# Influence of Cross-Border Economic Cooperation in Border Areas on Sino-Vietnam Opening-up Based on Grey Correlation Model

Xiaoyan Liu*

Corresponding author: dlwslxy@126.com*

Wenshan University, Wenshan, 663000, China

**Abstract.** Based on the data of cross-border economic cooperation in China-Vietnam border areas and the opening-up between the two countries from 2011 to 2018, the principal component analysis was used to comprehensively evaluate the overall level of opening-up and economic cooperation in China-Vietnam border areas. By analyzing the influence of cross-border economic cooperation level in China-Vietnam border areas on the overall opening-up between the two countries and the openness for import, export, investment and engineering cooperation with grey correlation model, the results were as follows: (1)the cross-border economic cooperation level of Dongxing City and Hekou County had the strongest promoting effect on the overall opening-up between China and Vietnam, (2) the level of cross-border economic cooperation in Jinping County and Malipo County had the greatest promoting effect on the openness for engineering cooperation between China and Vietnam, (3) the cross-border economic cooperation level of Fangchenggang City and Dongxing City had the strongest promoting effect on the openness for investment between China and Vietnam, (4) the level of cross-border economic cooperation in Fangchenggang City and Jinping County played the most important role in promoting the import and export between China and Vietnam.

**Keywords-**cross-border cooperation; opening-up between China and Vietnam; grey correlation model

## 1. INTRODUCTION

Connected by the same mountains and rivers, China and Vietnam share the same social system and have similar traditional culture and customs. With strong economic complementarity and huge potential for cooperation, the opening-up between China and Vietnam is conducive to the economic development of both sides (Xie, et al., 2014) [1]. The opening-up between China and Vietnam mainly relied on trade. At present, however, there is relatively little room left for traditional trade policies and measures to stimulate the opening-up between the two countries. The cross-border economic cooperation in border areas aims to break the border barriers,

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promote the free flow of economic factors across borders and the accumulation of economic factors in border areas, and realize the economic integration in border areas, thus transforming the China-Vietnam opening-up from trade opening to regional economic integration (Zhang, et al., 2015) [2]. As a mode of regional cooperation aiming to accelerate regional economic integration, the cross-border economic cooperation in border areas has become an important way to promote China-Vietnam opening-up and cooperation. Studying the impact of cross-border economic cooperation on China-Vietnam opening-up is of great significance for China and Vietnam to conduct better opening-up and cooperation.

## 2. MODEL, INDICATOR VARIABLES AND DATA SOURCES

### 2.1 Model Selection

The grey correlation model can be used to analyze the impact of cross-border economic cooperation in border areas on China-Vietnam opening-up. The widely-used model is not strict about sample size and probability distribution. Therefore, discrepancy between quantitative results and qualitative analysis results can be avoid. The basic idea was to determine the reference sequence (explained variable) and several comparative sequences (explanatory variables), and to calculate the grey correlation degree between the reference sequence and several comparative sequences. The closeness of the connection between the comparative sequence and the reference sequence was judged by grey correlation model. The specific steps of modeling were as follows:

(1) Determine the reference sequence (explained variable) $X_0$ and comparative sequence (explanatory variable) $X_i$

(2) Carry out standardized processing of the raw data (to solve the discrepancy in dimension).

(3) Calculate the grey correlation coefficient

$$\xi_i(k) = \frac{p \max_i \max_k \left|x_0(k) - x_i(k)\right|}{\left|x_0(k) - x_i(k)\right| + p \max_i \max_k \left|x_0(k) - x_i(k)\right|}$$

$p \in [0,1]$, generally, $p$ took 0.5

(4) Calculate the grey correlation degree

$$R_I = \frac{1}{n}\sum_{i=1}^{n} \xi_i(k)$$

### 2.2 Variable Selection

The grey correation model was used to analyze the impact of cross-border economic cooperation in border areas on the opening-up between China and Vietnam. The level of China-Vietnam opening-up was selected as the reference sequence (explained variable) and expressed as $X_0$. The level of cross-border economic cooperation in different areas along the

border between China and Vietnam was selected as the comparative sequence (explanatory variable) and expressed by $X_i$ .

