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A Stochastic Frontier Analysis of Trade Efficiency for the Sino-Korea Trade*

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Abstract

Purpose – This paper intends to make theoretical analysis and empirical test on the factors influencing China's export to South Korea, and draw conclusions about China's export efficiency and trade potential. Based on the conclusions, the reasons for China's trade deficit with South Korea are found, and a solution is put forward for solving the problem of China's trade deficit with South Korea.

Design/methodology – Based on the data of 2004-2017 years in China, this paper uses the stochastic frontier gravity model to analyze the influencing factors of China's export to South Korea, as well as the export efficiency of each province and the export potential that can be explored.

Findings – First, in terms of the factors affecting China's export trade to South Korea, the GDP of the provinces and cities in China, the FDI of South Korea to the provinces and cities in China, the GDP of South Korea, the population and education level of provinces and cities in China can significantly promote the export scale of Chinese provinces and cities to South Korea. The distance between Chinese provincial capitals and the South Korean capital significantly hinders Chinese exports to South Korea; Second, in terms of export trade efficiency, the trade exchange rate of the economically developed cities along the eastern coast of China and several provinces that are close to South Korea is higher than that of the cities in the central and western regions; Third, economic globalization makes trade more convenient, the average export trade efficiency of China's exports to South Korea showed an upward trend. However, under the influence of the 2008 global financial crisis, the export trade efficiency declined from 2008 to 2009, indicating that the impact of the financial crisis on the trade efficiency cannot be ignored.

Originality/value – This paper finds out the influencing factors of China's export to South Korea, analyzes the export efficiency of different provinces and cities, excavates the export potential, and puts forward some suggestions for the balanced development of China and South Korea trade in the next step.

Keywords: Sino-Korea Trade, Stochastic Frontier Analysis (SFA), Trade Efficiency, Trade Potentials
JEL Classifications: F18, F40

1. Introduction

China and Korea are geographically close to each other and share a similar history and culture. Since the establishment of diplomatic ties in August 1992, the economic and trade exchanges between the two countries have achieved rapid development, According to the

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statistics of the Ministry of Commerce of China in 2020, China is the largest trading partner, the largest export market, and the largest source of imports of South Korea, while South Korea is the third largest trading partner of China. The bilateral trade volume of the two countries has increased from US $5 billion at the time of establishing diplomatic relations to US $284.53 billion in 2019, an increase of more than 50 times. In 2019, China's exports to South Korea reached US $110.96 billion, and imports from South Korea reached US $173.57 billion. The trade deficit between China and South Korea reached US $62.61 billion. With the rapid expansion of bilateral trade scale, the trade imbalance between China and South Korea has become increasingly serious, and South Korea has become the largest source of trade deficit of China. The signing and implementation of the China-South Korea Free Trade Agreement will inject strong vitality into bilateral economic and trade activities, and the trade scale will further expand. At the same time, trade frictions between the two countries will further increase and the competition between the two sides will be more intense. With the increasing trade friction between China and the United States, China is bound to increase cooperation with Japan and South Korea, especially the latter, which is closer to China in distance and has similar cultures. Therefore, the bilateral trade situation and development potential between China and South Korea have become one of the hot issues for scholars at home and abroad.

Trade potential measures how much a country gains by moving from a market with trade resistance to one without. So the measure of trade potential can be the scale of trade as well as the revenue. Among them, the analysis based on trade scale is the main method used by scholars. Zhang Hong et al. (2009) investigated the current situation of intra-regional trade among China, Japan and South Korea, studied the factors influencing trade flow by using gravity model, and examined the trade potential of the three countries.

