countries along the Belt and Road has gradually climbed from 18.43% in 2004 to 30.69% in 2019, which is 1.67 times higher than that in 2004. It can be found that in recent years, the proportion of China's exports of mechanical and electrical equipment products to countries along the "Belt and Road" in China's total exports of mechanical and electrical equipment products has gradually climbed from 18.43% in 2004 to 30.69% in 2019, which is 1.67 times of that of 2004. Especially, the growth rate is even faster after the concept of international production capacity cooperation was put forward in 2014, which fully indicates that the market of the countries along the "Belt and Road" is becoming more and more important for China's electromechanical and mechanical equipment products. During the same period, the proportion of exports of mechanical and electrical equipment products in China's total exports to countries along the "Belt and Road" increased from 8.84% to 13.53%, which fully indicates that the dependence of countries along the "Belt and Road" on China's mechanical and electrical equipment products has been gradually increasing, but at the same time, it has also become one of the important sources of growth of China's exports to countries along the "Belt and Road". It has also become one of the important sources of China's export growth to the countries along the "Belt and Road".

3.2. Concentration of export markets

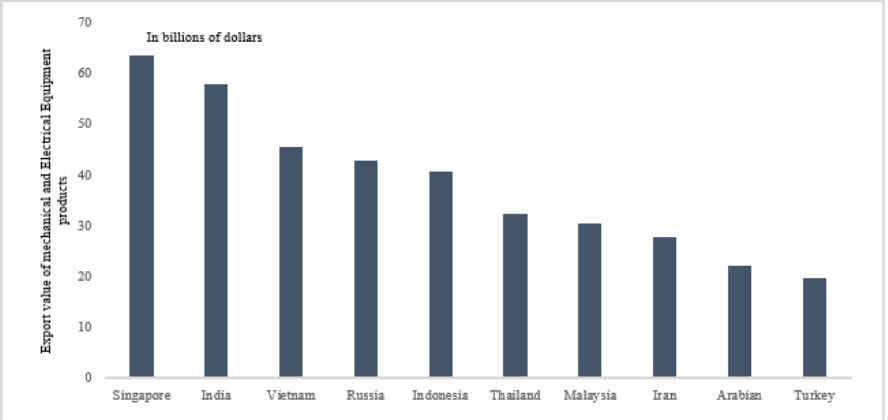

Fig 2. China's Average Export Ranking of mechanical and electrical equipment Products to Countries Along the "Belt and Road", 2004-2019.

China's exports of mechanical and electrical equipment products to countries along the "Belt and Road" have obvious country-specific differences. Between 2004 and 2019, China's exports of mechanical and electrical equipment products to countries along the "Belt and Road" were mainly concentrated in 10 countries (Fig. 2), of which 5 were in Southeast Asian countries, namely, Singapore, Vietnam, Indonesia, Thailand and Malaysia; three West Asian countries, namely, Iran, the United Arab Emirates and Turkey; India in South Asia; and Russia across Eurasia. Among them, Singapore is the largest export market for Chinese mechanical and electrical equipment products among the countries along the "Belt and Road".

In terms of the scale of mechanical and electrical equipment exports, China and the countries along the route of the scale of the obvious expanding trend, and mechanical and electrical equipment products to China's exports to the countries along the route of the overall contribution to the rising trend, but the main export market shows a diversified trend, country-specific differences are obvious, and the main export advantage is reflected in the South-East Asian countries, and there is still a huge space for trade and cooperation in the future.

3.3. Exports Product agglomeration is more significant

From the perspective of the exports of the three major categories of mechanical and electrical equipment, from 2004 to 2019, China's exports to the countries along the "Belt and Road" are, in descending order, transportation, machinery and electric power, and accordingly, their respective export value is 346.046 billion U.S. dollars, 323.321 billion U.S. dollars and 198.136 billion U.S. dollars (Table 3 in detail). 198.136 billion dollars (see Table 3 for details). It should be noted, however, that due to the impact of the financial crisis in 2008, the products of the above three major categories of industries declined in 2009, rebounded in 2010, but then fluctuated to some extent in subsequent years.

In terms of product-specific growth rates, the fastest-growing sector during the above period was specialized machinery, with exports in 2019 13.55 times higher than in 2004, at an average annual growth rate of 18%; followed by power transmission equipment, with a growth rate of 12.80 times, at an average annual growth rate of 17%.

To summarize, during the 16 years from 2004 to 2019, China's exports of mechanical and electrical equipment products to countries along the "Belt and Road" have achieved good results; not only has the scale of exports expanded significantly, but also the position of mechanical and electrical equipment products in export trade has become more and more significant. However, there are some problems, such as the market in Southeast Asia is more concentrated, but the export scale of other markets is not large, and the export product structure is not balanced enough. In the future, China needs to pay attention to the volatility of market structure and product structure, and further expand market diversification.

