

Empirical Analysis of Xinjiang's Bilateral Trade: Gravity Model Approach

CHEN Xuegang^{1,2}, YANG Zhaoping¹, LIU Xuling¹

(1. *Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China;*

2. *Graduate University of the Chinese Academy of Sciences, Beijing 100049, China*)

Abstract: Based on the basic trade gravity model and Xinjiang's practical situation, new explanatory variables (*GDP*, *GDPpc* and *SCO*) are introduced to build an extended trade gravity model fitting for Xinjiang's bilateral trade. From the empirical analysis of this model, it is proposed that those three variables affect the Xinjiang's bilateral trade positively. Whereas, geographic distance is found to be a significant factor influencing Xinjiang's bilateral trade negatively. Then, by the extended trade gravity model, this article analyzes the present trade situation between Xinjiang and its main trade partners quantitatively in 2004. The results indicate that Xinjiang cooperates with its most trade partners successfully in terms of present economic scale and developing level. Xinjiang has established successfully trade partnership with Central Asia, Central Europe and Eastern Europe, Western Europe, East Asia and South Asia. However, the foreign trade development with West Asia is much slower. Finally, some suggestions on developing Xinjiang's foreign trade are put forward.

Keywords: trade gravity model; extended trade gravity model; bilateral trade; Shanghai Cooperation Organization (SCO); Xinjiang

1 Introduction

Trade is an integral part of the all-round development and economic growth of a country. It is, in fact, a crucial instrument for industrialization and sustainable economic development. Traditional trade theories mainly concern the qualitative question of identifying the trade pattern, that is to say, what goods does a country trade? But they ignore the question of the trade volumes. In fact, understanding the factors determining bilateral trade volumes of a country or a region is a practical task, as it opens up an additional horizon for a country or a region's trade policies. For instance, successful case of identifying the bilateral trade flows can suggest a desirable free-trading partner and conjecture the volume of a missing trade or unrealized bilateral trade flows. The trade gravity model is a powerful tool for explaining the bilateral trade flow and volume, which is widely applied to analyzing the inter-national bilateral trade volumes since the 1960s and estimating trade potentials, identifying the effects of trade group, explaining the trade

patterns and assessing the cost of a border trade (Lin and Wang, 2004; Liu and Jiang, 2002; Sheng and Liao, 2004). So it better explained some economic phenomena observed in the reality. From the 1960s to 1970s, many studies concentrated on the extended model to optimize the trade gravity model gradually. Regarding the extended trade gravity model, the economist mainly introduced the new explanatory variables to modify the basic gravity model. These new variables are divided into two types: one is exogenous variable that affects the trade volume, like population, per capita GDP and so on, the other is the dummy variable such as the preferential trade agreement, integration organization and so on (Shi et al., 2005). Aitken (1973) added new dummy variables to estimate the impact of European Economic Community on the trade of its member states. Frankel and Wei (1993) found that the level of economic development, i.e. per capita GNP, in a country is an additional significant factor to determine bilateral trade.

Researchers used the resultant extended gravity model to explore the effects of regional groups on the

Received date: 2007-01-18; accepted date: 2007-10-10

Foundation item: Under the auspices of Knowledge Innovation Program of Chinese Academy of Sciences (No. KZCS-SW-355)

Corresponding author: CHEN Xuegang. E-mail: caschxg@126.com

trade performance. In the late 1990s, Frankel and David (1999) took both domestic and bilateral trade volumes as the research objects. Although the gravity model answers the question of the flow direction of trade successfully in a quantitative way, the prediction of potential bilateral trade volumes is restricted because of a lack of reasonable economic theoretical foundation (Liu and Jiang, 2002). In recent years, the theoretical foundation of gravity model has been further consolidated by Anderson, Helpman, Krugman, Bergstrand and Deardorff (Sheng and Liao, 2004).

