Empirical Analysis on Foreign Economic Trade of Smart City under the Background of Free Trade Agreement

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Abstract. Taking the construction of smart city in Yantai as an opportunity, this paper analyzes the current situation of foreign trade under the background of free trade agreement, explores the main factors affecting the level of trade, and puts forward feasible Suggestions for the development of foreign trade in Yantai based on the construction of smart city. Through the analysis of the trade flow between Yantai and 13 major trading countries(regions), the time-varying attenuation stochastic frontier gravity model is constructed to explore the main factors affecting Yantai's foreign trade, and the total trade efficiency of Yantai is analyzed. The research shows that the total trade efficiency presents an overall increasing trend, and the trade and population size of Yantai have a significant impact on the trade flow. In the process of building a smart city, the planning and integration of Yantai's foreign trade should be carried out from various aspects to further improve the trade efficiency.

Keywords: Free trade agreement, Stochastic frontier gravity model, Non-efficiency term

1 Introduction
In the transformation of Yantai's urban construction from a digital city to a smart city, the construction of the Internet of Things will have a positive impact on the development of foreign trade. Free trade agreements (FTAs) can promote foreign trade between trading countries and provide a green channel for bilateral trade. Smart city promoting the construction of smart city is conducive to cultivating and developing strategic emerging industries and creating new economic growth points.

In the past research, qualitative theoretical analysis has been the focus of research, however, there have been few specific work in the empirical research on foreign trade in Yantai. Taking the opportunity of the construction of Yantai smart city, this paper analyzes the current situation of Yantai's foreign trade under the background of free trade agreement. Construct a time-varying decaying random frontier gravity model, and perform panel data regression analysis on trade between Yantai and 13 major trading countries(regions). Explore the main factors affecting Yantai's foreign trade, use a more scientific and intuitive method to summarize the main factors affecting Yantai's foreign trade [1-3].

2 Model Establishment

The basic form of the traditional trade gravity equation is as follows:

\[
\ln X_{ijt} = \ln C + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 D_{ij} + \sum_{k} \beta_k Z_{ik} + \varepsilon_{ijt} \tag{1}
\]

In the equation, \( X_{ijt} \) is the total amount of imports and exports from region i to region j in year t; \( Y_{it} \) is the GDP of region i in year t; \( Y_{jt} \) is the GDP of region j in year t; \( D_{ij} \) is the distance between region i and region j; C is a constant term; \( Z_{ik} \) is the non-efficiency term affecting bilateral trade[4].

According to stochastic frontier analysis, the basic Settings of panel data are as follows:

\[
T_{ijt} = f(X_{ijt}, \beta) \exp(\nu_{ijt}) \exp(-u_{ijt}), u_{ijt} \geq 0 \tag{2}
\]

\[
\ln T_{ijt} = \ln f(X_{ijt}, \beta) + \nu_{ijt} - u_{ijt}, u_{ijt} \geq 0 \tag{3}
\]

Where, equation (2) is the stochastic frontier gravity equation, and equation (3) is the logarithmic form of equation (2)[5,6]. \( T_{ijt} \) represents the trade level between region i and region j in year t; \( X_{ijt} \) is the core factor affecting trade flow; \( \beta \) is a parameter vector to be estimated. \( \nu_{ijt} \) is the random error term and represents the unobservable factors affecting the trade. \( u_{ijt} \) is the non-efficiency term of trade and represents the degree of inefficiency of trade, including the main human factors that promote or restrict trade.

3 Measure Foreign Trade Efficiency and Influencing Factors of Yantai Based on Stochastic Frontier Gravity Model

3.1 Sample Selection

In order to ensure the accuracy of the conclusion, this paper selects as many countries (regions) and time span as possible. Based on the situation of foreign trade in Yantai, 13 main observing countries (regions) were finally confirmed as research objects, and the sample interval was set as 2006-2017, with a total of 156 observing simple.

3.2 Model Construction and Testing

Draw lessons from past research, estimate the frontier trade using economies of scale, distance, such as total population as the main model of core variables, and introduce human factors such as tariff levels constitute trade efficiency model. Based on the existing research results, the following regression equation is established:

\[
\ln T_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln dist_{ijt} + \nu_{ijt} - u_{ijt} \tag{4}
\]

\( T_{ijt} \) represents the actual trade volume between Yantai and country (region) in year t; \( GDP_{it} \) and \( GDP_{jt} \) respectively represent the economic scale of Yantai and country (region) in year t; \( POP_{it} \) refers to the total population of Yantai in year t, and \( POP_{jt} \) refers to the total population of country (region) j; Dist represents the distance between Yantai and country (region) j. The detailed description of each variable is shown in table 1.