Table 3. Product breakdown of China's exports of mechanical and electrical equipment to countries along the "Belt and Road" (in billions of dollars).

year	means of transportation	78	79	robots	72	73	771	electrical power	71	773
2004	31	23	8	31	20	3	7	20	15	5
2005	49	33	15	46	31	5	10	27	20	7
2006	76	52	24	71	48	8	15	38	27	11
2007	142	97	45	110	76	12	23	63	45	18
2008	190	121	69	163	113	21	29	103	78	25
2009	151	66	85	132	84	18	29	100	80	19
2010	199	96	103	164	106	19	39	124	98	26
2011	257	138	120	215	146	24	45	163	130	33
2012	287	157	130	234	160	27	48	154	117	37
2013	269	167	102	260	178	29	53	159	118	41
2014	278	190	88	285	196	33	56	161	115	46
2015	271	177	93	265	180	29	56	165	114	51
2016	239	161	78	251	175	25	50	169	120	50
2017	302	236	66	290	209	25	56	169	113	56
2018	339	256	83	331	242	30	59	185	126	59
2019	380	284	96	385	277	34	74	180	121	60
total	3460	2254	1207	3233	2243	341	649	1981	1438	544

3.4. Export Competitiveness Advantage is more obvious.

In 1965, the American economist Balassa pointed out that the question of how competitive a country's products are in the international market can be determined by the index of demonstrated comparative advantage (RCA). When the RCA exceeds 1, it indicates that in the international market, the product has a certain comparative advantage; when the RCA is less than 1, it indicates that such products have relatively weak international competitiveness; the more the RCA is infinitely close to 1, the more it implies that such products have inconspicuous advantages and disadvantages in the international market.[15] The closer the RCA is to 1, the more it means that these products have no obvious advantages and disadvantages in the international market.

Since this paper studies China's export potential of mechanical and electrical equipment to the countries along the "Belt and Road", the modified RCA is used to measure the comparative advantage, and the formula is as in (1):

$$RCA_{ij}^{a} = \frac{X_{ij}^{a}/X_{ij}}{X_{iw}^{a}/X_{iw}} \quad (1)$$

Where refers specifically to the research object of this paper - mechanical and electrical equipment products, i refers to China, and j refers to the countries along the "Belt and Road".RCA_{ij}^{a} Is the comparative advantage.X_{ij}^{a} Represents the trade volume of China's exports of mechanical and electrical equipment products to the countries along the Belt and Road.X_{ij} Represents China's total exports of goods to countries along the Belt and Road;X_{iw}^{a} represents China's exports of mechanical and electrical equipment products to the world, andX_{iw} represents China's total global exports. IfRCA_{ij}^{a} is greater than 1, it means that China's mechanical and electrical equipment products in the countries along the "Belt and Road" have a comparative advantage over China's mechanical and electrical equipment products in the global market; on the contrary, it means that China is in a comparative disadvantageous position. According to equation (1), the competitiveness of China's mechanical and electrical equipment products to 51 countries along the "Belt and Road" in 2019 is calculated, and the results are shown in Table 4:

Table 4. China's RCA Index of mechanical and electrical equipment Products to Countries Along the Belt and Road, 2019.

States	RCA	States	RCA	States	RCA
Albania	1.17	Indonesia	1.14	Polish	1.02
Azerbaijan,	1.22	Iranian	1.38	cartel	1.08
Bahrain	2.55	Palestine	0.77	Romania	1.32
Bangladesh	1.07	Kazakhstan	1.56	Georgia	1.28
Armenia	1.30	Jordan	0.78	Saudi Arabia	1.04
Bosnia	0.77	Iraq	1.58	India	1.01
Bulgaria	1.20	Kyrgyzstan	0.46	Singaporean	1.36
Byelorussia	2.05	Laos	1.89	Vietnam	0.90
Cambodian	0.95	Hostilities	1.19	Slovenia	0.94
Ceylon	0.98	Latvia	1.05	Tajikistan	1.40
Croatia	1.06	Lithuanian	1.24	Thailand	1.05
Cyprus	1.12	Malaysia	0.89	Arabian	0.99
Czech Republic	0.83	Mongolia	2.72	Istanbul	1.14
Estonia	1.22	Moldova	1.44	Turkmenistan	3.52
Georgia	1.70	Omani	1.34	Belarus	1.25
Greece	0.71	Nepali	1.01	Egypt	1.38
Hungary	1.13	Pakistan	1.29	Uzbekistan	2.38

As can be seen from Table 4, relative to the world market, China's mechanical and electrical equipment products have comparative advantages in about half of the countries in China's "Belt and Road" market. The top ten countries in the RCA index are Turkmenistan, Mongolia, Bahrain, Uzbekistan, Belarus, Laos, Georgia, Kuwait, Kazakhstan and Moldova; there are also some countries with RCA index close to 1, such as Poland, India, Nepal, Arabia and Sri Lanka, which indicates that the competitive advantages of China's mechanical and electrical equipment products are not obvious enough in these countries; Countries with RCA index less than 1, such as Kyrgyzstan, Greece, Bosnia and Herzegovina, Israel and Jordan, indicate that the competitiveness of China's mechanical and electrical equipment in these countries is at a disadvantage. In the future, China can differentiate between advantageous types of countries when exporting mechanical and electrical equipment products to the countries along the route, so as to effectively increase the total export scale and export efficiency of mechanical and electrical equipment.

3.5. Looser trade links

Table 5. TDC Index of mechanical and electrical equipment Products between China and Countries Along the Belt and Road, 2019.