Zhang and Zhu (2014) used the expanded gravity model to study the development of trade flow and trade potential between China, Japan and South Korea. The research shows that China's export trade potential to both South Korea and Japan is "of huge potential", Japan's export trade potential to China is "of reshaping potential", and the trade potential between Japan and South Korea and South Korea's export trade potential to China and Japan is "of pioneering potential." Kuang (2015) used the gravity model to analyze the trade potential of China, Japan and South Korea. The research shows that the income level and distance factors have a significant impact on the export trade volume, and there is a huge trade potential among the three countries. Jin and Yang (2015) made an empirical analysis on the current situation and trade potential of China-South Korea trade by using the bilateral trade data between China and South Korea from 2003 to 2013. The results show that the degree of trade integration and trade complementarity between China and South Korea are decreasing, and the potential of bilateral trade is increasing, with huge development space. Waugh and Ravikuma (2016) and Gozgor (2017) calculated the Trade Potential Index (TPI) from the perspective of income to measure the benefits of a country's transfer from a world with trade costs to a frictionless world, so as to evaluate its trade potential.

Gravity Model is the most commonly used research method in the literature of measuring trade potential by using trade scale (Tinbergen, 1962; Rauch, 1999; Sheng and Liao, 2004). The traditional gravity model and stochastic frontier gravity model are mainly used by scholars. Anderson and Wincoop (2003) and Armstrong (2007) show that the traditional gravity model is based on the assumption of frictionless trade and iceberg transport cost, and ignores the influence of multilateral resistance factors on trade when estimating trade potential, which may lead to deviations. Secondly, Kang and Fratianni (2006) found that when using ordinary least squares (OLS) to estimate the traditional gravity model, the R2 value is generally small, because most of the trade is determined by some other factors besides economic size and distance. Furthermore, Ravishankar and Stack (2014) proposed that trade potential should be the maximum possible trade value under the minimum trade friction or the maximum degree of trade liberalization that may be achieved in the current environment, rather than the average value in the traditional gravity model. Therefore, Kalirajan (1999, 2007) and Armstrong (2007) introduced stochastic frontier method (SFA) into gravity model to analyze trade efficiency and potential. Compared with the traditional gravity model, stochastic frontier gravity model can analyze the impact of artificial trade inefficiency. However, in the early stochastic frontier gravity model, it is generally assumed that the trade inefficiency term is time invariant (TIM). Since then, Battese and Coelli (1992) proposed a time-varying model (TVDM) which is more consistent with the reality of trade. The main methods used to study trade inefficiency are two-step method and one-step method. Kumbhakar and Ghosh et al. (1991), R eifschneider and Stevenson (1991) proposed that the two-step method is logically inconsistent, and the one-step method proposed by Battese and Coelli (1992) is more rigorous.

In addition, the existing studies on the factors affecting the efficiency and potential of China's export trade to South Korea mostly focus on the foreign factors restricting China's commodity export. For example, the studies of Wang Lili and Yao Zhiyi all point out that the infrastructure conditions of export market, the level of investment facilitation, government efficiency, and technical barriers to trade can significantly affect China's export trade efficiency. Although a few scholars have analyzed the impact of domestic factors on the trade potential of China's provinces and cities, such as Wu(2003) and Zhang (2016) , no paper has paid attention to the trade potential of China's regions to South Korea from the perspective of domestic factors. Lu Xiaodong (2011) and others believe that export trade is a cross-border market behavior, which will be restricted by both domestic and foreign factors. Although the Chinese government has adopted a variety of policies to strengthen ties and cooperation with other countries, such as the construction of the Belt and Road, and although it provides a strong external demand support for the further release of China's trade potential with various countries, this external demand is often accompanied by a strong uncontrollability. In this context, how to further enhance the effective domestic supply level is more practical.

To sum up, the existing research on trade potential is relatively fruitful, which provides a strong foundation and support for this paper. This paper takes the export trade efficiency and trade potential of China's provinces and cities to South Korea as the research object, analyzes the impact of China's domestic factors on South Korea's export trade by constructing a stochastic frontier model, calculates its export efficiency and export potential, investigates its power sources, and puts forward some suggestions. Compared with previous studies, this paper has the following differences: in terms of research perspective, it is the first time to explore the export trade efficiency, export trade potential and its influencing factors from the perspective of provinces and cities in China; in terms of research content, the imbalance of economic development among provinces and cities in China is obvious. Ignoring the regional differences will not only produce certain evaluation deviations, but also fail to provide targeted suggestions for provinces and cities to improve trade efficiency and explore trade potential. Therefore, this paper attempts to analyze the impact of domestic factors on South Korea's export trade based on the stochastic frontier model.

