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Study on the Trade Efficiency of China's High-Tech Product Exports to India

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Abstract: Since joining the WTO in 2001, China has attached more importance to the development of high-tech products and actively advocated entrepreneurs to establish high-tech product manufacturing enterprises to accelerate the industrial upgrading of high-tech products in China and seek foreign trade. As India is an important destination for China's high-tech products to expand trade, what are the factors influencing China's export trade of high-tech products to India? Based on this, this paper selects the relevant data of 29 major trading partner countries from 2005-2020 to empirically analyze the main influencing factors of China's high-tech products export to India. The results show that the economic size and population size of China and the trading partner countries are positively influenced, and the geographical distance is inversely influenced, while the level of R&D, trade freedom, investment freedom, and institutional improvement will weaken the trade inefficiency and thus promote the export of Chinese high-tech products.

1. Introduction

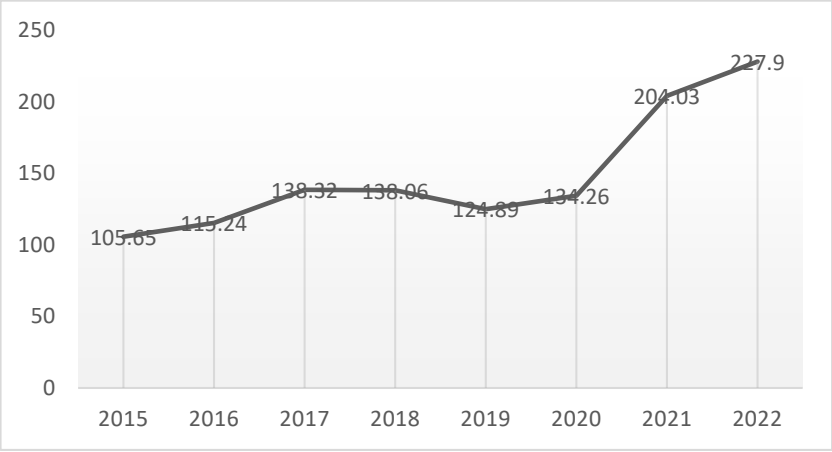

Figure 1: China's exports of high technology products to India (USD billion)

High-technology products are an important part of China's commodity export trade products and have an important driving force in promoting national economic development, promoting social production efficiency as well as social progress. In recent years, with the continuous deepening of economic globalization and technological products, the total export of high-tech products in China's

foreign trade has continued to grow, and the development momentum also needs to further break through. The total export of high-tech products in China to India has increased from $10.57 billion in 2015 to $22.79 billion in 2022, an increase of 1.12%, as shown in Figure 1. In general, the expansion of the export scale of high-tech products and the optimization of export structure represent the growth of China's high-tech enterprises, and provide favorable conditions for the optimization of China's industrial structure, economic development and technological innovation. As two developing countries with large populations, China and India's trade relations are of great importance to the Asian region and the global economic landscape.

2. Review of the literature

Armstrong [1] (2007) points out that traditional gravity models are widely used, there are still problems, the biggest of which may lie in dealing with unobservable trade influences. While the "trade potential" in traditional gravity models represents the value of trade predicted by the model after taking account the average effect of trade determinants, the trade potential in stochastic frontier gravity models is interpreted as the maximum possible value of trade that can be obtained assuming the most open trade policies, the highest level of trade institutions and trade practices. Chen Jiyong etc.[2] (2019) used stochastic frontier gravity model and inefficiency model to find that trade between India and China is inefficient and mainly influenced by free trade agreements, level of infrastructure and currency freedom and overall tariff level, but the trade potential is huge. Wang Ling etc.[3] (2019) measured the trade efficiency and trade potential of the Bangladesh-China-India-Myanmar Economic Corridor using a stochastic frontier gravity model and estimated the main factors affecting the trade volume, and the results showed that China and India have great trade potential, and efficient economic and trade cooperation would drive the development of the entire Bangladesh-China-India-Myanmar region and produce huge economic effects. Currently, the literature related to the study of trade potential between India and China exists mainly for products such as electronic mechanics. Cai Yuqiu etc. [4] (2019) studied the trade efficiency and potential of China's exports of electromechanical products to India, and the results showed that China's export resistance to India's electromechanical products has been decreasing year by year, which has increased the trade potential, and although the trade efficiency is on a growing trend, there is still a certain gap compared to other exporting countries. In view of this, this paper, based on the experience of previous studies, adopts the traditional gravity model, which is more popular in explaining actual trade patterns, in the trade potential research methodology, and tends to add other influencing factors such as tariffs, policy regimes, and free trade agreements to the two basic variables of economic size and geographical distance to form an expanded gravity model, so as to more comprehensively consider the possible impact on China's trade performance to India factors that may have an impact on the trade performance of China's exports of high-technology products to India.

