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 groningen**

**THE RAILWAY CHALLENGE IN CHINA:  
 SOLUTIONS FOR THE MISMATCH BETWEEN  
 DEMAND AND SUPPLY**

**MASTER THESIS**

**by**

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## **ABSTRACT**

Transportation is a tool enabling communication among different geographical locations. Various areas relative to geography, the economic, political, regional and historical geography and demography, are involved in transportation geography. Affecting factors for demand and supply of transportation are included in these fields derived from literature. Then a model is built to visualize the relationship of these influential factors and of demand and supply interaction in the research. Contextual factors are added to the model that can explain the causes of the mismatch between demand and supply and the current situation of railway transportation development in China. Economic losses and social tension are the main problems resulted from the mismatch between demand and supply. To mitigate the disparity, various current used or possible measures as well as the recommended approach, the construction of an analogous spoke-and-wheel network, of this thesis are analyzed and evaluated by qualitative criterion—feasibility, efficiency and rationality.

**Key words:** Transportation, Geography, Railway, Demand and Supply, China

## **Summary**

The large territory and huge population make China railway become a crucial actor in passenger transportation. Railway is the favorite vehicle for Chinese people as it is an economical, convenient and effective modal for travel. However, development of railway transportation can hardly catch up to the demand of the increasing mobility under booming economic circumstances. The mismatch between demand and supply in railway transport is a major problem and it becomes more and more serious. Even though many solutions have been tried, the mismatch is mitigated so far.

To respond to the problems above, this research is aimed at analyzing the disparity between demand and supply of passenger rail transport of China through the case of Wuhan-Changsha-Guangzhou line and the problems caused by the mismatch. It also aimed at analyzing the feasibility, efficiency and rationality of solutions for the mismatch between demand and supply of China rail transport. To achieve these goals, the influencing factors of demand and supply of transport derived from geographical literature, the contextual factors relevant to passenger rail transportation in China and their influence on the passenger rail transport, the extent of the mismatch of rail supply and demand in China, the problems raised by the mismatch, and the possible/current measures to mitigate the railway problem are analyzed.

Geographical literature of geography knowledge relative to transportation is reviewed. Models provided by Rodrigue et al. (2006) and Sydney (2000) are referred for explanation where it is necessary. These geographical knowledge and models are the theoretical basis of the conceptual model reflecting influential factors of demand and supply of transport. The conceptual model consist of affecting factors for demand which are economic, political and societal issues, and those for supply which is also impacted by technical conditions except for financial support and political decision. Furthermore, Chinese contextual factors are put in the right position of this model, constituting the sub-models of demand and supply respectively. In demand subsystem, influential factors are booming economy, income growth and foreign direct investment (economic aspects); regionalization and (sub)urbanization (political aspects); and trans-provinces mitigation, cultural tradition and population (societal). In these factors, floating population is worth to make a detail research to study its distinguishing feature because it is the main group of passengers especially in busy sections during peak periods. In supply subsystem, national investment, economic development and revenue

of railway are categorized into the financial factors; the five-year-plan which is the guideline of transportation development as well as the management and operation of the transport system tend to be regarded as political items while foreign and local technology implementation and geographical limitation are the technical elements. However, the boundaries between factors are not entirely identifiable. Some of the factors, for example urbanization attributes to two or all fields. To show the situation of China Rail, data collected from other research and authoritative publications and websites are used for the analysis of the current demand and supply. Some modification is taken through tools like GIS and Photoshop to transit the numerical data to visualized graph (map) or to highlight the important information.

The mismatch between demand and supply of China railway transport is showed by the statistics of number of passengers and rail service provision of Wuhan-Changsha-Guangzhou (-Shenzhen) sections. It can be seen from the analysis that the rail supply only meet half or one third of domestic demand. Such mismatch raise economics and social problems such as financial losses, safety, physical and psychological problems of passengers.

The measures or strategies which try to mitigate the demand-supply disparity are analyzed and evaluated. According to the analysis, the approaches of rearrangement of holiday time, staggering different flows, introducing competition, increasing the information transparency and shortening the travel duration are highly recommended to implement. Price policy and acceleration of urbanization are less promoted but can be helpful if they are deliberated and put into use with elaborated plan. The PDL network, abolishment of *hukou* system and changing the tradition approaches seem to be less rational in the Chinese background so they are suggested to be postponed or abandoned in the thesis. There is another technical measure recommended in this thesis which is called the construction of an analogous spoke-and-wheel network. It contributes to provide advanced traffic service and alleviate the travel difficulties of the majority, trying to put the transport resources into fully use in order to prevent from financial and resources waste. Of course, this scenario has some drawbacks, for example, a large number of data and information is needed for further research to test its feasibility but they are not collected or published yet, and geographical condition is a vital limitation for network construction as well. Instead of functioning solely, the recommended actions should be implemented in practice jointly to reach the goal of mitigating the mismatch of transport demand and supply.

## ***Preface***

The original idea of this research for China rail transportation arose as I was doing my bachelor program in Hunan University and had been annoyed by the difficulty of purchasing tickets to go home and overcrowded trains in spring festival. People, especially rural laborers and students studying out of hometown, suffer too much by the shortage supply of train problems. I wished that I am able to do something for it to find out a good solution for this serious situation which puts the whole society into disordered. But my dream cannot come true until I acquired infrastructure planning knowledge from the master program of RUG and learned some skills of study, searching information and analysis.

At the beginning of the writing, I felt completely confused. I focused too much on the data, model and literature searching which is very difficult because not all the data are available and there are not too much publication discussing about the demand and supply of railway transportation. I would like to thank my supervisor, Dr. Femke Niekerk, who has been guiding me in the process of my thesis writing, teaching me the skills and methods of conducting scientific research. She is scrupulous scientist making a good example for me. I also feel grateful of her help to arrange my thesis schedule in addition to her encouragement so that I did not give up, being able to finish this one year program on time. I also thank Dr. Pengjun Zhao, who is an expert of China transportation and give significant suggestion of research methods and direction.

Moreover, I have to express my highly appreciation to my friends in China who offer their help for data and Chinese publication search. I am particularly grateful to Matson Ho who gave me a great help on data search and graph modification.

After this one year program, I acquire not only the academic knowledge, but also precious friendship with my dear classmates, especially with my Indonesian friends.

Finally I need to thank my parents who offer me a chance to study in the Netherlands and have such a terrific experience.

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## **Chapter 1**

### **Introduction**

Transport as a tool overcoming geographical restraints avails interoperability of different locations. It interests scientists and planners for it is benefit for human's life but meanwhile it can constrain the development of society. Frequent problem of transport, which is more severe in developing countries, is the mismatch between demand and supply. This chapter will begin with the context of China transport problems, in which developing country the railway transport is the claimed to be the busiest in the world in number of passengers, as the research background. Main objectives of this thesis will be shown next. These objectives will be achieved by offering answers of four research questions, and there are six steps to take as the research methods. Main data sources will be also included. Finally, the structure of this thesis will be described and will be visualized by schematic framework.

#### **1.1 Background**

In the booming country with tremendous areas of land with population over 1.3 billion, China Rail system railway is responsible for carrying individuals, natural resources, industrial products and food etc. across cities and provinces, fulfilling the need of the whole country each day. Prevailing in transportation, China railway is the cheapest, safest and relatively convenient and effective mode when comparing with other vehicles in the view of Chinese people. Responding to the rapid economic development, China transportation world becomes increasing active—the system is evolving, regardless railway, highway or airway, meanwhile, the growth of stupendous demand never stops. Meanwhile, the shortage of rolling stocks is more severe. Even if the China Rail system has been trying the best to improve and extend, it can hardly meet the astonishingly huge demand of freight and passengers, and the demand is still growing in a rapid speed. In the peak periods, the rail system has been facing grand challenge in capacity, for example the spring festival which disturbs the whole country every year. The great majority of peak-period-travelers are peasant laborers or their family, who migrate temporarily from rural to urban more job opportunities and higher quality of life or travel trans-province to spend the holiday with family. This group of people is

called floating population (Ye et al. 2003), the forming of which is due to discrepancy of economy development of coastal and inland area (Liang & Lin 2008), western and eastern China, as well as the rural and urban.

The high speed of growing demand of passengers who make long-distance journey, the floating population in particular, is overwhelming the Chinese railway transport and getting it into scrape. For some sections, taking the Guangdong to Wuhan line for example, the trains are described as crowded as “no room to breathe”. This situation is certain to make numerous problems such as economic losses and social unrest. Governments and transport authorities have been figuring out measures, but problems arising from mismatch of transport capability and public need have not been solved fundamentally, by contrast, situation tend to be getting worse in the recent years.

### 1.2 Research Objectives

Two primary objectives will be achieved through this research:

- 1) To analyze the disparity between demand and supply of passenger rail transport through the case of Wuhan-Changsha-Guangzhou line and to analyze the problems caused by this disparity
- 2) To analyze feasibility, efficiency and rationality of solutions for the mismatch between demand and supply of China rail transport

### 1.3 Research Questions

Objectives of this research will be reached by answering the following questions:

- 1) What are the influencing factors of demand and supply of transport derived from geographical literature?

*Chapter 2 Theoretical Review*

- 2) What are the contextual factors relevant to passenger rail transportation in China? How do they affect the passenger rail transport?

*Chapter 3 Passenger rail transportation in China*

- 3) What is the extent of the mismatch of rail supply and demand in China referring to the example Wu-Guang rail section? What problems are raised by the mismatch?

*Chapter 4 Mismatch of Supply and Demand in China Railway Transportation*

- 4) What are the possible/current measures to mitigate the railway problem?

*Chapter 5 Mitigating the Mismatch between demand and supply*

### 1.4 Research Steps

In order to achieve the objectives of this research, five steps will be taken.

- 1) Literature Review/Theoretical Framework

It is about the theory knowledge relevant to transportation geography. It is focused on the connection and significance of different geographical areas—economic, political, regional geography and other demographic and historical factors, for transportation. Moreover, review of factors affecting transport demand and supply will be carried on as well. Specifically, the various transportation network forms are worth mentioning as a “supply” side leading to different quantities and flow of passengers.

2) Model Referring and Building

A model reflecting the relationship of the long-distance travel and the influencing factors, and the relationship of them with demand and supply will be created, by referring models of other scholars. For the China Rail case, such model will be elaborated and contextual details of China will be manifested specifically. Purpose of creating such models is not listing the factors purely but the positioning of the each element has special meaning—to reflect the physical relevant degree with other elements.

3) Main Travelling Group Research: the Floating Population

Because of its crucial role in long-distance transport, studying the characteristics of floating population contributes to the rail transport planning, including its number and geographical distribution, changing trends and features of these changes. By doing such research, the places where there is a large amount of travel needs and the busy sections will be easily distinguished.

4) Data Processing

All data used in this thesis are from secondary databases. Some of the maps are modified or edited as needed based on the original source. And the data of the distribution of floating population is processed through spatial analyst of ArcGIS 9.2 and laid out in the form of map. Some of the statistic results are from calculation of data of published literatures.

5) Case study: Wu-Guang section

Wu-Guang section will be applied as an example section to show the terrible mismatch of supply and demand. There are no statistics of the “demand” (how many people want and need to choose trains as the long-distance travel mode), thus it is assumed the number of passengers taking trains as the “demand” even though the real need must be greater (some people not able to buy train tickets have to choose another mode or give up the travel). The statistics of the passenger quantities since the beginning of new century will be shown. The situation of

disparity will come out by comparing the passenger number in the past and the capability of rail transport in non-peak and peak periods.

#### 6) Analysis

Some measures or strategies are already taken or in the progress of contemplating and preparing. Many scholars express their views and provide various solutions. Analysis will be conducted on these measures and solutions in the light of affecting factors in demand and supply models, to point out their advantages and disadvantages, and evaluate their feasibility, efficiency and rationality according to the principles provided in this thesis.

#### 1.5 Data Sources

The data sources of China transportation and population derive from secondary databases, most of which are from the national statistics bureau and Chinese published literature. Map resources are from relevant official websites.

#### 1.6 Structure of Thesis

The structure of this thesis is going by the flow which is explaining the theoretical framework, describing the case in reality, pointing out the problems, then analyzing and arguing possible solutions and suggesting a feasible scenario, finally evaluating all of these solutions. There are six chapters totally.

This first chapter introduce the research background of thesis, providing the generally information of current situation of the China railway system and transport market and presenting why this research is necessary. The followed section in chapter one will be about the research objectives expressed by research questions which will be answered in the coming chapters. The research steps, methods and data sources are also described.

Second chapter is the review of theoretical paradigm. Since the transportation geography cover a wide scope, relation among transport and geography of the economical, the political, the regional and demography and history elements will be discussed in the first section. And the knowledge will become the basis of creation of the model reflecting affecting factors and connection of demand and supply in transport. Economic, political and societal issues are concluded to be the main factors for leading the change of transportation need which are also those for influencing the transport capability. But for the supply, there is another factor, the technique level also taking vital part in transport development. The chapter will be end with the interaction of demand and supply consists of two parts: demand is acting as an influential factor for

the supply, and vice versa.

The China passenger railway transport will be displayed in chapter 3. The involving issues reflecting the situation and its causes will be explained according to the created demand-supply model. Two sub-models will be built, concerning the demand and supply subsystem in first model. The peculiar phenomena, such as the coastal economic zones (delta economic regions), *hukou* system, floating population and so on, and their characteristics are interpreted in detail. Mismatch of supply and demand will be manifested in the next chapter, using the typical example section linking Guangdong, Hunan and Hubei provinces. Economic and social problems induced by the disparity will be in the second, but not less important, section of chapter four.

Chapter five is the measures taking at present, in the progress of planning or suggested by scholars. These solutions will be analyzed and argued. The second part a railway network planning scenario will be provided. Evaluation result of all these solutions and plans will be posted as a table at end of the chapter.

The last chapter is the conclusion of the thesis, constituted by general answers of all research questions and a brief reflection of the research. The schematic structure of thesis is displayed in Figure 1.1 to show the research flow and connection of the steps.

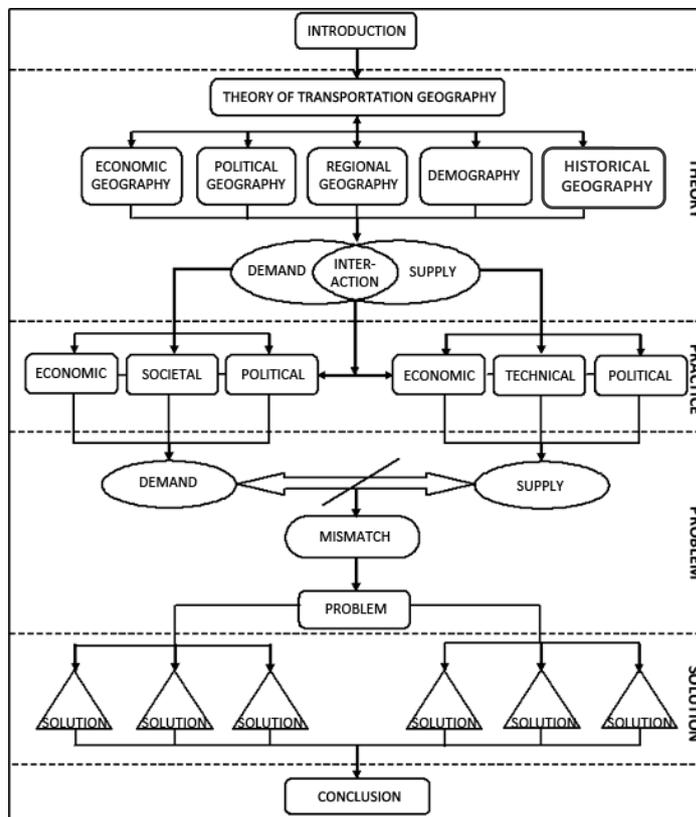


Figure 1.1 Schematic Structure of Thesis

## **Chapter 2**

### **Theoretical Review**

This chapter starts with literature review of geography theory relative to transportation. Geography theory is important for understanding and analyzing transportation because it is about density and distribution of population and resources, about civilization and objective condition, also about the past, current and trend, all of which are vital for transportation development and maintenance, changing the demand and supply of passenger and freight. Definition of transportation theory and models of affecting fields of other scientists will be explained. Following questions will be concerned: What fields are involved in transportation geography? Why are these fields related?

Second part of this chapter is about the model showing the influencing factors of *Demand* and *Supply* in rail transportation derived from geographical theory in the first section. The demand, supply and interaction of them will be described briefly. Particularly, the way supply impacting demand is not only about the availability of access and conditions or facilities, but also includes the form of the traffic network provided as determinants of flow and its concentration degree. Objective is to answer questions: What factors are relative to the change of demand and supply of rail transportation? Which factors are prior and which are less influential?

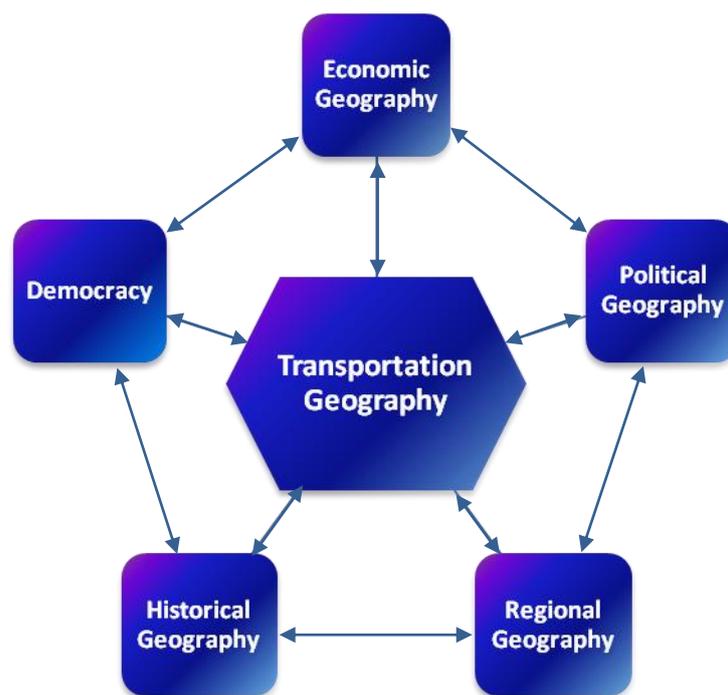
#### 2.1 Transportation Geography Theory

##### 2.1.1 Definition of Transportation Geography

Transportation emerged to meet the economic and social demand. Spatially distributed population, natural resources and new rising information media industry need infrastructure, equipment and networks to overcome time and distance restraints and achieve movement, connection and communication (Rodrigue et al, 2006). Acting as linkages, transportation realizes intercourse among different locations. Activities like commuting, tourist travelling, labor mobility, materials carrying and telecommunications rely on the efficiency of infrastructure or equipment. As it develops, people can choose the suitable mode as need according to their different requirement of speed, price and service. In a word, transportation is a necessity and is playing an increasing significant role in the daily life of human beings.

Locations are important for transportation because differences existing on the places on

the surface of earth affecting transport operation and development (Black 2003). Characteristics varying in locations are economic activities, historical background, size of population, natural resources distribution (for freightage), environmental aspects and other modern tendency such as regionalization/globalization and urbanization (Holve 1998). For each place, some of them take priority while the others have minimal impacts or do not affect the local transport. In this thesis, fields of economic geography, population geography, regional geography, political geography and historical geography will be discussed as affecting factors for passenger transport. All of these fields of geography are interrelated to each other (Figure 2.1). Transport geography, in the heart position of the relationship web has dual-identities: on one hand, it is affected by other fields; on the other hand, it reacts on fields of economic development, policy decision and regionalization. Environmental geography and natural resources geography included in the literature of Rodrigue et al. (2006) are not showed in Figure 2.1 because they are less impacting to demand and supply of passenger transport.