Through the above analysis, Chinese provinces and cities should objectively evaluate their own trade efficiency and trade potential, explore the endogenous driving force for their growth, improve innovation ability and supply level, tap the potential of export trade, improve the quality and efficiency of export, and realize high-quality development of export trade to South Korea. Such measures will help improve the situation of China's trade deficit with South Korea, and provide a solid theoretical basis for the government.

2. Methodology

Due to the unbalanced development of China's provinces and cities, there are great differences in their export trade status. Therefore, this paper chooses the stochastic frontier model to study the export trade status of China's provinces and cities to South Korea. With the help of the stochastic frontier gravity model proposed by Aigner et al. (1977), this paper constructs a model to study the export trade potential and trade efficiency of China's provinces and cities with South Korea.

$$export^{*}_{it}= f(x_{it} ,\beta) \tag{1}$$

wherex_{it}refers to the endowment scale of various factors owned by i region, such as land, labor, capital, etc.; β is parameter vector to be estimated; $export^{*}_{it}$ is the largest export scale of region i in the t period. However, in the actual trade, affected by various inefficiency variables, the export trade level is difficult to reach the maximum possible export trade level $export^{*}_{it}$. Therefore, the actual export trade level can be expressed as:

$$export_{it}= f(x_{it},\beta)exp(-\mu_{it}) , \ -\mu_{it}\geqq 0 \tag{2}$$

here, $TE_{it} = exp(-\mu_{it})$ is the specific export efficiency parameter of sample i. μ_{it} is the export inefficiency effect, which determines the export efficiency parameters. When $\mu_{it} =0$, the export of i achieves the maximum efficiency; When $\mu_{it} > 0$, that is, $export_{it} \leq export^{*}_{it}$, there is trade low efficiency (inefficiency),Considering the random measurement error or random impact, the observed real trade level is determined by:

$$export_{it}=f(x_{it},\beta)exp (v_{it} - \mu_{it}) \tag{3}$$

By taking logarithm on both sides of formula (3), we can get that:

$$lnexport_{it}= f(x_{it},\beta)+v_{it} - \mu_{it} \tag{4}$$

The expression is the basic form of stochastic frontier exit equation. Among them, v_{it} is the random measurement error or random factor, μ_{it} is the trade inefficiency term. Meanwhile, $v_{it} : N(0,\sigma^2_v)$, $\mu_{it} \geq 0$, . It is generally considered thatv_{it} and μ_{it} are independent of each other, which can be expressed as $Cov(v_{it} , \mu_{it}) = 0$. In general, it is assumed that the inefficiency term μ_{it} has the following distributions: Semi normal distribution, truncated semi normal distribution, logarithmic distribution and gamma distribution. This paper assumes that μ_{it} obeys a more flexible truncated semi normal distribution, that is, μ_{it}: N(ϖ,

σ_{it}^2):

$$\omega_{it} = \exp(b_0 + z_{it}^k \delta);\ \sigma_{it}^2 = \exp(b_1 + z_{it}^k \gamma) \tag{5}$$

Formulas (4) - (5) show the stochastic frontier model used in this paper. On this basis, we can not only analyze the impact of constraint variables z_{it}^k on the size of trade inefficiency (ω_{it}) and its volatility (σ_{it}^2), but also calculate the export trade efficiency of provinces and cities to South Korea in each period. Trade efficiency refers to the degree that the actual trade volume deviates from the maximum possible export trade level.