3. Model Setting and Testing

Stochastic boundary gravity model is one of the main research methods to measure the efficiency of trade, which is different from the traditional gravity model in nature, economy, political system and man. In the stochastic boundary gravity model, the trade inefficiency term that constitutes the stochastic disturbance term is selected in this paper for countries and regions from 2005 to 2020. Representatives of Australia, Belgium, Brazil, Canada, Chile, Colombia, Czech Republic, France, Germany, Hong Kong Special Administrative Region, Hungary, India, Italy, Japan and the Republic of Korea, Luxembourg, Malaysia, Mexico, Netherlands, Pakistan, Poland, Russian Federation, Saudi Arabia, Singapore, South Africa, Spain, Thailand, United Kingdom and United

States. Drawing on the existing literature and the actual situation of Chinese high-technology products exported to India, the stochastic frontier gravity model is constructed as (1):

$$\ln ex_{ijt} = \alpha_0 + \alpha_1 \ln gdp_{it} + \alpha_2 \ln gdp_{jt} + \alpha_3 \ln pop_{it} + \alpha_4 \ln pop_{jt} + \alpha_5 \ln dist_{ij} + \theta_{ijt} - \mu_{ijt} \quad (1)$$

where ex_{ijt} represents the trade volume of high technology products exported from China to trading partner country; gdp_{it} and gdp_{jt} denote the GDP of China and trading partner country respectively, representing the level of economic development , the size of economy, pop_{it} and pop_{jt} are the number of population of China and trading partner country respectively, the size of population, and the variable data are from the World Bank; $dist_{ij}$ denotes the geographical distance between China and its trading partner countries.

Considering the influencing factors of the trade inefficiency term of high technology product exports of China and other 29 trading partner countries, the trade inefficiency model is constructed as (2):

$$\mu_{ijt} = \beta_0 + \beta_1 ifd_{jt} + \beta_2 mon_{jt} + \beta_3 tfd_{jt} + \beta_4 tbt_{jt} + \beta_5 drb_{jt} + \beta_6 policy_{jt} + \beta_7 tariff_{jt} + \beta_8 fta_{jt} + \varepsilon_{ijt} \quad (2)$$

μ_{ijt} denotes trade inefficiency term; ifd_{jt}, mon_{jt}, tfd_{jt} denote investment freedom, monetary freedom and trade freedom respectively, which reflect the trade ecological level of each country from three aspects of investment, monetary and trade respectively, and lower investment freedom, monetary freedom and trade freedom will reduce the enthusiasm of trade and have a negative correlation on export trade volume, data from American Heritage Foundation. tbt_{jt} denotes technical barriers to trade[5] , data from the World Bank tbt-ops notification volume; drb_{jt} which are the level of R&D is expressed in terms of the level of patents filed by residents of a country and represents a country's position in the global value chain. The R&D technology gap allows high-technology products to flow from products in countries with high R&D capabilities to those with low R&D capabilities[6].$policy_{jt}$ denotes institutional distance, institutional distance is an invisible cost, unsound political system will bring political risk to export trade[7],by constructing the institutional distance conformity index to indicate the political distance between two countries $tariff_{jt}$ denotes the tariff rate of the trading country, the higher the tariff level will also have a negative impact on export trade, the data comes from the World Bank; FTA is a dummy variable indicating whether China has signed a free trade agreement with the trading country, if yes, take 1, otherwise take 0, the data comes from the China Free Trade Zone Service Website. ε_{ijt} is the random error term.