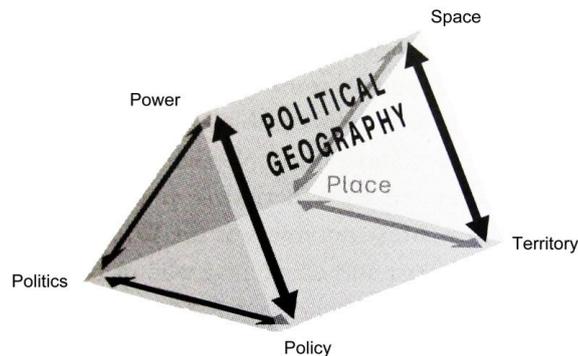
**Figure 2.1** Relative Fields of Transport Geography (Source: Rodrigue et al. 2006)

### 2.1.2 Economic Geography

Economic geography is *about* location of production, consumption and distribution of services (Hanink 1997). Whenever production/distribution and consumption are discrepant, economic flow of people, goods and information emerges. For example,

agriculture products such as vegetables, fruits, flowers or milk can fulfill demands of local people in addition to people living in other cities, regions and they can even be consigned to countries all over the world by air. “Enhanced mobility is an attribute of an increasing globalization of the world space economy” (Holye & Knowles, 1998) and it is supported by infrastructure and equipment, which is described as transportation. No matter what area related to economics--trade, commodity, labor migration or tourism, transportation has been underpinning the proceeding of economic activities. What’s more, transport itself is a component of economics as an infrastructure industry. Supplying of transport, including speed/efficiency, frequency and quality of service and amount of length (road and rail) and expansion, has become a significant assessment criterion of economic growth. Where accessibility is not available or not in good condition, there must be an impeded progress of development since freightage and passengers carrying will be more time and cost consuming, which mean there will be less labor and material resources. In the western China, for instance, lacking transportation routes is one of the causes that some places are less urbanized and economy there is less developed. Therefore, geographical distribution of transportation links closely to development potentials.

Meanwhile, economics is an attraction to population resulting to increasing movements. Technicians, professionals and manual workers are attracted to places where growth of economics is taking place, with more employment opportunities by new factories and companies establishing. Example can be seen in 18<sup>th</sup> century, when international migration occurred due to spreading of international and continental transport infrastructure (Rodrigue et al. 2006). Growing demand calls for enhanced system in terms of alternatives of modes, safety, speed, frequency and other aspects in services quality. Transport web can also be changed by economic specialization (Taaffe et al 1996), in form of transport direction—routes radiating from certain centre(s), and growth of carrying distance. Similarly, formation of regional economic circles also causes modification of flows of people and freight so as to induce evolution in transport system. As mention above, transportation arises and changes by promotion of economics.



**Figure 2.2** Political geography<sup>1</sup> (Source: Sydney 2000)

### 2.1.3 Political Geography

There are many opinions on definition of political geography, the one defined by Sydney in 2000 as “a cluster of work within the social sciences” is adopted to explain its connection with transportation in this article (Figure 2.2). Power is the ability of decision making—it is the tool of application of politics. For transportation, power determines “YES” or “NO” issues—whether to invest on transportation systems, expand existing routes, or improve facilities. And policy is concerned with the “how” and “what”—how much money will be spent; in which route will the new constructed roads/tracks go (land use issues); which facilities will be improved; what strategies will be taken for solving current problems, etc. Politics is the whole process of implementation of these set policies through power in a macro, meso and micro level which is on the other triangle of space, territory and place. Power, policy and politics vary in countries, provinces/regions and cities. Different style of administrations and decision making leads to diversity in places, so does the society forms. One of the typical examples is privatization of transport. In the case of British Rail, it is operated by nearly 30 companies (Black 2003) while a majority of railways in China are still state-run today. To be noticed, the territory has remarkable meaning for defining population migration as well as regionalization/globalization.

According to the layer concept of Ike (2009), policy as the forth layer above the other

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1. In front side of triangular pyramid, power is the backstop maintaining the other two elements as a tool to achieve the outcomes (policy) through political process. In another triangle side, space acts as important as power does in the front triangle. Points consist of space and territory is the formal horizon of space. Political geography is concerning the interaction of these six entities (power, policy, politics, place, space, territory) through for instance spatially different political decision and implementation. (Sydney 2000)

three (ground, infrastructure and occupancy layer) affects notably transportation geography and also on economic geography and environmental geography.

#### 2.1.4 Demography

There are two essential aspects related to transportation in population. The first is the density of population. Generally, world population is tend to grow continually even the speed of growth has been slowed down (Haggett 2001). The increase of population is one of the main reasons for surging demand of transport, especially for railway system in developing countries like China and India. The second aspect is about how people are distributed. The greater population is concentrated, shorter travel distance is and the less inter-city transportation is used. Thus “compact city” is a popular measure for applying to decrease usage of motor vehicles that can be taken place by walking and cycling. Additionally, “The different rates of growth from region to region around the world are leading to a drastic redistribution of the world’s population” (Hanink 1997). This social phenomenon of movement is called migration.

Migration is one of those important concepts in population science. In 1990, Jones remarked migration as “...a spatial reallocation of human resources, is of central interest to the spatially orientated discipline of geography, particularly with the modern emphasis in human geography on spatial processed and spatial interaction.”

According to Jones (1990), there are two dimensions: temporal and spatial. The significance for transport study of each category of population mobility (Duncan 1959) is as followed (Table 2.1).

	Recurrent	Non-recurrent
Local	a) Intra-city mobility	c) Inter-city mobility
Non-local	b) Inter-city mobility	d) Inter-city & Intra-city mobility

**Table 2.1** Category of Population Mobility (Source: Jones 1990)

a) For local residents, commuting is the main mobility in their daily life. Even the number of commuter is quite large and there must be peak time-- this may bring traffic problem such as congestion and shortage of bus/underway, this period is not long-lasting and it occurs at a set time every day. Thus their movement is regular that the situation is predictable.

b) In most cases, this happen on the non-local commuters. The travel distance will be longer. And they require vehicle like trains, long-distance bus or individual mobiles. This kind of population becomes an affecting factor of the local traffic after they reach

the city. But, again, their impacts are anticipated and controllable for the regularity of their shifting.

c) This is considered as inter-city mobility because for local people, non-recurrent travelling reasons can be business, entertainment, tourism, visiting, education (for local students study in another city; this can also be included in category b)) and other unusual situations. The emigration is also classed in this group (Jones 1990). This kind of movement is less predictable with more dynamics.

d) The last but not least category is the nonnative's infrequent mobility. Unlike Jones, temporal workers are put in the fourth group instead of the second in this paper. Here temporal workers are those who do not have stable jobs and fixed accommodation inside the city, which is considered as floating labor in Chapter 3. Their moving is unpredictable, being a most influential factor in transportation. On the contrary, the immigrants' movement which does not occur recurrently is less dynamic than the temporal workers for they become a part of local residents with fixed residence.

Learning the mobility of population, learning its temporal and spatial changing regularity is conducive to transportation study. Moreover, trend of population of growth and demographic structure are also interesting and significant for transportation planner.

### 2.1.5 Regional Geography

Regional geography is about the structure of a country or the whole world in term of political, social and economic perspectives. The main fields connected with transportation geography are the trend of industrial specialization, regionalization and globalization.

Regions were indistinct until industrial revolution introduced and strengthened the meaning of working-class (Claval 1998). Industrial specialization, which is also called agglomeration economics (Haggett 2001), becomes popular because it helps to cut down the cost of production. The higher level of manufacturing is concentrated, the longer travelling distance of workers will be.

Distinguish from industrial specialization, (economic) regionalization is personally identified that national or foreign investment gives priority to certain area for economic development. The Pearl River Delta and Yangtze River Delta in China are good examples for they are attracting thousands of rural laborers away from their home.

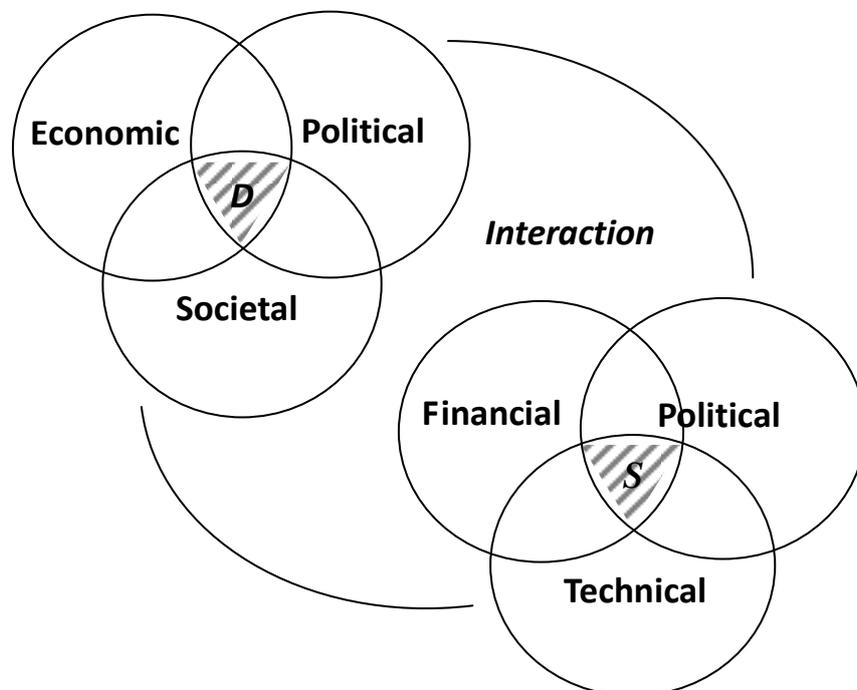
Globalization is "the process by which events, activities, and decisions in one part of the world can have significant consequences for communities in distant parts of the globe" (Haggett 2001). It stimulates frequent contact of people in the form of

obfuscating the geographical boundaries among countries so that construction of trans-national routes can be possible and well-developed.

### 2.1.6 Historical Geography

In historical science, impacting factors for transportation can be settlement culture, colonialism, isolation and various kinds of revolution (Holve 1998). For instance, during the northeastern China was occupied in the invasion of Japan, railway in Manchuria was greatly expanded by Japanese (Li et al. 2006). Culture elements are always about local traditional activities causing large scale of domestic mobility.

### 2.2 Influencing Factors for Demand and Supply



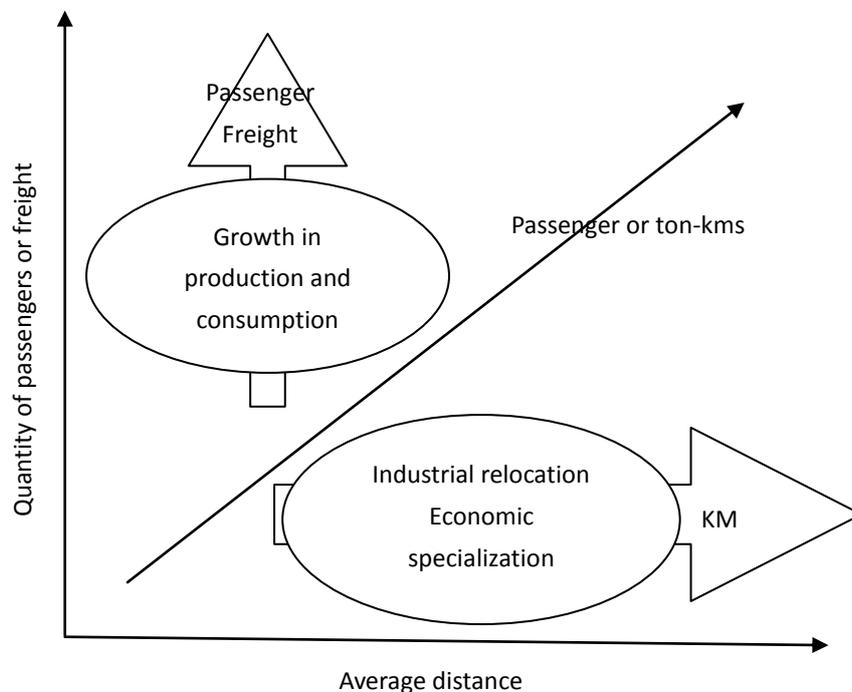
**Figure 2.3** Demand and Supply Model in Rail Transportation

Synthesizing and extending theoretical paradigm above, a new model is built, showing the influencing factors of demand and supply of transportation, especially for long-distance travel (Figure 2.3). This model consists of three parts: first is the influencing elements for the *Demand* of rail transportation, explained in economic, political and social aspects respectively; the *Supply* is elaborated next, similarly in term of financial and political factors, but it tends to be advanced by technical supports; finally, for interaction of Demand and Supply, the last part is supposed to be the intrinsic relationship of them. Demand and Supply located in the intersection (dashed areas) of all fields applies that elements can function separately, in addition, change of

demand and supply is also a result of their coactions. The margins between elements are ambiguous so some of the cases are possibly considered, for example, both in the economic and political aspect at the same time. Unshown fields such as regional geography and history are included in the economical/political and social respectively.

### 2.2.1 Demand

Economic factor is understood to dominate in the *Demand* subsystem. Rodrigue (2006) remarked two trends of mounting in transportation demand which are concomitant instead of separated (Figure 2.4, *See Box 2.1*): a) Quantity of passengers and freight is increasing as a consequence of population and income growth. b) Carrying distance becomes longer which means it is more time and resource consuming. Looking at these two trends, the growth of production and consumption, income increase, industrial relocation, economic specialization/regionalization and other tendencies which are not mentioned like globalization are relative to economic issues. Residential migration tends to be in the social group, which are also caused by the evolution of economics. Population growth and culture traditions involved the human phenomena are counted into the social factors as well. (Sub)urbanization is the result of economics development and social trends for some countries, but for the other countries, it might be the political strategy.



**Figur2.4** Growth Factors in Transport Demand (Source: Rodrigue et al. 2006)

### 2.2.2 Supply

Similarly, economic factor is also imperative in the second section of the model in that supply of the rail transportation, comprehending carrying capacity, length of tracks, distribution, speed and quality of service, etc. require financial provision to construct, maintain, and improve, which also need technical support. Political factor here expresses the policy decision or plan for rail transportation development and the freedom of rail transportation market—is the rail transportation owned and operated by authorities completely?

### 2.2.3 Demand and Supply Interaction

Demand and Supply are the influencing factors of each other. And main linkage between Supply and Demand should be the travel cost which is represent in ticket price: high transport expenditure leads to low demand, vice versa (Rodrigue et al. 2006). There is no absolute linear or stable changing relation between supply and demand, but how many people will choose railway as their long-distance travel vehicle is highly dependent on what kind of product railway system can provide. Not only the reasonable ticket price, factors of running speed of the train, safety, frequency and service such as working efficiency, customer treatment, travelling comfort and convenience are also the criteria of election of transportation mode (whether stations are far away from living place, whether there are enough direct trains)(Liu 1999 ). And the form of traffic network is a determinant of convenience of flow and concentration of passengers (*See* Box 2.2).

Transportation was born to meet the demand of people. The improvement of speed, increase of frequency and expansion of distribution are conducted to match the need of public. In other words, *Demand* is the motivation of *Supply*. However, this does not mean that “the more the better”. Actually, potential losses relevant to transport mentioned above can be those depending on access of traffic as well as those caused by redundant resources. Unstorability of transportation determines the surplus seats become a waste as long as they are not occupied. And when the provided resources are unaffordable for passenger, although the resources are abundant, they must cause financial losses. Therefore, the supply of transport is ought to be planned cautiously according to the market demand.

### 2.3 Concluding Remarks

As variable characteristics of locations are very important for transportation planning and management, this chapter explain the transportation geography theory involving

several fields such as demography, policy, history and regional geography, each of which influencing transportation in different degrees. Fields like environmental geography and natural resource distribution are not mentioned because they are more related to the sustainable development and freight transportation which are not the concerning issues in rail demand and supply view in this thesis.

Economics and policy, as are illustrated above, are the common factors both for demand and supply in rail transportation. Meanwhile, social trends lead to changes of the needs for rail transportation and transportation advancing require for technical supports. Demand and Supply, in the model, are located in the intersection of all elements. That is to say, they are the comprehensive consequence of various elements instead of sole impacts. In addition, the integrated subsystems of demand and supply keep affecting each other, being predominant part, especially in term of transport fares

***Box 2.1 Explanation of Growth factors in transportation demand (Figure 2.4)*** (Rodrigue et al. 2006)

*Quantity of passengers and freight*

Growth in number of people must raise human mobility. Development trends today of consumption are that even general transport demand is ascending rapidly, the rate of public transportation facility is slow down while the individual ones, particularly cars, are used more often than before, breeding more problems such as serious congestion during rush hours and environmental deterioration. Tourism development concomitant with income growth also pushes travel demand increasing.

*Average distance*

1) Large number of human or natural resource will be transported when business or industrial area moving for environmental or political reasons. The movement of human is not involved moving from one working place to another but the change of commuting from home to new working place—that means flow direction is modified, probably raising the travel distance for industrial area is tend to move from urban place to regions far from residence in order to reduce adverse impact to inhabitants. And typical geographical transferring example is Foreign Directive Investment (FDI) diverted from Pearl River Delta to Yangtze River Delta in China (He 2005).

2) How does economical specialization impact on carrying distance is that: human and natural resource distribution are dispersive rather than concentrated. Once specific industrial area forms, labor from far or near will go for jobs. In this way, their demand for transportation increases.

3) (Sub)Urbanization is closed related to population density and economic development. Rural dwellers are encouraged to immigrate to (sub)urban area by the temptation of job opportunities as well as better quality of life and education. Dwellers movement shift from intra-place to inter-place (Table1), extending the haul distance.

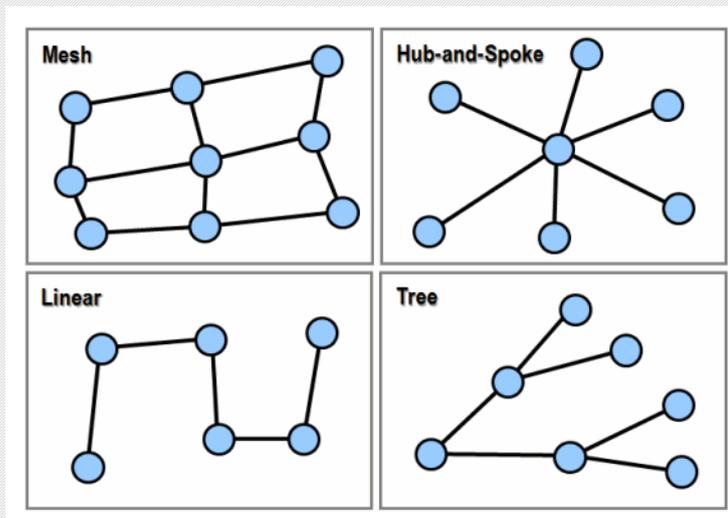
and provided network structure.

Hence when figuring out measures for the mismatch between demand and supply problem, contemplating regularity of demand growth and its connection with provision of railway is of great importance. All the theory and models in this chapter are the basis for analyzing the practical case, China rail long-distance passenger transportation in the coming chapters.

**Box 2.2 Transport Network Types and Its Influence to Demand**

(Rodrigue et al. 2006, & <http://people.hofstra.edu/geotrans/index.html>, 2010/08/24 )

Rodrigue et al. conclude four types of network topology (Figure 2.5). Looking at the rail network on the earth, railway in Germany is tend to be a mesh network as each city is linked to contiguous cities forming a grid structure. Typical example of hub-and-spoke network can be easily found in France and U.K., where Paris/London is centralizing and distributing passengers and commodities as a core. The main lines of Japan network, however, retrained by its territorial conditions, appear to be a linear type. In Australia, the stations in metropolises Canberra, Sydney, Melbourne and Brisbane are converging from other nodes (Map I). However, in practice, railways are usually mixed network. For example Paris is the central of transport system, but cities of France are well connected to each other in the way of mesh network.