$$\text{Export trade efficiency: } TE_{it} = \frac{\exp(x_{it}\beta - \mu_{it})}{\exp(x_{it,}\beta)} = \exp(-\mu_{it}) \tag{6}$$

$$\text{Export trade potential : } potential_{it} = 1\text{-}\exp(\text{-}\mu_{it}) \tag{7}$$

Export trade efficiency TE_{it} is between 0-1 . When trade inefficiency exists ($\mu_{it} > 0$), the greater the TE_{it} value is, the higher the trade efficiency is, and the smaller the trade potential is. The smaller the TE_{it} value is, the lower the trade efficiency is and the greater the trade potential is. If there is no trade inefficiency ($TE_{it} = 0$), export trade efficiency is the highest $TE_{it} = 1$.

In the early stochastic frontier model, it is assumed that the trade inefficiency does not change with time, but when the time dimension of the data in the model is long enough, the original assumption of "constant technical efficiency" is no longer reasonable. Therefore, Battese and Coelli (1992) proposed the basic form of stochastic frontier time-varying model. In the time-varying model, the trade inefficiency term is expressed as:

$$\mu_{it} = \eta_t \mu_i = \{\exp[-\eta(t\text{-}T)]\}\ \mu_i$$

where μ_i,is assumed to be a non-negative truncation of : $N(\varpi, \sigma_{it}^2)$:distribution, and the scalar parameter η, (which will be estimated) can be used to determine whether efficiency increases, decreases, or remains constant. The last period(t=T) for export from china's province i to korea contains the base level of efficiency, so $\mu_{it} = \mu_i$, Hence, the parameters u and σ_u^2 denote the statistical properties of the country effects related to the last period. If $\eta > 0$, the level of efficiency increases towards the base level, or the impact of country-specific man-made policy constraint on exports decreases over time; If $\eta = 0$ or is insignificant, the level of efficiency remains constant or the impact of country-specific man-made policy constraint on exports remains unchanged over time. The estimation also includes parameterization with$\sigma^2 = \sigma_u^2 + \sigma_\xi^2$ and $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_\xi^2)$where γ must take a value between 0 and 1. We can test whether or not we should include the error term u in the form of the stochastic frontier function by testing the significance of parameter γ. If the null hypothesis, i.e. γ equals zero, is rejected, this would mean that σ_u^2 is non-zero and therefore the term u should be added into the model, leading to a specification with the parameter that should be consistently estimated using the stochastic frontier approach.

3. Model Setting and Data Description

3.1. Model Setting

According to the above analysis and the needs of this study, this paper sets the export trade model of China's provinces and cities to South Korea as follows:

$$\ln EXPORT_{it} = a_0 + a_1 \ln FDI_{it} + a_2 \ln CGDP_{it} + a_3 \ln KGDP_{it} + a_4 \ln POP_{it} + a_5 \ln DIS_{it} + a_6 \ln EDU_{it} + v_{it} - \mu_{it} \quad (8)$$

3.2. Data Source and Description

This paper selects the panel data of 30 provinces and cities in China except Hong Kong, Macao and Tibet from 2004 to 2017. The description and data sources of each variable are shown in Table 1.

Table 1. Variables and Data Sources

Abbreviation	Variable	Data source
EXPORT	Annual exports of China's provinces and cities to South Korea (Million US$)	Korea Trade Association www.kita.net
FDI	South Korea's annual direct investment in China's provinces and cities (Million US$)	The Export- Import Bank of Korea https://www.koreaexim.go.kr
CGDP	Annual GDP of provinces and cities in China (Million US$)	China Statistical Yearbook, the statistical yearbooks
KGDP	South Korea's annual GDP (Million US$)	Korean Statistical Information Service
DIS	The linear distance from Seoul, South Korea to every provincial capital city in China (km)	Goole Earth
POP	Populations of provinces and cities in China (10 million)	China Statistical Yearbook, the statistical yearbooks
EDU	Average education time of people in different provinces and cities in China (Years)	China Statistical Yearbook, the statistical yearbooks