In summary, the stochastic frontier gravity model is determined as follows (3), and the maximum likelihood ratio LR statistic is taken to test the applicability of the model in order to ensure the accuracy of the final results of the stochastic frontier gravity.

$$\ln ex_{ijt} = \alpha_0 + \alpha_1 \ln gdp_{it} + \alpha_2 \ln gdp_{jt} + \alpha_3 \ln pop_{it} + \alpha_4 \ln pop_{jt} + \alpha_5 \ln dist_{ij} + \theta_{ijt} + \beta_0 + \beta_1 ifd_{jt} + \beta_2 mon_{jt} + \beta_3 tfd_{jt} + \beta_4 tbt_{jt} + \beta_5 drb_{jt} + \beta_6 policy_{jt} + \beta_7 tariff_{jt} + \beta_8 fta_{jt} + \varepsilon_{ijt} \quad (3)$$

4. Empirical Results and Analysis

After determining the stochastic frontier gravity model (1), the model is tested for applicability, and the hypothesis tests are that there is no trade inefficiency term and the trade inefficiency term does not change over time, respectively. The test results are shown in the figure, that is, the original hypothesis is rejected, and the model has trade inefficiency term and trade inefficiency term changes over time, just shown as table 1.

Table 1: Results of model applicability test

Original hypothesis	Constrained model	Unconstrained model	LR statistic	1% Critical value	Test result
no trade inefficiency	-713.171	-209.01	1008.322	8.287	Reject the original hypothesis
Trade inefficiency term does not change over time	-713.171	-208.308	1009.726	10.501	Reject the original hypothesis

Table 2: Regression results of the main model of stochastic frontier gravity

variable	OLS Returns	Time-invariant model	Time-variant mode
con	10.166***	11.776***	12.351***
	3.477	11.69	11.484
lngdp_it	0.544***	0.486***	0.435***
	5.930	13.123	6.890
lngdp_jt	0.121**	0.376***	0.342***
	2.751	3.81	3.823
lnpop_it	0.002	-0.2	-0.001
	0.069	-0.219	-0.135
lnpop_jt	0.022	0.023**	0.023**
	0.576	2.173	2.234
lndist_ijt	-0.881***	-1.284***	-1.085***
	-10.681	-6.422	-4.760
σ2	1.283	2.327***	2.137***
		4.84	4.870
γ		0.958***	0.956***
		202.036	182.431
μ		2.986***	2.858***
		5.519	5.379
η			0.003
			0.947
Log-likelihood value	-713.171	-209.01	-208.308
Sample size	464	464	464

The empirical regressions of the stochastic frontier gravity master model are shown in Table 2, which presents the regression results of the stochastic frontier gravity model 0LS regression, the time-invariant model, and the time-varying model, respectively. In terms of economic scale, both sides pass the 5% significance test level, which is consistent with the expected sign of the variable. It is found that the coefficient of economic scale of China is larger than that of its trading partners, indicating that the increase of economic scale of both sides is conducive to increasing the export volume of high-tech products, and China's economic scale has a greater impact on the trade volume. The population size of China and India is not significant enough, and the population factor has no significant impact on the export trade volume. The geographical distance between the two countries is negative, and the significance level is 1%, indicating that the geographical distance increases the export cost of high-tech products to a certain extent, which is not conducive to the export of high-tech products to India. Through the regression results, it can be seen that the coefficient of

trade inefficiency term γ of the time-varying model and the time-varying model is 0.96, which exceeds the significance level of 1%, indicating that the trade inefficiency term is the main reason for its occurrence.

From Table 3, the gamma coefficient of the trade inefficiency model (3) is 0.95, which passes the 1% level of significance, indicating that the model variables are reasonably chosen. From the estimated coefficient of trade efficiency model, whether to sign a free trade agreement is at the level of 1% with the trade efficiency model, but the coefficient is positive, which is inconsistent with the expectation, and may be affected by the choice of model variables, as well as other variable factors; The R & D level represents a country's innovation ability and innovation level. The R & D level is significant, and the condition of trade inefficiency period is 1%, indicating that R & D level can significantly reduce trade inefficiency, and a country's R & D level is conducive to promoting the export of high-tech products. Technical barriers to trade are positively correlated with trade dissimilarity. Technological innovation level will improve the productivity competitiveness of high-tech products, and high technical barriers will prevent technology diffusion, indicating that strict technical barriers in high-tech product trading partners will significantly improve trade disefficiency. The index of trade freedom is significant at the 1% level.

