Balancing China's Seasonal Intercity Travel Demand:

Alternatives for Freight-Rail Expansion to Reduce Seasonal Passenger-Rail Demand

By

Lingling Li

Submitted to the Urban Planning program, and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Urban Planning.

____

Anne Dunning, Ph.D., Chair

____

Bonnie Johnson, Ph.D.

____

Thomas E. Mulinazzi, Ph.D.

Date Defended: November 25, 2013

The Thesis Committee for Lingling Li
certifies that this is the approved version of the following thesis:

Balancing China's Seasonal Intercity Travel Demand:

Alternatives for Freight-Rail Expansion to Reduce Seasonal Passenger-Rail Demand

Chairperson Anne Dunning

Date approved: November 25, 2013

Abstract

Since 2010, China's annual domestic holiday travel for the 20-day season surrounding Spring Festival (a.k.a. Chinese New Year) has exceeded 200 million trips (China Transportation and Communication Yearbook). The demand surges have overwhelmed intercity transportation systems, particularly passenger rail. This transportation problem has emerged due to spatial economic imbalance: workers have had to travel between their homes in rural hinterlands to factory jobs on the industrial coast, which had grown into a migratory population of 261,390,000 by 2010 (National Bureau of Statistics of China).

The objectives of this research were:

- to examine spatial relationships among factories, raw materials, markets, workers, and rail connections; and,
- to identify how development of China's freight-rail industry can or will influence the Spring Festival travel season.

Spatial analysis using geographic information systems (GIS), statistical hypothesis testing, and economic analysis including location quotients were conducted to examine spatial relationships among markets, factories, raw materials, workers, and rail connections. Potential was explored for developing freight trail to support inland vertical industry and employment that might reduce worker migration and thus reduce the surges of the Spring Festival travel season.

It was concluded that research results indicated sixteen inland provinces stood to develop vertical industries and integration. The inland provinces offered resources to support developing six main value-added industries: food processing, fiber development into cloth and textiles, wood and paper products from timber, tobacco products, metals, and machinery. Inland industrialization can offer employment to current migratory workers, thus reducing domestic passenger travel and the volume surges of Spring Festival seasonal demand. As movement of finished goods from hinterlands to the coast replaces movement of workers to coastal factory jobs, freight demand will increase. Increasing freight volumes across the country will produce pressure on the current freight railway network, leading to a need to reverse recent disinvestment by investing in freight infrastructure.

Table of Contents

Figures

List of Tables

China has a gap between supply and demand in its intercity transportation system during the Spring Festival travel season. Essentially, the regional economies of the coastal region and the interior regions have long been unbalanced, which resulted in a huge migratory population. The increasingly migratory population resulted in a substantial seasonal demand for domestic intercity travel. Unlike most of the previous literature, which focused on expanding the passenger railway transportation to solve China's seasonal supply-and-demand gap, this paper researches the planning and strategies of the freight rail industry, and focuses on the connectivity between freight railway transportation and regional economic development. It examines the feasibility of adjusting the existing unbalanced regional economy in China through developing the freight railway industry, which can finally thoroughly solve or at least largely mitigate the Spring Festival travel problem.

China's Changing Regional Development

Rapid Growth of Urbanization

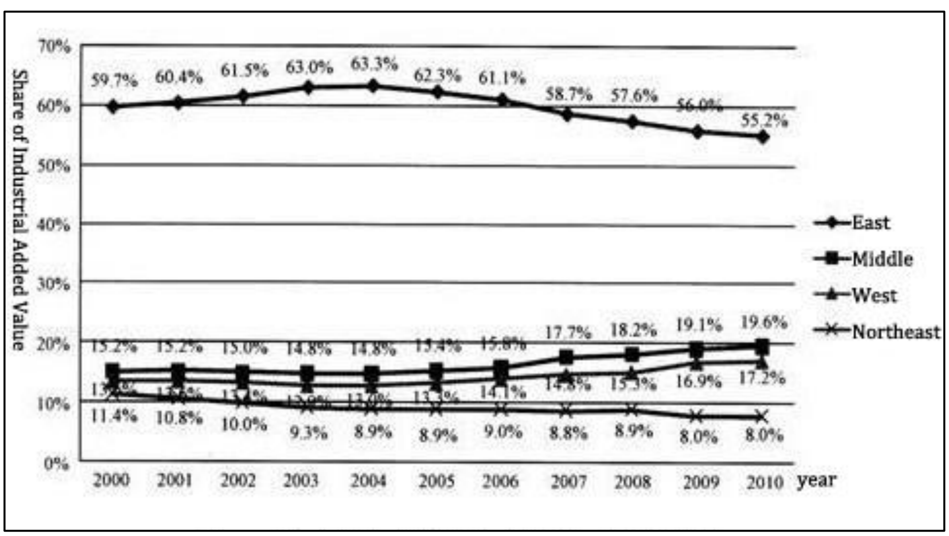
China has faced accelerating urbanization. Before the 1978 program of economic reforms introducing capitalist market principles into the socialistic market referred to as *Reform and Opening,* China's urbanization rate was less than 20 percent. By 2007, the rate increased to 32.9percent, and will be expected to reach 65 percent in 2030 (International Urbanization Development Strategy Research Committee, 2010).

China's Regional Industrial Development

Based on the central government's 11th Five-Year Comprehensive Plan for Economic and Social Development (2005), industry location in China can be divided into four regions: the east coastal region, the middle region, the west region, and the northeast region. As shown in Figure 1, although the central government carried out a series of policies to promote industry development in the interior regions that led to the increase of the share of the industrial added value, there is still a huge gap between the east coastal region and the three interior regions.

Figure 1

Changes in the Share of Industrial Added Value, 2000–2010



Source: China Statistical Yearbooks, 2001–2011.

Table 1 shows the major industry output share of the four different regions in 2010. In general, the east coastal region has absolute advantage in manufacturing and high-technology industries such as computer, integrated circuit, and automobile manufacture, as well as the textile industry. The major industries and factories in the middle and west regions are the bases of energy industries such as electricity processing, coal exploitation, and natural gas exploitation. The northeast region has a solid foundation in the traditional heavy industries, like petroleum exploitation and processing, and iron and steel manufacturing.

Table 1

Share of Major Industry Output

Industry Output	East (%)	Middle (%)	West (%)	Northeast (%)
Electricity	41.11	23.23	29.13	6.53
Natural gas	11.62	3.66	78.88	5.84
Coal	9.62	35.87	47.81	6.7
Petroleum	38.42	2.93	28.88	29.77
Iron	53.02	21.03	14.42	11.52
Steel	55.53	20.72	12.96	10.79
Cement	41.99	26.01	25.31	6.68
Automobile	45.96	17.94	22.33	13.76
Fabric	77.32	12.78	6.82	0.78
Cigarette	31.35	28.16	35.92	4.56
Micro-computer	99.45	0.51	0.03	0.02
Molectron	91.73	0	8.06	0.21

Source: China Statistical Yearbook, 2011.

According to Chen Yao and Chen Yu (2011) and Xiao Chunmei (2011), there are several major problems in China's regional industry development and factory location. First, as mentioned previously, the industry location and development is unbalanced between the east coastal region and the interior regions. In 2010, the three states in the coastal region, Guangdong, Shandon, and Jiangsu, had taken more than 30 percent of the gross industry output value, while the total value of industry output of the other 10 interior states only took around 8 percent. Second, heavy industry plays a key role in industry development. According to a 2009 survey, heavy industry had taken 73.2 percent of the whole large-scale industry (Xiao Chunmei, 2011). This trend is still growing. Third, the export trade has taken the dominate position in industry development, which assembled in the coastal region. In 2004, the industry output of foreign enterprises had taken almost 75 percent of the total value of industrial output. The growth rate of export is much faster than the growth rate of gross domestic product (GDP). In 2005, China's export growth rate was 28 percent, while GDP growth rate was 10.4 percent. Fourth, the manufacturing aggregated in the coastal region, which resulted in the agglomeration economies. Therefore, it is difficult to transfer these industries to the interior regions in the short term.

Classical Theory and Applicability of Regional Development and Factory Locations

There are plenty of theories about regional industry and factory locations. These can be divided into two major categories: equilibrium development and disequilibrium development.

Three theories of equilibrium development have been analyzed for their applicability to China. These are the neoclassical trade theory, the Big Push theory of economic development developed by Paul Rosenstein-Rodan in 1943, and the vicious cycle of poverty theory developed by Ragnar Nurkse. The neoclassical trade theory is based on the law of diminishing marginal returns. The theory states that in the developed region, the high capital stock per capita leads to the low return of capital, while in the developing region, there is abundant workforce and low income. Therefore, the capital flows to the under-developed region, while the workforce goes to developed regions, which finally results in the development of equilibrium among regions. However, the neoclassical trade theory is not applicable to China. Besides its over-idealism, China's dual economies, a circumstance common in developing countries, has made both the capital and workforce flow to the developed region on the east coast, which has enlarged the disparity among regions.

Besides the neoclassical trade theory, both the Big Push theory and the vicious cycle of poverty theory provide regional industry development theories for developing countries and regions. However, the Big Push theory relies heavily on government interference, and puts strict limitations on free market development, which is opposed to the development objective of China's central government. The vicious cycle of poverty theory intends to promote the synchronous development among multiple regional industries, which is over-idealistic and not applicable to China's large regions and complicated markets.

Compared with the theories of equilibrium development, the disequilibrium development theories, including the Product Life-Cycle theory originated by Vernon and the Cumulative

Circle Causation theory developed by Myrdal are more widely used in developing and analyzing the strategies of the regional factory and industry location in China and foreign countries. The Product Life-Cycle Model (Vernon, 1966) indicates that each region is in its own economic development stage. The three major gradients are new, mature, and standardized production. In the gradients of new and mature production, the industry and technology transfers from cities to suburbs. In China, according to the Product Life-Cycle Model, most production is in the new or mature gradients. As development progresses, the industry and technology will in time transfer from developed regions to undeveloped regions. According to the Cumulative Circle Causation theory, to promote industry in a developing country, the government needs to carry out some unbalanced strategies to preferentially develop industry in the regions with favorable geographical location, convenient transportation, and fast economic development. Then the diffusion effect of this region can promote the industrial development in other under-developed regions (Eff, 1999). In the 1970s, both the Gradient Transfer theory and the Cumulative Circle Causation theory were introduced into China's regional economic research, which played an important role in the Reform and Opening in 1978.These strategies of prior development in the east region successfully resulted in the agglomeration economy with fast growth (Gao Shenhong, 2002). However, until now, with the huge economic gap between coastal and interior regions, the diffusion effect of industrial development has not been obvious.

According to the classical location theories like the Weber model of industrial location (L'Harmet, 1998) and the theory posited by David L. Huff (personal communication), for a country like China where heavy industry dominates manufacturing, transportation cost is the significant consideration and the most crucial principle of factory location. The cost is divided into two categories, the procurement cost and distribution cost. Therefore, the optimal factory location is at the market where the distribution costs are minimized and procurement costs are zero. At the current time, since China's manufacturing has been dominated by the export trade, in accordance with the classical location theories, the enterprises have preferred to locate factories in the coastal region, where there is much less distribution cost, rather than the interior regions. Therefore, besides agglomeration mentioned previously, the number of factories in the coastal region continue to grow.

Cultural and Population Effect

Population Growth and Change

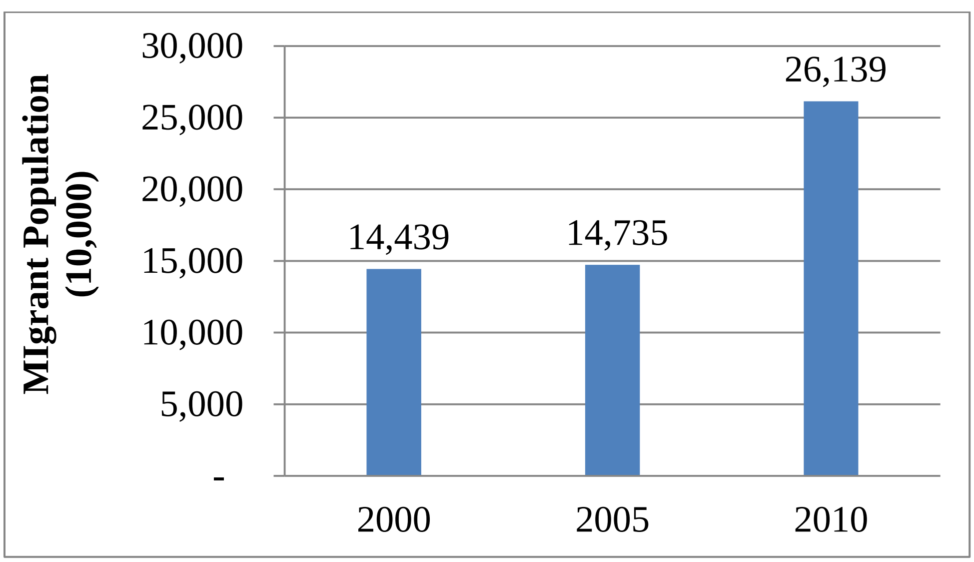
As mentioned previously, China is experiencing rapid urbanization. China's government focused on development of labor-intensive industries in metropolitan cities, which resulted in a great migration of the rural surplus labor force to metropolitan areas to find employment opportunities. Figure 2 shows that with the development of urbanization, the migratory population has continued to increase. The floating population, most of which is migrant labor, increased 81 percent from 2000 to 2010; therefore, this rapid urbanization created a spatial mismatch between worker homes and places of employment, changing long-standing cultural traditions of staying in proximity to family (Feng Jicai, 2010).

Changing Travel Demand

Intercity travel. As Chinese workers migrated to factory towns and their families stayed in traditional homelands, unprecedented travel demand emerged between the two. Between 1979 and 2009, demand for passenger transportation increased 9 percent annually. In 2009, more than 29 billion passengers were transported (Mao Baohua, Sun Quanxin, and Chen Shaokuan, 2009).

Figure 2

China's National Migratory Population



Source: National Bureau of Statistics of China, 2012.

Migratory workers do not commute from their homelands daily. They tend to travel home for holidays and other special occasions. Confucianism, which is the core of Chinese traditional culture, emphasizes values oriented to the family rather than the individual (Feng Jicai, 2010).Confucianism plays a key role in the Chinese traditional outlook on values, which make much account of family and homeland. Cultural family bonds stretched over distances to urban workplaces have created the need for travel.

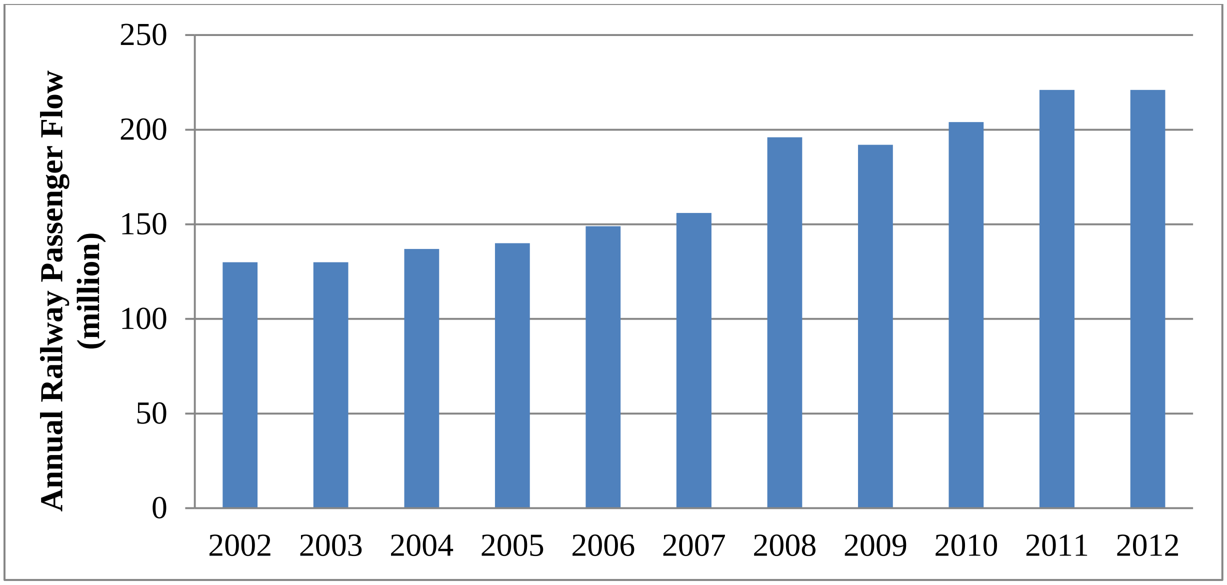
The increasingly migratory population resulted in a substantial seasonal demand for domestic intercity travel. The large seasonal demand has far exceeded regular travel demand for which transportation capacity is traditionally scaled. Demand for special-event travel started overwhelming the supply to an unprecedented degree, spurring quick development of transportation infrastructure.