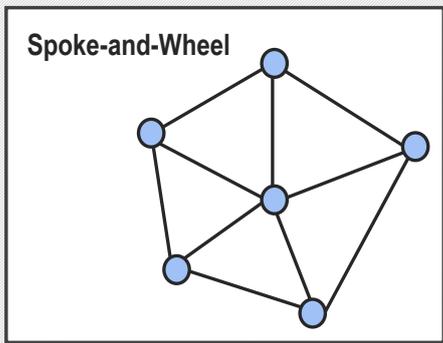
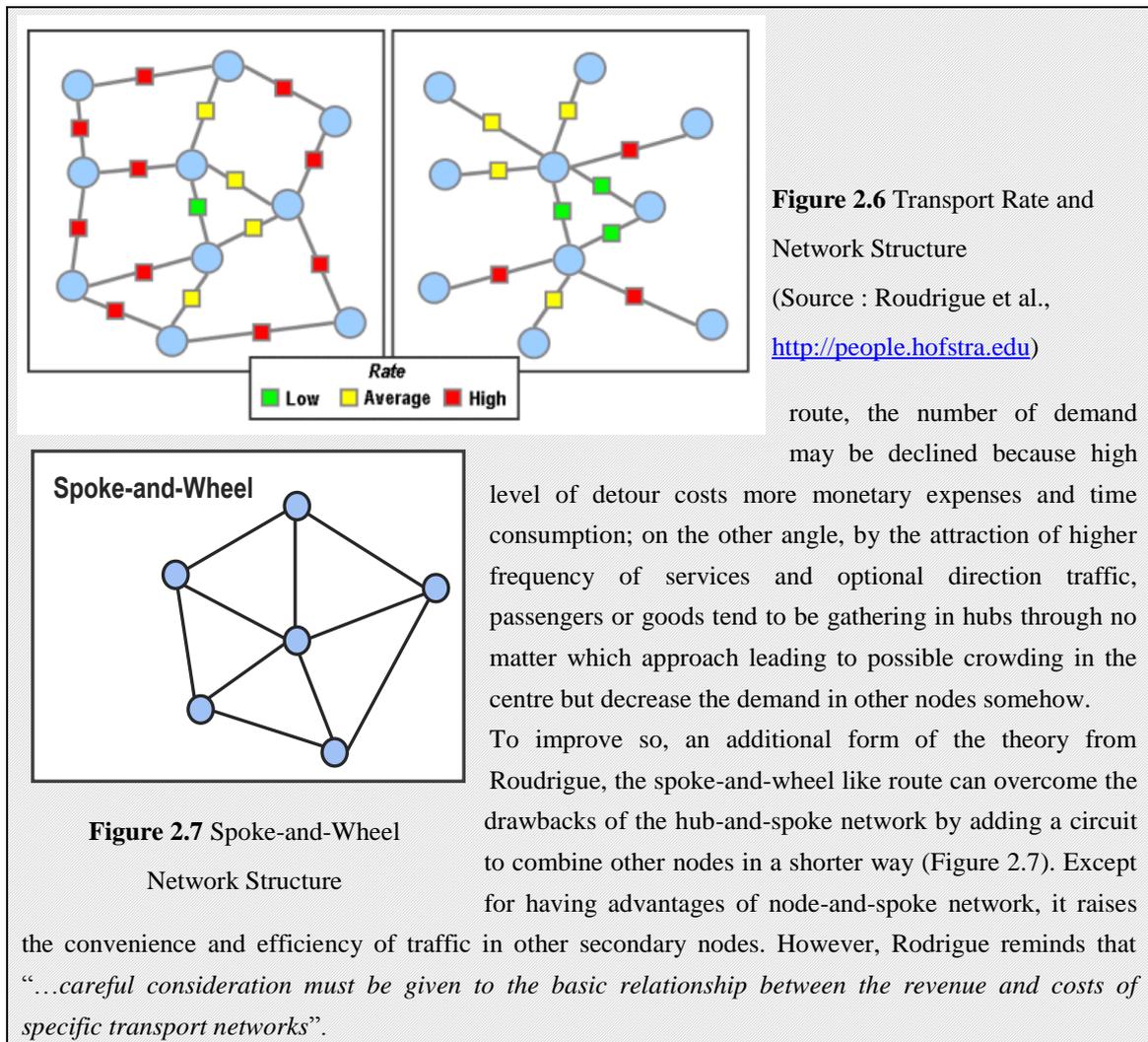


**Figure 2.5** Type of Network Topology

(Source: Roudrigue et al., <http://people.hofstra.edu>)

Among these types, hub-and-spoke is popular in recent years as a strongly centripetal structure, functioning consolidation, transition and distribution. Compared with the centrifugal network, this form shortens the total length of constructed network, raises the efficiency of transport and cut down the transport costs (Figure 2.6). But meanwhile it has obvious shortcomings: hubs require more facilities to offer the increased frequency of services and higher concentration of flow denotes higher possibility of disruption and delay. Noticeably, such connection results in lack of direct linkage of contiguous nodes.

Here is the way how transport network form affects the flow of passengers or freight: for diffused network, there is a point-to-point route to take so that the traffics are spread over on the linkages and nodes while flows are converging into the centre with consequence of congestion or delay in a concentrated structure, driving customers reconsider their choice of transport modes; lacking of direct



## **Chapter 3**

### **Passenger Rail Transportation in China**

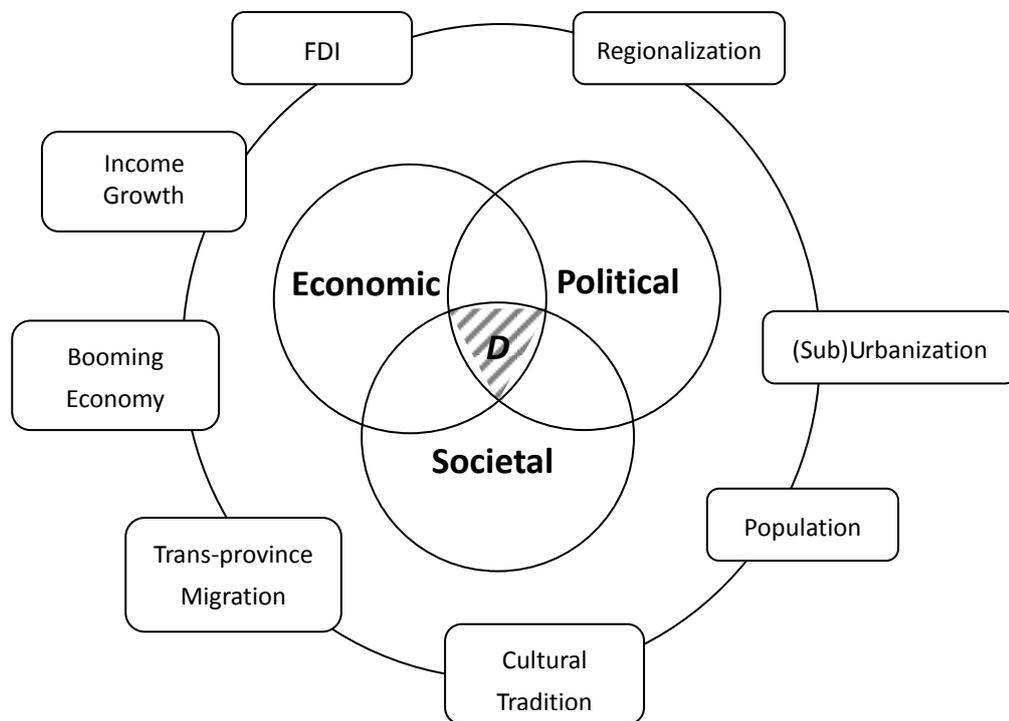
Understanding about the relative fields of transport geography and the factors of which involving the supply, demand and interaction in between, theoretical knowledge can put into use of practical case, the mismatch of supply and demand in rail transportation. Mismatch should be constituted of supply exceeding demand and shortage of supply. For the China Railway case, the main problem is severe short supply in peak periods and for some segments, it even occurs in non-peak periods. Thus it is interesting to study the determinants of such sharply increasing demand and the current condition of supply of railway system.

In this Chapter, the China situation and process of rail transportation development will be discussed according to the Demand-Supply model in Chapter 2. Statistic evidence and statements from scientists are applied to show the connection of variable phenomena, for example the discrepancy of coastal and inland economy and urbanization etc., with transportation development. Moreover, floating population as the particular phenomenon of China is necessary to elaborated in cause, distribution and feature for this group of people is the majority of railway passengers because it takes a large proportion in the rail transportation users and set difficult questions to the China transportation authority during peak period. The answer of the following research questions will be served: What are the issues/situations involving to the passenger railway transportation in China? What is the trend of these issues? How do they impact passenger rail transportation?

#### **3.1 Demand Subsystem**

Three trends of transportation demand growth in China are: the number of passengers is growing—domestic mobility is increasing regardless of traffic of inter-city or intra-city; the frequency of flow is accelerating—traffic flows have to be speeded up to save time and space for enormous demand; and the scale of demand is expanding as needs of railway for trans-provinces travel are ascending faster than that for urban travel. As essential causes of these trends, impacting factors in each aspect are displayed in Figure 3.1. The positioning of them on the graph represent of their relation to the adjacent element. For example, the forming of economical regions is the synthesis result of

economics evolution and political decision.



**Figure 3.1** Demand Subsystem, impacting factors of China Rail transportation

### 3.1.1 Economic Factors

Since economic development was put on the primacy at the first time China open to outside world, all work has been proceeding from economic in this one-party-dominated country. Unexceptionally, for rail transportation as infrastructure closely relating to people's livelihood, economic development is of importance—booming economy, FDI and income growth has been changing the demand situation in the recent ten years.

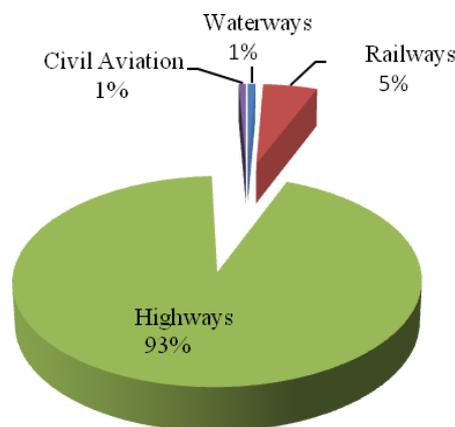
#### 3.1.1.1 Economic Development Speed

Economic evolution must motivate increasing consumption and production requiring more mobility of goods and passengers. When the economic crises came in 2008, there was a manifest decrease of proportion of transportation in living expenditure for households (Statistics Year book, 2009).

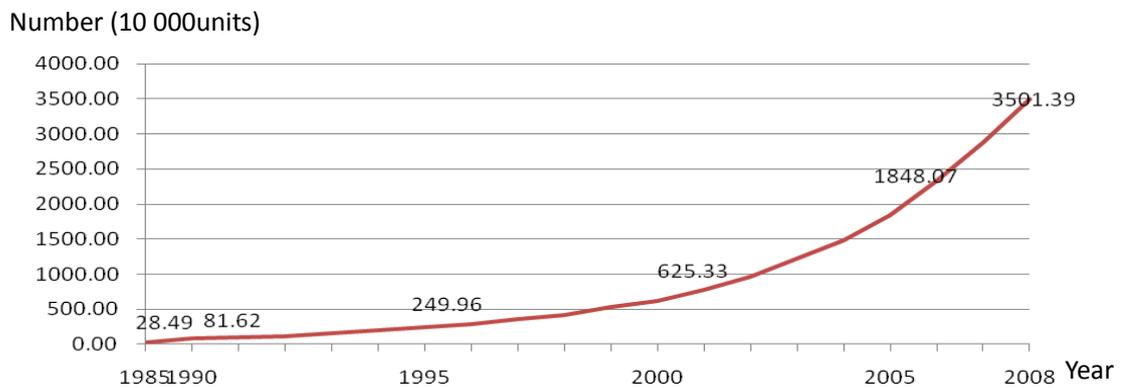
Economic development level also stimulates transportation demand in the way that: the more active market is, the more employment is created. Thus the growth economy is a great attraction for labor, particularly for the rural workers.

### 3.1.1.2 Income Growth

Higher salary allows and encourages people to travel more for interaction commercially or tourism individually, but it is not always a positive actor in rail transport demand when individuals are able to afford other more vehicles. In spite of the soaring of whole demand for transportation, the increment speed of rail transport usage falls behind comparing to the bus, flight and private car (Figure 3.2 & 3.3).



**Figure 3.2** Percentage of Carrying Passenger of Public Transportation Modes in 2008  
(Source: National Bureau of Statistics 2009)



**Figure 3.3** Possessions of Private Vehicles in China  
(Source: National Bureau of Statistics 2009)

### 3.1.1.3 FDI

The foreign direct investment can be also considered as the political factors because in 1980s, the open-door policy was set to stimulate the economic development in coastal regions by outside financial aid, taking PRD and YRD<sup>2</sup> as initiatives.

In the past 30 years, it has been driving urbanization and industrialization in these two economic regions, aggravating the uneven distribution of population. People from rural places rush to urban cities to seek jobs or higher-quality-life. As China being a member of World Trade Organization (WTO) in 2001, the globalization trend gives incentives to expansion of FDI, forming the “Great Pearl River Delta Economic Region (PRD)”. Thus larger areas participate in the agglomeration economics, with large number of people involved, requiring for more advanced capability of transportation (Tuan and Ng, 2004). Moreover, the Yangtze River Delta (YRD) is superior for foreign investment than PRD since 2001. Similar with relocation of industry (He 2005), large number of labor force migrating from PRD to YRD gradually needs rail transportation support.

### 3.1.2 Social Factors

#### 3.1.2.1 Population

The massive population of China is still growing despite of the One-Child policy<sup>3</sup>. But great number population is not the vital problem for long-distance transportation—provided that people stay in their original born places, not matter modern city or countryside, there would not be shortage in long-distance public vehicles. Labor migration is the main reason for inter-city travel, increasing the passenger number and travel distance. At the same time, it also impacts the peak period during one year for during graduation time in July, August and September a large quantity of graduates go to other cities as job-seekers usually overloading the capacity of trains. Besides, students going back to universities/schools are another major part for the September and other holidays travelling peak period.

#### 3.1.2.2 Labor Migration

Similar with globalization, trans-province movement of Chinese people are the new trend in the recent 30 years for economic reasons. The majority of people moving

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2. In Pearl River Delta economic region (PRD), there are 9 cities/counties locating in Guangdong province while in the Yangtze River Delta economic region (YRD) consists of 16 cities/counties including Shanghai, eight in Jiangsu province and the rest seven in Zhejiang province (Tuan and Ng, 2007). Besides, the Bohai Economic Rim is another coastal economic developing zone including areas such as Beijing, Tianjin, and some cities in Hubei, Liaoning, Shandong provinces surrounding the Bohai Sea. (*See* Map II)

among different provinces are the rural surplus labour force actually. And this mobility is called labour migration in China, forming the main group of floating population.

### *Floating Population*

#### 1) Definition

Admittedly, trans-regionalization/nationalization must raise the mobility of dwellers. Migration is ubiquitous all over the world. Why is the China's case abnormal? Floating population, unlike usual resident migration in other countries, is defined as

*"...those migrants who have moved across a township-level boundary for more than 6 months without changing their places of household registration in the 2000 census."*

(Zhu 2007)

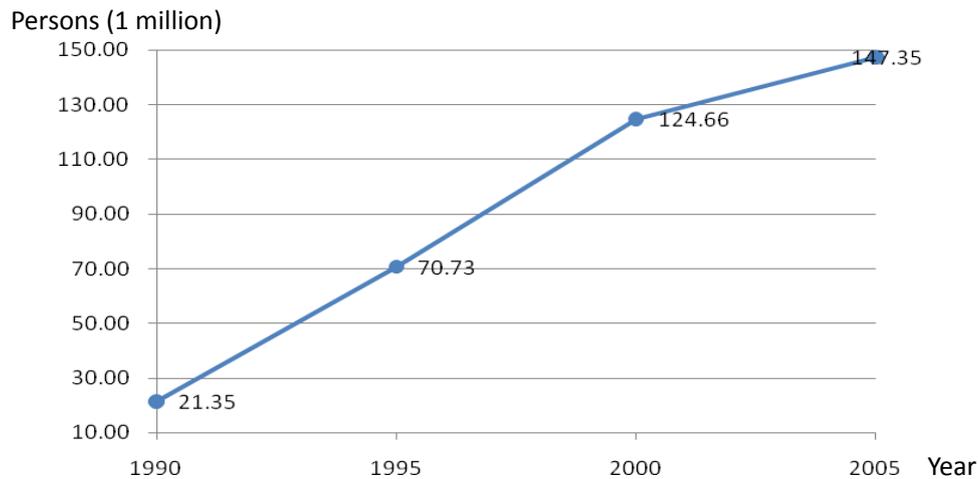
The unique *hukou*<sup>4</sup> institution in China explained above is evident to be main cause of this phenomenon. It functions as the identification card with resident area of a person, constraining the number of rural immigrants and their staying time. Main force of pulling labors to cities is the booming economics (Seeborg et al. 2000). It is vital for the whole society by involving urbanization, poverty reduction(Du 2005) and social safety etc., so that its characteristics, referring to size, growth, density and distribution, draws attention of scientists in relative areas.

#### 2) Population and Distribution

Based on the research of population of floating people is booming in an unimaginable rate ( See Figure 3.4 ) (Duan & Yang 2009). Guangdong is the most popular immigrant province for floating people accounting for 32.6% in the total amount (including inside and outside migrants) (*See* Map III). These people are mainly from Hunan (24.14%), Sichuan (16.45%), Hubei (11.46%), Jiangxi (11.18%), Guangxi (11.02%) and Henan (8.17%) (Immigrant Labor Survey Report, [www.gdftu.org.cn](http://www.gdftu.org.cn)).

3. Statistics of population number is shown in section 3.2

4. *Hukou* is a comprehensive institution for administrating rural and urban population. In the *hukou*, it is written on the place where people registered (originally it is the place where someone was born or the place his or her parents registered). The places are divided into two types: rural and urban, recorded from province, city to town or even village. People are allowed to change their *hukou* for working or education reasons. Unlike resident permit in the Netherlands, *hukou* cannot be changed only for residence moving. So people's freedom of movement from rural to urban places was limited. Thus *hukou* system is the vital approach to control unplanned rural-urban migration and over-development of urbanization.(Liu 2004)



**Figure 3.4** Total Floating Population,

(Source: Duan & Yang 2009, National Population Census in 2000)

### 3) Features

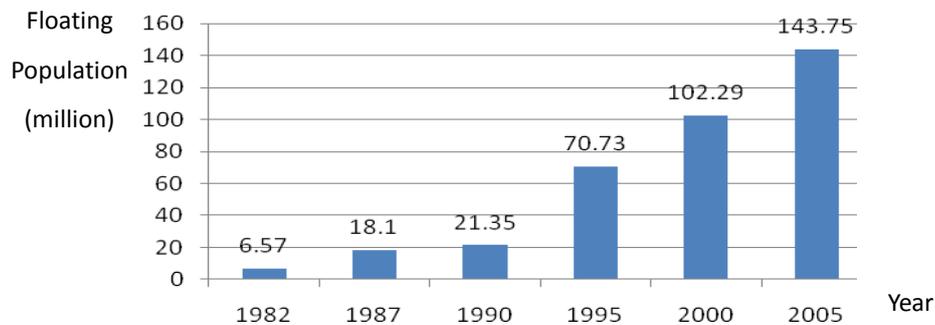
As floating persons are major users of long-distance transportation, studying this group of people are identical with passenger flow. Generally, there are three features of the mobile population and their movements (Wu & Gong 2000).

a) Uneven distribution. Movement direction is usually from less-developed area to developing or developed regions such as Pearl River Delta and Yangtze River Delta. Thus population density in western China is reducing while eastern places are over compact. Transportation is an unstorage product (Rodrigue et al. 2006), so railway resources cannot be fully used in the west while those in the east are often overburdened.

b) Chain-Reaction of trans-province labors. In the research of Wu and Gong (2000), marketers and manufactory workers amount to the most parts. And the movements of them are almost contemporaneous—they will go to visit their family before the holiday(around February) comes and return to work after their vocation; in summer holiday, a large number of graduates from schools will also go to the economic developed regions to hunt for jobs. This is called overflow of migrant laborers which has been challenging the capacity of rail transportation. To make matter worse, since normally only one or two move from the farmer family to the city, other members in the family will probably visit or migrate as a household, doubling or tripling the demand of transportation.

c) Extension of travel distance. Except for the enlarging size of floating population

(Figure 3.5), the travel distance of them becomes longer and longer in term of increase of trans-province/region migration instead of only moving between countryside to city, all of which should add pressure for rail transportation. Besides, gradual transferring of FDI and economic crises also evoked large scale relocation of labor migration.



**Figure 3.5** Number of Floating Population in China (Source: Duan 2008)

### 3.1.3 Political Factors

The whole nation is operated by government under Communist Party, thus political decision they make determine the development of any areas. And these policies, of course, are able to contribute to create more and more need of transportation and convince the public to use advancing transportation facilities on one hand, can also limit the usage in term of developing alternative vehicles. Expansion of road network and reducing price of flight are two of the strategies for Chinese government mitigate the heavy pressure on railway.

#### 3.1.3.1 Cultural Factor

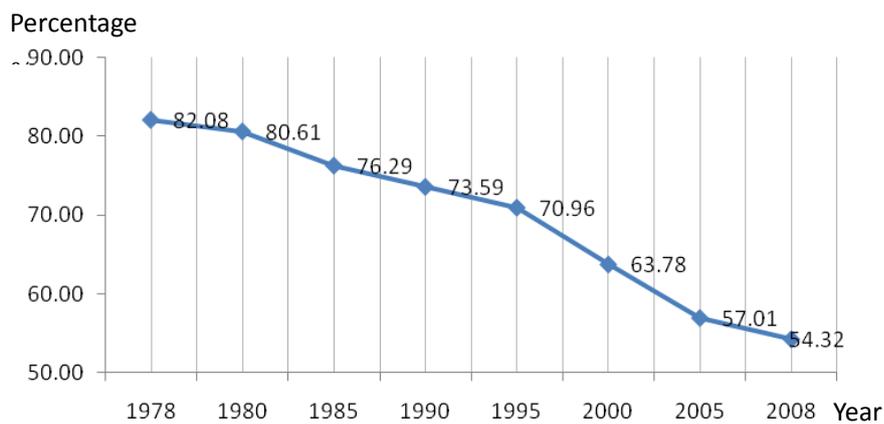
Cultural activities, such as conventional festival and national day when people have enough time to go to meet their families or take a trip, is still an important factor influencing the variation curve of passenger number in a year. Extraordinarily the most important holiday Spring Festival (the time varies in January to February every year) in China, draw attention of authorities and infrastructure planners as the principal determination to peak time for rail transport. There are two possibilities: a) flow of worker from the rural or other less developed cities scrapping in limited number of trains to go back to their home and spend the festival with their family; b) people from rural places stay in their working cities but their family travel by train to the urban for visiting. In this case, the number of travelers is double or triple. Hence, in the Spring Festival transport period, the biggest gap between demand and supply appears every year, without effective measures for mitigation so far.

