

教育部人文社会科学研究西部和边疆地区项目

——西北回族聚居区交通运输与区域经济耦合分析及鲁棒优化研究(项目批准号: 14XJC630003)成果

Coupling Analysis and Robust Optimization for Transportation and Regional Economy
——Taking the Hui Nationality Agglomerations of Northwest China as an Example

交通运输 与区域经济耦合分析及鲁棒优化

——以西北回族聚居区为例

马昌喜 冯忠祥 / 编著



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Preface

Transportation is the material basis and prerequisite for the survival and development of human society, it is a leading, basic and affordable industry in regional economy development, and there is a close relationship between transportation and regional economy. For a long time, the study of the relationship between transportation and regional economy is a very important research topic. Transportation plays a guiding role in economic development and economic structure optimization, and economic development will also continue to put forward new requirements for the transportation system. With the acceleration of regional economic integration and the deepening of transportation infrastructure construction, whether the transportation capacity and quality in the Hui Nationality Agglomerations of Northwest China can meet the demands of regional economic development? What's the impact of the development of the regional economy on the transport system? How to optimize the allocation of transportation system resources to further promote the sustainable development of regional economy? These are the issues which the relevant departments and experts concern about.

Aiming at the relationship, there are many researches on the developed areas, however, there are few studies on the Northwest ethnic minority areas in China. Based on the theories of transportation economics, regional economics, operational research and traffic planning, the coupling relationship is respectively analyzed by qualitative and quantitative methods from the internal relations of transportation and regional economy in this book. On

this basis, the corresponding multi-objective and multi-constrained robust optimization model is established, and then the improved genetic algorithm is used to calculate the robust Pareto optimal solution of the traffic network layout scheme. Combining with the typical Hui Nationality Agglomerations in Northwest China, the case study is carried out, and the strategies and specific measures of coordinated development are put forward. The research results may enrich and improve the transportation theory and regional economic development theory, and provide a reference for the western traffic network extension planning and construction as well as the development and management of ethnic areas.

In the process of writing, the book references a great deal of literatures. We would like to express our high respect and heartfelt thanks to the authors of the literature. Although we have already made a careful proofreading, but there may be some leaked literatures, we will express our sincere apologies to these authors. Due to the limited level of the author, there are inevitably omissions in the book, we sincerely request the readers to criticize and correct.

For this book, many thanks go to my students, Xiong Ruiqi, Tao Lang, Guo Min, Jia Zhiyan, Liu Pengfei, Yang Dong, Yang Xueyan and Liu liqiao, for their proofreading support.

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Changxi Ma

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Jan. 20, 2018

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Chapter 1 Overview

1.1 Introduction

The Hui nationality is the most widely distributed among the minorities in china. The sixth national census statistics shows that the population of the Hui nationality is second only to the Zhuang nationality among the 55 national minorities, major population of which is in the northwest area of China, such as Ningxia, Gansu, Qinghai and Xinjiang. These places have unique natural landscape and cultural environment, which leading to great development potential, market capacity and development prospects. However, the constrains of various factors such as natural, economic and historical development etc, which caused that the productivity is relatively backward and the resource development and the ability of the transportation is relatively weak, and they also face some difficulties and obstacles in their own economic development and social progress. Therefore, it is an important research topic that how to accelerate the economic development and social progress of the Hui Nationality Agglomerations of Northwest China and to achieve the goal of building a well-off society in an all-round way.

For a long time, it is a great important research topic that the study of the relationship between transportation and regional economy^[1]. Transportation plays a guiding role in economic development and economic structure optimization, and economic

development will continue to make new demands on the transportation system^[2]. With the acceleration of regional economic integration and the deepening of transportation infrastructure construction, whether the transportation capacity and quality in the Hui Nationality Agglomerations of Northwest China can meet the needs of regional economic development? What's the impact of the development of the regional economy on the transport system? How to optimize the allocation of transportation system resources to further promote the sustainable development of regional economy? These are the issues which the relevant departments and experts concern about.

Since the reform and opening up, China's economic policies have been constantly relaxed, and the economy has entered a state of rapid development, each region is taking the opportunity to take full advantage of the policy to actively develop the economy. However, because of the different natural resources, geographical advantages and development degree, the level of the economic development in the eastern region is higher than that in the western region. Therefore, it is an important prerequisite for regional economic research to study the economic development in different areas through the sub-region^[3-4].