### 2.2.1 Explained Variables:

the level of the overall opening-up between China and Vietnam and the level of openness for import, export, investment and engineering cooperation.

China-Vietnam opening-up covers four aspects: import, export, investment and engineering cooperation, represented by China's total volume of import from Vietnam, China's total volume of export to Vietnam, China's direct investment to Vietnam and the business revenue of China's contracted engineering projects in Vietnam respectively in this paper. According to the index data of the above four aspects, the principal component analysis was used to comprehensively evaluate and estimate the level of overall opening-up between China and Vietnam.

### 2.2.2 Explanatory Variable:

the level of cross-border economic cooperation in border areas between China and Vietnam

The cross-border economic cooperation in China-Vietnam border areas mainly covers several aspects including trade, transportation, industry, tourism and labor service. This paper took the volume of freight transport of import and export at border ports as the indicator of trade cooperation, the number of inbound and outbound means of transport as the indicator of transportation cooperation, the proportion of the industrial output at border ports in GDP as the indicator of industrial cooperation and the number of entry-exit personnel at border ports as the indicator of tourism and labor cooperation. According to the indicators of the above four aspects, the principal component analysis was used to comprehensively evaluate and estimate the level of overall opening-up between China and Vietnam.

## 2.3 Research Objects and Sources of Indicator Data

The areas studied in this paper were mainly port cities where the data of cross-border economic cooperation could be obtained, including Pingxiang City, Longzhou County, Fangchenggang City, Dongxing City, Jingxi County and Napo County in Guangxi Province and Malipo County, Jinping County and Hekou County in Yunnan Province.

The index data related to the level of China-Vietnam opening-up was from *China Statistical Yearbook* (2012-2019). The index data of the volume of import and export freight as well as the number of inbound and outbound means of transport and personnel in the border areas involved in estimating the level of cross-border economic cooperation in border areas by principal component analysis was from *China's Ports-of-Entry Yearbook* (2012-2019). The data of industrial output and GDP in border areas between China and Vietnam was from *Yunnan Statistical Yearbook* and *Guangxi Statistical Yearbook* (2012 - 2019).

## 3. EMPIRICAL RESULTS AND ANALYSIS

### 3.1 Overall Analysis

The Statistic Package for Social Science (SPSS) principal component analysis was used to comprehensively estimate the level of the overall opening-up between China and Vietnam and the cross-border economic cooperation level in border areas of China and Vietnam from 2011 to 2018. By analyzing the grey correlation degree between the level of the overall China-Vietnam opening-up and the cross-border economic cooperation level with grey correlation model, the calculated results are shown in Table 1. From Table 1, it can be seen that : (1) the grey correlation degree between the level of the cross-border economic cooperation in Dongxing City and Hekou County and the level of the overall China-Vietnam opening-up was the biggest, showing that the cross-border economic cooperation of Dongxing City and Hekou County was the strongest driving force in promoting the overall opening-up between the two countries; (2) the grey correlation degree between the level of cross-border economic cooperation in Malipo County and Jinping County and the overall opening-up level of China and Vietnam was the smallest, indicating that the level of cross-border economic cooperation in Malipo County and Jinping County had a small promoting effect on the overall opening-up level between China and Vietnam.

**TABLE I.** GREY CORRELATION DEGREE BETWEEN THE LEVEL OF CROSS-BORDER ECONOMIC COOPERATION IN THE BORDER AREAS BETWEEN CHINA AND VIETNAM AND THE OVERALL LEVEL OF OPENNESS BETWEEN CHINA AND VIETNA

| Region | Grey relational degree | Sort |
|---|---|---|
| Hekou | 0.83 | 2 |
| Dongxing | 0.8 | 1 |
| Jingxi | 0.74 | 3 |
| Pingxiang | 0.7 | 4 |
| Longzhou | 0.66 | 5 |
| Fangchenggang | 0.63 | 6 |
| Malipo | 0.6 | 7 |
| Jinping | 0.53 | 8 |