Relying on the unique advantages of opening up westward, the local government of Xinjiang Uygur Autonomous Region consistently implements the strategies of “Joint East for Exporting Westward and Importing Westward forward East”. Furthermore, they fully utilize the markets at home and abroad and resources. Thus, Xinjiang’s foreign trade has developed rapidly. However, Xinjiang’s total trade volume takes up a small percentage of the whole Chinese foreign trade. Moreover, Xinjiang’s trade value is more dependent on Kazakhstan and Kyrgyzstan, which might make Xinjiang take a passive role in the trade, thus increase the risks of foreign trade. This paper adopts the trade extended gravity model to explain the bilateral trade flows of Xinjiang, and then try to analyze the reasons for this kind of trade pattern. In addition, it estimates trade potentials between Xinjiang and its main trade partners for providing a valuable reference frame of improving Xinjiang’s trade performance. In the previous study, this model was commonly used in the researches on the trade flows of country-pairs, while the trade flow between a specific region and nations was less investigated. Here the trade flow between a specific region and nations is verified by the study in Xinjiang bilateral trade.

2 Data and Methodology

2.1 Data

In this paper the data of the bilateral import and export trade flows between Xinjiang and its main trade partners were used, and 34 countries (or regions) of Xinjiang’s foreign trade partners were selected as samples. The reasons for selecting those countries are as follows. 1) Those 34 countries (or regions) are main trade partners of Xinjiang, in 2004, whose trade volumes with Xinjiang took up 83% of Xinjiang’s total foreign trade vol-

umes. 2) Xinjiang’s eastward and westward opening mainly relies on the new Eurasian continental bridge. Therefore, the countries (or regions) that it covers are typical samples (Fig. 1). And 3) those samples exclude Hong Kong whose data coming from entrepot trade are difficult to deal with. The data on bilateral trade volumes between Xinjiang and its 34 trade partners, GDP and per capita GDP of Xinjiang in 2004 were extracted from the *Xinjiang Statistical Yearbook 2005* (NBSC, 2006). The GDP and per capita GDP of trade partners in 2004 were taken from the website of International Monetary Fund (<http://www.IMF.org/>). In addition, the distances between Urumqi and the capitals of other trade partners were obtained by GIS software.

2.2 Gravity model

Largely inspired by the “Law of Universal Gravitation” proposed by Newton in 1687 (Isard, 1990), the gravity model was exploited by Tinbergen (1962), Poyhonen (1963) and Linnemann (1966), roughly with the same function, in international trade flows between countries or regions. According to this model, the bilateral trade volume between two countries or regions is directly proportional to their respective economic gross and inversely proportional to their spatial distance. Deardorff (1998) used the following equation as a basic trade gravity model (the natural logarithm form):

$$\ln T_{ij} = \alpha + \beta_1 \ln(GDP_i * GDP_j) + \beta_2 \ln D_{ij} + \varepsilon_{ij} \quad (1)$$

where α is the constant of proportionality; T_{ij} , bilateral trade (sum of exports and imports) between country i and country j ; GDP_i and GDP_j , gross domestic product of country i and country j respectively; D_{ij} , distance between country i and country j ; ε_{ij} , random error; and β_1 and β_2 are coefficients.

The Equation (1) explains that the trade comes from the demand, but the demand is decided by the income. Therefore, the bilateral trade volume is positively related to two countries’ economic gross. Since the distance increases the transport cost of commodity and prevents communication in information, the bilateral trade volume is negatively related to the distance between them. This distance not only refers to spatial distance, but also denotes other factors influencing the bilateral trade (trade policy, cultural difference and so on).