### 3.1.3.2 Regionalization

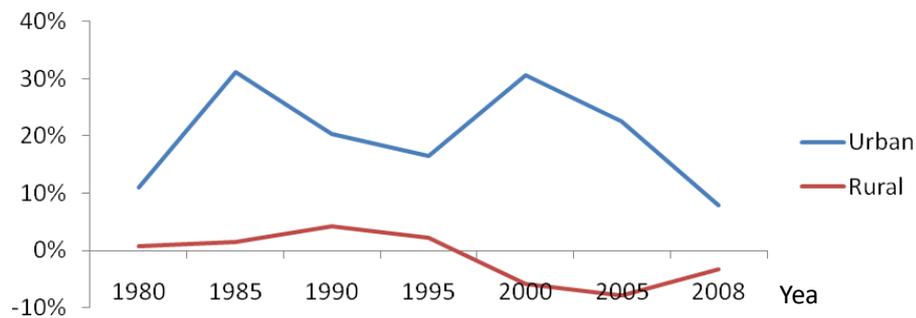
Regionalization in China is identical to the agglomeration economics, the PRD and YRD which is already discussed in last section. To be notice, it is not contrary to the trans-regional movement discussed above.

### 3.1.3.3 (Sub)urbanization

Urbanization is the integrated consequence of evolved economics, social mobility and, what is more important, the stimulation of government. It is a process of centralizing the population and increasing its density, in which way increase the demand for mobility. Chinese government focused on industrialization and strictly controlled the expansion of cities in the first three decades (Huang 2007). Rural-urban migration was impeded by the setting up of household registration (*hukou*) institutions during this time (Liu 2004). However, reform in 1978 as a milestone for China brought dramatic change in economic, social and political fields. And it was the commencement of rural-urban migration rush (Zhang & Song 2003). China experienced an industrialization and urbanization booming period in the 1980s. Figure 3.6 shows the decay of rural residence percentages from 1978 to 2008-- in other word, number of urban immigrant had been ascending rapidly, especially during 1995 to 2005. And from Figure 3.7, a negative growth of rural population was recorded since 1995.



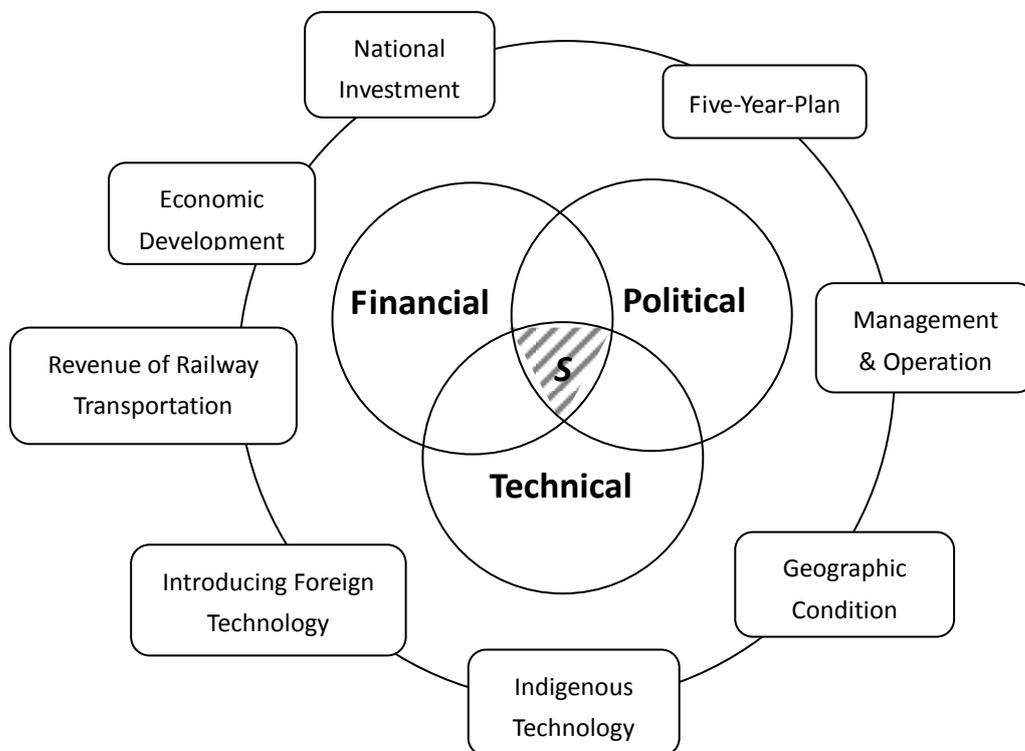
**Figure 3.6** Percentages of Rural Population of Total Population in China  
(Source: National Bureau of Statistics 2009)



**Figure 3.7** Growth Speed of Urban and Rural Population  
(Source: National Bureau of Statistics 2009)

### 3.2 Supply Subsystem

Similarly, economic and political factor are also imperative in the second section of the model *Demand and Supply in Rail Transportation* (Figure 2.3). Connection of the political factor and technical factors is that the scale and scope of development of rail transportation including the adoption of new technology, is determined by policy and national plan. Figure 3.8 indicates the sub-factors relative to financial, political and technical aspects.



**Figure 3.8** Supply Subsystem, Impacting Factors of China Rail Transportation

### 3.2.1 Economic and Railway Development

Financial support is required for construction, maintenance, and improvement of the Rail transportation. According to Bai and Qian (2010), there are 18% of the fixed asset investment in transport and postal service sector for railway while the proportion of roads is more than three times in contrast. But the investment has been growing rapidly from 2004. Till 2007, there are around 250 billion Yuan (around 43 billion Euros) for rail transportation construction.

Chinese railway industry, as Wang stated (2000) both in passenger and freight transport, evolved in about the same pace with economy. Extension of tracks is demonstrated in Table 3.1. In the new century, the achievement in rail transport is even more noticeable. Steam-power engines are completely replaced by diesel and electric locomotives. Construction of 9 passenger delicate lines was listed in the tenth “five-year-plan<sup>5</sup>” and was authorized in 2004 (Zhang 2007). At the beginning of 2010, the first PDL, Wu-Guang Line whose maximum speed is 350 km per hour, was officially open to traffic. It reduces the journey time from 14 hours to 3 hours from Wuhan to Guangzhou to finish 1068.6 kilometers distance in total.

Year	Total Population (million)	Length of Railways in Operation (1 000km)	Increase rate of length of Railways in Operation (%)	National Electrified Railways (1 000km)	Per-capita length of Railways (cm)	Increase rate of per-capita length of Railways (%)
1978	962.59	51.70	--	1.00	5.371	--
1980	987.05	53.30	3.09	1.70	5.400	0.540
1985	1058.51	55.22	3.60	4.14	5.217	-3.392
1990	1143.33	57.90	4.85	6.90	5.064	-2.927
1995	1211.21	62.39	7.75	9.70	5.151	1.716
2000	1267.43	68.70	10.12	14.86	5.420	5.231
2005	1307.56	75.44	9.81	19.40	5.769	6.437
2008	1328.02	79.69	5.63	25.01	6.000	4.006

**Table 3.1** Transportation and Population Development in China  
(Source: National Bureau of Statistics 2009)

5. Five-Year-Plan in China is the guild lines including the targets set, economic development strategies, reforming policy for next five years economic development.

However, considering the simultaneous growth of population, the development speed of railways is not admirable as expected. In the end of 2008, average length of tracks for each person was only 6 centimeter, increasing by only 11.7% compared to 5.3 centimeter in the first year of Reform (1978). Over the three decades, manifest negative growth appeared in the 1980s. In a word, unlike remarks of Wang, evolvement of rail transport construction is not matching to rapid rising of population and speed of urban sprawl, neither of the economy development.

Matching of transport and economy development is so important because of their interaction. Active economic activities is the primary incentive of transport mobility as it needs convenient traffic to back up; transport system plays a role of carrier to meet the need of travelers, meanwhile monetary consumption for mobility support the system as the revenue—the greater number of railway customers is, the more expenditure they will spend on better service (supported by higher income and increased high-income population), the more fund is collected for maintenance and improvement.

### 3.2.2 Political Stimulation

Without pushed by political measurement, rail transportation in China can hardly have leaped forward since the foundation of the new China in 1949. Being an essential part of logistics and business activity, transport development has been taken serious by the public and governments for its tremendous impact to national economics. Since 1953 Railway construction has been put into the “Five Year Plan” signifying development of railway began to be conducted systematically (Li, 2010). Then how many tracks will be built, in what route, using what kind of techniques will be decided and put on the agenda. Up to now, the whole railway system is operated and managed by Ministry of Railways and its secondary bureaus or group companies which are state-owned enterprises (Zheng & Xiang, 2009). Foreign investment for railway has increased in 2007 (Bai & Qian, 2009) compared to that in the past; however, the Chinese railway is not allowed to be carried on by companies from other countries. From the government angle, it is benefit for management and price control whereas the disadvantage is that lacking of competition is not conducive for service quality improvement.

It is worth emphasizing that, the adopted system of organization and operation is involved to skill and strategy. Hence it is classified into the Technical factor as shown in the *Supply-Subsystem* model.

### 3.2.3 Technical Achievement

By Li (2010), none railway was designed and constructed by Chinese natives entirely until 1905 when Jiangzhang railway was built. The *Switchback* of this railway applied initiatively overwhelming the rugged mountain terrain was the outstanding achievement at that time. Today, Chinese engineers are still challenged by the complex terrain and adverse geographic condition in western China during the extension of railway network. In speedup, advanced technique and planning concepts from other countries is introduced and applied in China. Examples are the passenger delicate line for the inner city transportation, and, the first Magnetically Levitated Train operated in Shanghai whose maximum speed is up to 431km per hour so that 30 kilometer journey can be finished in only 8 minutes, for intra-city connection. But no matter which technology is adopted, the indigenous one or the one introducing from foreign countries, the financial support is always indispensable. And the whole course of technical improvement strictly follows the transportation development plan.

### 3.3 Supply and Demand Interaction

From the information in the previous sections, distinct connection between Supply and Demand is already expressed. It is to be noticed that another main linkage between Supply and Demand should be the travel expenditure, in form of ticket price. Even though income of citizens has considerable grown, for majority of people in China, it is still unaffordable of expensive travel alternatives such as high speed train or flight. That is why trains with cheap and medium price are most popular for the masses. Rodrigue (2006) remarked that high transport expenditure leads to low demand, vice versa. There is no absolute linear or stable changing relation between supply and demand, but how many people choosing railway as their long-distance travelling vehicle is highly dependent on what kind of transport industrial product and service railway system being able to provide. Not only concerning the reasonable ticket price, other norms are running speed of the train, safety, frequency and service such as working efficiency, customer treatment, travelling comfort and convenience (whether stations are far away from living place, whether there are enough direct trains)(Liu 1999 ). Furthermore, the provision of transport system is inclusive of the network structure of rail routes as well, which determines concentration and distribution of flows. To overview the whole China railway map, stations overburdened in peak periods or even in short supply in non-peak periods are usually primary transitions in certain area or pivotal nodes, which are colored yellow with blue label in Figure 3.9.

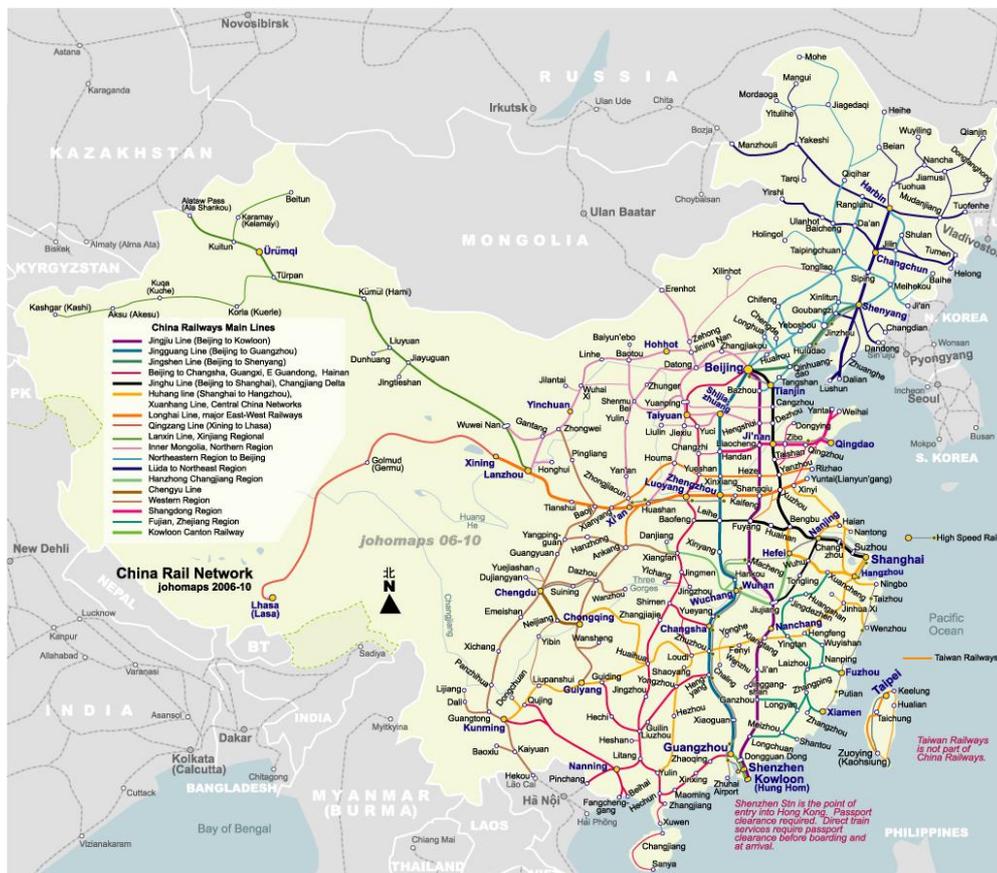


Figure 3.9 China Railway Network (Source: <http://www.johomaps.com>)

Rail transportation was born to meet the demand of people, but its supply, particularly of the busy cities in economic zones, can rarely catch the surging need of Chinese people. For railroads to extremely popular cities, such as the Wuhan-Guangdong section, in some non-peak periods during a year, trains are scanty to accommodate the huge demand of job-seeking, tourism, commercial trade and migration flows, leave alone burdens brought by floating population (spring holiday) in addition to tourists and family-visiting people (on national holiday and summer holiday) in the peak periods. Case of Wuhan to Guangzhou line in Chapter 4 will be studied to illustrate the current situation of the great mismatch between demand and supply in China rail system.

### 3.4 Concluding Remarks

To sum up, the specific economic, political and social situation and context in China help to form the rail network spreading over vast area, including the flow of passengers and the availability of infrastructure. The factors do not impact solely, by contrary, they functions jointly—some of the elements can be classified into the intersection of two

fields while some, like urbanization, involve economics, political decision and trend of society evolving. And all the fields in each subsystem also affect each other as a whole. It is evident that the development of rail transportation is, chiefly, the concomitant outcome of the urbanization and population growth. The significant affiliation of supply and demand in transportation strengthens their significance of status and change. No matter which one is superabundant comparing to the other, economics or/and social issues must arise. Furthermore, such disparity will be aggravated for it can not only impinge on the railway system but also spread to other transportation network, flight and long-distance bus. In this sense, there is high necessity of studying the extent of the mismatching of demand and supply of train provision and problems result from which in various fields.

## **Chapter 4**

### **The Mismatch between Demand and Supply of China Railway**

#### **Transportation**

In 2009, China Railways carried 1.525 billion passengers, ranking in the front of the transport world (Liu 2010). When some Chinese people are proud of this astonishing number, a question attracts attention of the public and scientists: is carrying capability of the current system able to manage such tremendous number of passengers?

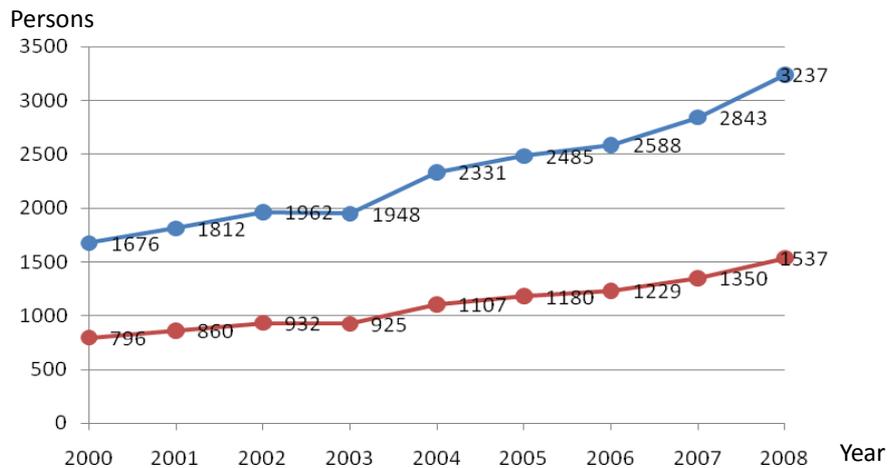
This chapter begins with the manifestation the disparity of supply and demand, mainly about the shortage of supply in this thesis, by the case of Wuhan to Guangdong section. This rail section is the linkage of the two of the biggest rural labor providing provinces, Hubei and Hunan, and the most popular labor immigrant province, Guangdong (*See* Map IV) as one of the busiest rail lines in China. As the most severe shortage must show up in the Spring Festival, data during this time will be used to illustrate the mismatch situation.

The second part is about economic and social problems created by the disparity of supply and demand, to be more exact, the exceeding of demand to supply. Economic losses including the impact caused by the exhausted migrant laborers who travel up and down in limited time of vacation, and the spreading losses produced by the unsatisfactory rail traffic. It also raises safety problem. And the spring festival, in particular, is an anxious time for travelling people. So the questions of what the mismatch is and what problems are induced by such mismatch will be answered.

#### **4.1 Demand and Supply Mismatch:**

##### *– Example of Wuhan-Changsha-Guangzhou Rail Section*

It is already mentioned in the previous chapters that, Guangdong is the biggest rural workforce-importing province in the whole country with his economic inducement. Hunan and Hubei are two of the largest labor-exporting provinces, supplying abundant labor resources but becoming a big problem for the limited circumscribed transport conditions. For this reason, trains from the major economic-developing cities in Guangdong , such as Guangzhou, Shenzhen, Dongguan, to name a few, to places where there are plenty of labor in Hunan and Hubei province, or trains going way back are,



**Figure 4.1** Daily Dispatched Passengers Number from Guangdong to Huan and Hubei  
(Source: National Bureau of Statistics 2009 & Immigrant Labour Survey Report

([www.gdftu.org.cn](http://www.gdftu.org.cn) , 2010/06/04)

most of the time during a year, fully passenger loaded or overloaded.

The number of rail passengers has been growing rapidly. Figure 4.1 shows the growth trend and statistics of the number of passenger dispatched per day from two main stations in Guangdong, Guangzhou and Shenzhen, to Hunan and Hubei province during 2000 and 2008. Average number of passengers travelling both between Guangzhou/Shenzhen to Hunan and Hubei in 2008 is twice as that in 2000. It seems that those showed statistical data is not to a shocking degree, with 3237 and 1537 to Hunan and Hubei respectively, in that each day, there are 138 trains from Guangzhou to Changsha and 180 trains to Wuhan (included 38 trains stop by Changsha station) (<http://www.tielu.org>) supposed to be able to accommodate these passengers. However, the supply seems to be sufficient or becomes excess but the fact is contrary because: first, the data is the average statistic number of passengers temporally and spatially. Situations of uneven distribution of passengers on the sections or in different time period may happen—in certain segment, trains are overcrowded but when they pass some points, they may become over 50 percent empty; probably, trains are overcrowded going forward but might seats become over-supply when they are on the return way; trains departing/arriving during daytime are popular than those at nights as long as they have a choice (because in the high peak periods, passengers do not have too many options due to the severe shortage supply). The number is also variable during different time in a year. There are two obvious peak period, one is the

job-searching season in summer and the other is days around the most important traditional festival—it is witnessed that rail transport is sufficient during non-peak time or may be surplus sometime in some sections while it is super-burdened even if lots of temporary trains are increased to meet the urgent needs. Thus this shortage of supply is periodical instead of continual. Second, some of the 138 trains to Changsha and 180 to Wuhan, for example PDL operated at the beginning of 2010, or seats/beds in each train are higher classed with higher speed or bed service, whose prices are approaching to the flights, are highly unaffordable for over 70% passengers, the rural migrant laborers or students (Xie 2008), in peak period, thus these high-priced provision cannot be considered as “supply” for these low-income but high-quantity-needed group of people. Therefore, the appearing “large” number of trains is not equal to sufficient for railway customers.

