

# Influence of Openness on the Efficiency of the "Core Area" Logistics Industry in the Silk Road Economic Belt

-From the perspective of technology spillover theory

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**Abstract**—Based on the review of relevant literature, the definition of core concepts and the analysis of theoretical mechanisms, based on the relevant data from 2008 to 2015, the paper first used the DEA model to measure the logistics industry efficiency of the "core area" of the Silk Road Economic Belt and found that the efficiency of the overall logistics industry in the "core zone" has decreased significantly in 2009 compared to 2008. The openness index of all provinces and regions shows that the overall openness of the five Central Asian countries is higher than that of the five provinces and regions in northwest China, and mainly depends on international trade, and foreign capital dependence is lower than the five provinces and regions in the northwest. The empirical analysis of the above two aspects shows that the degree of opening to the outside world in Chinese northwest region has promoted the efficiency of the logistics industry but the impact is not significant. The opening of the "core area" and the opening of the five countries in Central Asia has a significant inhibitory effect on the efficiency of the logistics industry. It is suggested that the "core zone" of the economic zone should focus on improving the technology spillover and absorption capacity so as to increase the positive spillover effect of opening up to the logistics industry.

**Keywords**—*Logistics efficiency; Openness; Technology spillover theory; DEA model; Tobit model*

## I. INTRODUCTION

The logistics industry is an important guarantee for the economic development of the countries of the world and whether the first and second industries can flourish. Under the backdrop of China's vigorous efforts to promote the "One Belt and One Road" development, the five provinces in northwest China and the five countries in Central Asia as the Silk Road While the "core zone" of the economic belt is continuously expanding its opening to the outside world, how to better promote the efficiency of the logistics industry is also a top priority. Based on the theory of technology spillover, this article analyzes two aspects of international trade and FDI respectively.

The Tobit model was used to analyze the impact of openness on the efficiency of the "core zone" logistics industry in the Silk Road Economic Belt, and the problems existing in the process of opening up in various countries and provinces and regions were identified, and relevant recommendations were made in a targeted manner.

## II. LITERATURE REVIEW AND QUESTIONING

### A. Literature review

#### 1) Selection of efficiency evaluation methods for logistics industry

Data Envelopment Analysis was created by A.Charnes, W.W.Cooper, and E.Rhodes (1978) [1], the famous American mathematicians and economic managers. In the process of continuous development, there are already some expanded DEA models. However, the main research is still using the traditional DEA model. For example, Zhang Cheng et al. (2013) used the CCR and BCC models in the DEA model to perform a longitudinal analysis of the overall efficiency, pure technical efficiency, and scale efficiency of the logistics industry in the six central provinces [2]. Wang Lei et al. (2014) analyze the modern logistics efficiency of northern Xinjiang based on the traditional DEA CCR and BCC models [3].

#### 2) Research on the factors affecting the efficiency of the logistics industry

Among the many factors affecting the efficiency of the logistics industry, there are many studies on the level of economic development (GDP), utilization of logistics resources, industrial structure, urbanization level, location conditions, human capital level, and openness to the outside world. Among them, most scholars study the degree of opening to the outside world as one of the factors that affect the efficiency of the logistics industry, and use the degree of foreign trade dependence and total foreign investment (FDI) to represent the degree of openness to the outside world. On the one hand, the dependence of foreign trade dependence on the efficiency of the logistics industry. Ding Bin et al. (2014) measure the degree of opening to the outside world by the degree of foreign trade dependence, and believe that the degree of opening to the

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outside world has a significant impact on the efficiency of the logistics industry [4]. On the other hand, Zhang Baoyou et al. (2013) analyzed that FDI has a relatively large impact on the efficiency of China's logistics industry. The technical content, profitability, and localization of FDI are positively correlated with the efficiency of logistics industry [5]. Huang Jie (2015) used FDI to express the degree of opening to the outside world. The regression results showed that the degree of opening to the outside world of Yunnan Province was positively correlated with logistics efficiency, but the correlation between the two was not very high [6].

### B. Questioning

In summary, scholars at home and abroad have made some progress in the study of the impact of opening up on logistics efficiency, which lays a solid foundation for the study of this article, but there are still deficiencies:

1) Existing domestic and international correlations The selection of indicators for measuring the degree of openness in the study is often relatively single and not comprehensive, and it is difficult to obtain scientific and objective results.

2) Under the background of China's vigorously promoting the "One Belt and One Road" strategy, there has been relatively little research on the impact of the degree of opening up of the "core zone" of the Silk Road Economic Belt on the efficiency of the logistics industry from both theoretical and empirical perspectives.