States	TDC	States	TDC	States	TDC
Albania	1.81	Indonesia	2.60	Cartel	0.45
Azerbaijan,	0.46	Palestine	0.57	Romania	0.39
Bahrain	1.67	Kazakhstan	3.03	Georgia	1.41
Bangladesh	0.59	Jordan	1.45	Saudi Arabia	0.97
Armenia	0.07	Iraq	1.08	India	2.33
Bosnia	0.47	Kyrgyzstan	6.60	Singaporean	1.76
Bulgaria	0.83	Laos	3.57	Vietnam	4.56
Byelorussia	2.43	Hostilities	1.45	Slovenia	0.52
Cambodian	2.15	Latvia	0.45	Tajikistan	5.67
Ceylon	0.42	Lithuanian	0.48	Thailand	2.16
Croatia	0.34	Malaysia	2.67	Arabian	1.03
Cyprus	0.36	Mongolia	3.52	Istanbul	0.82
Czech Republic	0.44	Moldova	0.28	Belarus	1.06
Estonia	1.57	Omani	1.09	Egypt	2.44
Georgia	1.18	Nepali	4.25	Uzbekistan	2.41
Hungary	0.37	Polish	0.61		

The Trade Integration Index (TII) is used as one of the key indicators to measure the closeness of trade between two countries. The formula for its calculation is as follows:

$$TDC_{ij} = \frac{X_{ij}/X_i}{M_j/M_w} \quad (2)$$

Where i refers to China, j refers to the countries along the "Belt and Road", j refers to the countries along the "Belt and Road", and j refers to the countries along the "Belt and Road".TDC_{ij} Denotes the trade integration degree of mechanical and electrical equipment products between China and its trading partner countries, and other variables are explained as follows:X_{ij} refers to China's exports of mechanical and electrical equipment products to the countries along the route, where i refers to China and j refers to the trade integration degree between China and its trading partners.X_i Denotes China's total world exports of mechanical and electrical equipment products.M_j Is the total import value of mechanical and electrical equipment of the countries along the Belt and Road? M_w Represents the total world imports of mechanical and electrical equipment. The larger the ratio, the closer the trade between the two countries. When$TDC_{ij} > 1$ when the ratio is higher, it means that a country along the "Belt and Road" has closer ties with China in the export of mechanical and electrical equipment; when the ratio is higher, it means that a country along the "Belt and Road" has closer ties with China in the export of mechanical and electrical equipment.$TDC_{ij} < 1$ When the ratio is higher, it means that the trade between a country along the "Belt and Road" and China is loosely linked in terms of imports of mechanical and electrical equipment products.[16] The data are not available. Due to the lack of data, here we take 47 countries along the "Belt and Road" as an example to measure the TDC of mechanical and electrical equipment in 2019, as shown in Table 5.

As shown in Table 5, among the 47 countries along the "Belt and Road" in 2019, China's TDC index is greater than 1 for 27 countries, among which, the trade integration degree of Kyrgyzstan, Tajikistan, Vietnam, Pakistan, Laos, Mongolia and Kazakhstan is greater than 3, which indicates that the trade exchanges of mechanical and electrical equipment products between China and these countries are the closest; the trade integration degree of the remaining 20 countries is less than 1, which indicates that the trade links between China and a large part of the countries along the route are relatively loose. Among them, the trade integration degree of 7 countries, namely Kyrgyzstan, Tajikistan, Vietnam, Pakistan, Laos, Mongolia and Kazakhstan, is greater than 3, indicating that China has the closest trade exchanges with these countries in electromechanical and mechanical equipment products; the trade integration degree of China to the remaining 20 countries is less than 1, which indicates that the trade links between China and electromechanical and mechanical equipment products of a large portion of countries along the route are relatively loose, which suggests that there exists a huge potential of the market in the "One Belt, One Road" waiting to be tapped.

4. Theoretical analysis

4.1. Introduction of the stochastic frontier idea

In traditional gravity models, factors limiting bilateral trade that are difficult to obtain for practical reasons are generally categorized as residuals in the model, but these categorized factors also tend to affect the estimation of "trade potential", which in turn affects the accuracy of the estimation results.

The stochastic frontier gravity model was proposed by Meeusen and Broeck (1997) and Aigner et al. (1997) and was initially used to analyze technical efficiency in the production function. The stochastic frontier gravity model treats the disturbance term and the non-trade efficiency term as two separate parts, with equation (3) representing the original stochastic frontier gravity model and equation (4) representing the logarithmic treatment of the data on both sides of Eq. where v_{ijt} represents the traditional zero-mean stochastic perturbation term, and u_{ijt} represents the trade inefficiency term, this paper incorporates these relatively fixed, traditional non-anthropogenic factors

into the stochastic perturbation term and short-term volatile human factors into the trade inefficiency term[17] .

$$T_{ijt} = f(x_{ijt}\beta)\exp(v_{ijt} - u_{ijt}) \tag{3}$$

$$lnT_{ijt} = lnf(x_{ijt}\beta) + v_{ijt} - u_{ijt} \tag{4}$$

The trade efficiency formula set in this paper is given in equation (9):

$$TE_{ijt} = T_{ijt}/T^{*}_{ijt} \tag{5}$$

Unrealized potential, on the other hand, is the difference between the ideal trade value and the real trade value, which refers to the part of the trade value that cannot be realized due to the existence of trade resistance or trade inefficiency factors, and this paper will use unrealized potential as an alternative reference to the potential of capacity cooperation, as in equation (6).

$$\text{Unrealized potential} = \text{trade potential} - \text{actual trade value} \tag{6}$$

In the estimation of the stochastic frontier gravity model, there are usually two choices of methods: the “two-step method” and the “one-step method”. The “two-step approach” refers to the estimation of the firm's efficiency value through the stochastic frontier model and then regressing the efficiency value on the relevant influencing factors using the efficiency value as the dependent variable. However, this two-stage estimation model can also be regarded as one stage, and because the assumptions about the inefficiency term in the two stages are inconsistent, such a two-stage estimation process is unlikely to produce results that are as efficient as the one-stage estimation.[18] Therefore, this paper will finally choose the “two-stage estimation process”. Therefore, in this paper, we will finally choose the “one-step method” for parameter estimation.