With the development of socialized production, transportation has become the basic industry of the national economy, and which degree of development is one of the criteria that measuring the modernization degree of a country or region. From the perspective of regional economy, the transportation system is one of the most important components of the regional economic system. At the same time, it is not only the basic condition of the regional industrial development, the support system of the social and economic development and the main constituent of the regional investment

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environment, but also the main way for regional economic systems to communicate with the outside. It is precisely that the impact of the transportation on the regional economic development is huge, and which occupies an important position, the coordinated development of the two is bound to provide good support for economic development, and bringing huge social and economic benefits. However, it is not harmonious between the development of the transportation and the level of the regional economic development. On the one hand, the imperfect transportation situation limits the development of regional economy, the products of the industries in the region can't be transported quickly and safely to other areas, thus it reduces the competitiveness of the industries in the region; on the other hand, the transportation industry is a capital-intensive industries, and the infrastructure investment is relatively large, and its development scale and level are subject to the regional economic development level, the backwardness of the regional economic development may hinder the development of transportation industry in a certain extent, if beyond a certain level of economic and scale, which not only caused the idle transport resources, but also take up a lot of money, which is contrary to the principle of optimal allocation of resources [5-6].

There is no balanced development of traffic and economy, the regional growth will be flawed. In the view of the important role of transportation in regional economic development and the development status of transportation in the Hui Nationality Agglomerations of Northwest China, it is necessary to straighten out the relationship between transportation and regional economic development. By correctly understanding the relationship between the two, it is not only provides for the coordinated development of the

two, but also provides some references for the development of the other western regions.

For promoting the healthy and sustainable development of the Hui Nationality Agglomerations of Northwest China, there is a need for further research the interaction, coupling relationship and optimal allocation of transportation and regional economy in the region.

Transportation is an important prerequisite for the development of regional economic. Region development and other industries development depend on transportation. Many regional economic development directly affects the size of fixed asset investment and the transportation demand. At present, China's research on the relationship between the transportation and economic is still relatively backward, most of them focus on macro policy level of development strategy, lack of targeted empirical research. On the whole, there are more researches focus on the eastern developed areas, the study of the northwest minority areas with a special geographical location and natural environment is lack of concern. Based on transport economics, regional economics, operations research and traffic planning theory, this book presents the coupling relationship of transportation and regional economy by using the method of qualitative analysis and quantitative research. Moreover, the multi-objective and multi-constrained robust optimization model is established. Then the advanced intelligent algorithm is used to calculate the robust Pareto optimal solutions of the transportation network layout. Taking the Hui Nationality Agglomerations of Northwest China as an example, the book put forward the coordinated development and specific measures of the development strategy. The research results are helpful to enrich and perfect the transportation theory and of regional economic theory.

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In addition, China is a multi-ethnic country, research on the feasible countermeasures of transportation and economic problems has important historical significance and profound realistic significance, which can help build a well-off society and speed up the economic development in minority areas. Therefore, this research has not only theoretical significance, but also practical application, can help measure and master the transportation system and regional economy development status of the Hui Nationality Agglomerations in Northwest China, provide a reference for the extension of transportation network.

1.2 Literature review

There is a close relationship between transportation and regional economy. Many scholars have made a deep research on this relationship from different levels and angles. Adam ^[7] is the founder of modern economics, he clearly discussed the transportation plays an important role in the economic development of the region in the book of THE WEALTH OF NATION. Transportation is the most basic conditions for the development of modern economy, and the convenience and economic exchange depends on the transportation.

John ^[8] believed that the most favorable conditions for the production of sea was the excellent harbor and large rivers, which can save transportation costs. Transportation costs will affect the international exchange of goods.

Lester ^[9] took the transportation network as a rich source of productivity, efficiency and cost of industrial products also depends on the transport system, he pointed out that the British complete

domestic transportation infrastructure network is one of the foundation of the development of the manufacturing industry, efficient transportation system effectively promoted British productivity. At the same time, Lester also believed that the industrial aroused railway, industrial development is an urgent demand for a good transportation system, and made the improvement of railway transportation in favorable circumstances.

Marx^[10] spent a lot of space to discuss the role of the railway and shipping of capitalist industry in his book “Das Kapital”, discussed the relationship between the transportation and the development of the capitalist economy from multiple angles and levels, that the development of transportation shortened the distance of time and space, changed the relative state of commercial space, expanded the supply and demand the field of commodity markets, and expanded the scope of capitalist commodity exchange.

Dixit and Stiglitz^[11] established a monopolistic competition in the new economic geography model, which laid the foundation of the spatial factors into the mainstream economic analysis framework, and the relationship between transportation and regional economic development achieved new development.

Krugman^[12] established an incremental model of scale returns under the imperfectly competitive market structure. They thought the manufacturing industry would have a self-sustained concentration phenomenon in an economically large area. The formation of the “core-periphery” structure depended on the economies of scale, transportation costs and the share of the manufacturing sector in the regional economy.

Durkin et al.^[13] obtained the relationship between the level of transport development and the gross national product through actual

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data analysis, analyzed the specific causes of this relationship, and believed that the development of transport can affect the industrial layout, the location of enterprises, thus affecting the regional economic development.