Based on this, from the perspective of technology spillover theory, this paper studies the mechanism of the degree of openness affecting the efficiency of the logistics industry, measures the degree of openness of the country and regions through the entropy method, uses the Tobit model to perform regression, and proposes further analysis. Strengthen the opening-up to the outside world, improve the absorption of technological spillovers, and improve the efficiency of the logistics industry.

## III. THEORETICAL ANALYSIS

### A. Technology spillover theory

#### 1) International trade technology spillover theory

According to modern economic growth theory, long-term economic growth can only come from technological progress, and the key to the growth of international trade lies in the dynamic benefits of trade, that is the technical spillover effects of international trade (Grossman and Helpman, 1991) [7]. The spillover effects of international trade on the host country's technological progress are divided into four categories: demonstration effects, competition effects, scale effects, and personnel training effects.

#### 2) FDI technology spillover theory

The FDI technology spillover effect refers to the direct or indirect impact of FDI on a country's technological progress. Kokko (1992) [8] divided the spillover effect of FDI on the host country's technological progress into four categories: demonstration imitation effects, competition effects, personnel training effects, and correlation effects.

### 3) Related theoretical explanations

a) The channels for technological spillover are five effects. An increase in the degree of openness of a country or region will promote more international trade activities and the introduction of more FDI, manifesting itself as an increase in the technological spillover of TNCs in that country or region.

b) The prerequisite for technology spillovers from multinational companies to logistics companies in the host country is a moderate gap in technology. When the technology gap between the two parties is too small, the lower level of technology of multinational companies does not greatly help the technological upgrading of the host country's enterprises.

c) Technology spillovers also produce different results due to regional differences. For example, Xie Jianguo (2006) believes that the spillover effect of foreign trade in China's provinces and regions has regional differences, and it has a positive spillover effect in some regions, but in other regions it has a negative effect on the improvement of local technical efficiency<sup>[9]</sup>. In addition, a UN study shows that in most cases, the positive spillover effect of foreign direct investment can make up for the negative impact on local companies, but some empirical studies on developing countries and transition economies have shown different results<sup>[10]</sup>.

d) Judging from the process of technology spillover, it includes two processes of technology spillover and technology absorption. Technology spillover and technology absorption are relatively independent. The main body of technology spillover is multinational corporations. The main body of technology absorption is host country logistics enterprises. The effect of technology spillover has a lot to do with the absorptive capacity of the host country's enterprises. When the host country's absorptive capacity for technology spillovers is not strong, the effect of international trade and FDI technology spillovers to enhance the technological level is not obvious. The extent of technology spillovers and absorption depends on the attributes and capabilities of their respective subjects.

## IV. Measurement of the efficiency of the logistics industry

### A. Measurement method

The BCC method of the DEA model is based on the fact that the unit-of-revenue size of the decision-making unit is variable, excluding the situation where the scale efficiency and the technical efficiency are mixed together. The technical efficiency is decomposed into pure technical efficiency and scale efficiency. It can be measured that the DEA non-effective decision-making unit is due to non-effective technology or non-effective scale. This paper selects the input-oriented model of the BCC method, that is, under the condition that the output of the logistics industry remains unchanged, it seeks to minimize the investment.

**B. Index selection and data sources**

*1) Index selection*

Through summing up previous scholars' research, three input indicators were selected, the number of employees in the logistics industry, transportation mileage, and investment in fixed assets in the logistics industry (fixed assets investment as an alternative to capital stock); three output indicators were selected, the value added of the logistics industry, railway freight turnover, and air freight turnover, of which the increase in the value of the logistics industry's output value is deflated by the GDP price index, and the actual increase in the output value of the logistics industry is obtained.

TABLE I. LOGISTICS INDUSTRY AVERAGE EFFICIENCY TREND TABLE 2008-2015

	2008	2009	2010	2011	2012	2013	2014	2015
Comprehensive technical efficiency	.631	.599	.639	.633	.646	.668	.674	.679
Pure technical efficiency	.833	.837	.866	.869	.895	.894	.917	.924
Scale efficiency	.746	.708	.741	.733	.725	.748	.745	.750

Table I shows: The overall logistics industry efficiency of the "core zone" from 2008 to 2015 is low. Among them, the average technical efficiency of the logistics industry averages between 0.599-0.679, showing an overall upward trend. The average value of pure technical efficiency is basically unchanged or even slightly improved; the annual pure technical efficiency value is between 0.833-0.924, which is significantly higher than the average of the overall technical efficiency and continues to increase; the average scale efficiency is between 0.708-0.750. The average value of pure technical efficiency is basically the same as that of the average, which shows that the overall technical efficiency of the logistics industry in the "core area" is mainly due to the insufficient scale of development of the logistics industry.