We use the stochastic frontier method to estimate the gravity model. Compared with the OLS method, the stochastic frontier estimation can accurately estimate the size of bilateral trade and effectively control the estimation error of trade inefficiency. This also means that the correct form of the gravity equation has to be determined when using the parametric stochastic frontier approach, so the applicability test of the stochastic frontier gravity equation using the likelihood ratio test has to be conducted to determine the final form of the equation before regression is carried out.

4.2. Variable selection and modeling

4.2.1. Selection of parameters for the time-varying stochastic frontier gravity model

On the basis of the previous analysis, this paper firstly constructs a time-varying stochastic frontier gravity model to estimate the export trade potential of China's mechanical and electrical equipment products to countries along the Belt and Road, and selects the export value of China's mechanical and electrical equipment products to countries along the Belt and Road as the explanatory variable. As the explanatory variable, denoted asEXP_{ijt} the value of China's exports of mechanical and electrical equipment products to countries along the Belt and Road is chosen as the explanatory variable, denoted as

The specific form of the equation setup is shown in equation (7):

$$LnEXP_{ijt} = \alpha_0 + \alpha_1 lnY_{it} + \alpha_2 lnY_{jt} + \alpha_3 lnCOMP_{ijt} + \alpha_4 lnD_{ij} + \alpha_5 BOR_{ij} + \alpha_6 LANG_{ij} + \upsilon_{ijt} - \mu_{ijt} \tag{7}$$

The selection of explanatory variables should not only take into account the common factors of tangible goods exports, but also closely combined with the industry characteristics of mechanical and electrical equipment and the implementation of the “Belt and Road” initiative, mainly:

(1) Economic scale. The larger China's economic scale, the more developed the industrial industry, the stronger the supply capacity of mechanical and electrical equipment products, the positive effect on China's exports of mechanical and electrical equipment; but this also indicates that China's mechanical and electrical equipment products, the greater the demand in the domestic market, which has a negative effect on China's exports of mechanical and electrical equipment; the larger the

economic scale of the trading partner country, the greater the market potential, the greater the demand for mechanical and electrical equipment products, the more conducive to the export of China to The larger the economic scale of the trading partner country, the greater the market potential, the greater the demand for mechanical and electrical equipment products, the more conducive to China's exports to that country; but it may also lead to meet the demand for mechanical and electrical equipment through its own production, which will not be conducive to the export of Chinese mechanical and electrical equipment.

(2) COMP is an indicator of complementarity in terms of factor endowments, measured as the difference between the natural logarithms of the per capita GDP of the two trading parties, which enters the model after taking the absolute value, with a larger COMP value implying higher complementarity.

(3) Geographical distance. Generally speaking, the farther the geographical distance, the higher the trade cost, the more unfavorable to China's exports of mechanical and electrical equipment. In 2002, Head and Mayer proposed a method to measure the weighted distance between two countries. In this paper, it is chosen to replace the geographic distance, which is written asDIS_{ij} the weighted distance between two countries is denoted as

(4) Common borders. If the two countries have a common border, there will usually be lower trade and transportation costs; at the same time in the customs and habits, cultural tendencies and other aspects of the differences are smaller, can avoid due to the existence of these aspects of the conflict and the possibility of trade friction, is conducive to the smooth conduct of trade. In this paper, we useBOR_{ij} indicates whether the trade partner country has a common border with China, and takes 1 if it borders with China, and 0 otherwise.

(5) Common language. If two countries have a common language, it usually means that the cultures of the two countries are closer and communication costs are lower. This paper takes$LANG_{ij}$ indicate whether the trade partner country has a common language with China, and take 1 if it has a common language with China, otherwise take 0.

Data for variables (1) and (2) were obtained from the World Bank, and data for (3) through (5) were obtained from the CEPII database.

4.2.2. Selection of parameters for trade inefficiency models

In order to further study the influence factors of trade inefficiency of China's exports of mechanical and electrical equipment products to the countries along the route, the corresponding trade inefficiency model is constructed as in equation (8):

$$\mu_{ijt} = \beta_0 + \beta_1 TRA_{jt} + \beta_2 INF_{jt} + \beta_3 PS_{jt} + \beta_4 GE_{jt} + \beta_5 FTA_{jt} \quad (8)$$

The existence of trade inefficiencies between China and the “Belt and Road” countries is mainly caused by infrastructure conditions, political environment, trade facilitation and other factors. In this paper, we draw on the research of Jiang Hui and Sun Yuqin, and select the sum of air freight volume and railroad freight volume to characterize the level of transportation infrastructure connectivity of the “Belt and Road” countries; trade facilitation selects trade freedom as a proxy variable; the political environment selects political stability and government efficiency as a proxy variable; and the trade agreement refers to the trade agreement between China and the countries along the route due to the signing of the “Belt and Road” agreement in 2013, and the trade agreement between China and the countries along the route. Since China signed the “Belt and Road” trade agreements with the countries along the route in 2013, this paper takes the value of this variable as 0 for the period from 2004 to 2012, and the value of this variable as 1 for the period from 2013 to 2019.[19] In this paper, the value of this variable is 0 for 2004-2012 and 1 for 2013-2019.