According to He (2010), in spring festival of 2009, the daily passenger flow who departed from Guangzhou rose sharply to 1.98 million, among which 478 thousand and 227 thousand are people of Hunan and Hubei (Immigrant Labour Survey Report, [www.gdftu.org.cn](http://www.gdftu.org.cn)). So only one of the two or even three taking the train on this section can have a seat during the journey over 700/1 000 km, more than 7/10 hours. The number of passengers assumed to be the Demand is the only quantity of traveler departed from the rail station every year, excluding the invisible need that people give up taking train to choose buses or airplane for the short supply in rail system or give up going to visit their family even if they are eager to because it is too difficult to get a train ticket around spring festival.

#### 4.2 Problems Caused by Demand-Supply Disparity

The mismatch between demand and supply is composed of shortage of supply, generally happening in peak periods, and oversupply in some non-peak periods. For a space dimension, more trains and tracks are needed in the eastern China than in the lagging-behind-western and middle area. Focus is always on shortage of supply in spring holiday each year, whose impact is expanding in scale and scope, economically and socially.

##### 4.2.1 Social Problems

###### *Safety*

Security problems exist in the whole process from buying ticket to taking train. Ticket halls of stations in big cities in eastern China are overcrowded around peak period. Such uncomfortable circumstance irritates people easily then trifles like jumping the

queue can cause offence. Similarly, dissension can also happen in the crowded carriage. Moreover, accidents caused by brakes failing can happen on not only the cargo-overloaded trucks but on the passenger-overloaded train as well.

*Health and Sanitation*

Almost all the rural workers are travelling across two or more than two provinces so as to visit their family. For technical limitation and unsatisfactory rail services, long-hour trips in crowded train with little breathing room and uncomfortable surroundings cause travel fatigue or boredom for passengers. Symptoms are the disorientation, general weariness and higher incidence of headaches and also oedema in legs and ankles (Reilly et al., 2009). As the satisfaction of customers for conditions and sanitation on trains reflects quality of service directly, Wei et al. (2005) carried on a sample survey of more than 2 000 people about passenger psychology and sanitation condition to analyze and evaluate the service of China Railway. A part of the results is shown in Table 4.1. It demonstrates that more than half of passengers have discomfort feelings on trains and a considerable proportion of them are unsatisfactory of the sanitation conditions. It also reflects the limitation in space: 46.23% of passengers prefer to avoid moving in the carriages. In one word, current condition of trains has negative effects in physical and

Psychological problem (%)	Percentage of Passengers %			Satisfactory to Sanitation (%)	Percentage of Passengers%		
	Yes	No	Unsure		Yes	No	Unsure
Having anxious feelings	52.31	45.23	1.45	Food	53.95	43.28	2.77
Feeling bored on the trip	79.45	20.01	0.55	Air	61.71	36.52	1.77
Taking train has adverse influences for health	58.62	39.84	1.54	Water	80.85	17.42	1.22
Worrying being inflected by disease	57.71	41.15	1.13	Public stuffs	56.13	35.66	8.21
Travel fatigue	84.07	15.06	0.86	Environment	79.04	18.92	2.04
Moving around as much as possible	52.26	46.23	1.41	First Aid	65.20	27.95	6.85

**Table 4.1** Physical/Psychological problems and Satisfaction of Sanitation of Passengers on Train based on Sample Survey of 2204 Questionnaires (Source: Wei et al. 2005)

psychological health for people and the sanitation conditions still need to be advanced.

#### *Social tension*

Supply should not be only involved the provision of seats/beds or space for passengers. The quality of service such as the efficiency of ticket purchasing, facilities in train stations and in the trains is ought to be the norms for evaluation of this system as well. One of the noticeable deficiencies of current rail system is the faulty ticket purchasing system. The public is upset by the ticket purchasing issue for three reasons. First, shortage of provision of tickets is even more serious when scalpers buy tickets and sell them for higher price. Over one third of passengers have experience of buying tickets from scalpers with twice or three times of original price (Xie 2008). This phenomenon manifests the insecurity of availability of train tickets when they are in great demand. Second, transparency and disclosure of ticket information are very low. People are not allowed to know about whether there are tickets to buy or how many tickets are left. Third, there is no online ordering system for China railway, which means customers have to go to the train station for tickets. And this queuing process may last for more than three hours in busy seasons (Jin & Ding 2009), raising discontent from the public. High difficulty of getting train tickets (so as buying long-distance bus ticket) impedes the family gathering. In the traditional China, especially in the rural places, “family” signifies much. Those who have to give up the only opportunity to home may be affected by low spirits, and this also has adverse effects on working performance.

Too much attention is drawn on the shortage supply problem so that the oversupply in non-peak time is always neglected. The unstorability of transport industry makes the over-grown of frequency, over-construction of tracks or over-expansion of railways become an economic waste (Wang et al. 2004). In the intra-city traffic, building extra lanes or new roads cannot solve the traffic congestion thoroughly, but, it may create more serious traffic jam in that more drivers are attracted to the uncongested routes (Downs 2004). The automatic self-adjustment relationship is applicable for the rail transportation, corresponding to road system—the increased supply of train during peak time pulls more people to mobile. Hence, solution for mitigate the mismatch between demand and supply is not constructing tracks and increasing frequency simply.

#### 4.2.2 Economic Losses

Rural workers take a key role in profit creating as the cardinal actors in the production process. Long distance trip may probably cause travel weariness and other symptoms. Still worse, the short spring holiday does not allow rural worker to take a long time to

recover. Then their work under travel fatigue leads to reduction of working efficiency, causing financial losses eventually.

Economic activities are rather active in the traditional festival in China. The speeding up of flow of goods and soaring business or tourist travel ask for higher accessibility of traffic. Though both travelers and goods require more transportation resources comparing with those of the past, the growing speed of passenger transportation demand is much faster than that of freight (Jin & Zhen 2000). Priority given to passenger carrying makes rail freightage be neglected when freight and passenger transports are joint operated (Rodrigue et al. 2006). The joint operation rail system<sup>6</sup> indicates that delay or exclusion may always occur in the peak period, leading business loss. And the low availability of purchasing tickets in spring vacation shrivelling the enthusiasm of travellers does not facilitate to the transport market, tourism industry development as well as the development for lagging-behind areas where people live off tourism.

#### 4.3 Concluding Remarks

Data of Wuhan-Changsha-Guangzhou rail section proves the supply scarcity in railway system during peak period. Definitely, the Wuhan-Changsha-Guangzhou line is only one amongst many busy sections in the China railway system, though the inadequate supply in other sections is not as bad as Wu-Guang section which is adequate to half or one third of demand. The passenger number is still growing in dramatic speed, making the situation deteriorated with problems of economics and society. What is worrying is that adverse effects of chaos resulted from the shortage supply might not be limited only in the relative fields but spread over the whole society. The immediate problem cannot be resolved merely by speeding up the construction-- those extra provision of trains for meeting the demand in peak period may be idle in the rest of time in a year for some areas or perhaps, the extra supply may attract more rail users create intensive supply shortage. Therefore, to meet public demand and avoid transport resources waste at the same time, although at present the prominent issue should be the shortage of

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6. Most of the China railways are still in passenger-freight-operation. The Passenger Dedicated Line was introduced in 2004 to mitigate the tension of transportation in three economic circles, to separate the freight and passenger carrying in busy sections. One of nine lines (Wu-Guang line) is already in use while the other three are in the course of construction (Map V). There will be 100 000 km tracks for PDL in China in the year of 2020. (<http://news.chineserailways.com>)

supply, consideration of planners need to be more comprehensive, taking the two

eventualities, oversupply and short supply into account. Comprehensive solution for the disparity of supply and demand in railway service is worthy of deliberation.

## **Chapter 5**

### **Mitigating Measures for the Mismatch between demand and supply**

In the demand and supply models built in Chapter 2 and 3, causes of the imbalance of demand and supply and their interrelation are displayed clearly. Naturally, to abate this phenomenon and minimize its adverse influences to society and economic markets, solution and strategies are supposed to be put forwards in accordance with the involving factors. Rail-system-improving measures proposed by some Chinese scholars are argued in this chapter in term of analyzing their feasibility, advantages and disadvantages and other possible alternatives solutions by the *Demand* and *Supply* aspects, on the basis of theoretical paradigm in previous chapters. Impediments of transportation development are also described in the first section.

Besides, theory of nodes and linkage will be applied to elaborate the recommended solution for mitigating over crowded situation of trains in this thesis. Unlike the common tendency of most transportation network development, it is suggested that China should be aimed at decentralization, of population, rail passengers as well as train stations. New tracks should not be built as double line along the original route only. Re-diffusion of passengers can be achieved by more direct linkages in secondary cities constructed. Evaluation of all measures is put in the third section, as a brief description of pros and cons and estimation of their feasibility, efficiency and rationality.

All the alternatives and suggestion mentioned in this chapter are mainly concerning on the shortage problem of rail supply. But the oversupply issue must also be taken into account in the assessment of these solutions, to avoid unnecessary resources waste as much as possible.

#### **5.1 Arguments on Measures for D-S Mismatch**

To decrease the shortage of rail transportation capability, the challenges for China Rail improvement and possible intervention are discussed from the Demand and Supply aspects according to models in Chapter 2 and 3 (Figure 2.3, 3.1 & 3.6). Some of these measures are already in use or in progress of preparation as some of them are the suggested methods not applied into practice.

### 5.1.1 Challenges and Intervention on the *Demand*

#### *Economic: Income and Transport Expenditure*

Undeniably, economic factors are the primary incitement for increase of transport demand. But at the same time, they are also the support for the improvement of the short-supply situation. From the economic angle, there are three main problems for transport users with regard to payment ability.

First, limited alternative modes are available for price reasons. There are three main transportation modes for long-distance-trip in China, Railway, Highway and Airway. Waterway is not the main and effective approach for large amount of passenger in long distance (Speece & Kawahara 1995). The train is the lowest consumption method for travelers, while the price of bus ticket is higher and airplane is considered the most expensive way. For the rail transport, there are various classes of trains or various classes of seats/beds in a train, which has been mentioned in Chapter 4. Un-affordability of this higher classed transportation service limits the choice of most of the floating people, who are low salary people or none-income group (students, rural laborers and their rural family). Thus economical alternatives for them are train and long-distance-bus.

Second, half of floating populations as major rail customers are low-income individuals, with only 600 Yuan or even less than 600 Yuan (around 550 Euros) income per month (Duan & Yang 2009). They cannot afford expensive tickets of high classed trains. So actually, high speed trains are not crowded no matter in peak or non-peak periods. The average occupancy of Wu-Guang PDL high speed trains is less than 40% in the first four days when it stated to be put into use (Zhu & Mei 2009). So construction or expansion of high-speed network will not be rather helpful to moderate the overcrowded phenomenon of rail system but it wastes tremendous amounts of transport resources.

Third, floating price measure does not have significantly influential effect for the demand reduction, regardless the mode of railway or highway (Lü & Ma 2007). Slight price change is not effective to stagger rush period-- people care the expenses less than family reunion or enjoying vacation, while drastic adjustment raises public disquiet—low-come people cannot afford such high travel expenditure. Therefore price policy is not the highly recommended measure (Xu 2006, Lü & Ma 2007, Shao 2008). Zhang (2006) stressed: “ *if such price-policy has to be used for demand and supply adjustment in spring festival transport, it should be announced in advance so that the public can make a plan of their holiday, to decide to have a trip or not, choosing the*

*mode of transportation.”*

Overall, the higher income customers have, the greater amount of high-income people, the more variety of alternatives they have and less density of passengers in the moderate/low-speed-trains, moreover, the greater usage of air transport or the inter-modality will be.

*Political:*

*Population Growth, Urbanization and Hukou System*

Explained in chapter 3, population growth in China is more for urban residents than that in rural places: urban population increasing is apparently much faster than the rural one (in negative growth) (Figure 3.5). Although the growth speed of number of urban residents is slowed down in recent 5 years, cities in coastal zone are still becoming increasing compact. Since urbanization is an inevitable trend in this country as a result of great discrepancy of coastal and inland area and population concentration, *Hukou* system as the policy preventing this trend, telling differences of *Urban* and *Rural*, must raise social problems. Under this migration limitation, rural families are separated so they have to depend on transport network to keep in touch, making it overburdened in certain period of a year.

Since the over-demand is mainly caused by rural laborers, fundamental approach is to lessen their mobility. Wang (2008) advocated realization of equalization—the *hukou* system is supposed to be abolished or at least lightened its effect. With different *hukou* status, inequality exist their life, work and education (Liu 2004). For instance, employees do not have the same welfare like insurance and housing allowance as the local citizens; students with out-of-town *hukou* status have to pay extra fee for education in the city, etc. People from rural are usually low-income groups. Thus they prefer to leave their children at their hometown for lower-tuition-fee-education and they cannot afford the living expenses of the whole family in cities. That is the reason of rural family separation. So annulment of such unfair institution let rural people gather as a family and live in the city, cutting down the trans-province-travel of large number of temporary migrants. Whereas, obvious drawback of this measure is that it encourages large scale of permanent migration to the urban. Growing rate of urban resident number will climb the new high peak, making cities more compact or even over-compact, overwhelming the intra-city transportation and housing systems.

Dang (2008) also believes that rural-urban variances should be diminished, in the way of speeding up urbanization, instead of be hindered its sprawling as the mainstream

doctrines. It is pointed out that in 30 years, the urbanization rate will reach to 80%. Supposed that there is no significant difference of living, working and education circumstances between coastal and inland area, between the rural and (sub)urban, there will not be large scale and scope migration. The stimulation of urbanization is equal to increasing the spatial accommodation capability for individuals. It requires expansion of infrastructure and facilities network. To be noticed, other problems will occur, for example the environmental problem of decreasing green areas and natural habitats. The quality of life of citizens is degraded from the health and harmony angle.

*Societal:*

#### *Culture and Population Control*

After all, the essential reason turning holiday time to long-distance-travel peak period is the strong desire for family reunion derived from Chinese traditional thought. Wei (2008) advises to change traditional minds of rural laborers in term of persuading and encourage them to stay in working places to spend the spring festival. It seems to be scarcely possible to carry on such thought transition, but it is feasible to stagger the travel peak period by measures on culture. Typical example is the re-distribution of holiday time—the May holiday is shortened to arrange official holiday for traditional days so that people have alternatives of time for family visiting (Shao 2008).

Another policy still needs be paid attention in the long term is the population control policy, especially for those in the rural. The negative growth rate of rural population does not imply the population decline. Since the 1990s, steep increase of floating population as a part of rural population (Figure 3.4), is due to the prevalent rural-urban migration. But traditional thought of birth<sup>7</sup> has an important effect on such rapid population growth in the whole country, particularly for the rural families. Birth limitation is hard to be implemented attributing to its high mobility. Controlling the family growth by coercive measures is neither rational nor practical; Publicity and educational activities are helpful for transition of minds, getting rid of sex

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7. In the undeveloped rural area, labor is the main resource for farming, instead of machines. Children are the dependence and the hope for rural households because they become able to work on the housework and farm work in the very early age, making household income, whereas the adult members do the rewarding jobs. Thus the more children a family has, the more labor resources they own, then the larger extra earning they have. Children are taken as a long term investment. In addition, boys are preferred than girls because boys are stronger than girl for farm work. The strong desire for infant sons accelerates the rural population growth (Davin 1985)

discrimination and “the more, the better” thoughts.

#### *Staggering Holiday Schedule*

Students moving trans-province for education are a principle component of floating population. Higher Education Stimulation Policy in China doubles the number of students. The students flow forms the summer holiday peak period and aggravates high traffic density on rail transport during spring festival. Since the holiday schedules for universities are more flexible than working schedules for workers, Wei and Chen (2008) suggest adjusting the holiday time among universities as viable method of staggering peak days. This is an efficient approach as redistribution the passenger flow temporarily to both alleviate the crowding in peak periods and make the transport resources into fully use.

#### 5.1.2 Improvement on the Supply

##### *Financial and Political:*

##### *Introduction of Competition*

One of the noticeable defects of China Rail is the lack of competition. Its detrimental influences are involving financial funding, management and operation.

Problems of monopoly of Ministry of Rail (MOR) are obvious. It constrains the diversification of reserve fund, in other word, reduces the funding. Maintenance, construction and improvement of rolling stock need to implement by enormous costs. The reason China Rail is criticized to be “lagging behind economy development” is that the fund is inadequate under the booming economy circumstances. Despite mileage of China’s railway in operation ranks the top in the world and its traffic density is far beyond those of many countries such as U.S., France and Germany (Zhang & Bouf 2005), the investment on rail transportation each is inferior by contrast. Since government investment is the major financial source, the revenue has significant meaning for railway system development<sup>8</sup>. Though rail transport industry seems to be great profitable, actually high investment is spent on the continuously upgrades its locomotives and improves its services (Wan & Liu 2009). The development plan,

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8. Revenue of 14 Railway Bureau, which sub-department of MOR, is collected as a part of state revenue. Then there is a distribution of the fund. How much finance will be spent on which section improvement/construction and railway bureau operation. Cross-subsidies (eastern coastal provinces subsidize the less-developing western ones) are a good example of national distribution of finance (Zhang & Bouf 2005).

“Medium- and Long-Term Railway Network Plan” is grandiose in a certain respect. Wan and Liu (2009): “...*The operating mileage of domestic railways will reach 100,000 km by 2020...By this date, the investment scale will exceed 2,000 billion yuan. Incidentally, there is a huge financial gap in the railway construction under the 2006-2010 Plan.*” Such problematic plan not merely is helpless for mitigation of supply shortage, but puts on pressure on China’s financial expenditure. In addition, financial centralization distribution reduces the competition among stations and railway companies leading to lower quality and efficiency of service. To sum up, merging function of government, from owning, planning, investment to operation and management, has been proven unfavorable for advancing railway transportation. Then competition is expected to be introduced (Li, Liu & Zhang 2000, Liu 2003, Zhang & Bouf 2005, Xu 2006).

Innovative action for introduction of competition to be taken is to make necessary separation, of regulation-funding and regulation-operation (Liu 2003, Zhang & Bouf 2005), that is to say to narrow the scope of government. The strict government restriction is necessary to be relaxed. Investment should be diversified, instead of increasing domestic private investment only, to be more important, abandoning the cautious attitude to attract foreign capital in railway transport will be appreciated. MOR/government plays the sole role of regulating when the organization and operation is conducted by railway companies, so the railway system can gradually swift to be “market-oriented running”. This introduction of foreign and domestic competition in economics and management is called horizontal competition introducing. Vertical introduction of competition, which is also named external competition by Zhang and Bouf (2005), is about the construction and improvement of intermodal system. Extremely low price of tickets makes train become a dominant alternative as railway is always regarded as public facility. In the chart shown in chapter 3 (Figure 3.2), over 90 per cent of transport is taken on by highway and railway. By comparison, the aviation accounts around 19% and 30% of the total transport capacity in Japan and U.S. (Xie 2008). Even though the price of airplane seems to be far from affordable for most of the peasant workers, there is still a part of passengers (for business or tourism) will spend more money on a higher efficient mode. In this way, if the aviation becomes more attractive, for example raising its convenience, it can contribute to release the traffic pressure in peak period by carrying one fifth passengers with affordability of railway. Another necessary separation is dividing passenger and goods trains. In fact, trains are prevailing modes for the logistics in China, or it may be busier than passengers carrying

sometimes. For freight transport subordinate, or even inconsiderable in the passenger flow peak period, its effectiveness cannot be guaranteed, dragging the economic development. Thus PDL is introduced to prevent two kind of traffic from delaying and obstructing each other. But for the PDL network constructing in China, tracks are only open to high speed trains, unaffordable for over 80% passengers in the time of vehicle shortage. Therefore, it is advised that such PDL network should not only aim at updating the speed and technology of trains, but consequentially, at really separating the freight and passenger transport to meet the demand of both.