Table 2. Summary Statistics

Variable	Mean	Std. Dev	Min	Max
LNEXPORT	6.5248	1.6919	2.4849	10.1512
LNFDI	2.6186	2.4363	-0.4933	7.6145
LNCGDP	11.1355	0.9845	8.0011	12.8751
LNKGDP	11.8873	0.1437	13.5844	14.0833
LNDIS	7.2683	0.4387	6.3323	8.1219
LNPOP	3.5654	0.7487	1.6845	4.7157
LNEDU	2.1603	0.1171	1.8528	2.5822

3.3. Analysis of the Results of Influencing Factors

In the time-varying stochastic frontier gravity model, η value is 0.0149, greater than 0, and it passes the t-test at the significance level of 1%, which indicates that the technical efficiency is affected by time change, and the time-varying stochastic frontier gravity model is more applicable than the time-invariant stochastic frontier gravity model. μ is significantly greater than 0, which confirms the existence of inefficiency factors in Chinese provinces and cities' export trade to South Korea. And the value of γ is close to 1, indicating that the variation of the error component factor of the model is mainly caused by the inefficiency factor. The trade inefficiency factor results in the gap between the actual and the potential level of trade, which indicates the applicability of the stochastic frontier gravity model. The hypothesis of LR test based on likelihood ratio is that the least square model is more suitable than the stochastic frontier model, but the result of LR is significant at 1% level. It is considered that rejecting the original hypothesis, that is, the stochastic frontier model is more suitable than the least square model. (Marie M Stack, Eric J Pentecost and Geetha Ravishankar, 2018)

In the time-varying stochastic frontier gravity model, the coefficient of FDI of South Korea to foreigners in China is 0.237 and is significant at 1%, which also proves that FDI is complementary to international trade (K. Kojima, 1987). The GDP coefficient of each province in China is 0.285 and is significant at the level of 1%, which indicates that the growth of GDP of each province has a positive effect on promoting China's export to South Korea. The coefficient of GDP of South Korea is 1.033 and is significant at the level of 1%, which indicates that the greater the market size of China's export to South Korea, the greater the impact on China's export to South Korea. The coefficient of DIS between capitals is -0.928 and is significant at 1%, which indicates that distance variables have negative effects on export trade. The greater the distance between capitals, the higher the cost of export trade transportation, so distance is an obstacle to export trade. The coefficient of population (POP) in China is 0.597, and it is significant at 1%. The increase of population increases the labor force, and thus increases output, and thus the number of exports. The coefficient of education (EDU) is 2.249, and it is significant at 1% level, which shows that China's education level has played a great role in promoting the export to Korea. In the past, China mainly exported basic products and energy. With the improvement of Chinese education level, the proportion of high-tech products in export trade has been increasing, which will play an important role in solving the trade deficit between China and South Korea.

Table 3. Estimates of the Stochastic Gravity Model

Independent Variables	Frontier Estimate	OLS Estimate
LNFDI	0.237***	0.053***
	(9.78)	(0.183)
LNCGDP	0.285***	0.005***
	(4.32)	(0.087)
LNKGDP	1.033***	1.403***
	(3.10)	(0.244)
LNDIS	-0.928***	-1.776***
	(-7.16)	(0.306)
LNPOP	0.597***	0.911***
	(7.71)	(0.177)

Table 3. (Continued)

Independent Variables	Frontier Estimate	OLS Estimate
LNEDU	2.249*** (4.49)	2.046*** (0.548)
Constant	-11.866*** (-2.85)	-7.927*** (3.294)
σ2	0.531*** (1.75)	
γ	1.038*** (5.63)	
μ	3.968*** (7.06)	
η	0.0149*** (3.78)	
LR	50.9***	
R2		0.731
Observations	420	420

Note: The t value in brackets, *, ** and *** indicate that the statistical value is significant at 10%, 5% and 1%, respectively.