Seasonal demand. The most representative situation of this mismatch is the Spring Festival travel season. The Spring Festival, which is also called the Chinese New Year, is the most important and longest traditional holiday in China. The traditional celebration runs from the last day of the Chinese calendar of the previous year to the 15th day of the first month of the New Year, which lasts 20 days. The key concept of the Spring Festival is “reunion.” During this holiday, migrants far away from home return to reunite with their families. Although Spring Festival customs and traditions have varied from region to region, the most important tradition for Chinese families is gathering for the annual reunion dinner.

The period around the time of this holiday is known as the Spring Festival travel season and has extremely high traffic load. Figure 3 shows that in2010, railway passenger flow exceeded 200 million passenger trips in the Spring Festival travel season; these seasonal flows have continued to increase in subsequent years. This period has been called the largest annual human migration in the world (Shao Cen, 2008). In recent years, the travel demand during this period has been expanding rapidly, especially for the railway. The main passengers are the laborers who work in big cities and return to rural areas to reunite with their families during the Spring Festival. Figure 4 shows the passengers structure during the Spring Festival rush in 2011. It indicates that the laborers account for more than half of the whole travel flow. Therefore, during the Spring Festival travel season, most of the passenger flow is unidirectional and highly concentrated. Before the Spring Festival, the flow is from metropolitan areas on the coast to the countryside in the middle and western regions. Traffic flow is reversed after the Spring Festival (Mao Baohua, 2009).

Figure 3

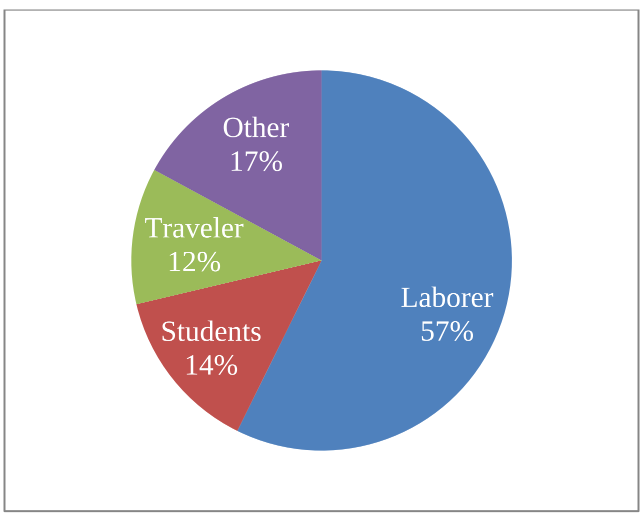
Annual Railway Passenger Flow in the 40-day Spring Festival Travel Season, 2002–2012



Data sources: China Transportation and Communication Yearbook, 2000–2011.

Figure 4

Passenger Structure, 2011



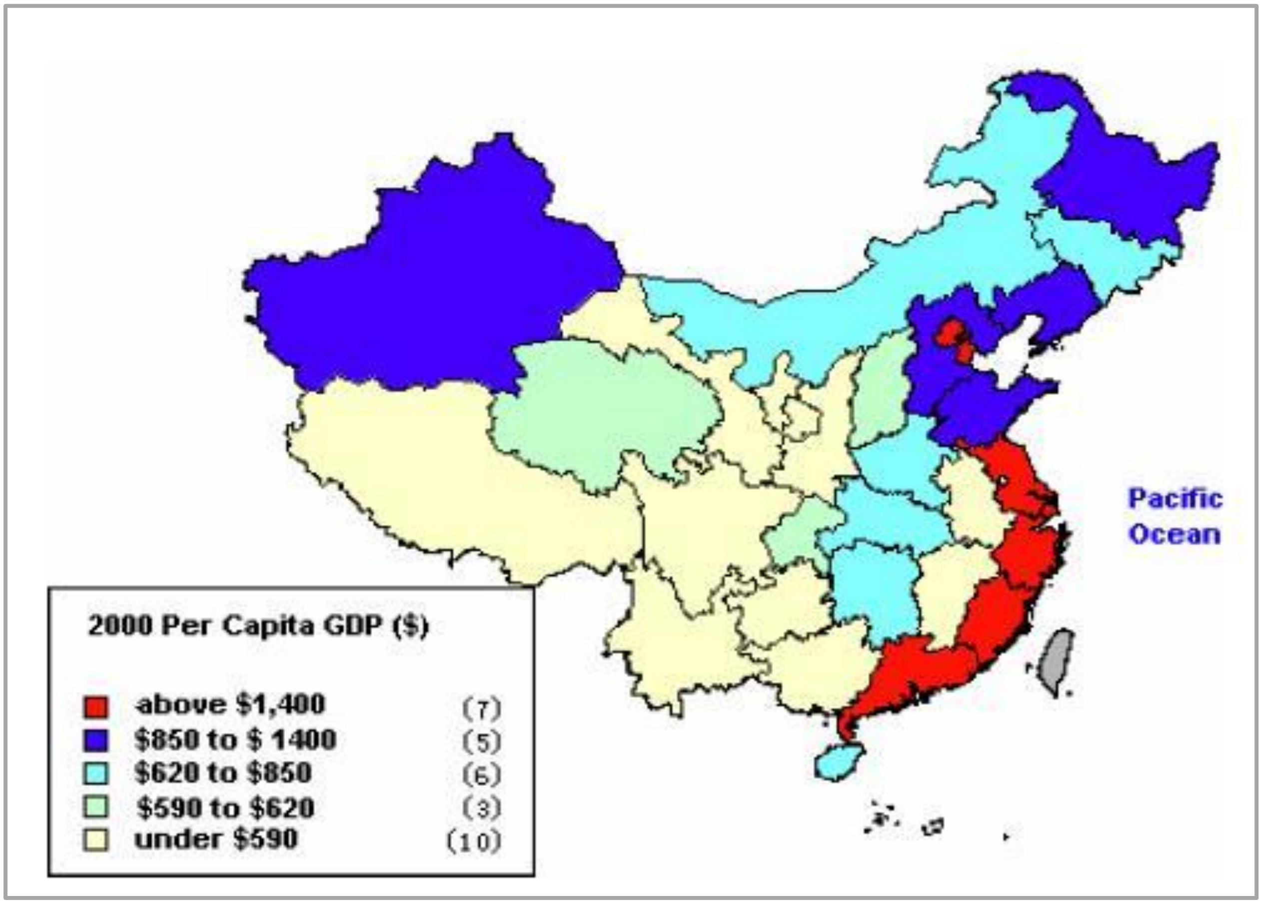
Source: China Transportation and Communication Yearbook, 2000–2010.

Reasons for demand growth. The way the Chinese transportation system has developed since the Reform and Opening has done little to mitigate Spring Festival transport problems, which have been growing with the development of the national economy. The previous literature paid much attention to the aspects of sociology and technology to analyze the reasons for China's Spring Festival transport problems. Some authors have concluded that the relevant factors of the Spring Festival travel season are the economy, culture, population sociology, operational management, and infrastructure (Zhou Ying, 2012).

Unbalanced regional economic development. Experts have pointed out that this phenomenon has resulted from China's unbalanced regional economic development, particularly the poverty in western China (Zhou Ying, 2012). Existing research has made detailed analysis of this regional economic aspect. For instance, Bin Jiang and Edmund Prater (2002) note that the "Reform and Opening" strategy has widened the gap between rich and poor because this strategy has accelerated the process of industrialization in China. Therefore, the rural surplus labor force in the middle and western areas is growing. Since the 1980s, China's market system has gradually turned from socialism to the free market. To experiment with this national economic strategy, China's central government planned five special economic zones along the coastal areas. After 30 years of construction and development, these zones play a key role in guiding the economic development of the whole coastal areas, which have made the disparity between the coastal and inland regions even larger. Figure 5 and Figure 6 show the huge difference in the industry output between the coastal and inland regions. Thus, as the manufacturing markets, especially the handicraft industries that need a large number of laborers, have rapidly developed in coastal areas, the trend has been for surplus laborers from rural areas to come to the coastal areas. This process of industrialization has resulted in a huge labor flow through the countryside.

Figure 5

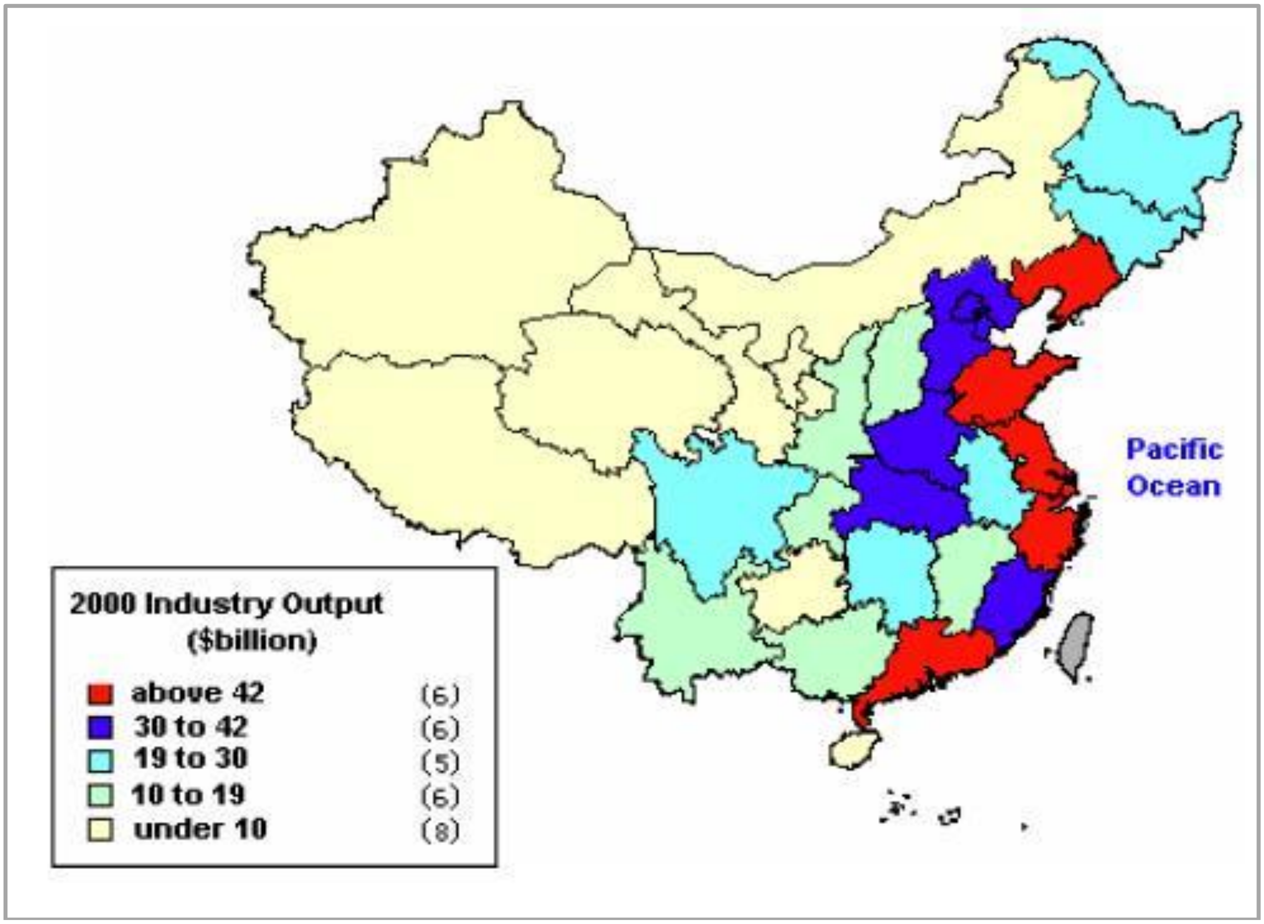
Distribution of Chinese Gross Domestic Product, 2000



Source: China Statistical Yearbook, 2000.

Figure 6

Chinese Industry Output, 2000



Source: China Statistical Yearbook, 2000.

Some experts, like Wang Luolin and Wei Houkai (2003), researched the impact of the unbalanced development of the regional economies on transportation. In China, the flourishing import and export trade made the coastal areas with developed transport networks far more affluent than the inland areas, especially the remote western areas. The coastal areas take the advantage as pioneers in developing the advanced industries such as information technology, biological engineering, and tertiary industry, while the remote western areas developed slowly and late because of the insufficient information and education. It is difficult to view China as a whole market. Instead, it is reasonable to divide China into two separate markets: the coastal area with the population of 400 million and the inland area with 900 million people.

Low cross-price elasticity. Other experts researched the microeconomic aspect to find the reason for the Spring Festival problem. According to Zhao Rongzhi (2011), there is not much cross-price elasticity of demand between railway and other modes of transport during the Spring Festival travel season. However, during other times of the year, the passenger market share of these modes, especially the highway, have become larger. During the Spring Festival, because of the particular categories of passengers, the cheaper ticket prices, and better accessibility, it is impossible to find other modes of transportation to share the burdens of railway.

Cultural significance. From a cultural perspective, the existing research contends that the traditional culture is the leading reason for this problem (FengJicai,2010).Some have suggested finding solutions through culture, such as emphasizing other traditional festivals such as Mid-Autumn Day and the Qingming Festival to disperse passenger flow into different periods. However, other experts such as Xie Linxia (2008) mentioned that family reunion during the Spring Festival results from the traditional concept of family and sense of worth. These traditions prevail in rural areas in central and western China, and cannot be replaced by new festivals in a short time.

Strict household registration system. In population sociology, DeJong and Fawcett (1981) describe a period of social transition and the advanced technology in transportation and communication that could result in frequent population migration. After the Opening and Reform, and the resultant rapid urbanization, the situation in China matched these conditions, which led to the large number of laborers who became the main passenger flow during the Spring Festival travel season. China’s strict household registration system is the leading reason for this condition. This system has divided the population of 1.3 billion into two categories: the farming population and non-farming population. According to existing research, more than 70 percent of the farming population in China is assembled in the western and middle regions (Wang Luolin and Wei Houkai, 2003). And these people cannot obtain any relevant social welfare in urban areas no matter how long they work there. For instance, it is difficult for the rural laborers to buy houses and send their children to school in urban areas. Thus, their families have to stay in the hometowns (Liu Li, 2012). Thus, every year during Spring Festival, many rural laborers travel to reunite with their families.