#### *Information transparency*

Low transparency of railway system information has been criticized by the public. The most influential one is the availability of checking number of tickets. There is no way for passengers to know about the total ticket number or number of tickets left until the end of 2009. Low information transparency brings a lot of troubles of making appropriate decision of transport mode to take and arranging their vacation plan which might causes social protest. And it is also obstructive to scientist research for high difficulty of getting statistic data. Hence providing clear information and data is well contributed to ease the social tense and system advancing research.

#### *Technical:*

##### *Trains Speeding-up*

Increasing the running speed is equal to enlarge the capacity volume of trains. It can absolutely cut the travel time and supply more frequency. Without any expansion of tracks or adding extra train, it is supposed to be the best way to solve the shortage problem. China rail experienced speeding up for six times (Table 5.1, Box 5.1), and the PDL high speed train becomes the seventh. Great strides of increasing-faster trains have been made since the beginning of new century, by introducing advanced techniques from developed countries such as Germany. But here it involves the speed-price issue again—it is taken for granted that faster trains require higher traffic fares. So the crucial issue is neither creating faster trains nor fasten the high speed trains, but the accelerating the medium-(lower than 160 km/hour) and low-speed (lower than 100 km/hour) trains, which the majority usually take, precisely, cutting the trip duration. Trains being “slow” attributes to its running speed and stopping times and duration. Rational arrangement of operation schedule of trains, cutting the stop time (on the way or at the station) and removing dispensable little stations are the way to help these slow trains to speed up. Wang (2004) suggested to cancel the short-distance trains to make way for the long-distance ones in extremely busy season. The principle of this measure

is similar with the PDL (to ease the over crowded situation on the way of passenger-trains) and acceleration (by cutting the time waiting on tracks to give way to other trains). Canceled trains can be taken place by bus service. But this cannot be accomplished without a well-organized inter-modality system.

Year	T-trains and K-trains <sup>9</sup>		
	Number(Pairs)	Percentage of total number of trains (%)	
			T-trains
1993	416	38	11
1997	553.5	57	22
1998	676.5	61	26
2000	798.5	64	31
2001	823	69	36
2004	878.5	75	46
2007	1106	84	59

**Table 5.1** Number and Percentage of Various Trains in Each Time of Speeding-up  
(Source: Zhao, Liu & Zhu 2008)

High electrification rate of locomotives (around 40% by 2008 (National Statistics 2009)) is advocated for the speed acceleration and being environmental friendly of electric trains. Even so, problems of the electric trains cannot be ignored: how can the power network withstand the enormous usage of electricity of these trains? What about the decreasing source of oil with increasing consumption? And how to keep good status of the operation when unexpected disaster occurs (e.g. the snow storm 2008 crushing the electric grids paralyzed the southern railway network (CNN news, 2008))? In another word, advanced techniques cannot be identified as “improved system” for the problems of current transport situation have not solved essentially or may bring new challenges.

9. G-trains: High speed electric multiple unit inter-city trains, up to 350 km/h

C-trains: High speed electric multiple unit intra-city trains, up to 350 km/h

D-trains: High speed electric multiple unit inter-city trains, up to 200-250 km/h

Z-trains: Direct trains for metropolises, up to 160 km/h

T-trains: Special-fast trains, up to 140-160 km/h

K-trains: Fast trains, up to 120 km/h

Y-trains: Temporary added trains specifically for tourists in tourist seasons

L-trains: Temporary added trains in spring and summer holiday

The rest of trains are those with highest of 100-120 km/h.(Source: <http://en.wikipedia.org>)

**Box 5.1 Six times Speeding-up of Trains in China**

(Wang 2007, Zhao, Liu & Zhu, 2008)

**1<sup>st</sup>** 1997.04.01 Speeding-up of China Rail in large scale for the first time, mainly on the Jing-Guang, Jing-Lu and Jing-Ha sections. Highest speed of fast trains reach to 140 km/hour, other accelerated trains' speed is up to 120 km/hour. The extension of lines is as follow: over 160km/h trains—752 km, over 140 km/h trains—588 km, over 120 km/h trains—1398 km. The average speed of all trains is increased from 44 km/h to 55 km/h.

**2<sup>nd</sup>** 1998.10.01 Second time of large scaled speeding up for trains, remaining on the Jing-Guang, Jing-Lu and Jing-Ha sections. 6 pair of G-trains, 23 pairs Z-trains, 4 pairs of high-classed T-trains, 43 K-trains 63 pairs Y-trains(for tourists only) are operated. Highest speed in China is on the Guang-Shen section, which is able to reach 200 km/h. Extension of railroads: trains over 160 km/h trains—1104 km, over 140 km/h trains—3522 km, over 120 km/h trains—6449 km. The average speed of all trains is increased to 55.6 km/h.

**3<sup>rd</sup>** 2000.10.21 Acceleration of rolling stocks on the sections in middle- and western China. Routes are extended, of over 160 km/h trains—1104 km, over 140 km/h trains—6458k m, over 120 km/h trains—9581 km. The average speed of all trains is increased to 60.3 km/h.

**4<sup>th</sup>** 2001.10.21 The scale is larger (over 13 thousand km), almost covering all metropolises in China. Extension: Over 160 km/h trains—1104 km, over 140 km/h trains—9779 km, over 120 km/h trains—13166 km. The average speed of all trains is increased to 61.92 km/h.

**5<sup>th</sup>** 2004.04.18 The average speed of Jing-Lu, Jing-Guang, Jing-Ha, Jing-Hai and Longhai sections is 200 km/h. 19 pairs of Z-trains start to be used, whose speed is up to 160 km/h. The extension of trains with 200 km/h speed reach to 1400km while that of 160 km/h trains is 7700 km and the 120 km/h one are 16500 km. The average speed of all trains is increased to 65.7 km/h.

**6<sup>th</sup>** 2007.04.18 Increasing the usage of D-trains, mainly in the intra-city transport. The usage is expanded to other cities in three coastal economic zones. Shorten duration of trip is around 2 hours, but some of them can be 5 to 7 hours. Average speed of the D-trains is 143.01 km/h. the Average speed of all trains is 70.2 km/h.

*Intermodality Network*

Another highly promoted measure is to accelerate the construction of intermodality network, to combine the railway, highway and airway as a completed transport network. At present, the bus and train networks are in good connection. And buses lines to airports are extending and expanding. But while thinking about the economic problem of major consumers explained in section 5.1.1, accelerating the inter network construction is not the most efficient strategy.

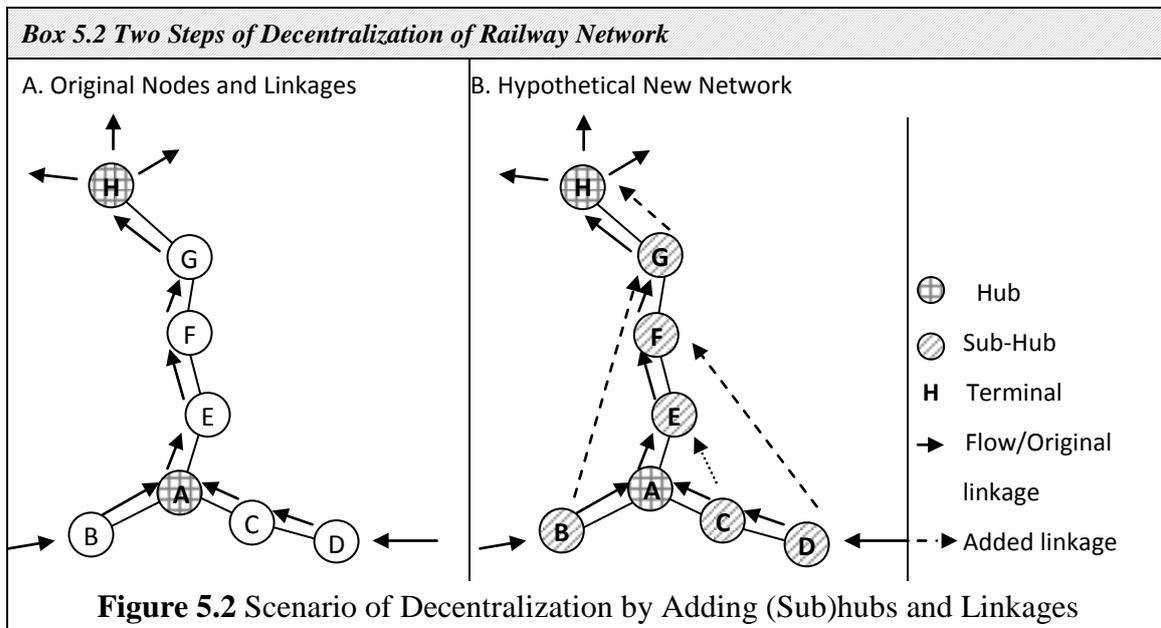
## 5.2 Recommendation (Technical): Decentralization of Passengers

From the description of chapter 2 and 3, too high density of passenger population can be summarized to be the essential reason of overburdening rail system. Those main stations, functioning as the hubs, become bottlenecks by the impingement of massive demand, which goes against the original principal of “convenience” and “efficiency” of hubs. The method of solution will be explained in the following.

The recommended approach for decentralization concerning “hubs” is to turn “hub-and-spoke” to analogous “spoke-and-wheel” (*See* Box 2.2). To do so, there are two steps to take: to *add* and to *connect* (*See* Box 5.2). Since hubs plays critically important role according to transportation geography (Haggett 2001, Rodrigue et al. 2006), there is no way to remove them from the railway network map or even ignore their dramatic effects on traffic network. By contraries, traffic pressure can be reduced by turning the nodes which geographically located in short distance away from the existing hubs, into new hubs or sub-hubs. Then how to select the locations of these new hubs? The reason driving passenger highly gathered in the stations in metropolis is not only people live in big cities need to take trains for long distance trip. Flows rush and converge in one hub-station because there are more frequencies, more direct trains and more alternative terminals to choose. But the truth is that passengers living in or near economically significant cities instead of living in metropolis also need such service. If only the amount of long-distance-travel customers reach to a certain level, stations of these cities are vitally necessary to transfer into (sub)hubs. When there is a nearer stations offering the same service as the central one of the province, passengers from far and near will not crowd in one point but will be distributed in various places. Thus the primary principle for selecting new hubs is that passenger demand in and around the cities should be big enough for additional services.

The second step is to *connect*, as an approach of transition from normal nodes into hubs. Similar as the intra-city road traffic, congestion also happens on the railways. If the construction and expansion of tracks are unavoidable in the short-supply circumstances, linkages connecting too populated node are worth building than the grandiose high speed dedicated lines. Strong points of these new built railroads are: 1) not all of the new hubs will be linked to the termination directly to cut the budget by building less tracks and it is rational as a part of passengers may get off on stations before the end of the line. 2) Trip duration from original to terminal will be decreased for the trains make fewer detours. 3) Pressure of metropolitan station will be relieved. 4) With alternative routes, trains from secondary cities will give way to traffic between central station and

terminal to reduce congestion on track and increase the flexibility for train arrangement. But weak points of this form of rail network are that construction of new tracks is time and finance consuming and there might be a risk of excess of supply or limited profitability.



This model is based on the physical geographical positions of stations on the Changsha-Wuhan rail section. It is worth mentioning that the lines on the diagram do not represent the physical geographical position of the tracks.

From graph A, it can be seen that the passenger flows from city B, C and D rush to station of city A, making A become overcrowded. Actually not all passengers are going to the final station H. A certain proportion of the passengers on trains from A to H direction may get off in the station on the way (E, F and G). In this new network, secondary cities (B, C and D) with huge amount of train takers can be linked to other cities, but do not connect all station to single point. The route should be the shortest and most rational one by taking land use, geographical conditions and profit rate into account.

Similar concept was proposed by Lü and Ma (2007): temporary direct trains can be added to alleviate the shortage in peak periods. The “direct” here means (a) they go from all of those busy station (B, C, D) and stop at the popular terminals (H) following the existing routes but canceling the stations in between, and (b) these trains are just for passenger carrying. Disadvantages of this strategy are, first, these trains may create congestion anyhow for the capacity of rail tracks is insufficient as the train accommodation; second, for those who need to take off the train at the station on the way, alternative trains are limited. From this view, the recommended method is superior to the measure stated by Lü and Ma.

### 5.3 Evaluation

To overview all the mentioned measures, a brief summary of their advantages, disadvantages is displayed in the table. And they are evaluated in term of efficiency and feasibility, each of which is classed three grades: low, medium and high. *Feasibility* is about the implementation in practice, is the synthesis consequence of financial and political conditions and acceptability of the public. If the measure is under affordable budgets, highly possible to carried on as transport policy (or may already be in used) and the public acceptable, it will be marked “high feasibility”; those requiring high financial support, or being less possible to implement under consideration of Railway bureau or other relative institution or companies (for example reducing largely the price of other transport modes to attract railway users must impact the profit of bus and airplane companies), or potentially raise public protest, will be marked “medium”; and measures probably causing these serious situations will be evaluated low feasible. *Efficiency* is concerned to be the effectiveness of problem solving, focusing on the shortage of supply especially in peak periods. Measures like construction of PDL network advancing the railway system but not contributing to problem of over-demand of main group, the floating population, is in the low or medium grade. For those probably help the mismatch between demand and supply mitigation, but it helps to the problem solving in long term instead of having instant effect, they will be also marked low or medium efficiency. Rationality is the criteria of public, national and operating benefit. If solutions will not have great adverse influences on the benefit of people, the nation or railway companies in economic, political and societal aspects, they will be regarded as “high” or “medium” rationality. But when they impact any benefit or might induce potential severe problems like civil unrest, or they cost highly but have limited effect for mitigation of the mismatch, they are of low rationality.

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Measures	Description and Explanation	Feasibility	Efficiency	Rationality
<b>PDL High Speed Train Network</b>	A part of passenger carrying is separated from joint operation of passenger and freight transport. But PDL network in constructing progress is for high class trains only so that it does not contribute to mitigate the high peak flows mainly forming by floating population	High	Low	Low
<b>Price Influencing</b>	Affecting demand through pricing system is a rational method in economy market. Actually its implementation is restrained in reality: the rail fares cannot be adjusted greatly as a public service; slight price change cannot make change of people's travel plan. However, price policy is not limited on the railway. Price policy can also be carried on highway and airway system to adjust and control the number of train passengers	Medium	Low	Medium
<b>Abolishing Hukou System</b>	Abolishment of the unfair institution may decrease the long distance mobility for more rural people are allowed to live in the urban, but it also causes other problem such as making urban areas over-compact.	Low	Medium	Low
<b>Accelerating Urbanization</b>	Urbanization is an unavoidable trend at present. It is identified to increase the accommodation of cities as another way to reduce large scale of inter-city migration. Potential issues involved are: intra-city infrastructure needs further development; environmental problems will be raised.	High	Medium	Medium
<b>Changing Traditional Culture</b>	Even though persuading people reduce their mobility must reduce the domestic transport demand, it is in rather low rationality for the culture tradition of family reunion in festivals is hard to change.	Low	High	Low
<b>Distribution of Holidays</b>	Rearranging public holiday duration by shortening the long vacation and distribution the days to other traditional festivals offers more time alternatives for family reunion instead of the only chance in Spring Festival and limit the tourist flows. But it might reduce the tourist revenue.	High	High	High
<b>Population control</b>	Population control, especially of floating population is long term tasks for China for it raises many problems not in transportation only. It can be conducted through birth concept of rural people, solving the problem gradually.	Medium	Low(slow)	High
<b>Staggering Holiday Schedule</b>	Staggering holiday of students in different schools/universities is feasible as the higher flexibility of education schedule than working schedule.	High	Medium	High

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<b>Introducing of Competition</b>	Increasing competition horizontally (introducing private and foreign investment) can strengthen the financial foundation for further development while the vertical competition (competition of alternative modes) pushes the improvement of services. But as the significance of railway transport as a part of live for people, it is not easy to persuade the governments to relax the limitations of investment.	Low	Medium	High
<b>Passenger&amp; Freight Separation</b>	Disjoint operation system must be the best way to enhance the carrying efficiency both in two kind of transportation. Requirement of great financial support makes it less feasible in current China and might make transport resources waste in non-peak periods.	Medium	High	Medium
<b>Increasing Information Transparency</b>	Making information and data published and providing service for helping check can be considered as a method to arrange the transport of the whole society in a rational way—people arrange their plan and transport mode, in which way they are distributed temporarily and spatially.	High	Medium	High
<b>Shortening Travel Duration</b>	It is not only about the speeding-up of trains but also about shortening trip duration in various ways. It is worth noticing that only speed-acceleration of medium/low speed trains is meaningful for solve excess demand of floating population. Higher-classed trains with higher speed are less helpful or even become a waste of resources.	Medium	High	High
<b>Intermodality</b>	Considering the current consumption of majorities of long-distance travelers, inter network, as a way to distribute passenger flows without concentrating in limited railway stations, does not contribute a great deal on meeting enormous demand. Even so, intermodality is necessary to complete for long-term development as an advanced and integrated transport system.	High	Medium	High
<b>Analogous Spoke-and-Wheel Scenario</b>	In those extremely busy sections, extra tracks added to existing network forming new type of network helps lower the density of central stations and of trains on railroads. Passengers are distributed in more hubs but not rush into one single point for better transport service. So comparing to other technical measures, for example the PDL, it is more rational and efficient to reduce the severe mismatch of supply and demand. Nevertheless, except for land use and geographical limitations, great time and economic expenses become a restrain of implementation of this suggestion. And it needs thorough survey on local demand or it will probably cause redundant supply.	Unknown (depends on practice)	High	High

**Table 5.2** Evaluation of Measures for Mitigation of Demand-Supply Mismatch

#### 5.4 Concluding Remarks

Restrains for rail system improvement is explained with personal advice and suggestion proposed by other Chinese scholars. Admittedly, the mismatch of supply and demand in rolling stock is impossible to be eradicated—its existence is natural and evitable in the physical world. But the severe short-supply situation is probably to be diminished in some way. From the explanation of the evaluation table, it can be concluded that measures mentions in this thesis can be classed into three groups: 1) the highly recommended measures: **distributing of holidays** and **increasing information transparency** are already in use and proved to be effective; **staggering holiday schedule** is a good method for arrange floating population mobility in a managing approach as described; **introducing competition** and **intermodality** supposed to be the trends of railway development need to be put on the agenda; **population control** is a critical long term task which can never be neglected even if its effects cannot be perceived immediately. **Shortening travel duration** measure should concentrate on raising speed of medium and low speed trains and cut unnecessary stop-time, but not speeding up the high speed trains which need huge financial and technical costs on the contrary. 2) Those with drawbacks but helpful are still recommended for practice if conducted moderately: **price policy** is still a useful tool for demand adjustment but it needs to be implemented in the whole inter-network; since **urbanization** is an inevitable trend, now the problem is about to slow down, for adverse environmental and social impact it makes, or to accelerate for reduction of domestic mobility. In this case, neutral attitude is held in this thesis. And 3) measures not recommended or suggested to be postponed: some evidence can be found to show **PDL High Speed Train Network** to probably have a risk of being of negative profit by over-supply phenomenon of the opened section thus it is a least recommended as “high-cost, low-efficiency and low-profit” measure; **Abolishing Hukou system** and **changing the traditional culture** may be helpful phenomenally but potential adventure that they may cause other serious problems makes them less promoted; **Separation of passenger and freight transport** should also be a tendency of rail system advancement and doubtlessly increase the transport efficiency reducing the chance of being over-burdened of trains, but the tremendous expenditure and exhaustive plans and designs that it needs makes implementation of such measure difficult and it is better for it to be postponed.

Similar with PDL HST network, the recommended scenario try to intervene from a technical aspect in supply, in term of extension and expansion of rail tracks. The reasons why it is superior to other measures like construction of PDL HST network or increasing temporary runs are, firstly, from the business profit angle, it tries to avoid unnecessary cost. Too many trains increased to meet peak periods demand might be idle in non-peak time in some sections in that not all rail segments are over-burdened in

both peak and non-peak periods. Such analogous spoke-and-wheel network is forming in the way of adding extra tracks for regular train running but not high speed trains merely so that new tracks can be put into fully use. But this can only be achieved by adequate survey and thorough plans. If there is not enough local demand, financial losses will happen. The second advantage of this scenario is that it is for the majority passengers to solve their travel problems. Passengers can pay the regular travel fare to get advance service while compared to the unaffordable price of high speed trains for the majority. Third, it makes the whole network tend to complete by increasing its convenience and carrying efficiency, raise the competition of railway business. But this scenario is only an initial idea for rail system improvement and development explained briefly in this thesis. Further research remains to be conducted on its feasibility and practicality.

Worth to be mentioned, none of measures should be implemented solely. The most efficient solution is to mitigate the mismatch from various aspects. Therefore, all recommend measures are worth to use at the same time.