3.4. Estimated Trade Efficiency

After estimating the main factors affecting China's export to South Korea, combined with equation (5), we can further calculate the export trade efficiency of China's provinces and cities to South Korea. According to equation (6), the lower the trade efficiency, the higher the trade potential. In this paper, a total of 420 estimations about export trade efficiency have been measured and calculated, of which the mean value is 0.468, the standard deviation is 0.255, the maximum value is 0.702, and the minimum value is 0.019. The interval span is large, indicating that the export trade efficiency and potential of different provinces and cities in China vary greatly in different years. See Table 4 for details of the estimated value of export trade efficiency.

From Table 4, we can see that the average export trade efficiency of China's exports to South Korea is on the rise from 2004 to 2017. However, affected by the 2008 global financial crisis, the export trade efficiency is on the decline from 2008 to 2009. With the adjustment of national policies and the recovery of economy, it has resumed the upward trend from 2010. Although the efficiency of China's export trade to South Korea is on the rise, we can see from the data that the average efficiency of China's export trade to South Korea is only 0.557 in one year, so there is still great potential for China's export trade to South Korea.

From Fig. 1, we can see that the trade efficiencies of the eastern provinces is higher than that of the central and western regions. On the contrary, the export trade potential of the central and western regions to South Korea is greater than that of the eastern coastal provinces. Therefore, in order to reverse the huge trade deficit with South Korea, China should vigorously tap the trade potential of the central and western provinces on the basis of maintaining the trade efficiency of the eastern coastal cities.

Table 4. Estimated Efficiency

	2004	2006	2008	2010	2011	2012	2013	2014	2015	2016	2017
ShanghaiCY	0.58	0.616	0.591	0.603	0.564	0.604	0.62	0.618	0.638	0.615	0.632
GuangdongPE	0.545	0.604	0.534	0.548	0.523	0.595	0.543	0.537	0.62	0.611	0.651
Tianjin CY	0.523	0.623	0.595	0.623	0.606	0.617	0.632	0.63	0.65	0.639	0.639
Jiangsu PE	0.52	0.53	0.443	0.494	0.332	0.443	0.392	0.24	0.444	0.435	0.442
Zhejiang PE	0.519	0.59	0.596	0.608	0.617	0.632	0.633	0.617	0.642	0.647	0.637
Beijing CY	0.518	0.659	0.645	0.653	0.67	0.69	0.692	0.693	0.702	0.7	0.699
Shandong PE	0.497	0.572	0.568	0.599	0.599	0.631	0.635	0.566	0.6	0.607	0.581
Henan PE	0.496	0.558	0.575	0.593	0.578	0.599	0.598	0.598	0.626	0.614	0.625
Jiangxi PE	0.495	0.526	0.548	0.56	0.432	0.536	0.557	0.544	0.591	0.577	0.599
Anhui PE	0.495	0.533	0.537	0.612	0.569	0.574	0.587	0.593	0.638	0.642	0.637
Shaanxi PE	0.492	0.56	0.576	0.554	0.536	0.567	0.572	0.585	0.627	0.621	0.606
Jilin PE	0.49	0.579	0.597	0.605	0.612	0.617	0.621	0.617	0.635	0.633	0.635
Hubei PE	0.438	0.47	0.498	0.538	0.501	0.513	0.564	0.496	0.571	0.582	0.602
Liaoning PE	0.43	0.512	0.53	0.534	0.545	0.572	0.578	0.538	0.6	0.561	0.602
Guizhou PE	0.418	0.588	0.555	0.582	0.525	0.564	0.551	0.554	0.566	0.554	0.537
Hebei PE	0.415	0.442	0.437	0.505	0.458	0.541	0.48	0.5	0.558	0.576	0.574
ChongqingCY	0.349	0.446	0.456	0.527	0.515	0.427	0.562	0.519	0.557	0.548	0.578
Hainan PE	0.347	0.374	0.512	0.501	0.394	0.389	0.526	0.427	0.555	0.552	0.556
Fujian PE	0.324	0.388	0.434	0.495	0.503	0.477	0.58	0.462	0.519	0.502	0.541
Gansu PE	0.305	0.347	0.381	0.405	0.363	0.412	0.452	0.479	0.558	0.548	0.58
Guangxi AR	0.295	0.369	0.278	0.284	0.355	0.467	0.382	0.354	0.484	0.474	0.459
Hunan PE	0.291	0.467	0.293	0.364	0.326	0.195	0.524	0.467	0.552	0.55	0.567
Yunnan PE	0.278	0.597	0.142	0.153	0.278	0.108	0.582	0.452	0.44	0.515	0.592
Inner Mongolia AR	0.27	0.25	0.087	0.187	0.131	0.333	0.358	0.366	0.491	0.485	0.49
Qinghai PE	0.257	0.465	0.41	0.413	0.387	0.333	0.333	0.232	0.403	0.448	0.385
Xinjiang AR	0.245	0.396	0.379	0.438	0.382	0.388	0.385	0.399	0.475	0.483	0.463
Heilongjiang PE	0.237	0.149	0.188	0.061	0.038	0.185	0.237	0.07	0.371	0.195	0.266
Ningxia AR	0.229	0.098	0.104	0.053	0.044	0.05	0.234	0.262	0.412	0.443	0.462
Sichuan PE	0.191	0.474	0.186	0.527	0.434	0.095	0.35	0.43	0.518	0.546	0.559
Shanxi PE	0.171	0.267	0.132	0.348	0.346	0.367	0.354	0.273	0.536	0.516	0.514
mean efficiency	0.389	0.468	0.427	0.466	0.439	0.451	0.504	0.471	0.553	0.547	0.557