The reason of the above conclusions was that the “spillover” effect of cross-border economic cooperation in border areas had promoted the opening-up between China and Vietnam.. According to the “spillover” effect proposed by the Neo-Functionalism Theory, the cross-border cooperation in border areas enhanced national opening-up mainly by expanding the field of cooperation through functional “spillover”, realizing supranational control through political “spillover” and continuously enlarging the scope of cooperation through geographical “spillover” (Haas, et al., 1958; Xiong, et al., 2006; Yi, et al., 2010) [3][4][5].

### 3.2 Partial Analysis

The China-Vietnam opening-up covered four aspects including import, export, investment and engineering cooperation. In the preceding chapter, the effect of cross-border economic cooperation in border areas on the overall opening-up between China and Vietnam was analyzed, yet it was unclear about what extent it will affect the openness for import, export, investment and engineering cooperation between the two sides. To test such effect, the grey correlation model was applied to analyze the grey correlation degree between the openness for import, export, investment and engineering cooperation and the cross-border economic cooperation in border areas. The calculation results are shown in Table 2,we found that: (1) the level of cross-border economic cooperation in Fangchenggang City and Dongxing City had the strongest promoting effect on China-Vietnam investment opening-up; (2) the level of cross-border economic cooperation in Jinping County and Malipo County had the greatest promoting effect on the opening-up of China-Vietnam engineering cooperation; (3) the level of cross-border economic cooperation in Fangchenggang City and Jinping County had the greatest impact on the openness for import and export between China and Vietnam.

**TABLE II.** GRAY CORRELATION BETWEEN THE OPENING UP OF CHINA-VIETNAM IMPORT, EXPORT, INVESTMENT, PROJECT AND THE CROSS-BORDER ECONOMIC COOPERATION IN CHINA-VIETNAM BORDER AREAS

| Region | The level of investment openness between China and Vietnam | | The level of opening up of China-Vietnam project cooperation | | The level of import opening between China and Vietnam | | The level of export opening between China and Vietnam | |
|---|---|---|---|---|---|---|---|---|
| | Grey relational degree | Sort | Grey relational degree | Sort | Grey relational degree | Sort | Grey relational degree | Sort |
| Hekou | 0.71 | 3 | 0.57 | 7 | 0.69 | 4 | 0.68 | 4 |
| Dongxing | 0.71 | 2 | 0.56 | 8 | 0.70 | 3 | 0.69 | 3 |
| Jingxi | 0.61 | 7 | 0.67 | 5 | 0.62 | 7 | 0.63 | 7 |
| Pingxiang | 0.59 | 8 | 0.75 | 3 | 0.58 | 8 | 0.59 | 8 |
| Longzhou | 0.62 | 6 | 0.64 | 6 | 0.63 | 6 | 0.64 | 6 |
| Fangcheng gang | 0.80 | 1 | 0.68 | 4 | 0.80 | 1 | 0.813 | 1 |
| Malipo | 0.68 | 5 | 0.76 | 2 | 0.67 | 5 | 0.67 | 5 |
| Jinping | 0.70 | 4 | 0.88 | 1 | 0.72 | 2 | 0.74 | 2 |

## 4. CONCLUSION

By analyzing the influence of cross-border economic cooperation level in China-Vietnam border areas on the overall opening-up between the two countries and the openness for import, export, investment and engineering cooperation with grey correlation model, the results were as follows: (1)the cross-border economic cooperation level of Dongxing City and Hekou County had the strongest promoting effect on the overall opening-up between China and Vietnam, (2) the level of cross-border economic cooperation in Jinping County and Malipo County had the greatest promoting effect on the openness for engineering cooperation between China and Vietnam, (3) the cross-border economic cooperation level of Fangchenggang City and Dongxing City had the strongest promoting effect on the openness for investment between China and Vietnam, (4) the level of cross-border economic cooperation in Fangchenggang City and Jinping County played the most important role in promoting the import and export between China and Vietnam.

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