5. Empirical analysis

5.1. Data sources and data processing

In order to ensure the authenticity of the research results, this paper selects multiple research samples and longer time dimensions as far as possible on the premise that the samples and data are available and accurate. In terms of time, in the process of data processing, it is found that among the 65 Chinese trading partner countries along the "Belt and Road", Afghanistan, Brunei, Bhutan, Iraq, Maldives, Macedonia, Myanmar, the Philippines, Serbia, Slovakia, Syria, Palestine and Yemen have no data on the degree of freedom, and the Republic of Montenegro lacks data on political stability, so the above 14 countries are excluded from the research process. Stability data is missing, so the above 14 countries were excluded from the research process. Finally, 51 countries along the Belt and Road Initiative were selected for the study, including the seven ASEAN countries plus Mongolia in East Asia: Singapore, Malaysia, Indonesia, Thailand, Laos, Cambodia, and Vietnam; and 14 countries in West Asia: Iran, Turkey, Jordan, Lebanon, Israel, Saudi Arabia, Oman, and the United Arab Emirates, Cartel, Kuwait, Bahrain, Greece, Cyprus, Egypt; 5 countries in South Asia: India, Pakistan, Bangladesh, Sri Lanka, Nepal; 5 countries in Central Asia: Kazakhstan, Uzbekistan, Turkmenistan, Tajikistan, Kyrgyzstan; 7 countries in CIS: Russia, Ukraine, Belarus, Georgia, Azerbaijan, Armenia, Moldova; 12 countries in Europe : Poland, Lithuania, Estonia, Latvia, Czech Republic, Hungary, Slovenia, Croatia, Bosnia, Albania, Romania and Bulgaria. In the time dimension, considering the data availability, a total of 816 samples from 2014 to 2019 were finally selected for the study. In terms of data sources, see Table 6 for details.

Table 6. Description of data sources.

variable name	variant	Data sources
Export volume of mechanical and electrical equipment	EXP_{ijt}	UNCTAD
Chinese GDP	GDP_{it}	World Bank
Host country GDP	GDP_{jt}	World Bank
Complementarity of factor endowments	COMP	World Bank
geographic distance	D_{ij}	CEPII database
common border	BOR_{ij}	CEPII database
common language	$LANG_{ij}$	CEPII database
economic freedom	TRA_{jt}	World Heritage Foundation
Level of infrastructure	INF_{jt}	WGI
political stability	PS_{jt}	WGI
Government efficiency	GE_{jt}	WGI
free trade agreement	FTA_{jt}	China Ministry of Commerce

Table 7. Test results of multicollinearity for each explanatory variable.

variable	VIF	1/VIF	variable	VIF	1/VIF
GDP_{it}	3.03	0.33	TRA_{jt}	1.15	0.87
GDP_{jt}	1.88	0.53	INF_{jt}	1.76	0.57
COMP	1.55	0.65	PS_{jt}	1.68	0.59
D_{ij}	2.33	0.43	GE_{jt}	2.59	0.39
BOR_{ij}	2.29	0.44	FTA_{jt}	2.80	0.36
$LANG_{ij}$	1.39	0.72	Mean VIF	2.04	

In view of the impact of multicollinearity on the empirical results, this paper uses Stata software to detect the variance inflation factor (VIF) of each explanatory variable before starting the empirical evidence to determine whether there is a multicollinearity problem. As shown in Table 7, the VIF value and the mean value of VIF of each explanatory variable are less than 10, which shows that there

is no multicollinearity in the explanatory variables of this paper, and the next empirical analysis of stochastic frontier can be carried out.[20]

5.2. Time-varying stochastic frontier gravity modeling

5.2.1. Applicability tests for time-varying stochastic frontier gravity models

Since the stochastic frontier approach is very demanding in terms of the form of the equations, the likelihood ratio test should first be used to validate the applicability of the model before performing regression analyses of the model and to determine theμ_{ijt} the existence of the stochastic frontier. Table 8 shows the results of the test, from which it can be seen that the stochastic frontier gravity model is suitable for measuring the potential of production capacity cooperation of mechanical and electrical equipment; China's export efficiency to the countries along the Belt and Road is indeed time-varying, so the time-varying analysis method is better than the non-time-varying method.

Table 8. Results of hypothesis testing for the time-varying stochastic frontier gravity model.

original hypothesis	Constrained model log-likelihood	Unconstrained model log-likelihood	LR statistic	1% threshold	Test Conclusion
Absence of trade inefficiencies	-941.079	-588.248	705.662	10.501	rejection
Trade Inefficiency and Non-Temporal Change	-599.458	-588.248	22.42	8.273	rejection

5.2.2. Analysis of the results of the time-varying stochastic frontier gravity model estimates

In this paper, Frontier 4.1 software was used to estimate the model, and the estimation results of time-varying and time-invariant models were carried out to ensure the correctness and stability of the results (Table 9). The estimation results show that the parameters to be estimatedη are significant at the 1% level, indicating that the trade inefficiency term changes over time, and the parameterη of the coefficient is positive, indicating that the trade efficiency of China's export of mechanical and electrical equipment products to the countries along the route is increasing year by year. Therefore, this paper finally adopts the time-varying model for regression analysis.