The setting of the non-efficiency model is:

\[
u_{ijt} = \delta_0 + \delta_1 FTA_{ijt} + \delta_2 TAF_{jt} + \delta_3 SHP_{jt} + \delta_4 FIN_{jt} + \varepsilon_{ijt} \tag{5}
\]
Table 1. Description of trade gravity model variables

| Variable | Variable declaration | Expected symbol | The theoretical analysis | The data source                      |
|----------|-----------------------|-----------------|--------------------------|--------------------------------------|
| GDP_{jt} | GDP of Yantai         | +               | Reflect the economic scale of Yantai | Yantai bureau of statistics |
| GDP_{jt} | GDP of trade area in year t | +         | Reflects the size of the economy of the trading area | World bank WDI database |
| POP_{jt} | Total population of Yantai in year t | + ( -) | Reflect the market size of Yantai | Yantai bureau of statistics |
| POP_{jt} | Total population of trading area in year t | + ( -) | Reflect the market size of the trading area | World bank WDI database |
| dist_{ij} | Distance between the two places | -               | Reflect the transportation cost between the two places | www.indo.com |
| FTA_{jt} | Virtual variable (the FTA signed by the two countries is 1, otherwise it is 0) | -               | Reflect the level of regional integration | Ministry of commerce of China |
| TAF_{jt} | The tariff level of the trading area in year t (expressed in terms of actual weighted average tariff) | +               | Reflect regional tariff barriers | World bank WDI database |
| SHP_{jt} | Liner transport connectivity index in year t | -               | Reflects the state of regional maritime infrastructure and the extent of participation in global maritime networks | United Nations conference on trade and development |
| FIN_{jt} | Index of financial freedom of trading area in year t | -               | Reflect the level of regional financial liberalization | The heritage foundation and the Wall Street journal |

In order to select the correct functional form of the stochastic frontier gravity model, the likelihood ratio LR statistic was used to test the applicability of the stochastic frontier gravity model.[7,8] As shown in table 2, the null hypothesis is rejected at the level of 1%, indicating the existence of non-efficiency term and the time-varying random gravity model should be used.

Table 2. Test results of likelihood ratio of model setting

| The null hypothesis | Constraint model | Unconstrained model | LR statistic | inspection results |
|---------------------|------------------|---------------------|--------------|--------------------|
| No trade inefficiency | 285.81           | 265.38              | 65.10        | Refused            |
| Inefficiency do not change | 21.33           | 17.65               | 29.02        | Refused            |

3.3 Empirical Analysis
The empirical results are shown in table 3. Almost all variables are significant, indicating that all variables have good explanatory ability to the explained variables.
Table 3. Results of stochastic frontier gravity model review

| Variable | OLS model | Time invariant model | Time-varying model |
|----------|-----------|----------------------|--------------------|
| lnGDP<sub>i</sub> | 0.673 *** (0.136) | 0.669 *** (0.133) | 0.682 *** (0.190) |
| lnGDP<sub>j</sub> | 0.062 *** (0.069) | 0.034 ** (0.035) | 0.035 *** (0.035) |
| lnPOP<sub>i</sub> | 51.384 * (23.138) | 52.506 ** (22.824) | 52.004 ** (24.049) |
| lnPOP<sub>j</sub> | 0.482 *** (0.216) | 0.669 *** (0.114) | 0.671 *** (0.116) |
| dist<sub>ij</sub> | 0.611 *** (0.175) | 0.602 *** (0.097) | 0.603 *** (0.098) |
| _cons | 214.801 *** (96.09) | 218.711 *** (94.793) | 216.549 *** (100.233) |
| Sigma 2 | 1.10 | 1.435 (2.235) | 1.449 ** (2.242) |
| gamma | 0.818 *** (0.282) | 0.820 *** (0.280) |
| eta | | | |
| LR | 54.342 *** | 16.383 *** |

Note: *, ** and *** indicate that they passed the test at the significance level of 10%, 5% and 1%, respectively.

According to the time-varying model results in table 3, the expansion of the economic scale between Yantai and trading countries (regions) will improve the trade level. The population size (POP<sub>i</sub>) coefficient of trading countries is positive, which has a significant promoting effect on trade [9]. However, the population size of Yantai (POP<sub>j</sub>) is significantly negative, thus inhibiting the import and export. The negative coefficient of geographical distance (dist<sub>ij</sub>) indicates that the transportation cost will obviously hinder the development of trade.