## **Chapter 6**

### **Conclusion**

There are three parts of the conclusion chapter. The first one is the answers of research questions posed in Chapter 1. Answers will be given in an over view linking all chapters as a whole. Second part is a brief reflection, discussing the short points of this research, being critical of the literature review, data sources, methodology analysis as well as the measures for mitigating the mismatch of demand and supply of rail transportation. Further research of this thesis is also mentioned at the end of this chapter as the last part.

#### **6.1 Research Overview**

From the research, questions set in Chapter 1 can be answered.

***Question 1:** What are the influencing factors of demand and supply of transport derived from geographical literatures?*

Transportation is a tool to overcome spatial differences as defined. Categorized into geography sciences, transportation geography is connected to broad geographical areas. Economic geography plays a primary role in impacting transport for it determines aspects like the direction of flows and amount of demand; political geography meaning spatial variation of implantations of policies drives the future of transport ; regional geography is affecting in term of two tendencies—regionalization and trans-boundary trend(globalization); population as consumption objectives should be given attention for its distribution or willing of mobility decide the transport demand; history may has influential effects mainly in a cultural way. Environmental and natural resources geography included in the original model of Rodrigue et al. are disregarded for they have less impacts on the main topic of this thesis, passenger transportation. Theoretical knowledge of geography becomes the strong back-up for the Demand-Supply model displaying the influential factors of transport demand and supply.

Based on the theoretical knowledge, it is not difficult to draw out a model to demonstrate the influential factors of demand and supply respectively and inter-relationship among all the elements and understand how they affect transportation. In a horizontal scope, affecting factors of Demand side can be concluded to be the economic, political and societal aspects. It matches the model provided by Rodrigue et al. of growth factors for transport demand. The supply side is impacted by financial, technical and political issues. Economic factor is still in a dominant position in the supply subsystem for all provisions of transport services require financial supports. Besides, they interact and affect each other as a factor. And the media of their interaction is travel fare and provided traffic network structure, being the tools

intervening the demand amount and flows. On the other side, growing demand is the incentive of development of transport system in term of supplying advanced service. But it can lead to adverse effects easily without cautious plans.

In a vertical scope, the model is the clue for finding out the contextual reasons of current situation, mismatch situation of demand and supply, problems they cause in addition to solutions analysis to mitigate the mismatch of China railway passenger transport, which are concerning in the next three questions.

***Question 2:*** *What are the contextual factors relevant to passenger rail transportation in China? How do they affect the passenger rail transport?*

Sub-models of demand and supply parts in Chapter 3 show the detail involving factors specifically for China situations. In the economic part of demand subsystem, there are three elements: booming economy is pusher for growing demand by activating the market. Income level of customers limits the flexibility of alternative choice. Geographic relocation of FDI becomes a special and important cause of large scale movement. The most vital phenomenon in China about society is the floating population, forming by migration of surplus labor in the rural. Occurring of this group of people is partly due to the political institutions of *hukou* system, which is also related to urbanization, and also due to the some culture traditions—spring festival is the most important festival for family reunion that makes rural workers take long distance travel to meet their family.

As in the demand sub-model, economic and political factors also play important roles in the supply sub-system. It makes profit while requires financial support. Dramatic development of economy of China calls for advancing of transport system, the development of railway is dragging behind. Political decisions such as the five-year-plan stimulate the improvement of network, but it can become obstacles for example constraining foreign investment into rail transport market reduces the developing speed. Finally, technical aspects are engineering techniques regardless the local or the introduced ones, as well as planning or management concepts. Significant technical achievements are witnessed in recent years. Anyway, for technical development, financial support is indispensable and national, regional or local policies function as vital limiting elements.

Unaffordable price of airplane turn trains and buses into the inevitable choice for majority of floating population, leading to high incidence of overburdening situation for railway and bus systems. Overcrowded phenomena also can be seen in certain sections and train stations. One of the reasons is the hub-and-spoke railroad network which concentrates flows on stations of metropolises or important transition points and offers limited alternative routes. All phenomena result to over-demand situation in China, also forming some peak periods of long distance travelling. Typical example is sections in Gongdong province, directing to Hunan and Hubei provinces.

**Question 3:** *What is the extent of the mismatch of rail supply and demand in China referring to the example rail section Wu-Guang? What problems are raised by the mismatch?*

Supply of rail traffic is supposed to be sufficient when looking at the comparison of average number of passengers and carrying resources. But uneven distribution of passenger temporarily and spatially drives the occurring of trains over-burdening—in peak periods, only half or one third of the demand can be satisfied in Guangzhou-Changsha-Wuhan segments. The mismatch induces social problems and economic losses. Social problems involve safety in the process of large number of crowds purchasing tickets, physical or psychological health of passengers on train and sanitation of environment of trains. Immediate and potential economic losses results from inconvenience of traffic flows and travel fatigue of passengers both of which lower the working efficiency. Hence to avoid these economic and social problems, measures of mitigation of the mismatch are necessary.

**Question 4:** *What are the possible/current measures to mitigate the railway problem?*

Thirteen measures are mentioned to mitigate the serious mismatch. Rearrange of holiday time, staggering different flows, introducing competition, increasing the information transparency and shortening the travel duration are appreciative measures to take. Population control is also recommended to be carried on in long term even though its effects cannot be demonstrated immediately, so is the intermodality network accomplishment. Price policy and acceleration of urbanization can be feasible approaches but their probability of new raising problems limited their being promoted. The rest measures are not recommended or suggested to be postponed. Although PDL network is in progress of construction and will be finished in ten years, it becomes a waste for high travel fare which does not match consumption ability of the majority. Abolishment of *hukou* system must raise rural-urban migration chaos whose impacts are possible to cover the whole country. Changing the tradition is not reasonable either. Recommended scenario, building network analogous spoke-and-wheel, is a superior measure when compare to other solutions on technology. It mitigates the problem through extending existing network as PDL network, providing more convenient traffic. Different from PDL, it is the extending of regular tracks not for high speed trains only which means all passengers are able to afford the extra transport services. The risk of waste transport sources will be reduced.

Although some of these measures are highly promoted while some are less suggested, all appreciative approaches should be operated jointly. Any sole solution can solve the fundamental problem efficiently.

The main objectives of this research is to analyze the disparity between demand and supply of passenger rail transport through the case of Wuhan-Changsha-Guangzhou line and the problems caused, and analyze feasibility, efficiency and rationality of

solutions for the mismatch between demand and supply of China rail transport. After giving the answers of the questions, the objectives are achieved. It can be known that the supply of rail transport carrying capability is far from sufficient in peak periods which can only meet one third of demand. The mismatch produces economic losses and several social problems so many measures are proposed or in progress to mitigate such demand-supply disparity. Among these measures, distribution of holidays, population control, staggering holiday schedule, introducing competition, increasing information transparency, intermodality and construction spoke-and-wheel network are measures highly recommended in this thesis while the PDL high speed train network, abolishing *hukou* system and changing traditional culture thought of people are not appreciated. The rest solutions like price influencing, acceleration urbanization, separating passenger-freight transportation and shortening travel duration are less recommended than the first group measures but they are worth of implementing.

## 6.2 Brief Reflection

### 6.2.1 Research Method

- 1) Literature review refers to broad geography knowledge. The connection of these areas with transport geography is explained. However, the explanation is not in-depth but only a general and brief description.
- 2) Finding data and published literature of China is more difficult than expected because there are special institutions responsible of rail transportation research and only some of the data are published. Some important analysis, for example the extent of mismatch cannot be proved by detailed data because there is no way to find out the statistic number of passengers departing from and arriving at each station, neither is the official record of the peak periods open to the public, all of which leading to a less precise analysis of the research. So this analysis has to be more descriptive without details of reality to support. However, all the data used in this thesis are reliable for they derive from published statistics of national bureaus, official websites and published literatures of science journals in English and Chinese. In addition, Chinese literatures which provide abundant information and data are impossible to be found by the searching system in university of Groningen, making the searching literature process becomes more time-consuming. For the time and place limitation, the analysis is only based on information from secondary databases, but not from direct data collection through interviews, surveys or questionnaires. The research can be improved with additional information, for example surveys of current situation of rail system and geographical consideration for spoke-and-wheel network construction providing more data to estimate the feasibility of the new network structure, and interview with transport experts or planners in China for more suggestion on transport problem-solving.
- 3) The model concluding the influential factors of rail transport demand and supply

show their relationships and affecting effects clearly. But these models do not reflect the significance of these factors. It is better if the models are displayed as layers to show the relation of each factor: economy should be the primary element but it is intervened by political decision, therefore the political layer should be on the top covering other two aspects. Some of contextual factors in the demand and supply subsystem, for instance the urbanization and trans-province-migration in demand sub-model, are the synthesis results of three fields (economic, political and societal/technical), which is not the ichnography able to manifest.

- 4) The scores on the criterion of evaluation, the feasibility, efficiency and rationality are basis on literature research and documental analysis. There is no strict quantitative evaluating system from other research. Thus it is hard to identify the feasibility, efficiency and rationality “high” “Medium” and “Low” with not highly legible boundaries in between.

#### 6.2.2 Recommended Scenario

In spite of the spoke-and-wheel network is recommended, there are some drawbacks of this scenario. It is hard to define whether a secondary city has enough local needs for long-distance trip to be direct linked to another city. High dynamics of floating population makes the survey result less convincible. Change of passenger number in different time period always happens, but there is no precise records of the exact time periods and passenger amount so that it can hardly be estimated the real demand and risk of profit. And lacking of statistics of passenger traveling from which station to which terminal raises the difficulty for planners of deciding cities that will be connected. Furthermore, geographical conditions, including terrain, topography and land use plan etc. is also a great limitation element for the scenario implementing because such conditions vary in different areas and in some places, some physical conditions might be unavailable for construction. When the plan of new network by added hubs and linkages put into practice, it has to be taken cautiously.

#### 6.3 Further Research

Obviously, the spoke-and-wheel network scenario proposed in Chapter 5 is only a general concept for advancing the current railway system. Further research and cautious survey are necessary for its implementation. Possible research can be the study of feasibility or profit rate of this network. The features of demand, flows and their period changes of the target cities are interesting to study as well. Technically, physical conditions of construction and the precise network designs are also worth to research. Surveys are main concerning the travel habit and will of passengers in target cities. Example questions are what are their travel purpose and frequency? What are their most frequent routes? Where are their residences? How long is travel duration? et cetera. The surveys can be finished through questionnaires or interviews of passengers. Except for research about recommended scenario, studies can also be on other

measures mentioned in Chapter 5. The most interesting ones are the introduction of competition and intermodality. The possibility and approaches acceptable for private and public of raising the competition of transport market is necessary to elaborate. For integrated network construction, it also requires geographical and financial condition supports which may become an extended topic.

#### 6.4 Concluding Remarks

The four research questions have been answered in this research with theoretical knowledge, graphical models, practical situations, analysis and evaluations. The research method, literature review, information sources and modification, models displaying the affecting factors and analysis and evaluation, has some drawbacks so there is a space to improve. And there is no convincing evidence for the feasibility of the recommended scenario hence further research and survey are needed. The hypothetical solution asks for more research in practice. More studies on other measures like introduction of competition and construction of intermodality are also interesting for transport planners.

## References

- Bai C.E. and Qian, Y. (2010), “Infrastructure Development in China: The Cases of Electricity, Highways, and Railways”, *Journal of Comparative Economics*, Vol. 38 (2010), pp.34–51
- Black, W.R. (2003), “Societal Trends and Their Impact on Transport”, in William R.B. *Transportation: A geographical analysis*, the New York and London: Guilford Press, pp. 289-302
- Black, W.R. (2003), “Transport policy”, in William R. B. *Transportation: A geographical analysis*, the New York and London: Guilford Press, pp. 199-215
- Claval, P. (1998), “The Social and Cultural Dimensions of Regional Geography”, in P. Claval, *An Introduction to Regional Geography*, Blackwell, pp.118-137
- CNN News (2008.01.31): “China Advises Millions to Abandon Travel Plans”, <http://edition.cnn.com/2008/WORLD/asiapcf/01/31/china.weather/index.html>, read on 2010.08.18
- Dang, G.Y. (2008), in “春运难题破解 (Solving Problem of Spring Festival Transport)”, *小康 (Well-off)*, Vol.2008-03.A, pp.32-33
- Davin, D. (1985), “The Single-Child Family Policy in the Countryside”, in E. Croll, D. Davin, and P. Kane, (1985), *China's One-Child Family Policy*, Macmillan Press LTD, pp.37-82
- Downs, A. (2004), Policy Brief#128 of the Brookings institution, 2004.01
- Du, Y., Park, A. and Wang, S. (2005), “Migration and Rural Poverty in China”, *Journal of Comparative Economics*, Vol.33 (2005), pp.688–709
- Duan, C. et al. (2008), “改革开放以来我国流动人口变动的九大趋势 (Nine Trends of Floating Population since China's Reform and Opening Up)”, *人口研究 (Population Research)*, Vol.8
- Duan, C. and Yang, G. (2009), “中国流动人口状况：基于 2005 年全国 1% 人口抽样调查数据的分析 (Floating Population in China: Analysis Based on 2005 1% Sample Survey of Population)”, *Journal of Nanjing College for Population Programme Management*, Vol.25, No.4, pp.7-15
- Duncan, O. (1959), Human Ecology and Population Studies, in Hauser and Duncan (eds.), pp. 678-716
- Haggett, P. (2001), “An Urbanizing World”, in P. Haggett *Geography: A Global*

*Synthesis*, Prentice Hall, pp.232-269

Haggett, P. (2001), "Globalization", in P. Haggett *Geography: A Global Synthesis*, Prentice Hall, pp.586-615

Haggett, P. (2001), "Population Dynamics", in P. Haggett *Geography: A Global Synthesis*, Prentice Hall, pp.170-201

Hanink, D.M. (1997), "Introduction to the Study of Economic Geography", in D. M. Hanink *Principles and Applications of Economic Geography: Economic, Policy, Environment*, pp.1-28

He, L. (2005), "FDI 从珠三角向长三角转移的投资环境因素分析 (Analysis of Factors in Investment Environment of FDI Transferring from Pearl River Delta to Yangtze River Delta)", *Modern Economic Research*, Vol.10, pp.37-41

He, X. (2010), "广州全面迎接春运 (Transportation around Spring Festival in Guangzhou)", *广东交通 (Guangdong Transport)*, Vol.2 , pp. 17

Holye, B. and Knowles, R. (1998), "Transport Geography: An Introduction", in B. Holy and R. Knowles (eds) *Modern Transport Geography*, 2<sup>nd</sup> edn, London: Wiley, pp.1-12

Holye, B. and Smith, J. (1998), "Transport and Development: Conceptual Frameworks", in B. Holy and R. Knowles (eds) *Modern Transport Geography*, 2<sup>nd</sup> edn, London: Wiley, pp.13-40

Huang, Y. (2007), "Urban Development in Contemporary China", in G. Veeck et al. *China's Geography: Globalization and the Dynamics of Political, Economic and Social Change*, Rowmn & Littlefield Publishers, pp.233-262

Jones, H. (1990), "The Analysis of Migration", in H. Jones, *Population Geography*, 2<sup>nd</sup> edn, pp. 178-206

Ike, P. (2009), Lecture of Course of Environmental and Infrastructure Planning, in Environmental and Infrastructure Planning Master Program 2009-2010

Jin, W.J. and Ding, Y.R. (2009), " '载' 不动的年: 农民工春运问题调查与思考 (Research on Spring Festival Transportation Involving Rural Laborers)", *Legal System and society*, Vol.2009.07 (A), pp.240

Jin, Z.H. and Zhen, J. (2000), "21 世纪的中国铁路旅客运输 (China Railway Passenger Transport in 21 century)", *China Rail*, Vol.1, pp. 7-9

Li, C.J. (2010), "中国铁路发展简史 ( Brief History of Development of China Railway )", People Rail, <http://www.peoplerail.com/baike/201064/n407314189.html>,

read on 2010.08.14,

Li, X.S., Liu, Y.Q. and Zhang, X. Z. (2000), “中国铁路的规制改革与竞争 (Reform and Competition of China Railway System)”, *Working Paper*, No.23, 2000.08., [http://www.cass.net.cn/chinese/s05\\_sjj/rcrc/rcwp23](http://www.cass.net.cn/chinese/s05_sjj/rcrc/rcwp23), read on 2010.8.18

Li, Z.C. (2006), “近代中国铁路发展特色 (Characteristics of Rail development in Modern China)”, *Journal of Capital Normal University (Social Sciences Edition)*, Vol.4, pp. 47-51

Liang, P.F. and Lin, L.Y. (2008), “The Spatial Distribution Pattern of Chinese Floating Population and Its Relationship between Regional Economic Development in 2005”, *Yunan Geography Environment Research*, Vol.20 No.6,2008.11, pp.64-68

Liu, Q. (1999), “影响铁路客流因素及相关度分析 (Influencing Factors of Rail Passenger Flow and Relative Degree Analyst)”, *Journal of Shuanghai Tiedao University*, Vol.20, No.2

Liu, S.J. (2003), “中国铁路改革与重组模式：第三种选择 (Reform and Restructure Models of China Railway Industry: The Third Alternative)”, 《中国工业经济》 (China Industry Economy), Vol.2003 (3)

Liu, Z. (2004), “Institution and Inequality: The Hukou System in China”, *Journal of Comparative Economics*, Vol.33, pp.133-157

Liu, Z.J. (2010), “全国铁路工作会议报告 2010 (National Rail Meeting Report)”, *铁路工程企业管理 (Rail Engineering Industry Management)*, Vol.2010 (1)

Lü, H.Y. and Ma, J.H. (2007), “我国铁路春运存在问题的分析及对策 (Analysis and Strategy of Problems for China Rail Transport in Spring Festival)”, *Inner Mongolia Science Technology & Economy*, No . 2 , Vol.132, 2007-01, pp.78-79

Reilly, T., Waterhouse, J. and Edwards, B. (2009), “Some Chronobiological and Physiological Problems Associated with Long-distance Journeys”, *Travel Medicine and Infectious Disease*, Vol.7, pp.88-101

Rodrigue, J., Comtois, C., and Slack, B. (2006), “Transportation and Geography”, in J. Rodrigue, C. Comtois, and B. Slack *The Geography of Transportation Systems*, the London and New York: Routledge, pp. 1-37

Rodrigue, J., Comtois, C., and Slack, B. (2006), “Transportation Systems and Networks”, in J. Rodrigue, C. Comtois, and B. Slack *The Geography of Transportation Systems*, the London and New York: Routledge, pp. 38-73

- Rodrigue, J., Comtois, C., and Slack, B. (2006), "Economic and Spatial Structure of Transport Systems", in J. Rodrigue, C. Comtois, and B. Slack, *The Geography of Transportation Systems*, the London and New York: Routledge, pp. 74-100
- Shao, C. (2008). "对春运 '民工流' 人口迁移的探讨(A Discussion on Migrant Worker Flow in Spring Festival)", *Journal of Anhui Agricultural University(social science edition)*, Vol.17, No.6, 2008-11, pp.57-61
- Seeborg, M. C., Jin and Z., Zhu, Y. (2000), "The new rural-urban labor mobility in China: Causes and implications", *Journal of Socio-Economics*, Vol.29, 2000, pp.39-56
- Speece, M.W. and Kawahara, Y. (1995), Transportation in China in the 1990s, *International Journal of Physical Distribution & Logistics Management*, MCB University Press, Vol. 25 No. 8, 1995, pp. 53-71
- Sydney (2000), "Power, Space and Political Geography", in M. Jones, R. Jones and M. Woods, *An Introduction to Political Geography-Space, Place and Politics*, London and New York: Routledge, pp. 19-80
- Taaffe, E.J., Gauthier, H.L. and O'Kelly, M.E. (1996), "Selected Economic Aspects of Transportation Geography", in E.J. Taaffe, H.L. Gauthier *Geography of Transportation*, 2<sup>nd</sup> edn, Prentice Hall, pp. 44-72
- Tuan, C. and Ng, L. F.Y. (2004), "Manufacturing agglomeration as incentives to Asian FDI in China after WTO", *Journal of Asian Economics*, Vol.15, pp.673-693
- Tuan, C. and Ng, L. F.Y. (2007), "The Place of FDI in China's Regional Economic Development: Emergence of the Globalized Delta Economies", *Journal of Asian Economics*, Vol.18, pp.348-364
- Wang, J. (2000), "铁路旅客运输发展市场定位 (Market Orientation of Rail Transportation Development)", *Rail Transport and Economy*, Vol.22 No.7
- Wang, G. X. (2008), in "春运难题破解 (Solving Problem of Spring Festival Transport)", *小康 (Well-off)*, Vol.2008-03.A, pp.32-33
- Wang, H. (2004), "铁路客流高峰期旅客运输的特点及对策 (Characteristics and Strategies for Rail Passenger Transport in Peak Period)", *Rail Transport and Economy*, Vol.26 (10), pp.38-39
- Wang, L., Ren, M. and Xu, G. (2004), "Research on Peak Price Modeling of Railway Passenger Transport", *Railway Transport and Economy*, Vol.26-2, pp.7-9
- Wang, S.J. (2007), "历史回顾: 中国铁路前五次大提速 (History Review: The First Five Times Speeding-up of China Rail)", *Press Release*, Vol.2007 (4), pp.22-23
- Wei, Y.S., Chen, W.D., Ye, L.X., Wu, Z.Y., Zhang, L., Qin, C.M., and Qiu, H.S. (2005),