Addressing the New Demand

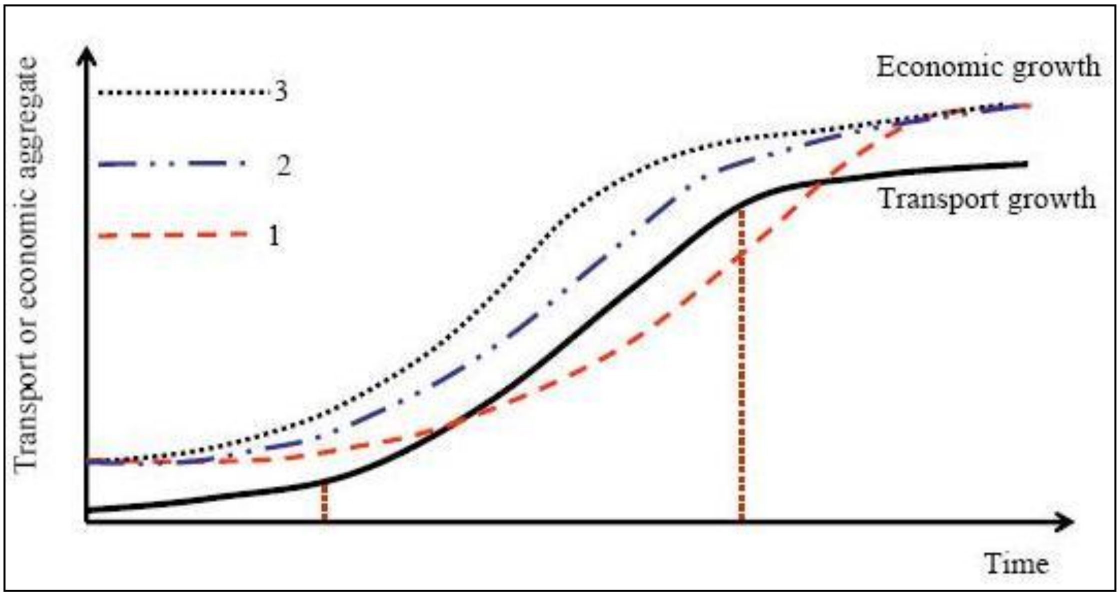
China's Intercity Transportation System

With a huge population, China has chosen her own patterns of intercity transportation development (Wang Qingyun, 2007). Several authors have contended that China has made great progress in the intercity transport system, especially for passengers, after the Reform and Opening policy issued in 1979(Wang Qingyun, 2007; Mao Baohua, Peng Hongqin, and Jia Shunping, 2010).

The past 20 years have yielded progress in national transportation infrastructure construction and major issues in relevant initiatives, such as the high-speed railway network and the General Assessment of the 11th Five-Year Comprehensive Plan for transport development; however, as the world's largest developing country, China's transportation has long lagged behind and constrained economic development. As stated by Mao Baohua and colleagues (2010), the relationship between the transportation industry and social and economic growth can be classified into three types by stage, as shown in Figure 7. Line 1 is the ideal transport-leading type. In this situation, transport can lead to growth of economic demand. Line 2 is the transport-adapting type, in which transport supply roughly matches the demand. Most developed countries have already entered this stage. Line 3 is the transport-lag type, in which economic growth leads transport. Line 3 represents the current situation in China, especially during special events like the Spring Festival travel season, where there is a growing gap between supply and demand. The seasonal, time-limited nature of the demand and regional imbalance are the major characteristics of China's transport industry, which led to the primary problems during Spring Festival (Wang Qingyun, 2007).

Figure 7

Relationship between Transport and Economic Growth



Source: Baohua et al. (2010).

Compared with the whole progress of transportation development in China, the development of the railway system has lagged far behind other modes of transport. The central government and its comprehensive intercity transport policy paid more attention to modes other than the railway for ordinary needs. Of all transportation modes, highways and airlines have developed much faster than railways. Their respective 11.3 percent and 17.2 percent average annual growth is larger than the 6.7 percent increase in passengers carried by railways.

The growth discrepancy among modes is one of the main factors for the spring festival transport problem because railway is the main passenger transportation mode for long-distance intercity transport during this special period (Mao Baohua, 2009). Other authors pointed out that the middle and western regions in China, which have a severe shortage in railway infrastructure, are the main destinations for the labor flow during Spring Festival, which led to the inadequate supply. Instead, middle and western China continue to pay much more attention to the construction of the roads (Kun-Chin Lin, 2010). Local governments in the middle and western regions tend to consider highways as more advanced and indicative of a higher-quality urban environment, and therefore more likely to attract investment. Highway construction is seen as a more notable “political achievement” by the leaders and bureaucrats. Therefore, a number of local governments focused on funding highway projects, such that there was not enough financing for the railway infrastructure construction.

Intercity Passenger Rail during Spring Festival

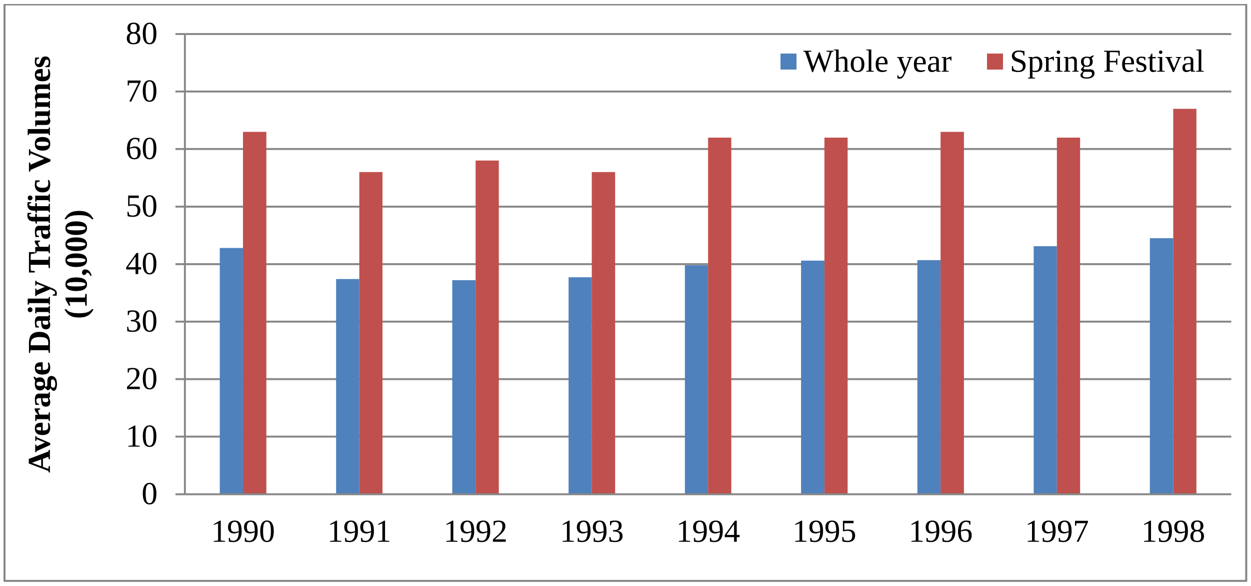
From a recent survey about the travel mode choice of laborers, we know that in China, more than 80 percent of the laborers choose railway for long-distance travel during the Spring Festival rush (Zhou Ying, 2012). There are many reasons for this phenomenon. Compared with other long-distance transport modes, the railway ticket prices are cheaper, and the ridership is larger. Moreover, the railway has better accessibility, an important factor because China has large remote areas without any airport or highway bus station.

After the Reform and Opening, with the development of other modes of intercity transportation, the market share of the railway has been decreasing year by year (Wei Zhou and Szyliowicz, 2006). In 1980, the market share was more than 60 percent; however, in 2002, it decreased to 35.2 percent, and continued to decline. Because of low market share throughout the year, there seems to be no need to expand the railway infrastructure: expanded routes and increased infrastructure will be operationally difficult to maintain because of the high ongoing costs (Wang Qingyun, 2007).

During the Spring Festival travel rush, the situation is different. In recent years, the Spring Festival travel season has become the main income source of the railway industry. For instance, in 2002, during this 40-day travel season, holiday passengers made up17.29 percent of annual railway revenue. There is a corresponding gap between day-to-day demand and demand for special-event capacity. For example, **Figure 8** indicates that Spring Festival daily traffic volumes for the Guangzhou Railway Bureau are almost 1.5 times the average daily volumes of the whole year. Even with the large number of passengers served during Spring Festival each year, current ridership fails to meet demand during the travel season.

Figure 8

Average Daily Traffic Volume



Data sources: China Statistical Yearbook, 2000–2011; China Transportation and Communication Yearbook, 2000–2010.

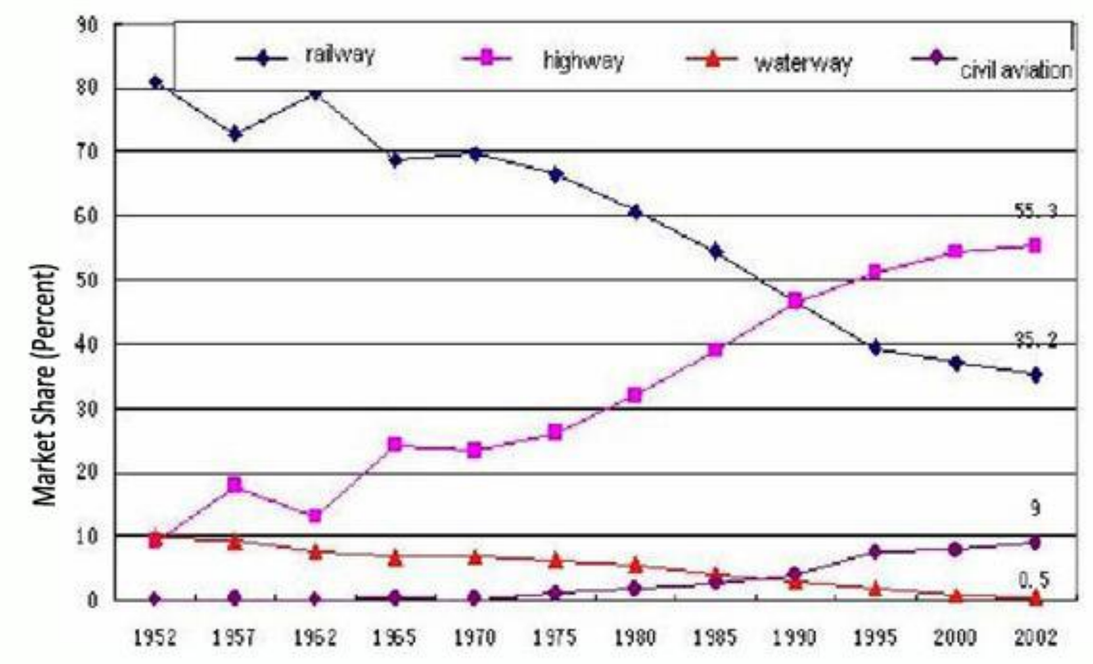
During every year's Spring Festival, transportation problems capture public attention. Each year, the spokesman of the Railway Ministry has promised to solve or mitigate the "hard-to-get tickets" problem; however, the demand-supply gap has continued to increase. Public discontent has grown, especially among the low-income rural labor force from rural areas (Zhou Ying, 2012).

Challenges in Supply of Passenger Rail

Operational management. In operational management aspect, Li Yinan, in "Monopoly, Competition and Regulation: China Railroad Reform" (2001), points out that the railway system has been losing industry share for years. From the 1980s, the market share of freight and passenger rail has continued to decrease. Beginning in 1994, the whole railway industry has run a deficit. Thus, there is not enough investment to expand the infrastructure. In China, the railway industry is usually considered to have a natural monopoly. The research of Wei Zhou and Joseph S. Szyliowicz (2006) provided an analysis of the current status of different modes of transportation in China. Figure 9 demonstrates that since the1980s, the passenger market share of the railway has reduced. And since 1994, the whole railway industry has lost money. There are many reasons for this situation. Free from pressures of competition, the monopoly tended to grow inefficient in operation and management (Steinemann, 2011). Although the market share has gradually reduced, the costs were still increasing, which led to a vicious cycle. When other modes of transport made effective improvements, such as the development of a long-distance bus industry and the lowering of air ticket prices, the railway became less competitive.

Figure 9

Trends in Mode Split



Source: Wei Zhou and Szyliowicz, 2006.

Transportation infrastructure. From a transport infrastructure perspective, some authors have pointed out that in general, China has not had a developed railway network (Wang Qingun, 2007). In 2000, the density of a railway route length was 5.38 cm per capita, which is far behind developed countries such as Britain and Germany, and cannot match the rapid growth of the economy. The railway system is unbalanced between the eastern coastal area and the western regions. Table 2 demonstrates that the density of length and infrastructure in the western regions are still far below the coastal areas, with only one fourth the density of coastal areas. Thus, railroads in the western regions cannot meet the needs of excessive passenger flows during special events. Moreover, during the Spring Festival rush, the passenger flows are highly concentrated, and the main streams flock to the trunk railway network that link with the eastern and western areas. Figure 10 indicates that the density of trunk railway network in western regions is also much lower than the eastern areas, and cannot satisfy the huge unidirectional traffic flows.

Table 2

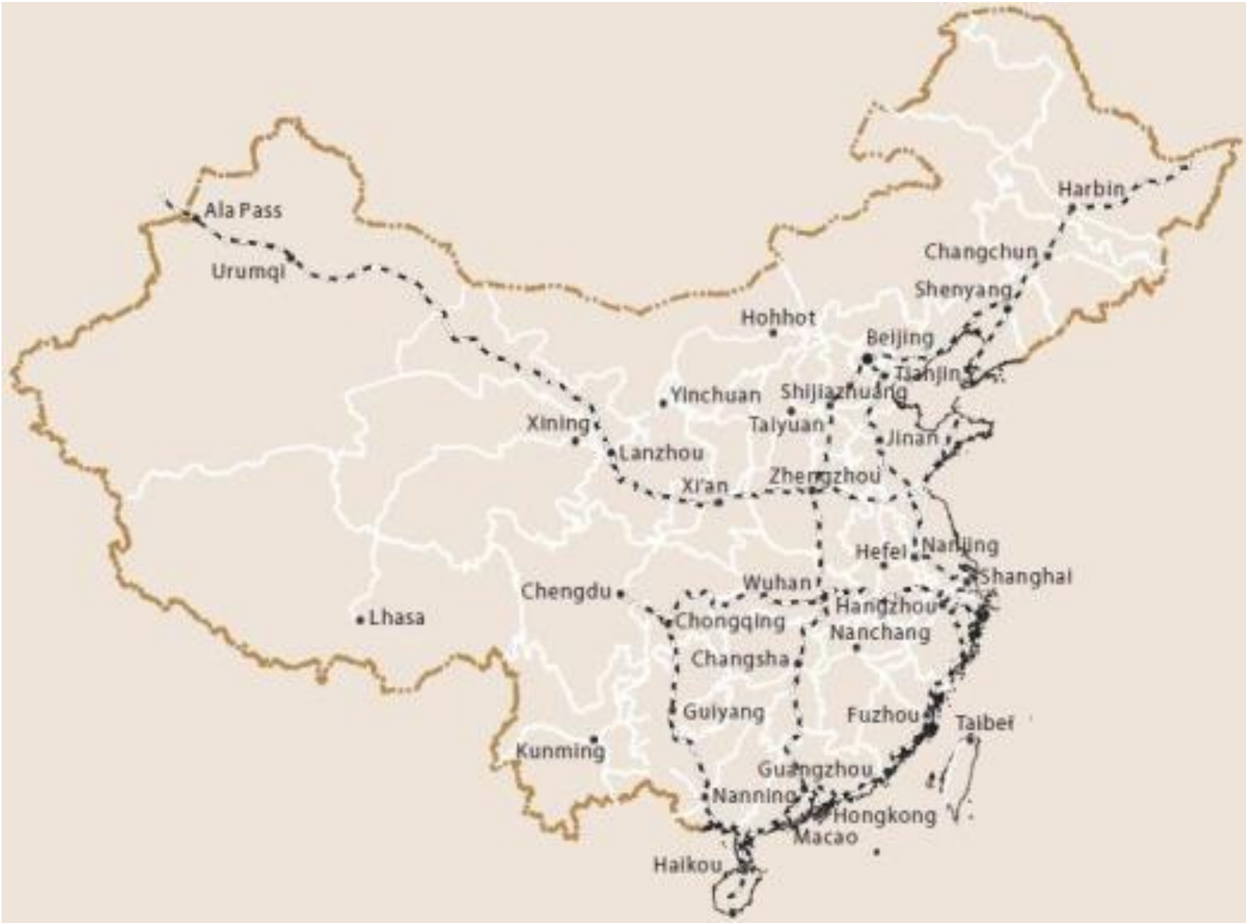
Density of Rail Infrastructure, 2000

Region	**Railways** (km/100 km^2)	
	National	Local
Eastern	1.40	0.13
Central	1.33	0.15
Western	0.33	0.02

Source: China Statistical Yearbook, 2000.