2.3 Extended trade gravity model

The basic trade gravity equation explained the relation-

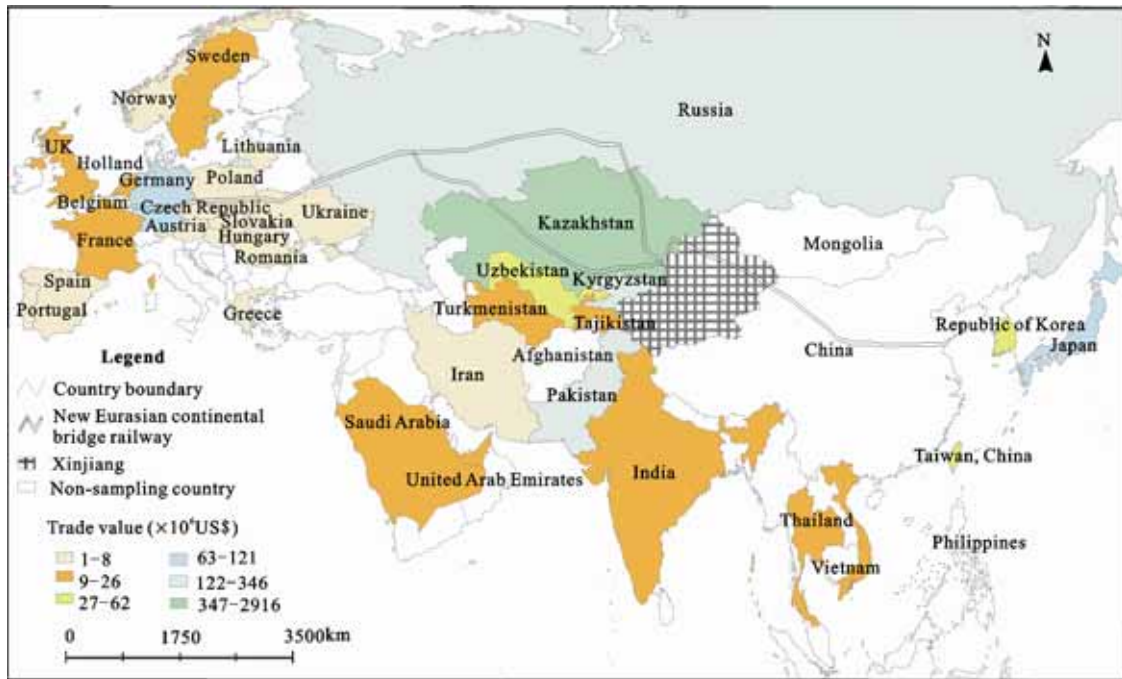


Fig. 1 Spatial distribution of trade volumes between Xinjiang and 34 trading partners in 2004

ships among trade, economic gross and trade cost (distance) successfully. But in the real trade, many other factors still influence the trade levels among partners such as tariff, quota, export tax, exchange rate and so on, which are controlled by governments or their agencies as well as by some companies. There are also economic and political barriers for some countries or regions, for instance, the European Union, North America Free Trading Area, etc., create trade preferences only to their member states. According to the empirical analysis of Whalley (1998), the member states could get more economic benefits from guaranteed markets within trade groups than in others. In order to analyze the effects of regional integration on trade volumes, the authors mainly add some dummy variables to the extended gravity model.

Since Shanghai Cooperation Organization (SCO) was established on June 15, 2001, the trade among its member states has been greatly promoted by the signed preferential tariffs policies. On the basis of the “Shanghai Five” mechanism (People’s Republic of China, Russian Federation, Republic of Kazakhstan, Republic of Kyrgyzstan, and Republic of Tajikistan), SCO was established after Republic of Uzbekistan joined in “Shanghai Five” mechanism equally. The cooperation of those six countries has dealt with very broad fields involving security, economy, transportation, culture, trade, energy, etc. Among them, the all-round cooperation in economy

and trade is the key field (Chen, 2004). At present, the trade volumes between Xinjiang and other countries in SCO take up 72.5% of Xinjiang’s foreign trade volumes. The trade volumes with Republic of Kazakhstan, Republic of Kyrgyzstan, and Republic of Uzbekistan reach 68% of Xinjiang’s total foreign trade. To explore the actual effect of other factors on Xinjiang’s bilateral trade flows except economic gross and trade cost, we introduce two new variables of per capita GDP and SCO, with reference to Frankel and Wei’s trade gravity equation and then get the extended gravity equation as follows:

$$\begin{aligned} \ln T_{1j} = & \alpha + \beta_1 \ln(GDP_1 * GDP_j) + \\ & \beta_2 \ln(GDPpc_1 * GDPpc_j) + \\ & \beta_3 \ln D_{1j} + \beta_4 SCO + \varepsilon_{ij} \end{aligned} \quad (2)$$

where T_{1j} is bilateral trade (sum of export and import) between Xinjiang and country (region) j ; GDP_1 and GDP_j are gross domestic products of Xinjiang and country (region) j , respectively; $GDPpc_1$ and $GDPpc_j$, per capita GDPs of Xinjiang and country (region) j , respectively; D_{1j} , distance between Xinjiang and country j ; SCO , binary dummy variable representing the influence from trade group of SCO, if country (region) j belongs to SCO, then $SCO=1$; otherwise $SCO=0$; ε_{ij} , random error; and $\beta_1, \beta_2, \beta_3$ and β_4 are coefficients.