Table 3: Stochastic frontier gravity model

Trade inefficiency model function					
variable	coefficient	T value	variable	coefficient	T value
con	17.750***	8.201	con	1.612**	2.724
lngdp_it	0.527***	10.294	FTA_jt	0.109***	5.341
lngdp_jt	0.075***	6.991	lnr&b_jt	-0.107***	-36.612
lnpop_it	0.011	0.505	lntbt_jt	0.122***	7.814
lnpop_jt	0.036	1.534	lnmon_jt	0.940***	8.906
lndist_ij	-0.865***	-12.016	lntrade_jt	-0.928***	-5.510
			lninv_jt	-0.045	0.741
			policy_jt	-0.326***	-6.674
			tariff_jt	0.050***	11.920
σ2	0.644***	16.674			
gammer	0.013***	4.288			
Log-likelihood value	-611.387				
Sample size	464				

Based on the construction of the trade inefficiency model, the estimated trade efficiency of China's exports of high-technology products to India from 2005 to 2020 can be obtained, and the results are shown in Table 4. The trade efficiency value is between 0 and 1, and the larger the trade efficiency value of high-technology products, the smaller the difference between the actual value and the potential value, and vice versa, the larger the difference. From the table, the overall trend of China's export efficiency of high-tech products to India is on the rise, with trade efficiency floating between 0.2-0.4 and an average expansion space of 253.33%, which still has a large room for expansion. If the impact of non-efficiency aspects of trade can be eliminated as effectively as possible between the two trading countries in the future, and the trade and high-tech industries can be continuously adjusted to fully grasp the opportunities of the times, then the increase of China's high-tech products to India will be huge.

Table 4: Trade potential of China's exports of high-tech products to India

year	Trade Efficiency	Actual value (USD billion)	Potential value (USD billion)	Exploitable Trade Potential	Expanding Space (%)
2005	0.21	22.27	104.06	81.79	367.32
2006	0.12	38.38	315.94	277.56	723.09
2007	0.19	46.91	248.86	201.95	430.46
2008	0.26	51.68	197.82	146.14	282.77
2009	0.25	49.47	194.12	144.64	292.38
2010	0.37	68.28	186.38	118.10	172.96
2011	0.34	75.06	218.00	142.94	190.44
2012	0.36	71.68	201.52	129.84	181.13
2013	0.33	86.21	264.13	177.92	206.37
2014	0.35	93.93	270.54	176.60	188.01
2015	0.37	105.65	285.77	180.12	170.49
2016	0.36	115.24	318.38	203.14	176.28
2017	0.37	138.32	374.06	235.73	170.42
2018	0.36	138.06	381.09	243.03	176.03
2019	0.36	124.89	343.34	218.45	174.91
2020	0.40	134.26	336.05	201.79	150.30

5. Conclusions

Based on the panel data of high technology product export trade between China and 29 countries with higher ranking of high technology product export value from 2005 to 2020, this paper empirically analyzes the efficiency and potential of China's high technology product export trade using stochastic frontier gravity model and trade inefficiency model, and the factors affecting trade efficiency. The results show that, firstly, the overall growth trend of China's exports of high-tech products to India. Second, the economic scale and population size of China and India become positive influence on export trade, and the geographical distance becomes the reverse influence. Third, the improvement of trade freedom, investment freedom, and R&D level will eliminate trade inefficiency and promote China's exports of high-tech products to India. Fourth, technical trade barriers, tariff barriers and trade barriers in trading partner countries have a limiting effect on trade non-efficiency, and because high-tech products have technical imitation and product homogenization, China's high-tech product exports encounter more serious TBT in other countries, and the inhibiting effect on exports will be greater, and in the future, we can continuously optimize the business environment, reduce tariffs, actively use economic and trade information, and strengthen trade cooperation Create favorable conditions for export trade. Fifth, China's exports of high-tech products to India are not very efficient and have more room for development.

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