**V. EMPIRICAL ANALYSIS**

*A. Estimation of openness index*

Opening to the outside world mainly affects the efficiency of the logistics industry through both international trade and international investment. This article selects the degree of foreign trade dependence (the proportion of total import and export in GDP) as an indicator in international trade, and chooses the degree of foreign capital dependence (FDI as a percentage of GDP) as an indicator in international investment. It can be weighted by the entropy method and can be obtained Openness Index.

After calculating with EXCEL software, the index weights of foreign trade dependence degree and foreign capital dependence degree are 0.624 and 0.376. According to the weights of the two external opening indicators and the average value of foreign trade dependence and foreign capital dependence of the "core zone" of the Silk Road economic belt during 2008-2015, the "core zone" average opening degree index for 2008-2015 can be calculated. The relevant data comes from the "China Statistical Yearbook", the Asian Development Bank statistical database, and the World Bank public database.

*2) Data sources*

The data in this paper comes from the "China Statistical Yearbook," the World Bank's Public Database, and the Statistical Database of the Asian Development Bank.

*C. Measured results and analysis*

*1) Overall efficiency analysis*

Based on the relevant data, the input-oriented model of the previously selected BCC method was used to calculate the efficiency of the "core area" logistics industry. The results are shown in Table 1.

*B. Model selection and establishment*

*1) Model selection*

Since the efficiency value calculated using the BCC method of the DEA model is between 0 and 1, it is a restricted dependent variable. If an econometric model is established directly using the efficiency value as the explanatory variable, and the model is directly returned by the ordinary least-squares method, the data can not be completely presented, resulting in an estimation bias. Therefore, this paper uses the Tobit model for regression analysis.

*2) Selection of variables*

The explanatory variables of the model are the comprehensive technical efficiency of the logistics industry. The core explanatory variables are the degree of openness to the outside world. Four control variables are selected: economic development level (measured by GDP), utilization rate of logistics resources, industrial structure, and urbanization level.

*3) The establishment of Tobit model*

The Tobit model expression established in this paper is:

$$Y_{it} = c + \beta_0 + \beta_1 O_{it} + \beta_2 G_{it} + \beta_3 R_{it} + \beta_4 S_{it} + \beta_5 C_{it} + \epsilon \quad (1)$$

$$Y^*_{it} = \beta X_{it} + \mu \quad Y^*_{it} > 0 \quad (2)$$

$$Y_{it} = \begin{cases} Y^*_{it} & Y^*_{it} > 0 \\ 0 & Y^*_{it} \leq 0 \end{cases} \quad (3)$$

Among them,  $Y^*$  is the truncated dependent variable vector;  $Y$  is the efficiency value vector;  $\beta$  is the regression coefficient of each influencing factor;  $O$  represents the degree of opening to the outside;  $G$  represents the level of economic development;  $R$  represents the utilization rate of logistics resources;  $S$  represents the industrial structure;  $C$  represents the level of urbanization;  $\epsilon, \mu$  are error terms, and  $\mu \sim (0, \sigma^2)$ .

### C. Empirical results and analysis

During the empirical study, the Tobit regression was first performed on the “core area” of the Silk Road Economic Belt, taking into account the significant differences in the economic

environment, policies, and regulations between the five provinces in northwest China and the five countries in Central Asia. Five provinces in northwest China and five countries in Central Asia have returned independently.

TABLE II. TOBIT MODEL ESTIMATION RESULT

Variables	The overall "core area"	Five provinces in northwest China	Five countries in Central Asia
Constant term	-0.479*** (-3.18)	-0.891** (-2.15)	-0.451** (-2.08)
O	-0.418** (-2.35)	0.512 (1.01)	-0.716*** (-3.74)
G	-3.83e-06 (-0.820)	-4.04e-06 (-0.62)	-0.00003* (-1.80)
R	0.022*** (6.560)	0.024*** (4.22)	0.053* (1.88)
S	0.011*** (4.110)	0.016** (2.42)	0.017*** (4.42)
C	0.007*** (2.790)	0.009 (1.23)	0.007** (2.11)
LR chi2	73.13	30.67	47.25
Prob>chi2	0.0000	0.0000	0.0000

<sup>a</sup> Note: I. \*\*\*, \*\*, and \* are significant respectively at the 1%, 5%, and 10% levels; II. The value in parentheses represents the t value of the estimated coefficient.