A larger country or region, with a great production capacity, is more likely to achieve scale economy and increase its exports based on comparative advantage. It

also possesses large domestic markets to attract more imports. Accordingly, the augmentation of both GDPs of a country (region) and Xinjiang will increase bilateral trade volumes, thus, the estimated coefficient $\beta_1 > 0$. Per capita GDP serves as a proxy for the income level of the exporting and importing countries or regions. Generally speaking, the richer the trade partners are, the stronger purchasing power they would have, and the more trade volumes are, then the estimated coefficient $\beta_2 > 0$. In addition, we anticipate the coefficient $\beta_3 < 0$, because the distance variable is a trade resistance factor that represents trade barriers. As for β_4 , when Xinjiang's partner is the member of SCO, owing to the preferential trade arrangements, Xinjiang's bilateral trade volume will accordingly increase, thus, the estimated coefficient $\beta_4 > 0$.

Under the environment of SPSS11.0, Equation (2) was estimated by the OLS of the multiple linear regression with cross-sectional data of foreign trade volumes (exports plus imports), GDP and per capita GDP of Xinjiang in 2004. Furthermore, the results of regression were tested. Then the regression equation was used to analyze Xinjiang's bilateral trade performance.

3 General Situation of Xinjiang

3.1 Location of Xinjiang

Xinjiang Uygur Autonomous Region is located in north-west frontier of China and situated in the interior of Asia-Europe continent. It has eight neighboring countries and is a region of many minority nationalities. Xinjiang covers an area of $1.66 \times 10^6 \text{ km}^2$, which is approximately the one sixth of the total area of China. It is not only an important trade road, which joins China with the Central Asia, West Asia, South Asia and the East-western Europe, but also the key of the grand development program in the western China. Since the ancient times, Xinjiang had the historical blood relationship with the nationalities of Central Asia and West Asia. They had something in common such as culture, custom, religious belief and so on. In addition, the folk trade was early well established between each other and there were many similarities in resources, natural environment and economic structure (Hairer et al., 2000).

3.2 Status of Xinjiang's foreign trade

Xinjiang's foreign trade has been variously developed in different periods, steadily developed in 1950–1962, slow-

ly in 1963–1980, and rapidly from 1981 to now. In 1994, the trade volumes exceeded $\text{US}\$1 \times 10^9$ and achieved $\text{US}\$5.636 \times 10^9$ in 2004, which had risen by 239 times compared to that of 1978, with the annual average growth rate of 23.5%. It has risen 12.5 percent point compared with the growth rate of Xinjiang's GDP of the corresponding period and 10.2% compared with the growth rate of domestic trade of China (Liu et al., 2005). The development of Xinjiang's foreign trade has greatly promoted the whole regional economic and social development. Nowadays, Xinjiang has initially formed a two-way opening pattern (north-south, east-west). Xinjiang's foreign trade mainly presents the following characteristics: 1) contribution rate of the foreign trade to GDP has increased yearly. In 2004, Xinjiang's foreign trade dependence amounted to 21.2%, which rose 15.3% compared with 5.9% in 1980. In 2004, the export and import dependence was 13.45% and 7.75%, respectively. 2) The trade patterns tend to be diverse. The traditional patterns of Xinjiang's foreign trade were the general trade, the clearing account trade and the frontier trade. After the reform and open-up, the foreign trade enterprises of Xinjiang have used various ways to develop foreign trade and the trade patterns present the multiplex tendency. In 2004, the ratio of the general trade, the frontier trade, and the processing trade was 26.9:65.8:5.6. The frontier trade has become the fundamental support and the main pull force of Xinjiang's foreign trade, and the general trade and the processing trade are increasing continuously. 3) The commodity structure of export is optimized increasingly. After the development in 1980–2004, manufactured goods have accounted for the great proportion instead of primary goods in Xinjiang's export. At the same time, the export proportion of high added-value products has been increasing continuously. And 4) Trade partners are distributed globally day by day, and mainly concentrated on the Central Asia. At the beginning of the establishment of Xinjiang, its trade partners were only several countries such as former Soviet Union. From 1963 to 1980, Xinjiang's import and export markets were mainly Japan and Hong Kong, etc. By the end of 2004, Xinjiang has already set up trade partnerships with more than 135 countries and regions, and has gradually formed the domain markets including the Central Asia, USA, European Union, Russia, Hong Kong, Macao, Taiwan, etc. Among them, Kazakhstan has become the biggest and most stable

trade partner of Xinjiang in particular (Fig. 2).