Figure 10

China's Trunk Railways



Source: Asian Development Bank, 2004.

Experience with Seasonal Demand

Theoretical Approaches to Temporary Travel Surges and Spikes

There are four major categories of theoretical approaches to solve the seasonal traffic problem: infrastructure expansion, operational expansion, transportation industry reform, and public education and cultural shifts. Among these approaches, infrastructure expansion seeks to increase the scope of supply, while the operational expansion seeks to increase the scale of supply. Both approaches are short-term strategies to expand the supply of passenger traffic. In the long term, the transportation industry reform can promote the growth of efficiency, which will lead to supply expansion. The public education and cultural shifts are also long-term strategies for demand reduction.

Infrastructure expansion (growth in scope of supply). As mentioned previously, there are not enough railway lines connecting eastern developed areas and western areas. Therefore, it is necessary to expand the transport infrastructure. In China, the regular railway networks are passenger and freight rail, while the new high-speed rail trunk lines are all designed only for passenger trains, such as the Beijing-Shanghai High-Speed Line and the Beijing-Guangzhou High-Speed Line.

Dedicated freight railway. India, which also has a huge passenger demand and passenger and freight rail, planned to build dedicated freight rail to relieve passenger crowding on the existing rail network. Beginning in 2010, the Indian railway industry planned to invest $15 billion to $20 billion to establish approximately 10,000 km of dedicated freight railway. The freight lines would parallel existing railways connecting developed metropolitan areas, such as Delhi, Mumbai, Kolkata, and Chennai, which had overcrowded trunk lines. Thus, the existing lines could have more passenger trains, effectively improving daily passenger capacity (Dou Guili, Dai Xinliu, and Sun Xiaofeng, 2009).

High-speed rail network. If the Chinese government has ample funds, it is possible to build a complete high-speed rail network connecting eastern coastal areas and western undeveloped areas, and provide a higher density rail network. China can also learn from the experience of the German high-speed rail system to establish high-speed passenger and freight rail instead of dedicated passenger lines. For example, the Hannover-Wurzburg high-speed line arranged 49 passenger trains in daily operation in the daytime and 37 freight trains operating at night. The high-speed passenger and freight rail can save the high cost of construction, complete the rail network, and also promote the development of manufacturing in western remote areas (Liu Jin, Tao Ran, and Jin Zude, 2003).

Operational expansion (growth in scale of supply). ***Emergency operation.*** Based on the existing transport infrastructure, during the Spring Festival travel season, the railway system reached the limits of the frequency of departure and hours of operation. As in other huge transport events such as the Olympics, to expand supply the operation system made a series of emergent strategies, such as increasing the frequency of departures and the number of vehicles, and extending the operation hours. However, even when the rail network runs almost non-stop, it still cannot meet the passenger demand. The railway industry also tried to restrict demand through raising the ticket prices, which was an ineffective approach. Thus, there is little space for the expansion of emergency operation during this special period. However, as was seen in the experience of the Beijing 2008 Olympic Games, it is possible to make some improvement in operation details such as adding extra workforce in the main stations to guide traffic flow and cope with emergent affairs, which can improve the efficiency of passenger flow distribution and transfer service (Mao Baohua, 2010).

Technology. Improving the ticket-sale system can reduce the waste of resources, and make a positive impact on the ridership management. In India, through the advanced passenger reservation system (PRS) and the real-name system, it is convenient to purchase individual tickets and group tickets online and in more than 1400 ticket-sale stations all over the country (Li Hongchang, 2009). Groups of passengers can purchase group tickets online with preferential policies such as discount and priority, which can be considered to improve the group ticket system in China to specifically serve the migratory workers. It also can avoid the unfair resource allocation caused by ticket scalpers and reservation tickets.

Taking experience from Japan Railways, the high-speed rail network can have multiple types of trains with different speeds, which can meet the various passenger demands. For example, the Japan Rail-East uses seven types of operation speed, which can use limited resources at maximum effectiveness (Li Hongchang, 2009).

Industry reform. Besides the expansion of infrastructure and operation, to improve the efficiency of operation and mitigate the demand-supply gap, it is necessary to have a reform of

China's state-owned railway company with the combination of government function and enterprise management. The following discusses the experience of the reform of the railway industry in Europe and Japan (Lan Zhe and Wen Li 1998; Liu Jin, et al., 2003).

Separation of infrastructure and operation. The Swedish rail system was the first system to separate infrastructure and operation, which built on the experience of highway management. In 1988, the Swedish National Rail (SNR) split into two individual systems. One independent company with autonomous management operates passenger transport in trunk lines and freight transport in branch lines. A state-controlled department is responsible for the infrastructure construction and maintenance using federal funds. Meanwhile, all companies using the railway network pay user charges to the federal government, including a fixed cost for each train and an alterable cost according to the wear and tear on the infrastructure. This strategy made the railway industry more competitive, and was immediately implemented by other European countries such as Spain and Germany.

Specific legislation and relevant regulation for reform. British Rail began to embark on reform and privatization in 1990. Like Sweden, British Rail also split management of infrastructure from train operations. In 1993, the government issued the 1993 Railway Act to guide the whole restructuring. This legislation made the rail industry separate into independent units, such as rail infrastructure, rail maintenance companies, rolling stock leasing companies, and freight and passenger service companies. It entitled the government to sell the restructured units to the private companies. It also created a body to oversee the franchising of the service of the railway (Koning, 2012). Japan provides another example: to guarantee the implementation of reform, Japan's government instituted a series of regulations and code, such as Japan's National Railways Reform Regulation, which provided the explicit guide for the reform process.

Pluralistic economy. Japan's reform of its railway industry improved the competitiveness of each railway company by introducing a pluralistic economy. Most of the companies began to develop multiple businesses, such as developing the real estate, tourism, entertainment, and insurance industries. Thus, the companies had enough funds to expand the supply and service of the railway industry to improve the market share, which created a cycle of improved services.

Federal subsidy. To promote the reform of the railway industry, there should be relevant federal subsidy. For example, in Japan, with the rapid development of the railway network, the central government supplied more subsidies to maintain the evolution of the rail industry. Likewise, the French government also offers six categories of subsidies for different objectives: basic infrastructure construction, branch line construction and maintenance, route for national security, retirement subsidy, debt subsidy, and a subsidy for preferential ticket fare. These subsidies guarantee that the railway industry can compete fairly with other modes of transport.

Public education and cultural shifts (long-term demand reduction). ***Economic rationale for factory co-location.*** There are plenty of regional theories to explain the factory and population clusters. A factory can benefit from both internal economies of scale and external economies of scale. The advantage of the internal economies of scale is that the larger scale production can result in lower cost per unit. According to the World Development Report (WDR) 2009 (World Bank, 2009) team, the internal scale economies are low in light industries and high in heavy industries. As mentioned previously, heavy industry plays a prevailing role in China's whole industry. Therefore, the scales of the heavy industrial factories intend to be large, which can easily result in co-location and external economies of scale. The external economies of scale are also called *agglomeration economies,* which result from the external localization economies and the external urbanization economies (Baldwin, 2005; World Bank, 2009). The sources of external localization economies include the share of input suppliers, share of the labor pool, and share of information, which can lead to the firm cluster of one industry. The sharing of input suppliers is crucial for the firms with high transportation cost and high inventory maintenance cost, while sharing a labor pool and information are very helpful, especially for the firms requiring intensive labors, specialized skills, and high technology. Other than the external localization economies, the external urbanization economies will not just lead to the agglomeration of one particular industry, but result in the increased scale of the whole industry in one region, which will increase the industry productivity, the rate of plant births, and the opportunities of employment.

Motivations of industry transference. There are four major categories of motivations of industry transference: disparity in economic development, adjustment of industrial structure, policy incentives by government, and private-sector motivation.

The disparity in economic development is the basic motivating element for factory relocation and industrial transference. As analyzed previously, according to Vernon's Product Life-Cycle Model, each region is on its own economic development gradient, which leads to the disparity in economic development, and the leading region and the lagging region. According to Gunnar Myrdal’s theory of development, the regional economic development has both the spread effect and the backwash effect. If the spread effects are dominating, the industry and technology will transfer from high-gradient regions to low-gradient regions, which can decrease the disparities.

Another major motivation is the adjustment of industrial structure. Experience demonstrates that regional industrial structures typically experience five steps of orderly transfer: (1) resource-intensive industry,(2) labor-intensive industry,(3) capital-concentrated industry,(4) technology-intensive industry, and (5) knowledge-intensive industry (Cui Haichao, 2009).Currently, in China manufacturing still has an important role in the coastal region’s industrial structure, while the interior region is the fundamental base of resource-intensive industry in China. With the upgrading of industrial structure, the developed region will experience the growth of higher gradient industry such as technology-intensive industry and knowledge-intensive industry. The labor-intensive industry and capital-concentrated industry will transfer from the coastal region to the interior region.

For industry transfer, the guidance of government policy is a crucial motivating factor, especially in China, where the central government plays a key role in market regulation. As analyzed previously, to balance the economic market, China’s central government has issued a series of preferential policies in the west regions, such as tax cuts for the enterprises that invest in the interior, construction of infrastructure for industry and transportation, reduction of the price of land-use rights for economic development, and moving state-owned factories to the interior. All these strategies have made an impact on industry transference.

The benefit drive of enterprise can also motivate the relocation of factories and industrial transference. According to John H. Dunning’s (2000) “eclectic paradigm,” the enterprise has three categories of advantages: (1) ownership advantage, which includes production technique, trademark, entrepreneurial skills, and return to scale; (2) location advantages such as the existence of raw materials, a cheap labor force, and special taxes or tariffs; and (3) internalization advantages, which include the merits of self-production rather than production through a partnership arrangement. All these advantages are motivating factors for enterprises to invest in or move factories to other regions.

Solutions other than factory co-location. Besides the development of a freight railway system, some researchers have considered the possibility that the government could make some changes to the Spring Festival, such as altering or shortening the period, or decreasing its importance. An example of a government changing a cultural event occurred when the North Sea Jazz Festival, a music festival originally held in the Dutch city of The Hague, was moved to another city because of the better geographic location for transportation and other economic objectives (Van Aalst and Van Melik, 2011). However, it would be much more difficult to change the traditions of the oldest and most important festival in a huge nation than to change the traditions of a local music festival no more than 30 years old. The feasibility is too remote.

Another option would be for the government to terminate the Spring Festival to reduce the seasonal traffic demand. However, as mentioned previously, the Spring Festival is one of the most important traditions in China, with a long history and rich cultural significance. It is almost impossible to terminate such a significant activity in China.

A third option to mitigate the huge seasonal traffic demand would be for the government to consider moving people from the interior homeland instead of transporting freight. However, at the current time, as mentioned previously, with all the strategies and policies China's government has carried out, the rail passenger system has already reached its limits and cannot expand capacity in the short term. In addition, the cost of expanding passenger traffic capacity is significant for the railway industry. Therefore, these solutions are not applicable to China's existing situation.

Limitation of potential approaches. Table 3 characterizes hypothetical impacts of various approaches to solving China's Spring Festival travel problem. Each of these approaches has its own drawbacks, and these characterizations remain vague and require further in-depth inquiry. According to Table 3, to solve the demand problem in the short term, other strategies and experiences need to be considered.

Table 3

Potential for Applying Approaches to China's Intercity Passenger Rail

Strategy	Benefits	Drawbacks
Infrastructure Expansion	Permanent assets	Expensive
Operational Expansion		
Workforce	Emergent operation Improved efficiency	Little impact
Vehicles	Increased temporary supply	Small improvement
Hours of Operation	Increased temporary supply	Small improvement
Technology	Maximum effectiveness Reduce resource waste Specific service for passengers	Expensive Uncertain feasibility
Industry Reform	Improve efficiency Monopoly reform More competitiveness Less burden for government	Uncertain feasibility for socialist country
Cultural Change	Permanence	Strong resistance Long wait before results manifest High cost

World Experience with Seasonal Travel and Special Events

There are two categories of experience relating to the Spring Festival travel season: huge demand for railway service and seasonal and special event travel. Each category has its own typical case.

High demand for railway service in India. India has the second largest railway network in Asia, second only to China. India and China are the only two countries with a state-owned railway company with combined government function and enterprise management. India has the Ministry of the Railway, which operates and manages the railway network through zonal railways and divisional railways. It is almost the same as China (Li Hongchang, 2009). Another similarity is that the Indian railway also affords plenty of public service responsibility. The railway network covers almost all the regions in India, including the undeveloped and remote areas. Besides the condition of the railway, China and India are both developing countries in a period of rapid urbanization, and are similar in terms of the size of the country, the size of the national population, and the level of economic development. Both China and India confronted the challenge of a huge demand for passenger railway transport. Compared with the annual passenger flow in 2008, India is four times larger than China (Li Hongchang, 2009).

However, in the problems of railway, there are quite a few differences between the two countries. First, the huge demand problem is a daily traffic challenge for the Indian railway, while in China, the traffic problem is seasonal. Even during the Spring Festival, the daily passenger volume in India is still almost three times of the daily passenger flow in China (Zhao Jian, 2009). In India, because of the slow development of roads, the lack of highways, and the poor quality of intercity highways with heavy congestion, the railway became the prevailing mode of transportation in India. In China, on the other hand, as mentioned previously, with the development of other modes of intercity transportation, the market share of the railway has been decreasing year by year. After 1990, highways became the prevailing mode of intercity traffic in China. Second, although both countries confront the challenge of huge demand of passengers, their key problems are quite different. China's railway network cannot provide enough supply connecting the developed coastal areas and undeveloped western and middle areas. However, in India, the major problem is the overcrowded trunk lines connecting with developed areas. The six trunk lines connecting India's four largest metropolises, Delhi, Mumbai, Kolkata and Chennai, take only 16 percent of the whole length of railway and afford almost 55 percent of the whole intercity turnover of passenger traffic in India's overcrowding problem (Dou Guili, et al., 2009). Third, the supply-demand gap in China occurs in the long-distance intercity travel. In India, although the railway has a huge passenger flow, most of the passengers are commuters using suburban lines. According to the survey of 2008, only about 27 percent of the daily passengers were traveling long distances (Shen Xilai, 2011).

Thus, it can be concluded that China's Spring Festival travel problem is a unique situation compared with the Indian railway. In many aspects, such as the technology of high-speed rail, the implementation of a centralized traffic-control system, and the condition of trains, India is far behind China. However, the Indian railway industry still has advanced experience China can learn from, like the PRS and cost-management policies. These methods make it more convenient for the passenger to purchase tickets, and help the government to save money (Li Hongchang, 2009).

Seasonal travel and special events. ***Olympic transportation planning.*** All Olympic Games include seasonal traffic issues. During the Olympics, for the host city, the traffic volume reaches a peak, and becomes geographically oriented. Taking the 2002 Salt Lake Winter Olympic Games as an example, Table 4 indicates that during the Olympics, there was a sharp increase of passenger volumes in all modes of the public transit, especially the rail transit. The host city's transport systems reached its limits, which required comprehensive traffic management strategies and advanced technology (Bovy, 2006). The host city's whole transportation system had to serve a huge number of passengers from all over the world. According to the different demands, the passengers can be divided into three categories: (1) the Olympic-accredited constituent groups and suppliers, who need dedicated cars, buses, and limousines; (2) the volunteers, workforce, and audience, who need mass public transit; and (3) the non-Olympic background travelers, who may choose any mode of transportation (Bovy, 2006). Besides the passenger transportation, the host city should also improve the games' logistical service.

Table 4

Ridership of Public Transit in 2002 Salt Lake Winter Olympics

	Ordinary Daily Ridership (unit: 10,000)	Peak-Day Ridership (unit: 10,000)
Light Rail	2	16.2
Dedicated Bus	—	7.9
City Bus	8	16
Total	**10**	**40.1**

Source: Park, 2001.