From the estimation results of the explanatory variables,

(1) Size of the economy. China's GDPY_{it} is significant at the 1% level of significance with a positive sign, which is in line with the expectation. This suggests that the larger the size of China's domestic economy, the more it promotes the export of China's mechanical and electrical equipment products. GDP of trading partner countriesY_{jt} is significant at 1% level of significance with positive sign, which is in line with the expectation. This indicates that the larger the economic scale of the countries along the route, the greater the demand for China's mechanical and electrical equipment products.

(2) Factor Complementarity COMP. The variable factor complementarity in the time-varying model did not pass the significance test.

(3) Geographic distance. The geographical distance variableD_{ij} is significant at 1% with a negative sign, which is in line with the expectation, indicating that the further the distance, the more unfavorable it is for the export of China's mechanical and electrical equipment products.

(4) Common Boundary and Common Language. The common boundary variableBOR_{ij} are significant at the 5% significance level and the coefficients are positive; the common language variables$LANG_{ij}$ are significant at 1% significance level and the coefficients are positive, which indicates that if the trade partner countries and China have a common border or a common language, it will be favorable to the export of China's mechanical and electrical equipment products, and the coefficient of the common language variable$LANG_{ij}$ The coefficient of common language variable is 0.982, which indicates that the role of culture and communication cost in international cooperation is gradually highlighting.

(5) It is worth noting that the variableγ The size of the variable indicates the proportion of unrealized trade potential caused by trade inefficiency, and this value in the time-invariant and time-varying models is 0.737 and 0.728, respectively, which indicates that electromechanical and mechanical equipment products still have export potential to the countries along the route, and that the study of the factors affecting trade inefficiency is still necessary to improve trade potential.

Table 9. Regression results of time-varying and time-invariant models.

estimated model	Panel stochastic frontier gravity model			
	time-invariant model (TIM)		time-varying model	
variant	ratio	t-value	ratio	t-value
a constant (math.)	-11.551***	-9.426	-9.727***	-4.86
Y_{it}	0.669***	17.094	0.487***	8.551
Y_{jt}	0.957***	18.037	0.873***	22.936
$COMP_{ijt}$	-0.048	-1.061	0.042	0.921
D_{ij}	-1.30***	-8.436	-0.716***	-3.532
BOR_{ij}	0.211	0.816	0.442**	2.096
$LANG_{ij}$	1.387**	2.241	0.982***	4.683
σ^2	0.759***	7.358	0.727***	3.095
γ	0.737***	25.284	0.728***	8.260
η			0.032***	5.238
log-likelihood	-599.458		-588.248	
LR test value	683.242		705.662	

Note: *, **, *** indicate significant at 10%, 5%, and 1% significance levels, respectively.

5.3. Modeling trade inefficiencies

5.3.1. Testing trade inefficiency models

Table 10. Results of testing the hypotheses set by the trade inefficiency model.

original hypothesis	Constrained model log-likelihood	Unconstrained model log-likelihood	LR statistic	1% threshold	Test Conclusion
Absence of trade inefficiencies	-941.079	-913.513	55.132	17.755	rejection
Non-efficiency terms are set incorrectly	-924.627	-913.513	22.228	8.273	rejection

This paper proposes two original hypotheses: that there is no trade inefficiency term; and that the export inefficiency model is incorrectly set up, i.e.: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$. The two original hypotheses are tested, and the results are shown in Table 10: both original hypotheses are rejected at the 1% significance level, indicating that there is a trade non-efficiency term and that the trade non-efficiency model is set up correctly.

5.3.2. Empirical results of trade inefficiency models

In view of the problems with the two-step method, a one-step regression is used here, and the results are shown in Table 11.With the addition of the influencing factors of export inefficiency, most of the main variables analyzed earlier pass the significance test and the positivity and negativity of the coefficients remain unchanged. The main explanatory variables of the trade inefficiency term are analyzed here:

Table 11. Regression results of trade inefficiency model.

variant	ratio	t-value	variant	ratio	t-value
a constant (math.)	-6.689***	-5.028	a constant (math.)	-14.791**	-2.022
Y_{it}	0.645***	14.565	TRA_{jt}	0.070**	2.505
Y_{jt}	0.882***	55.813	INF_{jt}	-0.101	-1.612
$COMP_{ijt}$	0.032	0.791	PS_{jt}	1.219**	2.009
D_{ij}	-1.693***	-17.844	GE_{jt}	-4.536**	-2.052
BOR_{ij}	0.112	1.215	BR_{jt}	-0.002	-0.007
$LANG_{ij}$	1.028***	8.031	σ^2	6.835**	2.209
			η	0.956***	45.299
log likelihood			-913.513		
LR test			55.132		

Note: *, **, *** indicate significant at 10%, 5%, and 1% significance levels, respectively.

(1) Trade FreedomTRA_{jt} : The regression coefficient of is positive and significant at 5% level, which is not in line with the expectation, which may be due to the fact that due to the higher trade freedom index of the country, the number of importers of mechanical and electrical equipment is larger, which, relatively speaking, restricts the export of Chinese mechanical and electrical equipment products;

(2) Degree of infrastructureINF_{jt} : The regression coefficient of the degree of infrastructure is negative, the sign of which is in line with the expectation, but it does not pass the significance test, which may be due to the fact that with the proposal of the "One Belt, One Road" Initiative, the state of infrastructure does not have a significant impact on the export of China's mechanical and electrical equipment products.