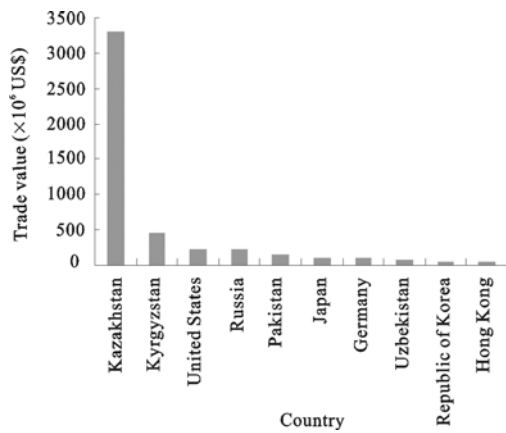


Fig. 2 Trade between Xinjiang and its main trade partners in 2004

4 Results and Analyses

The test parameters and statistical results of gravity Equation (2) are shown in Table 1. The goodness of fit is better with an adjusted R^2 of 0.79. All the explanatory variables are highly significant ($\alpha = 0.05$). The signs of equation coefficients are the same as expected. The above results show that the gravity model effectively explains Xinjiang's bilateral trade flow, successfully identifies the factors influencing Xinjiang's bilateral trade volume, and is well applicable to analyzing the bilateral trade flows between a specific region and countries. Among all the variables, the coefficient of distance variable β_3 is -2.98 , which indicates that geographic distance is a significant factor influencing Xinjiang's trade negatively. It is in consistent with Xinjiang's current trade situation. For a long time, the neighboring Russia and Republic of Kazakhstan, Republic of Kyrgyzstan and Pakistan with direct land corridor are always the main trade partners of Xinjiang. In 2005, the port trade volumes of Xinjiang with Republic of Kazakhstan reached $US\$5.7 \times 10^9$, which rose 60% compared with that of last year and took up 72% of Xinjiang's total import and export volumes, while those with Republic of Kyrgyzstan achieved $US\$683 \times 10^6$, which rose 75% and took up 8.6%. Furthermore, GDP and per capita GDP affect the Xinjiang's bilateral trade positively, i.e., with the economic development scale and level of Xinjiang's trade partners, the bilateral trade volume will increase. For example, although some developed countries like Germany and Japan do not have

any advantages in distance when developing trade with Xinjiang, the bilateral trade volumes of them are larger because of the higher economic scale and developing level. For some Eastern Europe countries, which do not have advantages either in economy or in distance, the bilateral trade volumes with Xinjiang are much lower. In addition, the SCO has promoted the trades between its member states, especially Republic of Kazakhstan and Republic of Kyrgyzstan, which have direct land corridor with Xinjiang.

Table 1 Regression results

	Expected sign	Coefficient	<i>t</i>	Sig.
α		10.79	3.04	0.005
$\ln(GDP_i * GDP_j)$	+	0.62	5.26	0.000
$\ln(GDPpc_i * GDPpc_j)$	+	0.37	1.11	0.036
$\ln D_{ij}$	-	-2.98	-6.12	0.000
SCO		1.59	2.41	0.002
$Adj.R^2$			0.79	

Note: Significant at 5% level; $F=32.68$, Sig. is 0.000

Then, according to regression coefficients, we get the extended gravity model calculating the Xinjiang's bilateral trade flows as follows:

$$\ln T_{ij} = 10.79 + 0.62 \ln(GDP_i * GDP_j) + 0.37 \ln(GDPpc_i * GDPpc_j) - 2.98 \ln D_{ij} + 1.59 SCO \quad (3)$$

Firstly, we used Equation (3) to calculate the simulated trade volume (T_{ij}) and then introduced two indices to analyze Xinjiang's bilateral trade performance. The first is the relative difference (Rd) between the actual and simulated trade volume, which is defined as:

$$Rd_{ij} = 100 * (A_{ij} - T_{ij}) / (A_{ij} + T_{ij}) \quad (4)$$

where Rd_{ij} denotes relative difference in trade of Xinjiang with country (region) j , A_{ij} means actual trade and T_{ij} simulated trade. This Rd is inspired by the Normalized Difference Vegetation Index (NDVI) (Li et al., 2002; Jiang et al., 2003). The relative difference varies between -1 and 1 . Rd_{ij} is used to measure the good or bad trade performance between Xinjiang and the country j , and analyze the Xinjiang's future trade direction in present trade circumstances. The larger the Rd_{ij} is, the more successful the bilateral trade cooperation is, but the bilateral trade needs to be enhanced urgently otherwise (Amita, 2004; Helmers and Pasteels, 2003). Figure 3 suggests that the Rd_{ij} between Xinjiang and its most trade partners were above zero, which indicates that Xinjiang cooperates with its most trade partners suc-