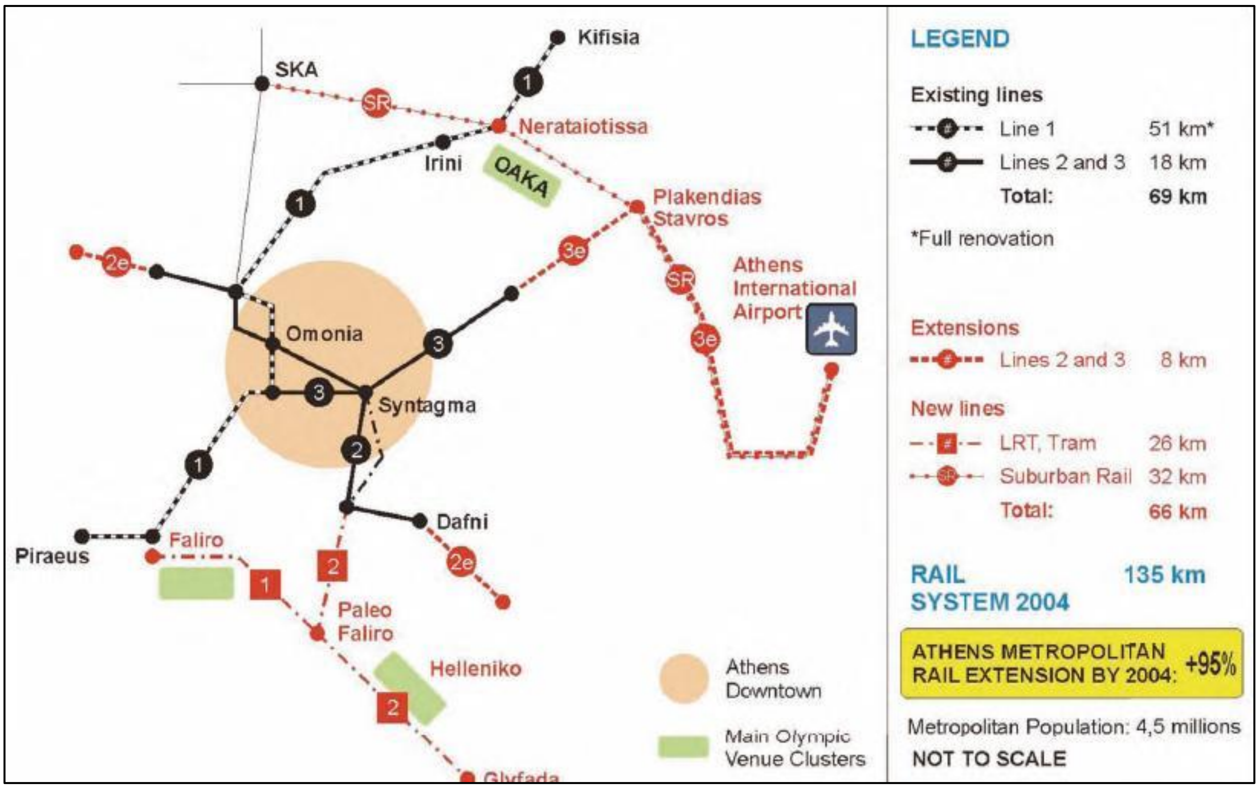
To solve these seasonal transportation problems, the previous host cities implemented a series of strategies, which are instructive in the search for a solution to the Spring Festival travel problem. First, for the transport infrastructure developments, different host cities had their own dominant policies. There are three main types: major upgrading, construction of new facilities, and extension (Bovy, 2006). In the 2004 Summer Olympic Games, the host city, Athens, Greece, made considerable upgrades to the capacity and quality of service of the existing transport facilities. Athens renovated the major highway and urban motorway system, and also enlarged the capacity of rail transit by extending the service coverage through new suburban rail and lengthening the trunk lines. Similar major upgrades to China's existing railway system may be considered to solve the Spring Festival problems. It may be possible to complete the high-speed rail network or to increase the density of regular railway lines, which can enlarge the service coverage and transport capacity.

Some host cities, such as Beijing, which had enough funds from government and other sponsors, chose to construct new facilities, such as new rail transit, new highways, and new terminals. For the 2008 Summer Olympic Games, Beijing built the Fifth and Sixth Ring Roads in urban areas, established new subway lines and new bus rapid transit lines that served the north and central city and the Olympic Green, and constructed a new airport terminal with new rail accessing the metropolitan area. Figure 11 and Figure 12 indicate that in rail transit development, the volume of construction in Beijing was far greater than in Athens. The multiple modes of transport infrastructure were integrated to meet the huge amount of travel demand. Using Beijing's experience as a guide to solve the Spring Festival transport problem, the railway can consider establishing new infrastructures, such as adding new lines of high-speed rail or regular lines to connect east and west areas (Bovy, 2006). Like introducing the new mode of bus rapid transit to Beijing, it is possible to find other new types of railway or integrate with other modes of intercity transport.

For the London games, the focus was on extending the existing infrastructure, such as rehabilitating the East London 9th Line rail hub and extending 2.7 km of Dockland light railway, which played a key role in the Olympic Games serving the River Zone and the Olympic Park. For the Spring Festival travel season, it is possible to extend the existing lines to the remote western and middle areas (Barrow, 2012).

Figure 11

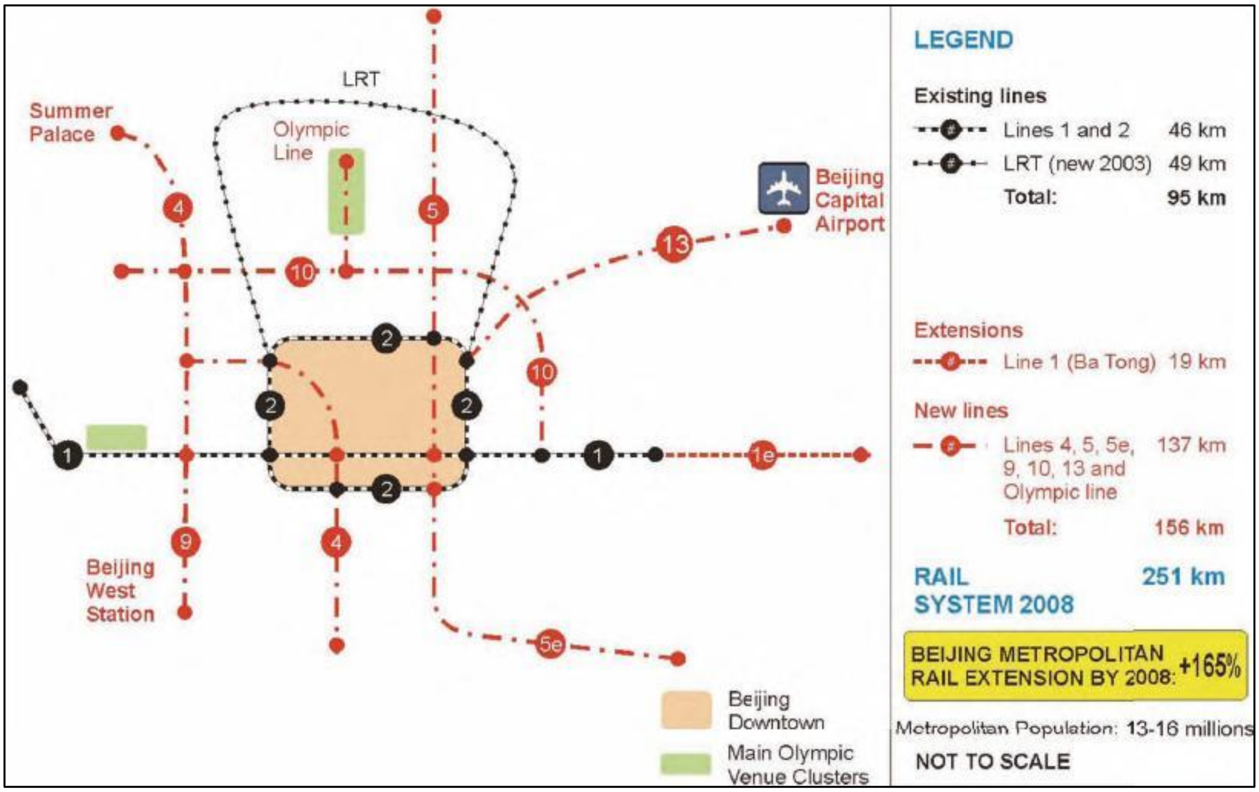
Athens Schematic Rail System Developments



Source: Bovy, 2006.

Figure 12

Beijing Schematic Rail System Developments



Source: Bovy, 2006.

Second, like the operational expansion that railway management institutes during the Spring Festival period, during the Olympics, host cities increased their transportation systems' frequency of departures and the number of vehicles, and extended the operation hours. For example, during the London 2012 Summer Olympic Games, the subway operation hours were extended by one hour. The London Underground also ran additional trains to meet the demands for events in the evening. To lead and manage the development of transportation, most host cities had the comprehensive transportation plans and specific authority to coordinate Olympic transport issues of different modes, such as the Transport Plan and the Olympic Delivery Authority for the London 2012 Olympics. In contrast, in the Spring Festival transport problem, China's government did not have a complete plan and specific department for organization and management. Although the Ministry of the Railway had a temporary department to deal with the emergency during each Spring Festival travel season, there was no authority to integrate with different modes and coordinate various transport systems to improve efficiency.

Third, to enlarge the capacity of public transit, some host cities' governments enacted policies to restrict the overall transport demand of citizens. Creating an effective travel demand management (TDM) is the crucial issue to handle the demand (Njord, 2002). For example, the government of Beijing made limitations on private cars, including the available travel period and parking lots. The local government also encouraged citizens to use paid vacation, to travel outside the metropolitan areas, or to keep working from a small office/home office (SOHO) during the Olympics. Thus, during the Spring Festival travel season, it is possible for the government to implement policy to restrict demands other than those experienced by the migratory workers, such as encouraging travelers to use other mode of transport or adjust the period of the winter break for students.

Other countries' travel problems surrounding traditional festivals: O-bon (Japan) and the Korean New Year. In Japan, during the O-bon Festival (August 12ththrough 16th) and the New Year (December 20ththrough January 6th), migrants return to their hometowns to reunite with their families. During these periods, the traffic flows of aviation, highway, and railway all increase sharply. As in China, the railway is the main travel mode for Japanese migrants. During the O-bon Festival and the New Year, the Shinkansen, a network of high-speed rail lines, have 11 one-way departures each hour. The more departures and frequency lead to fewer stops, which results in rapid and efficient operation (Wen Hai, 2012). However, because Japan's population and travel demand are far behind China, it is difficult for a high-speed rail network like the Shinkansen to meet China's huge seasonal travel demand. In addition, considering the territory of each country, Japan's linear shape makes it easier to establish a trunk rail line running through the whole country, while it is not possible for China to have one trunk line connecting eastern China and western China to meet the huge seasonal demand.

Like China, the Spring Festival is also a very important traditional festival in South Korea. The Ministry of Construction and Transportation of South Korea in 2009 found that among the national population of around 48 million, more than 33 million people returned to their hometowns during the Spring Festival. Thus, South Koreans also have difficulty obtaining tickets. To mitigate the problem, the government focused on improving the transfer service among different modes, and continued to strengthen the public transit service such as subway and bus route networks accessing the railway stations. South Korea's government also implemented the online ticket-sale system (Wen Hai, 2012). All the strategies played a positive role in the increased efficiency of the operation, but could not solve the demand-supply gap.

China's Experience

Several literatures have already analyzed the existing solutions and provided relevant suggestions based on policies of railway development, operational management, and transportation engineering.

Operational management. In the aspect of operational management, some authors (Ding Yuewei, 2006; Zhao Rongzhi, 2011) did research on the ticket price strategy. China's Ministry of Railways has kept raising the ticket prices during recent years to decrease the demands of rural laborers. However, this strategy has not reduced the growing demands. Table 5 shows that the policy of raising the price does not have a restrictive impact on the growing travel flows. From 1991 to 2005, the average annual growth rate of the daily passenger volumes during the Spring Festival rush has reached 22.46 percent. This is because, as mentioned previously, the railway is the only choice for most rural laborers. Demand for tickets is inelastic and difficult to lower with price fluctuations. The ticket-sale system requires reforming the resource allocation mechanism for special-event periods. Zhou Ying (2012) points out that some regulations in the current ticket issuing system, such as reserved tickets and priority tickets, led to unfair allocation, a situation that needs improvement. It is necessary to use the real-name system in issuing train tickets, which requires passengers to provide an ID card to purchase train tickets.

Table 5

Comparison of Price Policy with Passenger Volume

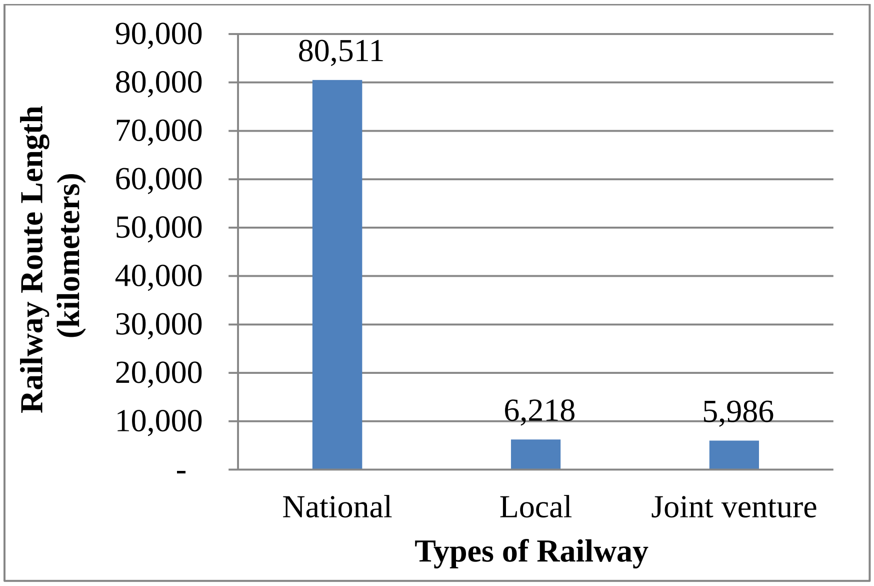
Year	Ticket-Price Strategy	Passenger Volume (millions)
2002	Seat price: increase 15% Other ticket: increase 20%	130
2003	All ticket: increase 20%	130
2004	Seat price: increase 15% Other ticket: increase 20%	137
2005	Seat price: increase 15% Other ticket: increase 20%	140
2006	Seat price: increase 15% Other ticket: increase 20%	149

Source: China Transportation and Communication Yearbook, 2000–2010.

Government and policies. In an analysis of railway development policies, Peng Hengwen mentioned in *The Analysis of Demand-Supply Gap of Chinese Railway Transportation and Relevant Industrial Policies Based on SCP Framework* (2006) that beginning in the1990s, the government tried to gradually tighten control of railway investment access. In some places, the railways were operated by local companies. The government and private companies also invested in some joint-venture railways. Figure 13 and Figure 14 indicate that after more than ten years' development, other types of railway still have only a small share of the railway market. And the shares of other types of railway in passenger volumes are even less. The national railway still takes more than 95 percent of the market share. Therefore, a policy restricting railway investment access would make only a small impact on the Spring Festival travel season.