(3) Political stabilityPS_{jt} :The regression coefficient is positive, which is not in line with the expectation and is significant at 5% level, which may be due to the fact that in the selection of the research object, due to the missing data of some countries because of war, they have been deleted in the process of pre-data processing, and in the existing 51 countries, the countries which are relatively unstable politically may have a greater demand for China's electromechanical equipment products;

(4) Government efficiencyGE_{jt}: The regression coefficient of (4) is negative and significant at the 5% level, indicating that the higher government efficiency of the host country is favorable for the country to carry out trade activities, and will also promote China's exports of mechanical and electrical equipment products to it.

(5) "Belt and Road" InitiativeBR_{jt}: The sign of the regression coefficients is as expected, but not significant. The "Belt and Road" initiative brings a lot of policy dividends to China's exports of mechanical and electrical equipment, but the empirical evidence in this paper (as of 2019) does not show that it significantly improves the efficiency of China's exports of mechanical and electrical equipment. The reason may lie in the fact that the Belt and Road Initiative vigorously promotes the development of China's outward foreign direct investment (OFDI), which has a greater crowding-out effect on exports than policy dividends, thus making the impact of the Belt and Road Initiative not yet significant.

Taken as a whole, the parametersσ^2 ,η all pass the significance test at 5% and 1% level of significance.

5.4. Potential measurement

Based on the previous results of parameterization of the stochastic frontier gravity model and trade inefficiency model, this paper measures the potential of mechanical and electrical equipment capacity cooperation among 51 countries along the route.

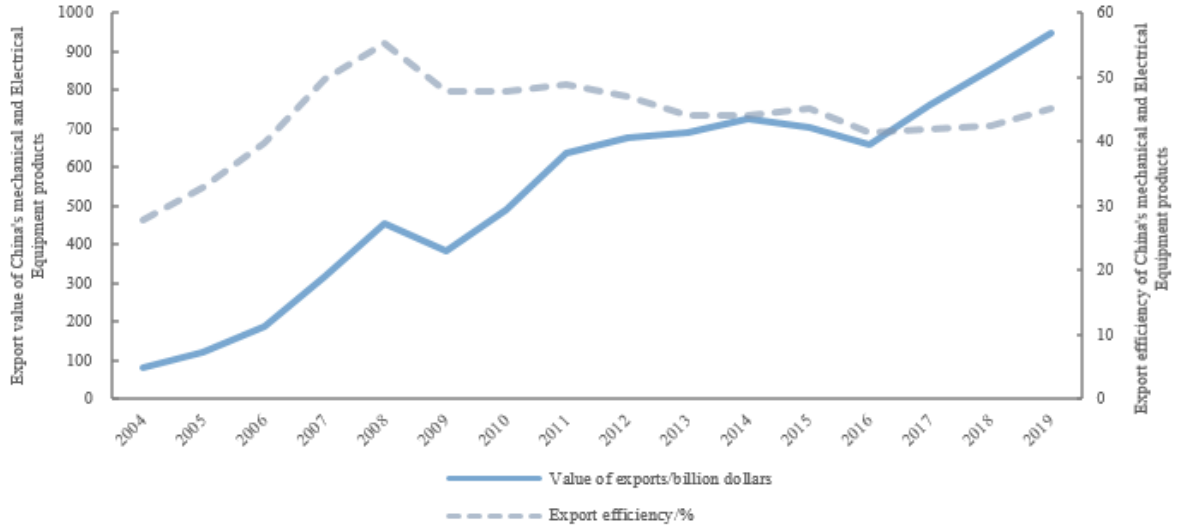

Fig 3. Trends in China's export efficiency and total export value of mechanical and electrical equipment to countries along the route, 2004~2019.

As shown in Figure 3, China's total exports of mechanical and electrical equipment to the countries along the Belt and Road during the period from 2004 to 2019 showed a fluctuating upward trend, and the exports of mechanical and electrical equipment were greatly affected by the changes in the global economic situation, with a significant decline in exports before and after the financial crisis in 2008. However, in general, China's exports of mechanical and electrical equipment to the countries along the Belt and Road rose from 8.2 billion U.S. dollars in 2004 to 94.5 billion U.S. dollars in 2019, an increase of about 12 times. Since the "Belt and Road" initiative was put forward in 2013, the export growth of China's mechanical and electrical equipment products has become more obvious. However, unlike the rise in the total value of exports, the export efficiency of China's mechanical and electrical equipment has shown a fluctuating rise, and after the "Belt and Road" initiative was put forward in 2013, China's mechanical and electrical equipment exports have increased by about 12 times. After the "Belt and Road" initiative was put forward in 2013, the export efficiency of China's mechanical and electrical equipment is basically balanced at 42%~45%, which on the one hand indicates that the foundation of China's mechanical and electrical equipment production capacity cooperation has been stabilized since the "Belt and Road" initiative was put forward, and on the other hand, it also indicates that China's current production capacity cooperation of mechanical and electrical equipment urgently needs to be injected with new vitality.