cessfully in terms of present economic scale and development. The bilateral trades between Xinjiang and Kazakhstan, Pakistan, Germany, Russia, Kyrgyzstan, Ukraine and France in particular were excellent. On the contrary, the Rd_{ij} between Xinjiang and India, Greece, Uzbekistan, Iran and Norway were much less than zero, which shows that serious trade barriers exist between Xinjiang and those countries (Chan and Yoon, 2001).

The most typical example was India. Although it is one of Xinjiang's neighboring countries, there was no direct land corridor between them. Therefore, the trade volume between them was only $US\$10.87 \times 10^6$ in 2004. Whereas, the trade volume between Xinjiang and Pakistan, which is located in South Asia and has direct land corridor with Xinjiang, reached $US\$163.15 \times 10^6$.

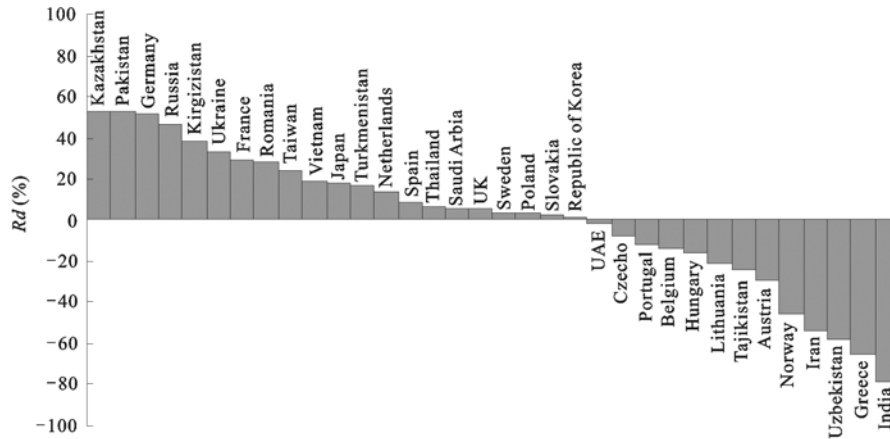


Fig. 3 Relative differences (Rd) between Xinjiang and trade partners in 2004

Now, the bilateral trade performances between Xinjiang and the continental regions are further discussed through the second introduced index, the absolute difference (Ad), which is defined as:

$$Ad_{ij} = A_{ij} - T_{ij} \quad (5)$$

where Ad_{ij} denotes absolute difference of Xinjiang with country (region) j . A_{ij} means actual trade and T_{ij} simulated trade. Ad_{ij} is also used to assess the good or bad trade performance between Xinjiang and country (region) j and analyze the Xinjiang's trade direction in the future. Although Rd can be a convenient index to describe the relative relation of actual and simulated trade value, it does not explain the deviation volumes between them. When $0 < Rd < 1$, we do not know how much more than simulated trade volume Xinjiang gains from its good trade partner actually. When $-1 < Rd < 0$, we could not know the trade potential of Xinjiang and its potential trade partner. However, we can calculate the gained or owned trade potential value by Ad which provides the actual reference value to identify the future trade partner of Xinjiang. Next, Xinjiang's trade partners could be further classified according to their geographic regions, then Ad_{ij} values of each trade partner in each classified region are calculated and finally intra-area's Ad_{ij} values

are summed up ($\sum Ad_{ij}$) and compared with each other (Fig. 4). That is to say, Xinjiang has established successfully trade partnership with Central Asia, Central and Eastern Europe, and Western Europe.