Figure 13

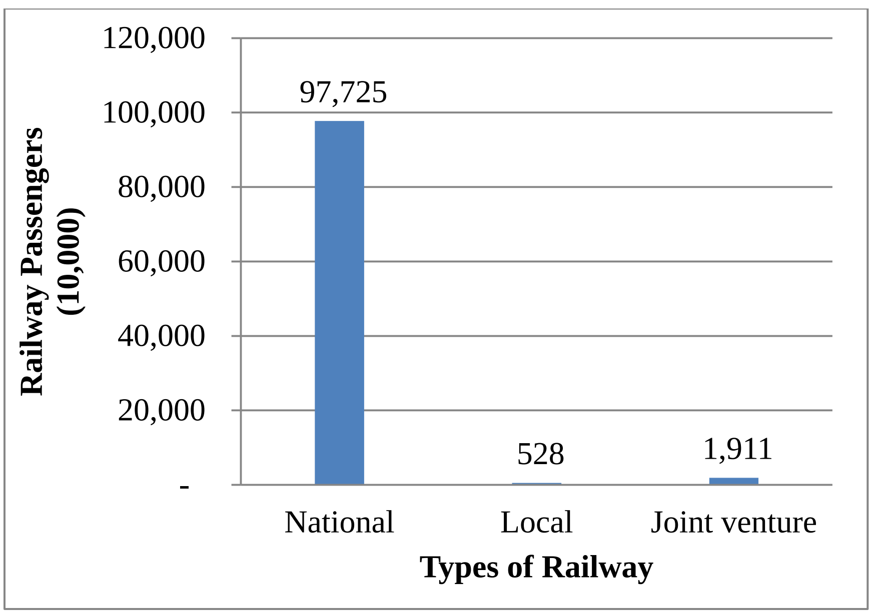
Railway Route Length, 2004



Source: China Transportation and Communication Yearbook, 2004.

Figure 14

Railway Passenger Volume Distributions, 2004



Source: China Transportation and Communication Yearbook, 2004.

Other policies have been issued to provide solutions such as China's Western Development policy in 2000. This strategy was not only intended to reduce the countryside labor flow during the Spring Festival rush, but also had the goal of adjusting the unbalanced economic market in China. The government has issued a series of preferential policies, such as tax cuts for enterprises that invested in the western regions, encouraging foreign-funded enterprises to invest, transferring the factories from coastal areas into middle and western regions, and lowering the price of land-use rights for economic development. However, after 10 years' construction and development, most of the policies have not had much effect. There is still a great disparity between coastal metropolises and inland areas, and a growing number of rural surplus laborers rolling from western areas into the eastern metropolises.

From Moving People to Moving Freight

Characteristics of the Freight Rail System

To analyze the characteristics of the freight rail system, it is necessary to compare freight rail systems and passenger rail systems to find unique characteristics of the passenger rail transport. Comparison among other freight modes is also needed to analyze the advantages and limitations of the rail transportation.

Comparison of freight rail and passenger rail. The main difference between the freight rail system and passenger rail system is the functional object. The passenger rail system is responsible for serving multiple groups of passengers, while the functional object of the freight rail system is to move commodities. For the rail transport system, from the nature and the competitive structure, there are three major categories of commodities: general freight, bulk goods, and specialized freight (Lewis, 2011). Each category needs its own service and infrastructure. General freight includes commodities that cannot be shipped in unit train groupings, and are usually shipped by truck. Bulk goods include the commodities that are heavy and need long-distance shipping such as coal and grain. Specialized freight includes the commodities that have specialized equipment for the railroad such as motor vehicles and chemicals (Martland, 2012). For these three categories of commodities, higher net loads, longer trains, and longer hauls can be used to improve the operational performance of freight railway system (Tolliver, Bitzan, and Benson, 2010).

There is also difference in the transport organization process between the freight rail system and the passenger rail system. Both systems have similar components during the transport process: departure and arrival, transfer, and en route transport. However, because of the different functional objects, during the process of transfer and en route transport, the passengers can self-organize on their own initiative, and can adapt to the environment and adjust the traffic themselves. In contrast, the commodities of freight rail transport are passive and need complete systems of transfer, loading and unloading, storage, intermodal transportation, forwarding agents, and information and communication (Yan Haifeng, 2006).

Comparison with other freight modes. Compared with other modes of freight shipments, such as road, waterways, and aviation, the freight rail system has several merits. First, the freight rail transport is operated based on the planned schedule and track without congestion.

So it has the merits of traffic accuracy and consistency. Second, the operating speed of a train is comparatively faster, especially the high-speed railroad and express-rail system. Third, the capacity of freight rail is much larger than most of other modes of freight shipments like aviation and road. Fourth, the freight rail has higher safety and security. According to He Yulong and Yang Zhongli's 2007 survey, the accident rate of freight transportation is 0.004 percent of rail, 0.105 percent of road, 0.030 percent of aviation, and 0.103 percent of waterways. Fifth, compared with other modes, freight rail is more environment-friendly. It uses less fuel and has a lower impact on the environment. However, besides the advantages, the freight rail transportation system also has disadvantages in that it lacks flexibility in operation and management and requires huge capital costs.

Components of the freight-rail transportation system. The freight rail system consists of several major components: infrastructure, staff, transport equipment, operation and management, and transportation production. To be more detailed about the infrastructure and equipment, to produce freight transportation service, there are plenty of inputs: right-of-way, tracks, locomotives, freight vehicles, labor, and fuel (Congressional Budget Office [CBO], 2006). Furthermore, specific regulations are also needed to support the operation and management of the freight rail transportation system.

China's Freight Rail Industry

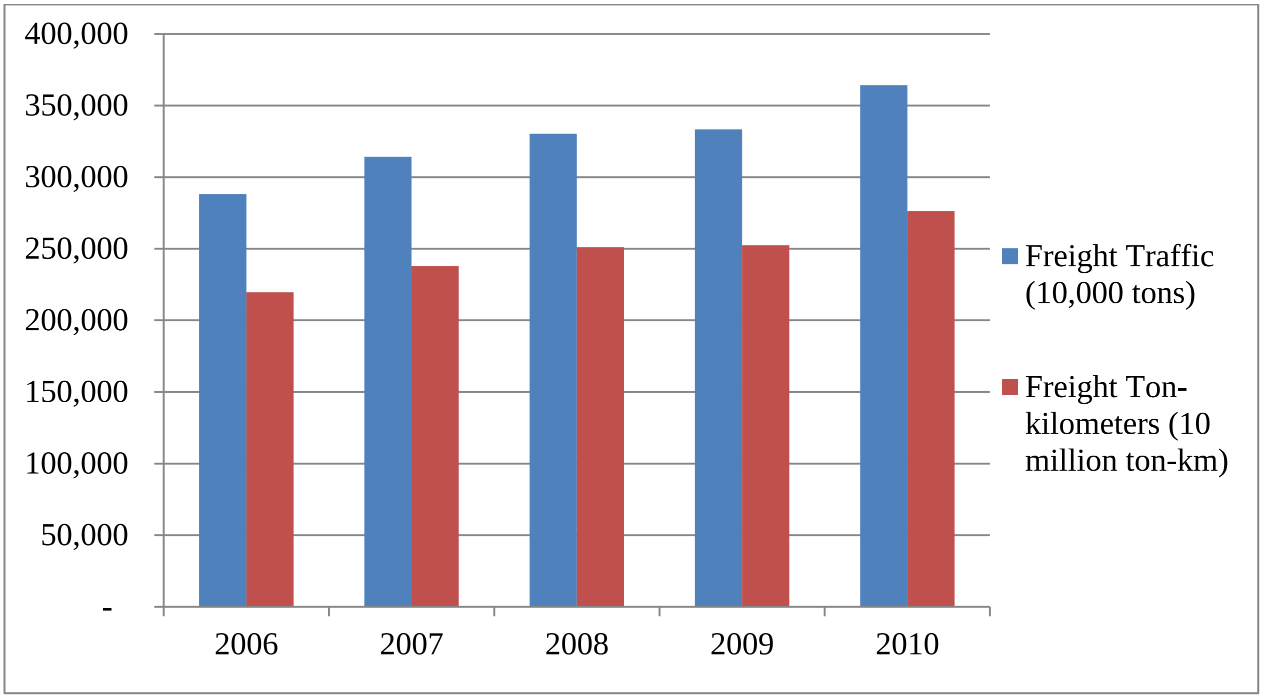
Organizations and infrastructure. In China, the fundamental units of railway freight traffic include 18 railway bureaus under the control of the Ministry of Railways, specific transportation corporations, 51 joint-venture railway companies, and local railway departments. In the freight railway market, the Ministry of Railways and the state-owned bureaus take 65 percent to 75 percent of the market share, while other corporations and organizations take around 30 percent of the market share (Tian Shengkui, 2007). From 1985 to 2010, operating railway length increased from 52,119 km to 66,239 km, while the number of locomotives increased from 11,770 to 18,349. In 2010, there were 622,284 freight cars. The total loading capacity of freight cars reached 39,340,000 tons with an average marked loading capacity of 63.2 tons per car.

Increase of freight volume and turnover. After the Opening and Reform in the 1980s, China's freight railway industry kept a stable increase in the freight volume and turnover.

From 1980 to 2010, the freight volume increased from 1.1 billion tons to 3.9 billion tons with the average growth rate of 5.94 percent. Meanwhile, the freight turnover had a similar increasing trend as the freight volume. Figure 15 indicates that in recent years, the freight rail volume and freight ton-kilometers followed the similar stable growth trends.

Figure 15

Freight Trends, 2006–2010



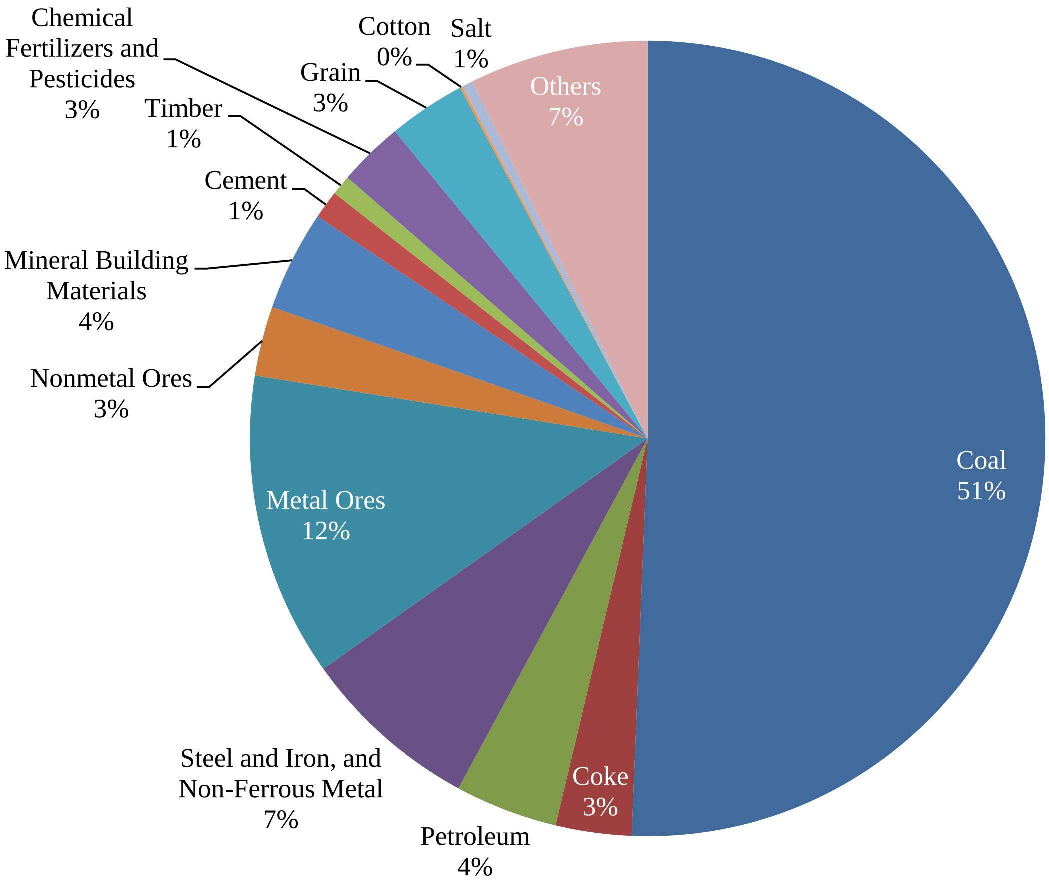
Source: China Statistical Yearbook, 2007–2011.

Decrease of market share. After the Opening and Reform, other modes of freight transportation, especially the rapid development of highway networks, took increasing share of the freight traffic market. Although there was a growing trend in freight volume and freight ton-kilometers, the market share of freight rail decreased from 54 percent in 1978 to 19.5 percent in 2010, with volume decreased by more than 50 percent.

Bulk freight. In China's freight railway transportation system, mass freight has taken the prevailing role, while the commodities with high added values have taken a much smaller share. According to Figure 16, mass freight, such as coal, grain, and agricultural commodities took more than 85 percent of the total freight traffic. The four major categories of mass freight—coal, steel and iron, ores, and petroleum—took 73 percent of the total freight traffic.

Figure 16

National Railway Freight Traffic by Category of Cargo, 2010



Source: China Statistical Yearbook, 2011

Unbalanced spatial distribution of freight flow. The unbalanced distribution of the resource base led to the uneven spatial distribution of freight flow. Northern and northeastern China have important bases in industry and grain, and these regions have a comparatively complete freight railway network. The interior regions of southwestern and northwestern China are the main supply bases of energy source and raw materials, and the freight railway transportation industry there is focused on mass freight. In the coastal region of eastern China and southern China, because most of the commodities in this region are those with high added value, the market share of rail is comparatively lower. Because of the uneven spatial distribution of freight flow, the rail trunk lines afford different freight traffic. The top 10 trunk lines are responsible for around 50 percent of the total freight ton-kilometers, most of which nearly reach to the limits.

Further Exploration

Four categories of factors can affect the freight railway transportation system: demand for commodities, production and supply of commodities, modal competition, and rail service (Lewis, 2012). In the existing studies of China’s freight rail system, most of the literatures focus on the rail service factor. Some authors include other factors to analyze the relationship between freight rail development and the broader marketplace. However, few authors mentioned coordinating the freight railways with balancing regional economic development. On the other hand, to find the solutions of the Spring Festival travel problems, authors still focused on analysis of transporting laborers from interior regions to the east coastal region. There is no research about incentivizing inland factory locations and developing freight rail instead of expanding passenger rail systems to mitigate the huge seasonal traffic demand. Coordinating the development of a freight rail system can facilitate the interior manufacturing in line, which can not only mitigate the Spring Festival traffic problems, but also have a positive influence on the current unbalanced regional economies in China.

Synthesis

The Spring Festival travel season and China's national-scale demand during this special event is a unique situation in the world. According to the existing literature, although recent years have seen transportation development in China, solutions to the demand-supply gap for passenger travel during the Spring Festival travel season are still elusive. There are several reasons for this situation. Some of the previous literature paid much attention to aspects of sociology such as economy, culture, and population sociology. Others focus on technology aspects like transportation engineering, operating management, and reform of monopoly. The previous literatures focused on expanding the passenger rail service, which analyzed the relevant solutions and policies such as the reform of the Ministry of Railways and China's Western Development policy, and provided suggestions based on these policies and railway development. Despite the many different approaches to considering and addressing the unwieldy travel demand of Spring Festival, demand has continued to increase and the problem has grown worse.

To date, little attention has been paid to addressing the core reason for increased seasonal travel demand: spatial mismatch between worker homes and employment locations. Planning research needs to explore ways of co-locating factories within the traditional homeland of the Chinese people. This co-location will require considering the needs of manufacturing industries, which includes movement of goods from factories to ports. Research should explore developing freight rail instead of expanding the passenger-rail system to mitigate the seasonal demand.

This research examined spatial relationships among factories, raw materials, markets, workers, and rail connections, and identified development of China's freight-rail industry that can or will influence the Spring Festival travel season.

China's Spring Festival travel problem occurs because the regional economies of the coastal region and the interior regions have long been unbalanced, which resulted in a huge migratory population. The increasingly migratory population resulted in a substantial seasonal demand for domestic intercity travel.

Methodology

With the long-term goal of mitigating demand for passenger travel during the Spring Festival, this research studies the feasibility of freight rail development to facilitate interior manufacturing. The objectives of this research are to:

- Examine spatial relationships among factories, raw materials, markets, workers, and rail connections.
- Identify development of China's freight-rail industry that can or do influence the Spring Festival travel season.