Fig. 1. The efficiency of China's export trade to South Kore

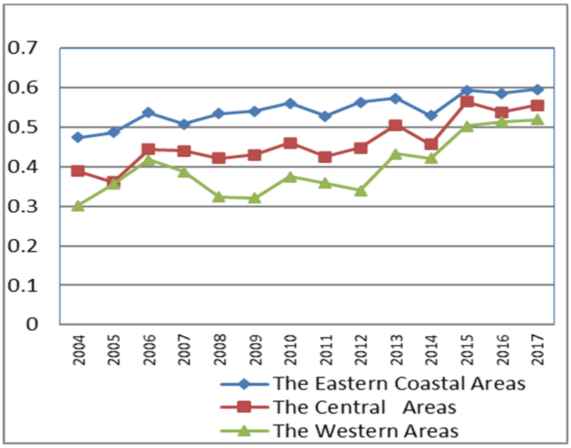
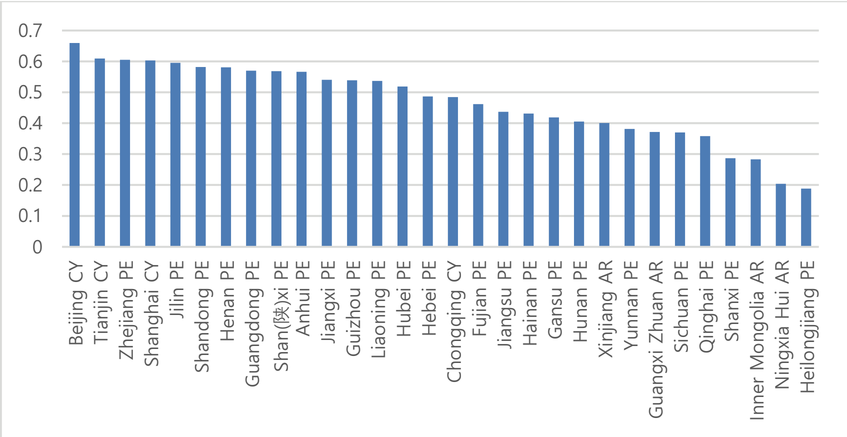


Fig. 2. Export trade efficiencies of Chinese provinces and cities to South Korea



According to Table 4 and Fig. 2, the provinces and cities with the highest export trade efficiencies are Shanghai, Guangdong, Tianjin, Jiangsu, Zhejiang, Shandong and other eastern coastal provinces and cities. The reason may be that these provinces and cities are relatively well developed in China's economy and foreign trade, and all have convenient port facilities. Shandong, Tianjin and other cities are geographically close to South Korea. At the same time, Shanghai has the first Pilot Free Trade Zone established in China, with a high degree of trade liberalization, which can effectively promote the development of its export trade.