Venables^[14] made the new economic geography model as the basis of interregional trade issues. In the process of differentiation of high-income industrial “core” area and low-income agriculture “marginal zone”, the driving force of market scale expansion is far more than the driving force of regional integration growth. In addition, Wiener and Brewer incorporated transportation costs into Heckscher-Olin’s trade model, and found that the mode of production and trade depended not only on resource endowments and factor-level, but also on transportation costs, the location of new trade activities depended on regional transport intensity.

In the late 19 century, the neoclassical economics representative Alfred^[15] tried to explain the “increasing returns to scale” under the conditions of transport costs, and analyzed the impact of the division of labor on the general equilibrium under the full market hypothesis, recognized that the transportation costs caused by space factors such as natural geography have an impact on the geographical distribution of the industry, and looked at the impact of the development of transport on the industrial distribution. The development of railways and the means of transport to the existing market to produce a place of value, which is the industrial environment changes in the production costs of the most significant impact, a group of land owners together to build a railway, which not expected the net income of rail transport to pay the capital invested in the railway to get any huge profits, but it would greatly increase the value of their land.

Fujita and Mori^[16] revised the central hierarchy system of

Kristal through the study of the transportation expense and the difference of the economies of scale in the multi-manufacturing economy, argued that the economy system would automatically develop into a central system, and analyzed and forecasted by the construction of the basic model, the results show that there was a new city would be generated in a long and narrow economic system with the population growth in a certain period, and along a line gradually outward expansion. As with the classical location theory, these studies emphasized that the external economy brought about by economic activity would have a significant impact on location selection.

Kikeimy et al.^[17] argued that the impact of transport development on different industries is different. For enterprises with higher transportation costs, they were concentrated in areas where transport was more convenient. For some enterprises with relatively low transportation costs, the clustering effect was not so obvious.

Buurman et al.^[18] introduced geographic information technology into the study of regional economic impact of transportation. By analyzing the actual data of Thailand, it was concluded that the construction of transportation could bring about a large number of employment opportunities and raise the income level of the residents, and thus affected the layout of the industry.

Chandra et al.^[19] analyzed the important role of transport investment in detail from both the expressway and the rural road. It was concluded that built the road for the promotion of the city is greater than the village.

Peter^[20] explored the dynamic model of urban spatial structure based on the self-organization theory. He used a hypothetical population growth equation and an attraction equation of the region

and other regions to explain the demographic changes in the location and the employment evolution provided by these locations. The model has a good effect in the urban system simulation test in the United States and other countries, and has a strong ability to explain, which showed that it would be played a role in the evolution of the urban spatial structure until the location investment of the transport infrastructure exceeded a certain threshold.

Banister ^[21] analyzed the role of transport in promoting economic growth, the article defines a set of necessary conditions for economic development, in addition to economic conditions, including political conditions and institutional conditions. From the new dimension, the complexity and causality of economic growth were proposed. Finally, the promotion effect of transportation on regional economic growth was analyzed.

Oosterhaven et al. ^[22] argued that the development of transportation can bring short-term and long-term benefits to economic growth, which could promote local production in a short time, and promote the production of economic regions in a long time. Through the example data analysis, they explained that the transportation had an important influence on the level of the economic development.

Banister et al. ^[23] found three important factors which influenced the economic growth, namely, policy, investment and externalities. And then they studied the impact of transport on economic development from the regional and national aspects, it concluded that transport could not only reduce costs and the time etc. to produce direct economic benefits, but also could bring some additional benefits.

Holl ^[24] studied the impact of transportation on the choice of the

location of the enterprise, and argued that the influence of transportation on the development of different industries was different. And the greatest degree of impact on the food processing enterprises, with the development of the transportation, these enterprises would be concentrated together.

Cantos ^[25] empirically studied the relationship among transport infrastructure, spatial spillover effects and regional economic growth in Spain, and put forward some suggestions.

Fedderke ^[26] used time series data to analyze the relationship between investment in infrastructure and economic growth in South Africa, indicated that infrastructure investment could indirectly or directly affect economic growth, and this promoting affect was more obvious, but the impact of economic output on infrastructure investment of the feedback was weak.

Herranz ^[27] used the VAR model to do an empirical analysis of the impact of Spanish infrastructure investment on economic growth between 1850 and 1935, and found that the impact of infrastructure investment on economic growth was positive.

Ozbay ^[28] used a variety of econometric models to empirical analysis of the relationship between transport and economic output, the results showed that traffic investment had a strong positive impact on economic output, and traffic had a certain lag effect and spillover effect to the economic output.

Jeffrey ^[29] used the production cost function model to do an empirical to study the importance of transport infrastructure to the economic impact.

Pradhan ^[30] used the error correction model and combined with the data from 1970 to 2010 to demonstrate the impact of Indian transport infrastructure on economic growth, and found there was a