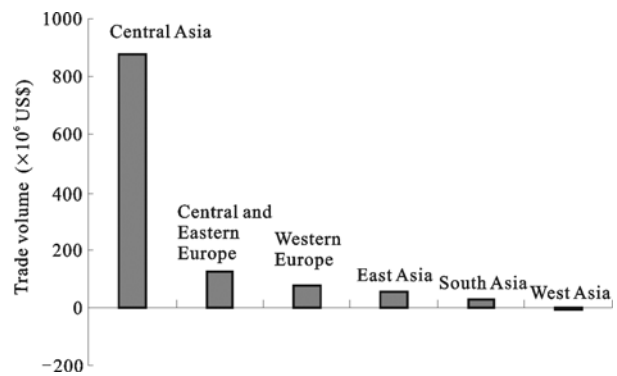


Fig. 4 Absolute differences of Xinjiang's bilateral trades in 2004

The reasons for the formation of this trade pattern are as follows: 1) Xinjiang and the Central Asian countries have much in common from the aspects of culture, customs and religious beliefs. They also have the traditional economic exchanges. 2) By the new Eurasian continen-

tal bridge and many land ports, Xinjiang has become a "bridgehead" of opening up westward. The new Eurasian continental bridge has shorten the trade distance between China and some countries, for example, the average distance of Xinjiang along the new Eurasian continental bridge to the Europe is about 6000km, accounting for 25% of the shipping distance. Xinjiang has opened up 17 land ports to foreign visitors and businessmen. It is the province which has the largest number of land ports so that it has the superiority to develop the border trade. In 2004, the border trade value reached US\$3.709×10⁹ and accounted for 65.8% of the total import and export value. 3) Xinjiang is the corridor of complementary economy among China and Central Asia and Russia. From the perspective of the resources, Central Asia, Russia, etc., are rich in energy reserves and they are one of the world's most important, but not yet fully developed energy-rich regions. With the rapid development of economy, China will need more oil to ensure the development of industries. According to the analysis of the International Energy Agency, 50% of China's oil demand will be dependent on imports in 2010 and 80% in 2020. Russia and countries in Central Asia will be important energy cooperative partners in future. From the perspective of the market, Central Asia and Russia's heavy industries are relatively developed, but their light industries relatively backward. Therefore, China's light industrial products will be sold well there. Chinese exports to these countries are the main daily consumer goods and the light textile and apparel products. While Chinese imports from Kazakhstan and Russia are mainly agricultural products, food, textiles, light industrial products, electromechanical products, etc., which obviously reflect the industrial complementarities. And Xinjiang is the corridor to perform the complementary trade.

5 Conclusions and Discussion

This paper uses the cross-sectional data in 2004 and adopts the multiple-factor linear regressions method to establish the extended gravity equation of Xinjiang's bilateral trade. The parameter test of regression equation shows that most of the explaining variables are statistically significant. Moreover, the obtained equation is effective in explaining Xinjiang's bilateral trade, which indicates that the gravity model is well applicable to

analyzing the bilateral trade flow between a specific region and nations. In the equation, the factors determining the trade flows between Xinjiang and its trade partners are their economic gross, per capita GDP and geographic distance. This conclusion disagrees with the classical trade theories which emphasize on comparative advantages and resources endowment. Furthermore, the coefficient of the dummy variable *SCO* shows *SCO* contributes to the trade between member countries and regions regardless of trade flows or directions. The quantitative analysis of the relationship between Xinjiang's actual and simulated trade volumes in 2004 indicates that Xinjiang has been established successfully trade partnership with Central Asia, Central and Eastern Europe, Western Europe, East Asia and South Asia. However, the foreign trade development with West Asia is much slower.

Whereas, some problems of the development in Xinjiang' foreign trades are as follows: 1) the import and export of foreign trade mainly present the increasing tendency, but fluctuate wildly. 2) The proportion in the whole Chinese trade volume is small. 3) The structure of export goods has been improved, but the internal structure is unreasonable. The export goods are mainly primary products like agricultural products, light industrial products and food. However, the number of high value-added products is relatively small (Chen et al., 2007). In order to solve the problems above, on the one hand, it is necessary to consolidate the markets of smaller bilateral trade flows. At the same time, the high foreign trade dependence on Kyrgyzstan should be reduced in order to avoid the subjection of Xinjiang's trade to its economic environment. On the other hand, it is necessary for us to increase the export of high value-added goods and explore more markets (India, Uzbekistan, Iran, etc.) of smaller bilateral trade flows to realize the diversification of foreign trade and gradually upgrade the foreign trade structure. Furthermore, it is better to remove trade barriers and save the transaction costs of the international trade by signing the regional trade agreement and creating the new direct trade corridor. The final aim for us is to establish not only an agglomeration area of goods and raw materials opening to the Central Asia, Central and Eastern Europe and Western Europe, but also a regional manufacturing base and an international transport hub of Asian and European hinterland.