4. Conclusions and Suggestions

To sum up, this study uses the panel data of China's export trade volume to South Korea and the factors affecting China's export trade volume to South Korea during the 14 years from 2004 to 2017 to construct a stochastic frontier gravity model to estimate the factors influencing China's export trade to South Korea, and thereby obtain the efficiency and trade potential of China's export trade to South Korea. The main conclusions are as follows:

First, in terms of the factors affecting China's export trade to South Korea, the GDP of China's provinces and cities, the FDI of South Korea to China's provinces and cities, the GDP of South Korea, the population and education level of China's provinces and cities can significantly promote the export scale of China's provinces and cities to South Korea. However, the distances between the capitals of China's provinces and cities and the capital of South Korea has significantly hindered China's export trade to South Korea.

Second, in terms of export trade efficiency, the trade efficiency of China's eastern coastal economically developed cities and several provinces close to South Korea is relatively high compared with those of the central and western cities, but the highest level is only 0.7, most of which remain at about 0.5. In particular, the trade efficiency level of the central and western cities is maintained at about 0.3. This shows that China's export trade to South Korea has great potential.

Third, with economic globalization and convenience of trade, the average export trade efficiency of China's exports to South Korea is on the rise. However, affected by the 2008 global financial crisis, the export trade efficiency declined from 2008 to 2009, which shows that the impact of the financial crisis on trade efficiency cannot be ignored.

Based on the above results, we propose the following suggestions:

First, improve trade facilitation.

Although the geographical distances between countries will not change, improving the convenience of trade will promote the development of bilateral trade. At present, we can consider establishing an open trading platform between the neighboring cities of the two countries to realize the sharing of information resources and shorten the time of customs clearance. We should also strengthen the cooperation between the two countries' customs, and promote the coordination, transparency and non-discrimination of tariff policies, coordinate the customs clearance system, and promote the development of E-customs.

Second, vigorously support the development of China's technology intensive industries.

The proportion of China's capital intensive or technology intensive products exported to South Korea is becoming close to that of China's imports from South Korea year by year. However, China's exports of such products are at the low end, and are mainly processing trade. Therefore, China should strengthen further cooperation with South Korea on technology intensive or capital intensive products, and promote China's related industries and enterprises to enhance their independent R&D and innovation capabilities through the introduction of technology. At the same time, the government should increase its support for technology intensive industries, formulate relevant industrial development plans and export support strategies. Enterprises should take the initiative to learn from the technology and experience of the high-tech enterprises of South Korea, narrow the gap with Korean enterprises in technology intensive industries, and enhance the international competitiveness of China's technology intensive products.

Third, enhance political mutual trust.

Due to historical and political factors, trade between China and South Korea is often affected by policy fluctuations. Therefore, we should enhance political mutual trust, strengthen dialogue at the government level, reduce the impact of political factors on China-ROK economy and trade, and take the establishment of China-ROK Free Trade Zone as an opportunity to improve the level of economic and trade cooperation between China and South Korea.

Fourth, most of China's exports to South Korea are inefficient and have great export potential.

In terms of tapping export potential, the less developed areas in the central and western regions and the developed coastal provinces in the east of Jiangsu, Zhejiang and Shanghai have different emphases. The developed coastal provinces should give full play to their own advantages while consolidating their own export capacity, and focus on the development of characteristic industries. Inland provinces need to rely on industrial policies, talent introduction policies, and to obtain scale effect by introducing foreign capital to establish advantageous industries, and then improve market efficiency and export efficiency.

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