Table 4. Non-efficiency model analysis

| Variable | Stochastic frontier function The coefficient of | Trade inefficiency The coefficient of |
|----------|-----------------------------------------------|-----------------------------------|
| lnGDP<sub>i</sub> | 0.480 *** (0.173) | FTA<sub>j</sub> | 0.259 *** (0.213) |
| lnGDP<sub>j</sub> | 0.07 * (0.031) | TAF<sub>j</sub> | 0.089 *** (0.024) |
| lnPOP<sub>i</sub> | 55.752 ** (27.342) | SHP<sub>j</sub> | 0.011 *** (0.023) |
| lnPOP<sub>j</sub> | 0.714 *** (0.080) | FIN<sub>j</sub> | 0.065 ** (0.01) |
| dist<sub>ij</sub> | 0.541 *** (0.073) | Sigma 2 | 0.363 ** (0.162) |
| _cons | 1.635 *** (0.602) | gamma | 0.821 *** (0.141) |
| The Log | 144.631 | LR | 168.866 |

Note: *, ** and *** indicate that they passed the test at the significance level of 10%, 5% and 1%, respectively.

The likelihood ratio test indicates the existence and time variability of trade inefficiencies. It can be
seen from table 4 that: (1) Free trade agreement (FTA) is an important factor to promote regional trade development. (2) The tariff level (TAF) has a negative impact on the trade efficiency, and is the main factor hindering the trade between Yantai and other trading countries (regions). (3) Liner transport connectivity index (SHP) is significantly negative at the 1% level, indicating that trade efficiency can be significantly improved if trading countries (regions) have complete maritime transport infrastructure and high maritime transport capacity[10]. (4) The FIN symbol is the same as expected. The significance test at the 5% level indicates that an efficient and open monetary and financial system is a factor of trade efficiency.

4 Trade Efficiency Analysis of Yantai

After identifying the influence of various human factors on foreign trade of Yantai, the change trend of trade efficiency (TE) based on one-step method was analyzed. Figure 1 shows the trade efficiency and average trade efficiency of bilateral trading countries (regions) in Yantai from 2007 to 2017. According to FIG.1, except for Malaysia and Russia, the trade efficiency between Yantai and trading countries (regions) increased to different degrees from 2006 to 2016.

![Fig 1. Trend of trade efficiency between Yantai and trading countries (regions) from 2006 to 2017 (trade non-efficiency model)](image)

5 Research conclusions and Suggestions

5.1 Conclusion

Using the method of step measuring Yantai trade with 13 countries (regions) of total trade efficiency, and get the following conclusions:

The estimation results of the time-varying attenuation stochastic frontier gravity model show that: (1) The economic scale of Yantai has a significant positive correlation with the total trade level, while the increase of the total population will inhibit the development of the trade level. (2) The economic scale and total population of trading countries (regions) are positively correlated with the level of trade. The scale of foreign trade of Yantai is highly dependent on the economic and population scale of its trading countries (regions). (3) The distance between Yantai and the trading country (region) has a significant negative impact on the level of trade, and the geographical distance constitutes an obstacle to the foreign trade of Yantai.

The estimation results of the trade inefficiency model show that: (1) The coefficient of the dummy variable free trade agreement (FTA) is significant, indicating that China's accession to the FTA can build a broader platform for the cooperation between Yantai and trading countries (regions). (2) The tariff level is inversely proportional to the trade efficiency. The tariff barrier will increase the friction cost of Yantai's export products and hinder the deeper cooperation between Yantai and major trading countries (regions). (3) Liner transport connectivity and financial freedom are in direct proportion to
trade efficiency, which play a significant role in promoting trade development.

5.2 Suggestion
The level of economic development of both trading parties has a significant positive impact on the level of trade in Yantai. The economic scale of Yantai largely determines the level of trade, so it is necessary to develop its own economic foundation. In the context of building a smart city in Yantai, the manufacturing industry should be vigorously developed to make it a high-end market segment with intensive manpower, knowledge, and technology. Improve the efficiency of information transmission using the Internet of Things. Encourage powerful local enterprises to create their own brands, master technical standards, and use smart cities to increase infrastructure construction.

Yantai should also seize the opportunities brought by industrial parks and bonded areas to accelerate the transformation and upgrading of foreign trade structure and promote economic and trade cooperation in high-tech industries. The government should explore a new model of innovation-driven development and deepen cooperation with Japan and Japan and other countries with high-tech content in areas such as technology introduction and industrial coordination. [11] One of the effective ways to promote the development of the upstream and downstream industrial chains is to encourage local enterprises to develop processing trade using supplies as raw materials.

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