Table 12. China's Export Potential of mechanical and electrical equipment Products to Countries Along the Belt and Road, 2019

ranking	nations	Export efficiency	Potential for capacity cooperation	ranking	nations	Export efficiency	Potential for capacity cooperation
1	Bosnia	0.04	95.81	27	Malaysia	0.46	54.39
2	Moldov	0.12	88.18	28	Iraq	0.47	53.26
3	Azerbaijan	0.13	86.63	29	Laos	0.52	48.13
4	Nepali	0.15	85.48	30	Iranian	0.54	46.21
5	Cartel	0.15	84.62	31	Mongolia	0.54	46.01
6	Armenia	0.16	83.90	32	Kazakhstan	0.55	45.23
7	India	0.18	82.09	33	Hungary	0.55	44.81
8	Cyprus	0.23	76.84	34	Czech	0.55	44.78
9	Palestine	0.24	76.05	35	Indonesia	0.56	43.65
10	Croatia	0.27	73.39	36	Polish	0.57	42.92
11	Turkmenistan	0.27	73.26	37	Byelorussia	0.57	42.88
12	Bulgaria	0.30	69.67	38	Slovenia	0.64	35.76
13	Latvia	0.31	69.44	39	Belarus	0.65	34.66

14	Romania	0.31	69.20	40	jordan	0.66	34.24
15	Estonia	0.32	67.97	41	Singaporean	0.68	31.88
16	Georgia	0.34	65.71	42	Thailand	0.72	27.73
17	Greece	0.35	65.31	43	Egypt	0.74	26.33
18	Lithuanian	0.38	62.40	44	Bahrain	0.88	11.99
19	Istanbul	0.38	62.37	45	Tajikistan	0.89	10.78
20	Pakistan	0.38	62.31	46	Arabian	0.92	8.49
21	hostilities	0.40	59.97	47	Kyrgyzstan	0.99	1.16
22	Bangladesh	0.41	58.60	48	Georgia	1.06	-6.37
23	Ceylon	0.41	58.53	49	Vietnam	1.20	-20.44
24	Albania	0.43	57.31	50	Uzbekistan	1.33	-32.73
25	SArabia	0.43	56.77	51	Cambodian	1.49	-49.30
26	Omani	0.44	56.46				

According to equations (5) and (6), the efficiency, export potential and capacity cooperation potential of China's exports of mechanical and electrical equipment to the countries along the Belt and Road in 2004-2019 can be calculated (table 12). The countries that have a better foundation for capacity cooperation with China in the mechanical and electrical equipment industry are Cambodia, Uzbekistan, Vietnam, Georgia, Kyrgyzstan, Arabia and Tajikistan, and the export potentials of these countries on the “frontier” measured by the model are basically close to or even smaller than the real trade value, which indicates that China's capacity cooperation in mechanical and electrical equipment for these countries has been carried out very well. This shows that China's production capacity cooperation in mechanical and electrical equipment in these countries is sufficient, and in combination with the trade inefficiency term, the degree of freedom of these countries is high, and the political characterization and government efficiency are better; from the perspective of geographic location, the production capacity cooperation basis of countries located in the middle line of the “One Belt, One Road”, such as Bosnia and Herzegovina, Azerbaijan, the Cartel and Armenia, is weak, which is probably due to the fact that On the one hand, the geographical distance between China and these countries is large, and on the other hand, it is also because these countries do not have a high degree of economic freedom and do not have a high government efficiency score, which affects the process of China's production capacity cooperation in their mechanical and electrical equipment; most of the countries located in the Northern Route, for example, Latvia, Romania, Estonia, and Lithuania, may be due to the reasons of geographic distance and the influence of the government efficiency score, China's cooperation with these countries may be weak, and China's cooperation with these countries may be weak. Score, the efficiency of China's production capacity cooperation of mechanical and electrical equipment to these countries is average, but has a certain cooperation basis.[21]

6. Conclusions and policy recommendations

First, we should speed up the implementation of the "Belt and Road" Initiative, and encourage enterprises related to electromechanical equipment products to give full play to their initiative to "go global". The "One Belt, One Road" initiative provides favorable conditions for electromechanical equipment products to "go out", and actively carrying out production capacity cooperation with trading partner countries will also help to achieve mutually beneficial and win-win results.

Secondly, accurately identify the influencing factors in capacity cooperation, and formulate scientific strategies for "going out" of electromechanical equipment industry. Emerging influencing factors such as infrastructure construction of the trading partner countries, government efficiency and the relationship between the two free trade partners will help China's electromechanical equipment products export, actively promote the cooperation and exchanges between China and the countries along the route, and create better conditions for the production capacity cooperation between China's electromechanical equipment industry and the countries along the route.

Thirdly, we should reasonably select the target countries for "going out" of electromechanical equipment industry, and explore the potential of production capacity cooperation. The potential of mechanical and electrical equipment production capacity cooperation between China and the countries along the "Belt and Road" is characterized by large geographical differences. China's production capacity cooperation with Southeast Asia and other countries has been carried out to a relatively full extent, but its production capacity cooperation with countries along the central and northern routes of the "Belt and Road" has been hindered by the economic development level and industrial structure of the partner countries, as well as their economic development level. However, capacity cooperation with countries along the central and northern routes of the "Belt and Road" is affected by the level of economic development, industrial structure, resource endowment and other factors of the partner countries, and there is still a large potential to be developed. We should prioritize, promote the production capacity cooperation of electromechanical equipment with the countries along the "Belt and Road" by levels and categories.

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