#### 1) The table II shows:

a) As a result of the impact of the degree of openness on the efficiency of the logistics industry, the overall “core area” is significantly negative at the level of 5%, while the coefficient of influence of the five provinces in northwest China is positive but not significant. The impact on the five Central Asian countries was significantly negative at the 1% level. This may well indicate that the “core zone” is still far from open to the outside world.

b) In the results of the impact of the utilization of logistics resources on the efficiency of the logistics industry, the overall “core area” and the five provinces and regions in northwest China have a significant positive effect at the level of 1%. The five countries in Central Asia have a significant positive effect at the level of 10%.

c) In the results of the impact of the industrial structure on the efficiency of the logistics industry, the overall “core area” and the five Central Asian countries all have a significant positive effect at the 1% level, and the five northwestern provinces and regions in China have significant positive levels at the 5% level. Effect.

d) In the results of the impact of urbanization on the efficiency of the logistics industry, the overall “core area” has a significant positive effect at the 1% level, and the five Central Asian countries have a significant positive effect at the 5% level. The coefficient of influence of five northwestern provinces and regions in China is positive but not significant

e) In the results of the impact of economic development on the efficiency of the logistics industry, the overall impact of the “core zone” and the five provinces in northwest China is negative but not significant, and the five countries in Central Asia have a significant negative effect at the 10% level.

#### 2) Result analysis

a) The degree of opening to the outside world of the five provinces in northwest China has a positive effect on the efficiency of the logistics industry but it is not significant. There are several main reasons. First, due to the high degree of tertiary industry development in the five provinces in northwest China, the linkage effect of FDI in the logistics industry after entering may be more apparent. Second, the logistics industry in the five provinces in northwest China also suffers from shortage of funds and relatively backward technology. It is difficult for foreign logistics companies to play a good demonstration effect and competitive effect when they enter, but mainly because the level of openness to the outside world is not high enough. The technology spillovers are low, resulting in insignificant positive effects.

b) Whenever the five Central Asian countries’ openness increases by one percentage point, the efficiency of the logistics industry will decrease by 0.716 percentage points. The reason is, first, the higher the degree of openness to the five Central Asian countries, the more fierce the competition in the logistics industry, and it is difficult in large-scale R&D innovations when foreign logistics companies enter. Secondly, because many companies are lagging behind in technology level, although there are technological spillovers when the degree of openness to the outside world increases, local companies cannot absorb the threshold because they do not have matching professional knowledge, professional talents, and related infrastructure. This will lead to unsatisfactory absorption of technological spillovers.

## VI. CONCLUSION

There are significant differences in the degree of openness and the efficiency of the logistics industry among the five provinces in northwestern China and the five countries in Central Asia. Therefore, the corresponding suggestions to increase the degree of openness to the five provinces in northwestern China and the five countries in Central Asia are as follows:

### A. *Suggestions for the five provinces in northwest China*

#### 1) *Strengthen the import of high-tech logistics services*

There is a lack of high-tech service products in the import trade of logistics services in five provinces in northwest China. This has led to an inconspicuous technological spillover effect in the international trade of the logistics industry. Therefore, to strengthen the trade in high-tech logistics services, this will improve the efficiency of the logistics industry.

#### 2) *Focus on improving the quality of FDI in the logistics industry*

The quality of logistics foreign-funded enterprises introduced in the five provinces in northwest China is not high, which brings certain difficulties for FDI's technological spillovers. Therefore, it is necessary to pay attention to improving the quality of FDI when introducing foreign capital, and to introduce more advanced technology and more profitability foreign logistics enterprises.

### B. *Suggestions for the five countries in Central Asia*

#### 1) *Strengthen the level of infrastructure construction*

The efficiency of the logistics industry in the five Central Asian countries is far lower than the five provinces and regions in northwest China, mainly due to the lack of scale in the development of the logistics industry, which has led to insufficient resources for input of resources. To improve the efficiency of the logistics industry in the five countries of Central Asia, it is necessary to vigorously strengthen and improve the infrastructure that can adapt to economic development and increase the efficiency of logistics in the country to a higher level.

#### 2) *Improve the technological absorptive capacity of domestic logistics companies*

The domestic logistics companies in the five countries of Central Asia must constantly improve the quality of their employees, optimize the organizational structure, and increase technological innovation so as to comprehensively improve the technology spillover and absorption capabilities of domestic-funded logistics companies, so that the international trade in logistics and FDI can be applied to domestic-funded logistics companies. The technology spillover effect works.

#### 3) *Make great efforts to cultivate logistics high-tech talents*

While increasing opening to the outside world, five countries of Central Asia must vigorously train and introduce high-tech logistics talents to prevent the loss of logistics high-tech talent in the region, allow more logistics talents to stay in enterprises in the region, and increase the level of technological innovation and technological spillover in the logistics industry in the region. Absorptive capacity to promote the efficiency of the logistics industry.

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