The following methods addressed these objectives.

Spatial and Quantitative Analysis

Spatial and quantitative analysis explores spatial and socioeconomic effects of China's freight-rail industry. Technical analysis for this project considers:

- balancing regional economics according to spatial proximity of land and labor
- connectivity between the freight railway transportation and regional economic development

Geographic information systems (GIS) identify spatial patterns, examining connectivity among regions and agglomeration of regional economies. It further examines potential for promoting interior manufacturing in line with the current freight rail network, exploring the benefits and drawbacks.

This project synthesizes data from multiple sources. Industrial data came from the National Bureau of Statistics of China. The China Transportation and Communication Yearbook provided operational data and historic trends of freight and passenger use, including volumes and seasonality of demand. Rail network data and intermodal transfer points came from China Rail and ESRI, maker of the ArcGIS software used for spatial analysis. The National Bureau of Statistics of China provided demographic information on traditional residential population and employment populations. All data were current as of 2012.

Discussion of Findings

This discussion explores the feasibility of adjusting the existing unbalanced regional economy in China through developing the freight railway industry, based on the internal relationships between the freight railway industry and regional economic development. Through the spatial analysis, the discussion identifies available value-added industries that can be co-located with workforce in the central and western regions. It also explores the feasibility of supporting workforce and railway systems through estimating industrial development. Recommendations are also made for the future development of freight railway system.

Spatial Trends

There are three major findings from the spatial trend analysis. First, from the relationship between the current freight transport and regional economy, except for the energy industries, the value-added factories in the east purchase raw goods from their own region and some particular middle provinces with location advantage. The rich natural resources and raw goods in the west region have been rarely utilized.

Second, sixteen inland provinces can support industrial development. Six main categories of value-added industries can be relocated from the coast to the inland regions: manufacturing of food, fiber, timber, tobacco, metals, and machinery. For the further development of regional economies and industrial relocation, the energy industries also should continue to be the pillar industries in the inland.

Third, the value-added industrial relocation will directly reduce the notable volume of seasonal passenger demand during the Spring Festival travel season. Meanwhile, moving factories from the coast to the west will increase a great number of the freight volume across regions, which will produce pressure on the current freight railway network.

Relationship between the Current Freight Transport and Regional Economies

Under the current freight railway network and industrial locations, the eastern value-added industries do not have a close relationship with the output of raw goods in the west region. The raw goods for the value-added industries come mainly from their own region and some particular middle provinces with location advantage. The value-added industries represent the industries which add value to raw material through industrial processing with intermediate inputs. With the less frequent freight exchanges across the regions and small freight volumes in most provinces of the inland, the current freight railway network can meet the transport demand. The conclusion came from two analyses, analysis of the transportation condition of raw goods and the analysis of the freight exchange among regions.

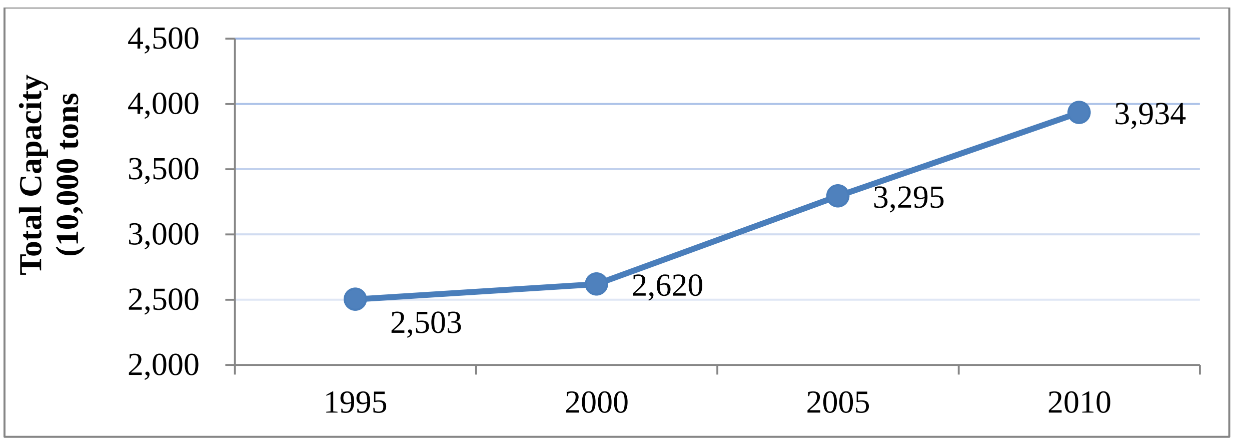
Transportation of raw goods. The freight volume of the major raw goods and preliminarily processed goods of industries has kept increasing. From 2005 to 2010, the freight volume of these goods increased from 2.31 billion tons to 3.08 billion tons, with the growth rate of more than 33percent. However, the average transport distance stayed almost the same for these raw goods. In 2005, the average transport distance was 838 km. After five years, it became

831 km in 2010. Thus, the facts indicate that there was not much change of the location of industries, and that the value-added industries had a stable growth in their current locations.

To meet the increasing demand of value-added industries, from 1995 to 2010, freight infrastructure and the operation increased. In 1995, the gross length of railways in operation was around 55,000 km. In 2010, the length increased to more than 66,000 km. In operation, from 2005 to 2010, the average running speed of freight trains grew from 32.1 km/hour to 33.4 km/hour. The density of freight transport also increased more than 19 percent. With the expansion of infrastructure and operation, the freight rail capacity kept increasing. As shown in Figure 17**,** from 1995 to 2010, the total loading capacity of freight cars increased more than 57percent, which can completely satisfy the current national freight volume of the railway.

Figure 17

Total Loading Capacity of Freight Cars, 1995–2010

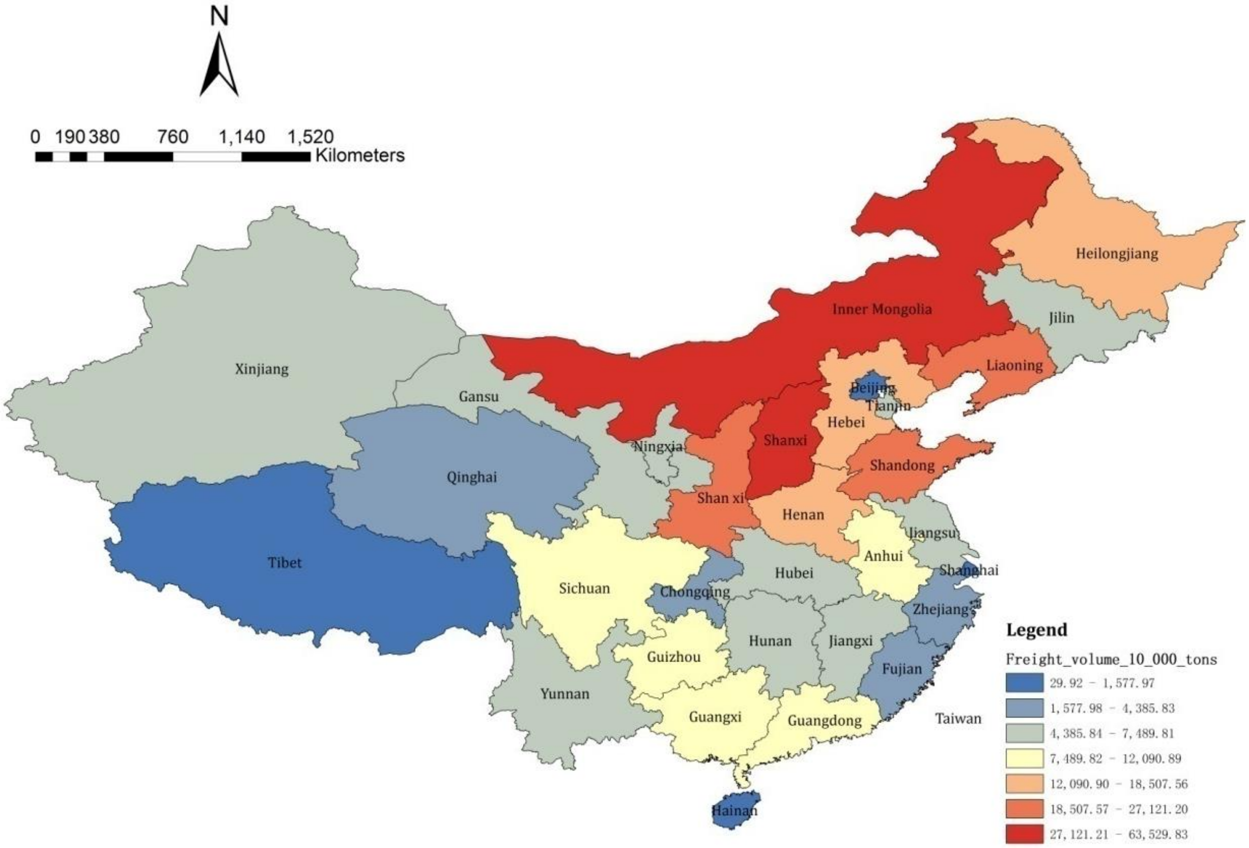


Data sources: China Statistical Yearbook, 2001 and 2011.

Freight exchange of railway. As shown in Figure 18 of the distribution of freight volume by provinces, it is obvious that there was not huge demand for the freight railway in the inland except for Inner Mongolia and Shanxi. The two provinces are the major supply bases of the energy raw goods such as coal and gas. The output of the coal from these two provinces took around 60 percent of the market share. The other provinces of the middle and the west had a comparatively lower freight volume.

Figure 18

Freight Volume by Province, 2010



Data sources: China Statistical Yearbook, 2011; National Fundamental Geographic Information System (NFGIS), 2000.

For the freight exchange among the provinces, Table 6, Table 7, and Table 8 mark the larger volume of freight exchange, using two cutoff points: above 2 million tons or above 10 million tons, which are shaded in this table. According to these tables, the provinces in the three regions all had large freight exchanges within the region. For each province, the largest exchange volume always occurred in the inner-province freight transport. For the freight exchange among the regions, there were not many freight exchange volumes between the east region and the west region, except for the exporting of raw materials from Inner Mongolia to some coastal areas. Except for the exchange volumes of Inner Mongolia, the average freight volume the western provinces sent to the coast was less than1 million tons. The coastal provinces had frequent freight exchange with other coastal provinces and some particular middle provinces, such as

Shanxi, Jilin, and Heilongjiang. Shanxi province, as discussed previously, is the major supply base for coal. The frequent freight exchanges among Jinlin, Heilongjiang, and Liaoning are due to the fact that in accordance with the central government's policy, they are in the same economic zone named "Dongsansheng." This economic zone covers the three provinces, and creates similar industrial structure and industrial chains among the three provinces. Thus, except energy industries, the value-added factories in the east purchase raw goods from their own region and some particular middle provinces with location advantage. The eastern value-added industries do not have a close relationship with the output of raw goods in the west regions.

Table 6

Freight Exchange between East Provinces and Others, 2010 (unit: 10,000 tons)

Sending \ Arrival	Beijing	Tianjin	Hebei	Liaoning	Shanghai	Jiangsu	Zhejiang	Fujian	Shandong	Guangdong	Hainan
Beijing	75	323	475	103	7	28	20	5	85	14	—
Tianjin	350	3,297	1,812	53	3	9	4	1	78	2	—
Hebei	1,258	3,007	7,237	486	143	293	160	23	1,204	80	1
Liaoning	130	272	629	12,694	19	48	31	3	211	10	—
Shanghai	26	28	21	13	62	17	51	20	29	19	—
Jiangsu	21	13	416	37	71	908	156	57	251	59	1
Zhejiang	17	6	18	17	93	30	2,223	114	14	31	1
Fujian	8	2	18	7	44	25	180	1,723	23	206	—
Shandong	33	78	2,074	226	67	607	488	67	6,825	38	1
Guangdong	7	2	26	1	19	12	26	82	14	1,522	11
Hainan	—	—	—	—	—	—	—	1	—	15	483
Shanxi	920	2,740	30,086	1,707	201	2,788	328	102	9,207	168	2
Jilin	63	41	103	2,380	25	52	140	40	93	11	—
Heilongjiang	120	68	304	4,096	58	106	123	34	203	16	—
Anhui	22	20	105	32	179	1,955	823	172	343	110	1
Jiangxi	12	7	20	20	82	31	490	550	44	248	4
Henan	49	20	164	236	118	847	235	202	516	548	7
Hubei	29	23	119	48	18	107	98	117	271	431	12
Hunan	19	10	33	16	53	55	194	102	94	1,054	9
Inner Mongolia	553	1,027	10,952	7,006	133	181	164	20	436	40	1
Guangxi	6	6	39	13	43	53	93	36	43	366	23
Chongqing	5	6	24	9	7	34	22	18	29	109	4
Sichuan	33	45	88	35	76	95	103	31	126	327	14
Guizhou	3	8	49	28	20	71	73	82	167	673	11
Yunnan	9	13	76	25	66	80	83	59	140	421	5
Tibet	—	—	—	—	—	—	—	—	—	—	—
Shan xi	42	22	310	16	52	674	148	12	948	50	1
Gansu	18	61	159	32	108	252	166	28	222	169	1
Qinghai	18	21	124	15	43	176	55	14	119	41	1
Ningxia	24	113	1,454	146	37	35	48	7	63	42	—
Xinjiang	45	137	94	40	58	250	188	32	277	115	—

Source: China Transportation and Communication Yearbook, 2011.

Table 7

Freight Exchange between Middle Provinces and Others, 2010 (unit: 10,000 tons)

Sending \ Arrival	Shanxi	Jilin	Heilongjiang	Anhui	Jiangxi	Henan	Hubei	Hunan
Beijing	84	24	14	13	6	26	23	12
Tianjin	387	41	47	7	6	109	23	16
Hebei	468	117	129	60	86	330	268	137
Liaoning	108	1,555	1,196	46	16	213	61	52
Shanghai	14	24	14	39	49	47	25	54
Jiangsu	656	31	56	636	263	1,262	75	103
Zhejiang	14	10	13	38	721	23	21	31
Fujian	10	3	8	24	850	46	49	73
Shandong	2,779	154	215	547	260	1,741	391	170
Guangdong	29	2	10	7	308	106	130	1,538
Hainan	—	—	—	—	5	2	1	4
Shanxi	4,402	144	53	748	455	2,540	2,001	849
Jilin	30	2,338	1,258	79	169	63	54	118
Heilongjiang	63	1,724	8,581	138	69	125	72	88
Anhui	35	22	24	6,296	806	109	362	279
Jiangxi	10	6	7	29	2,583	33	146	583
Henan	128	32	48	545	507	3,807	2,478	1,012
Hubei	62	43	59	74	204	249	1,905	469
Hunan	28	5	11	29	365	71	135	2,240
Inner Mongolia	136	2,956	3,959	68	67	211	95	136
Guangxi	22	6	5	51	96	126	143	857
Chongqing	7	5	20	8	12	32	34	32
Sichuan	30	16	21	40	46	103	395	167
Guizhou	28	32	33	20	189	76	94	671
Yunnan	31	34	31	23	86	77	41	122
Tibet	—	—	—	2	1	3	—	2
Shanxi	150	9	16	170	350	477	1,038	268
Gansu	83	16	15	70	44	309	249	81
Qinghai	97	10	10	35	25	131	143	60
Ningxia	24	14	6	14	4	43	33	24
Xinjiang	72	11	11	32	29	425	95	58

Source: China Transportation and Communication Yearbook, 2011.