- “铁路乘客乘车心理行为与卫生满意度调查 (Survey and Analysis of Psychological Behavior and Satisfaction on Sanitation of Railway Passengers)”, *China Medicine Journal of Communication*, Vol.19(2005), No.1, pp.84-85
- Wei, S.J. and Chen, S.H.(2008), “中国铁路春运问题分析 (Analysis of Spring Festival Transport of China Rail)”, *Economic & Trade Update*, Vol.6, Sum. No.114, 2008-09, pp.32-33
- Wu, L. and Gong, X., (2000), “我国客运市场的变化分析及铁路的对策 (Analysis of Change of Passenger Market and Strategy for Rail Transportation in China)”, *中国铁路 (China Rail)*, Vol.8, pp.25-28
- Xie, L.X. (2008), “从文化角度看春运 (Transportation of Spring Festival in terms of Culture)”, *Journal of Xinyu College*, Vol.13-1, 2008-02, pp.34-36
- Xu.J.Z. (2006), “中国铁路改革的现状分析 (Analysis of Status of China Railway Reform)”, <http://www.chinareform.org.cn/cirdbbs/dispbbs.asp>, read on 2010.8.18
- Ye, J., Peng, Q., Huang, C., Liu, J., and Zhong, Z. (2003), “广东流动人口问题研究 (Research on floating population in Guangdong)”, *Statistics and Forecasting*, Vol.2003.3
- Zhang, J.Y. (2007), “中国轨道交通发展与规划 (China Rail Transportation Development and Planning)”, *建筑机械 (Construction Machinery)*, Vol.3, pp. 26-29
- Zhang, K.H. and Song, S. (2003), “Rural–urban migration and urbanization in China: Evidence from time-series and cross-section analyses”, *China Economic Review*, Vol. 14 (2003), pp.386– 400
- Zhang, R. and Bouf, D. (2005), “How can competition be introduced into Chinese railways?” *Transport Policy*, Vol.12 (2005), pp.345–352
- Zhang, S.X. (2006), Interview, in Zhang, W., “春运症”的解决之道：分拆铁路，引入竞争 (Solutions for Spring Festival Transport Problem: Increase of Competition), *China Economic Forum*, Vol.2006-2, pp.24-25
- Zhao, C.L., Liu, X. and Zhu, J.H. (2008), “我国铁路旅客列车提速的历史回顾 (Review of Speeding-up of Passenger Trains in China)”, *Rail Transport and Economy*, vol.30 (4), pp.4-7
- Wan, Z. and Liu, X. (2009), “Chinese Railway Transportation: Opportunity and Challenge”, *Transportation Research Board Annual Meeting 2009 Paper*, #09-2279
- Zhu, A.Z. and Mei, D. (2009), “武广高铁开行四日上座率不足四成，票价为何难调

整?(The Occupancy of Wu-Guang High Speed Railway is Less than 40 Percent in the First Four Days, Why the Ticket Price Cannot Be Adjusted?)”, *楚天金报(Newspaper)*, published on 2009-12-30, <http://unn.people.com.cn/GB/14777/21747/10683448.html>, read on 2010.08.16

Zhu, Y. (2007), “China’s Floating Population and Their Settlement Intention in the Cities: Beyond the Hukou Reform”, *Habitat International*, Vol.31, pp.65-76

## **Other Websites**

<http://people.hofstra.edu/geotrans/eng/ch1en/conc1en/typenettopo.html>, read on 2010.08.24

<http://people.hofstra.edu/geotrans/eng/ch1en/conc1en/transportrates.html>, read on 2010.08.24

[www.gdftu.org.cn](http://www.gdftu.org.cn) , read on 2010.06.04

<http://www.johomaps.com/as/china/chinarail.html>, read on 2010.08.25

<http://www.tielu.org>, read on 2010.07.21

[www.gdftu.org.cn](http://www.gdftu.org.cn) , read on 2010.06.04

<http://danger-ahead.railfan.net/accidents/modane/home.html>, read on 2010.06.25

<http://news.chineserailways.com/HTML/16/200810/20081010165617.html>, read on 2010.06.25

[http://en.wikipedia.org/wiki/Passenger\\_rail\\_transport\\_in\\_China](http://en.wikipedia.org/wiki/Passenger_rail_transport_in_China), read on 2010.08.29

<http://www.eurail.com/eurail-railway-germany>, read on 2010.08.29

<http://www.thetransportpolitic.com/2009/12/15/united-kingdom-commits-to-further-rail-electrification/>, read on 2010.08.29

<http://www.railmaps.com.au>, read on 2010.08.29

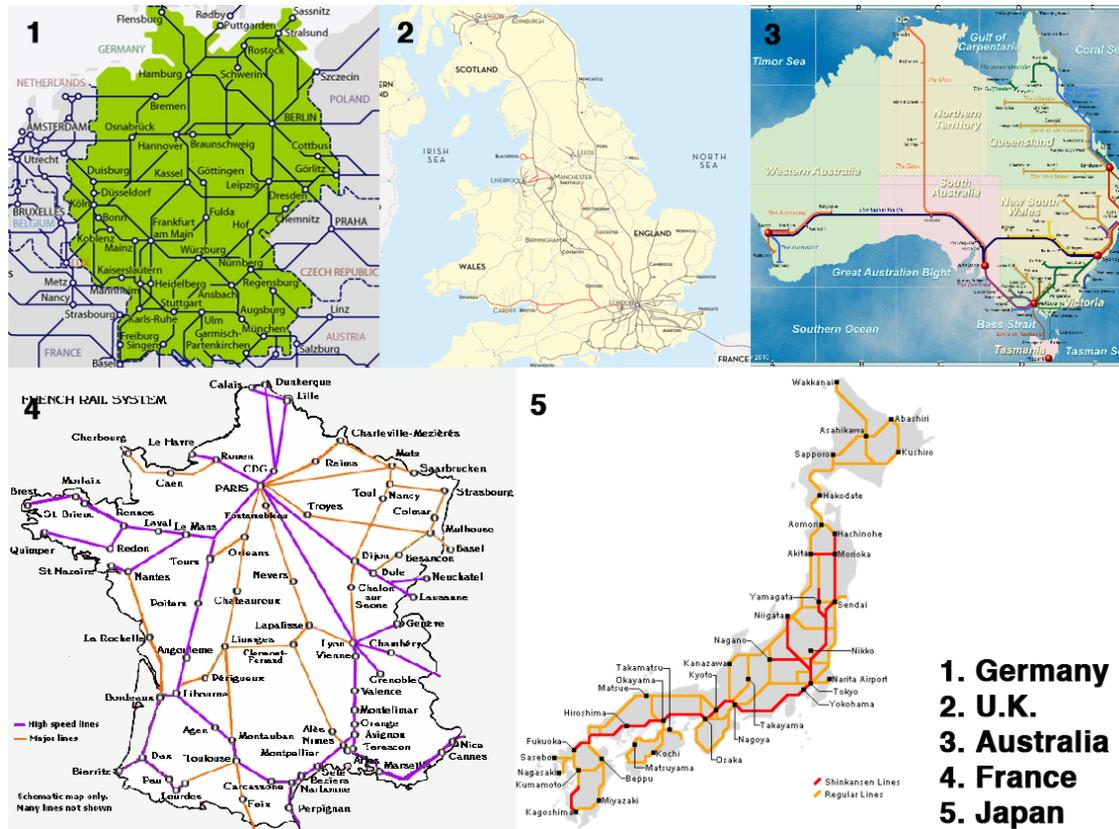
<http://www.holidayviewer.com/Holidays-by-train.php>, read on 2010.08.29

[http://www.travelbuoy.com/trains/japan\\_rail.php](http://www.travelbuoy.com/trains/japan_rail.php), read on 2010.08.29

<http://www.chineserailways.com/html/kyzx/kyzx.html>, read on 2010.08.29

## Appendix

### Map I. Different Network Types in Practice



1. Germany
2. U.K.
3. Australia
4. France
5. Japan

Source:

German Railway Network: EU Rail, <http://www.eurail.com>

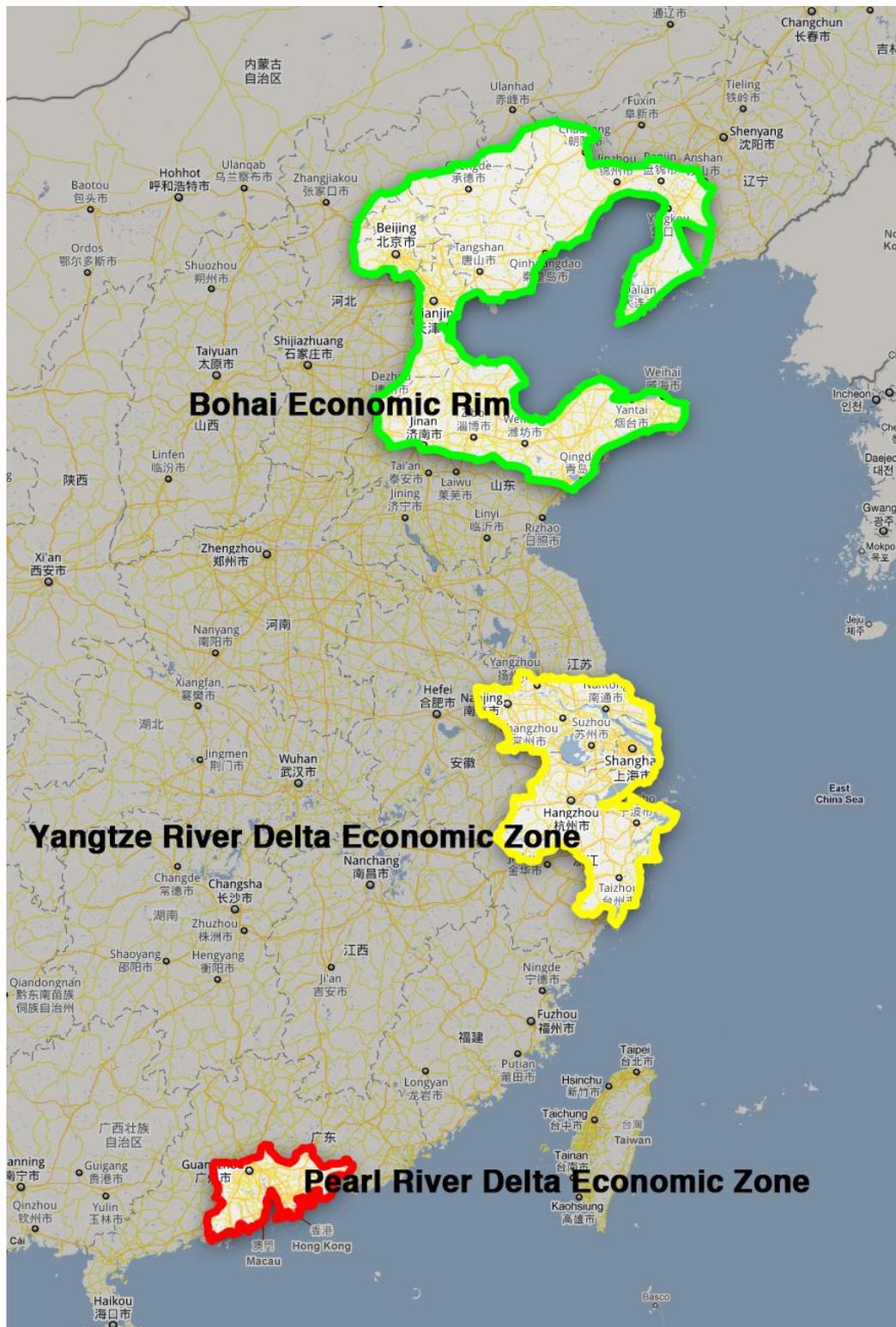
United Kingdom Railway Network: The Transport Politics, <http://www.thetransportpolitic.com>

Australia Railway Network: Australia Rail Maps, <http://www.railmaps.com.au>

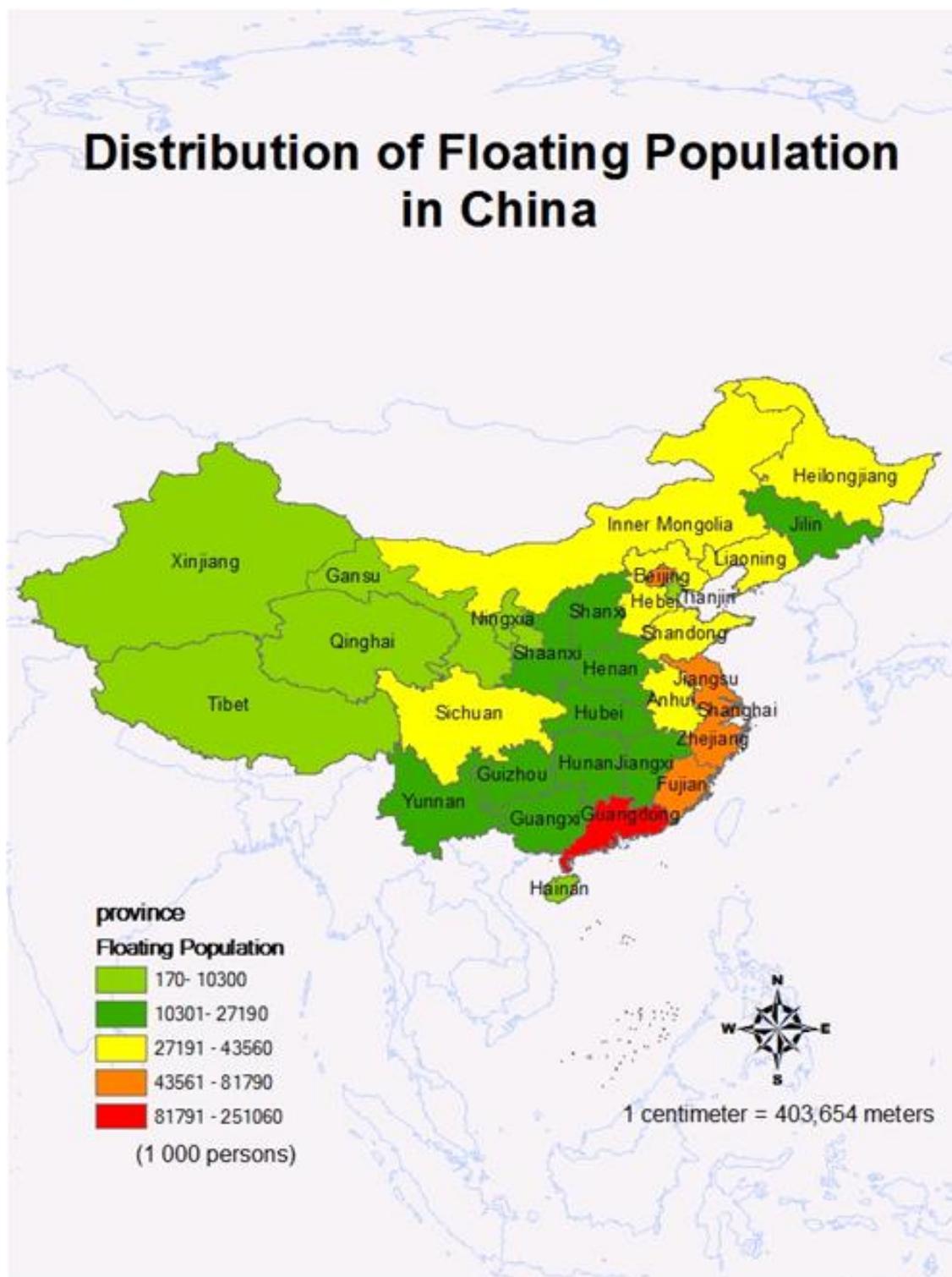
France Railway Network: Holiday Viewer, <http://www.holidayviewer.com>

Japan Railway Network: TravelBuoy, <http://www.travelbuoy.com>

**Map II. Pearl River Delta and Yangtze River Delta**

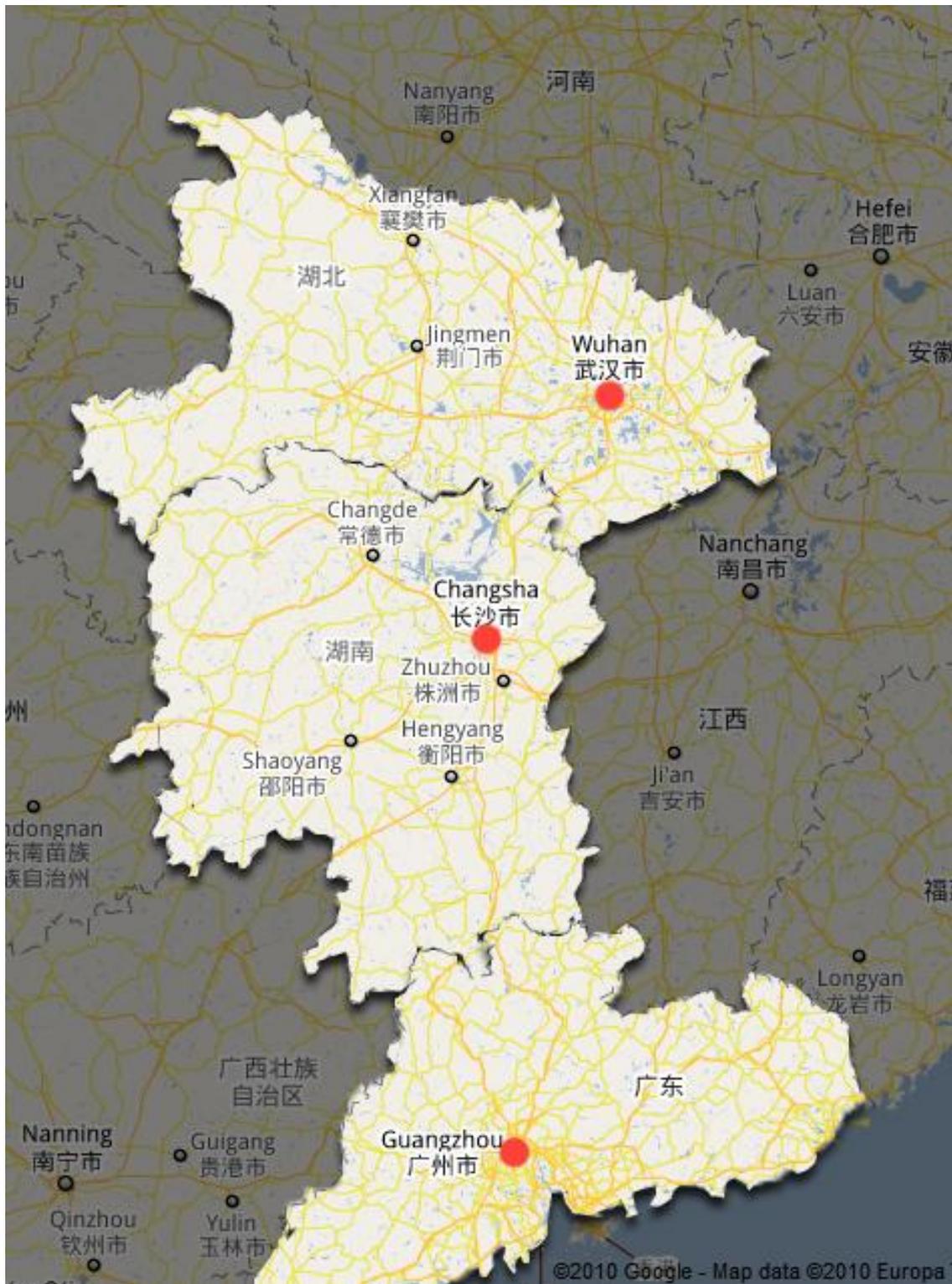


**Map III. Distribution of Floating population in China in 2000**



Source: Ye et al. 2003

**Map IV. Wuhan, Changsha and Guangzhou Location**



**Map V. The Passenger Dedicated Line Network on Schedule in 2020**



Source: <http://www.chineserailways.com>