References

- Aitken N D, 1973. The effect of the EEC and EFTA on European trade: A temporal cross-section analysis. *American Economic Review*, 63: 881–892.
- Amita B, 2004. India's global trade potential: The gravity model approach. New Delhi, India: Indian Council for Research on International Economic Relations.
- Chan S H, Yoon J, 2001. Does the gravity model fit Korea's trade patterns? Implications for Korea's FTA policy and North Korean trade. Seoul, Korea: Korea Institute for International Economic Policy.
- Chen Haiwei, 2004. Understanding the economic cooperation between Sino-Central Asian countries within the framework of the SCO. *International Economics and Trade Research*, 20(6): 74–77. (in Chinese)
- Chen Xuegang, Yang Zhaoping, Liu Xuling, 2007. Free Trade Zone and the export-oriented economy development in Xinjiang—Conception of Urumqi Free Trade Zone (UFTZ). *Arid Land Geography*, 30(1): 149–155. (in Chinese)
- Deardorff V A, 1998. Determinants of bilateral trade: Does gravity work in a neoclassic world? In: Frankel J A (ed). *The Regionalization of the World Economy*. Chicago: University of Chicago Press, 7–28.
- Frankel J, David R, 1999. Does trade cause growth? *American Economic Review*, 89(6): 379–399.
- Frankel J, Wei Shangjin, 1993. Is there a currency bloc in the Pacific? In: Wignall A B (ed.). *The Exchange Rate, International Trade and the Balance of Payment*. Sydney: Reserve Bank of Australia.
- Hairet Tursun, Ye Wenhui, Meng Haiyan, 2000. Great exploitation of the west and the basic thoughts of the great development strategy of Xinjiang. *Arid Land Geography*, 23(3): 193–196. (in Chinese)
- Helmets C, Pasteels J M, 2003. A gravity model for the calculation of trade potentials for developing countries and economies in transition. Geneva, Switzerland: International Trade Center.
- Isard W, 1990. *Introduction to Regional Science*. Beijing: Higher Education Press. 50–62. (in Chinese)
- Jiang Dong, Wang Haibin, Yang Xiaohuan et al., 2003. Study on the interaction between NDVI profile and the growing status of crops. *Chinese Geographical Science*, 13(1): 62–65.
- Li Linyi, Liu Zhaoli, Li Chunlin et al., 2002. Spatial correlation analysis of crop yield in the middle and west of Jilin Province. *Chinese Geographical Science*, 12(2): 182–185.
- Lin Ling, Wang Yan, 2004. Empirical test of China's bilateral trade with the trade gravity model and its policy implications. *World Economy Study*, 7: 56–60. (in Chinese)
- Linnemann H, 1966. *An Econometric Study of International Trade Flows*. Holland: North Holland Publishing Company.
- Liu Qingfeng, Jiang Shuzhu, 2002. Study on the Chinese bilateral trade arrangement using the gravity model. *Zhejiang Social Sciences*, 6: 17–20. (in Chinese)
- Liu Haiyan, Zhang Xiaolei, Yang Degang, 2005. Analyze and research of the modern logistics industry development in ALSK region. *Arid Land Geography*, 28(3): 404–406. (in Chinese)
- NBSC (National Bureau of Statistics of China), 2005. Xinjiang Statistical Yearbook. Beijing: China Statistics Press. (in Chinese)
- Poyhonen P, 1963. A tentative model for the volume of trade between countries. *Weltwirtschaftliches Archive*, 90: 93–100.
- Sheng Bin, Liao Ming, 2004. China's trade flows and export potential: The gravity model approach. *World Economy*, 27(2): 4–10. (in Chinese)
- Shi Chaoping, Gu Haiying, Qin Xiangdong, 2005. A survey of the theoretical basis of gravity model used in international trade. *Nankai Economic Studies*, 2: 39–40. (in Chinese)
- Tinbergen J, 1962. *Shaping the World Economy*. New York: The Twentieth Century Fund.
- Whalley J, 1998. Why do countries seek regional trade agreements? In: Frankel J A (ed.). *The Regionalization of the World Economy*. Chicago: University of Chicago Press, 63–82.