Table 8

Freight Exchange between West Provinces and Others, 2010 (unit: 10,000 tons)

Sending \ Arrival	Inner Mongolia	Guangxi	Chongqing	Sichuan	Guizhou	Yunnan	Tibet	Shanxi	Gansu	Qinghai	Ningxia	Xinjiang
Beijing	81	9	17	33	16	11	1	31	8	4	3	20
Tianjin	462	6	29	76	10	25	3	46	133	14	101	90
Hebei	190	65	108	257	41	54	7	123	47	6	21	75
Liaoning	485	12	21	81	10	24	1	89	40	13	15	33
Shanghai	18	43	21	125	33	41	1	42	14	7	7	55
Jiangsu	28	35	36	203	45	81	5	310	149	200	32	176
Zhejiang	8	24	40	80	42	57	4	15	17	6	2	76
Fujian	7	12	39	112	40	44	2	62	23	7	7	50
Shandong	174	39	74	224	49	83	6	332	156	123	80	184
Guangdong	9	1,256	272	654	571	595	2	122	47	17	11	97
Hainan	—	17	3	6	1	4			—		—	—
Shanxi	267	95	70	293	22	21	3	251	134	73	28	114
Jilin	183	65	33	165	37	69	—	27	14	7	5	12
Heilongjiang	384	35	40	192	36	65	5	56	38	14	11	24
Anhui	23	50	21	90	34	57	8	36	38	18	4	18
Jiangxi	3	123	50	80	143	35	1	8	8	2	3	15
Henan	38	316	141	500	117	125	25	96	293	120	7	97
Hubei	35	246	69	416	128	100	7	169	95	18	9	68
Hunan	7	565	104	195	231	68	1	40	18	3	5	23
In. Mongolia	8,669	54	43	177	21	15	2	119	228	28	148	53
Guangxi	7	1,477	227	564	794	911	2	45	27	7	5	16
Chongqing	7	161	748	605	149	62	2	13	10	3	2	18
Sichuan	19	287	624	3,577	262	541	19	95	72	21	24	57
Guizhou	16	2,841	366	491	1,360	405	—	31	99	5	21	28
Yunnan	26	795	146	766	123	1,671	—	75	66	35	29	55
Tibet	—	1	3	10	—	—	—	1	2	5	—	—
Shanxi	22	43	87	654	39	106	7	2,731	257	38	53	46
Gansu	69	25	75	331	32	49	23	636	2,396	151	121	195
Qinghai	179	13	43	112	4	19	101	74	193	1,187	24	9
Ningxia	89	5	17	545	3	7	-	64	755	55	598	145
Xinjiang	72	19	46	296	19	106	3	231	2,034	101	121	1,758

Source: China Transportation and Communication Yearbook, 2011.

Co-location strategies of value-added factories. Sixteen provinces in the inland are available for industrial relocation. Six main categories of value-added industries can be relocated from the coast to the inland: manufacturing of food, fiber, timber, tobacco, metals, and machinery. For the further development of regional economies and industrial relocation, the energy industries also should continue to be the pillar industries in the inland. The workforce in the middle and west region have enough potential to meet the increasing demand of value-added factories.

Co-location strategies for value-added industries from the coast to the inland provinces must include four steps:(1) determine the inland provinces for relocating factories,(2) identify the industries that can be relocated from the coast,(3) estimate the feasibility of the relocation,(4) estimate the supporting workforce.

Selection of inland provinces for co-location. To create strategies for the relocation of value-added factories, it is necessary to first determine the inland provinces that have poor development of value-added industries and have the needs for the industrial relocation.

The previous analysis of freight exchange among provinces makes clear that the coastal provinces have frequent freight exchanges with some particular middle provinces that have location advantages. These advantages are the result of two factors: the convenient locations near the coastal region and the good value-added industrial foundations. In these middle provinces, the value-added industries developed well, which resulted in the huge employment demand for the larger factories. These employment opportunities can meet the need of the local workforce. The objective of this discussion is to decrease the seasonal traffic demand from the rural labor force across regions. Thus, it is necessary to exclude these inland provinces for this research.

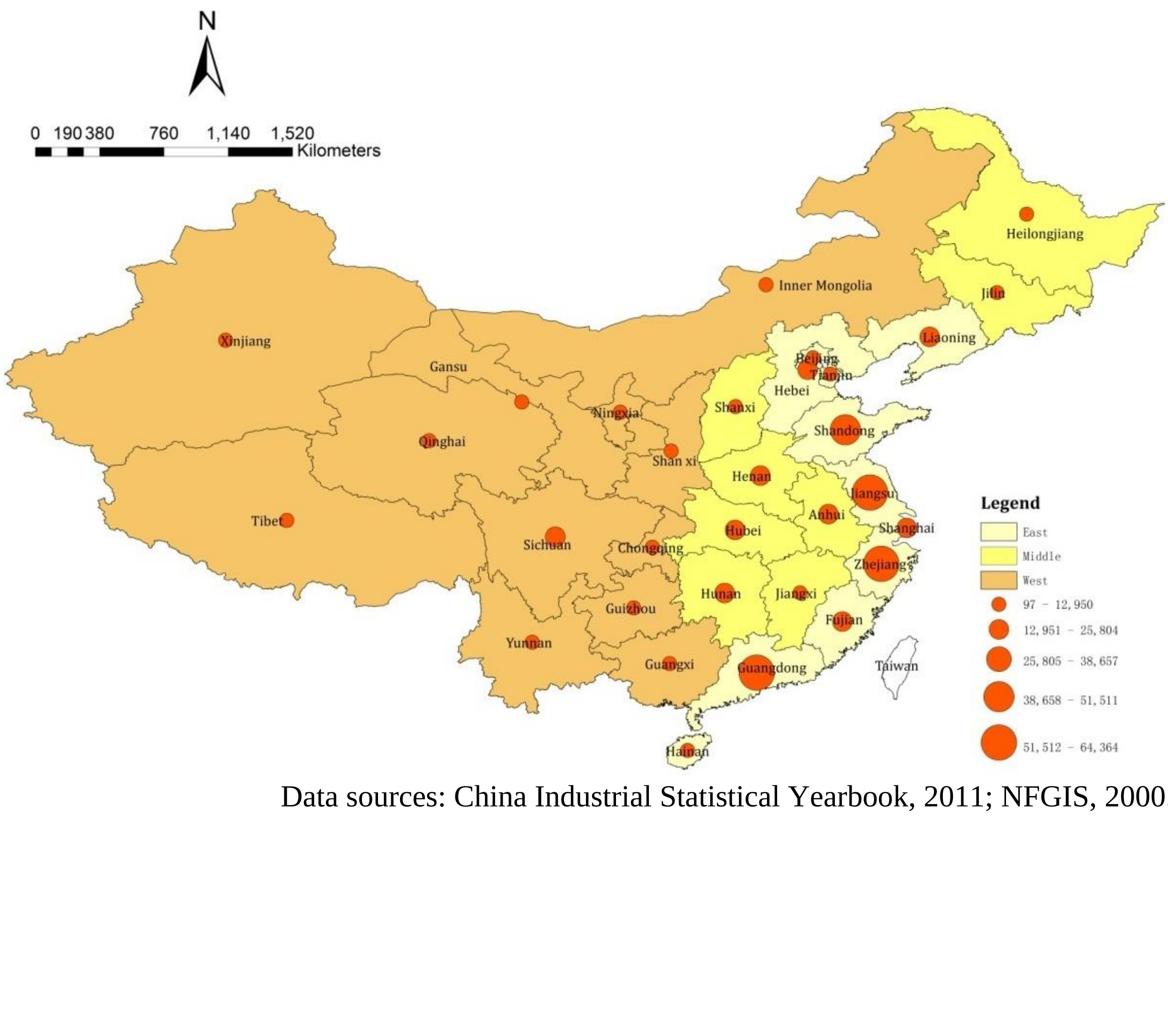
To identify the selected inland provinces, the analysis of scale of factories and employment and the analysis of output value of different provinces were used to estimate the performance of value-added industries in the inland areas.

To analyze the spatial distribution of factories and employment in the industrial enterprises, it is necessary to choose industrial enterprises above designed size to avoid factories with a scale so small as to have a negative effect on the veracity of the trend analysis. The National Bureau of Statistics of China (China Statistical Yearbook, 2008) defines industrial enterprises above designed size as those with the annual sales over 5 million Yuan, which is around $0.8 million.

The spatial analysis of factory and employment distribution shown in Figure 19 and Figure 20 demonstrates that, in 2010, the industrial enterprises above designed size were assembled in the east region. The demands of employments in the west were much smaller than the coast and even the middle regions, which will not satisfy the potential new urban population, thereby creating a large surplus labor force. It is also obvious that in the middle region, four provinces have a significant number of large factories and employment needs: Henan, Anhui, Hubei, and Hunan. Of these four provinces, Anhui and Hunan have the advantage of convenient locations, while Hubei and Henan have good industrial foundations.

Figure 19

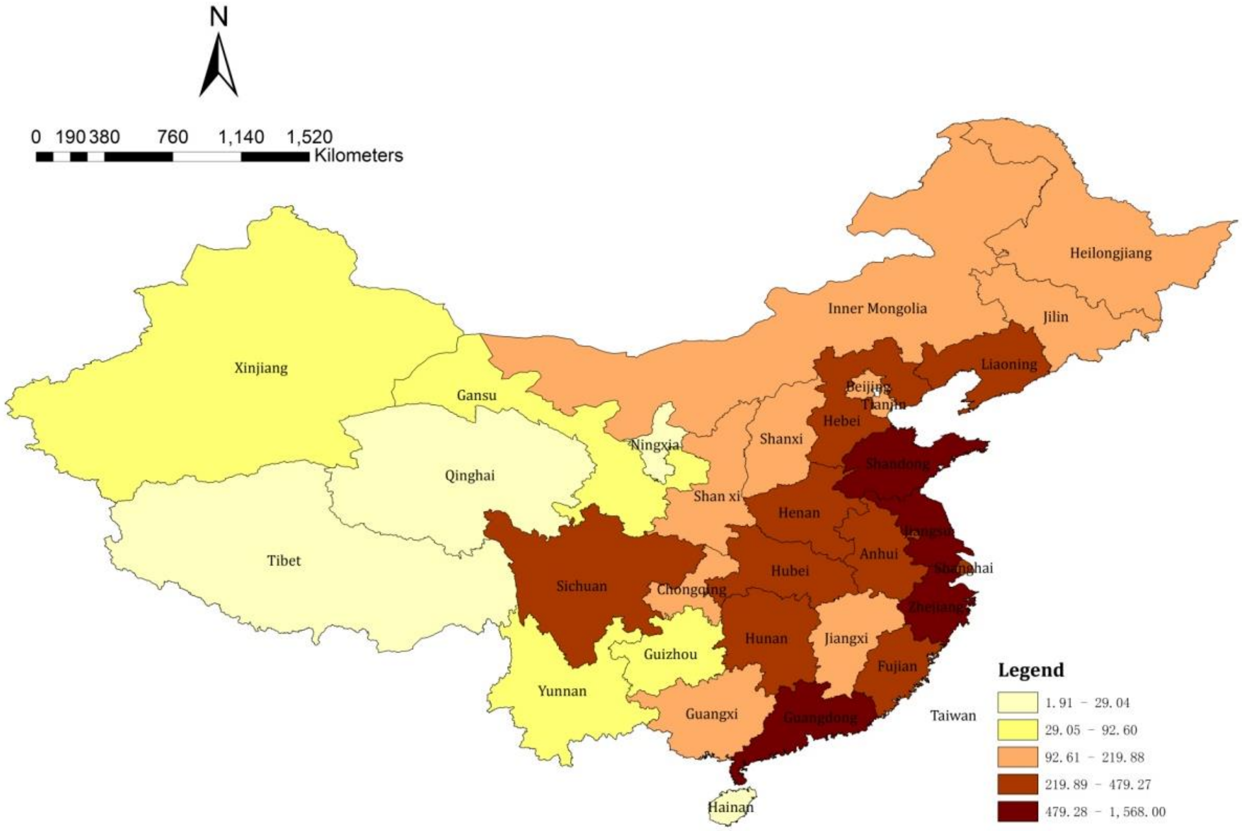
Distribution of Industrial Enterprises above Designed Size by Province, 2010



Data sources: China Industrial Statistical Yearbook, 2011; NFGIS, 2000.

Figure 20

Distribution of Employment of Industrial Enterprises above Designed Size by Province, 2010 (unit: 10,000 persons)

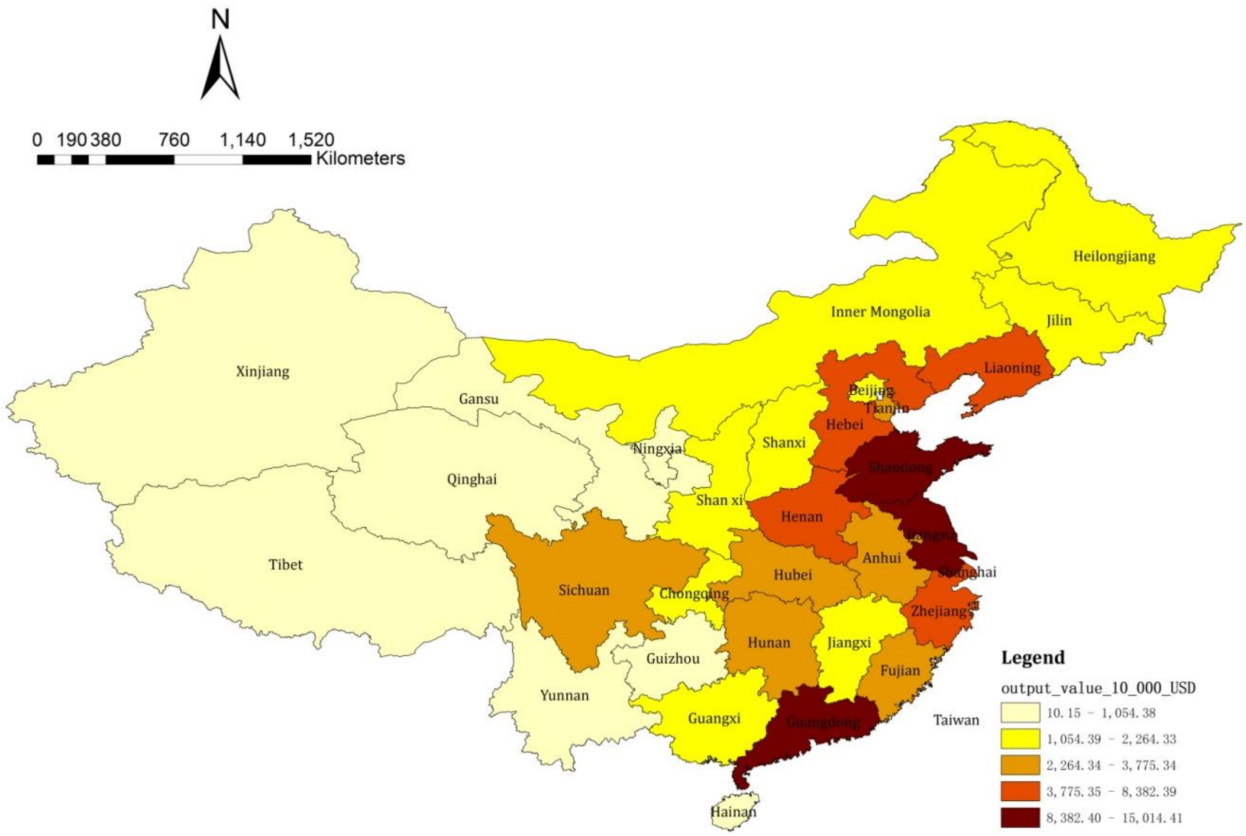


Data sources: China Industrial Statistical Yearbook, 2011; NFGIS, 2000.

The spatial analysis of output value also demonstrates this conclusion. Compared with the coast, the inland factories have smaller production capacity. As shown in **Figure 21**, there are three major layers in China. The coast region has the largest production capacity. Seven provinces of the 11-provinceregion reached above $5 billion of output value. The west region had a much smaller production capacity than the other regions. Seven provinces of the 12-provinceregion had less than $1.1 billion of output value. The scale of the middle region was between the east and the west. Four provinces, Henan, Anhui, Hubei, and Hunan, had production capacities similar to the coastal provinces; Henan has the highest output value based on its local industrial foundation.

Figure 21

Distribution of Output Values by Province, 2010



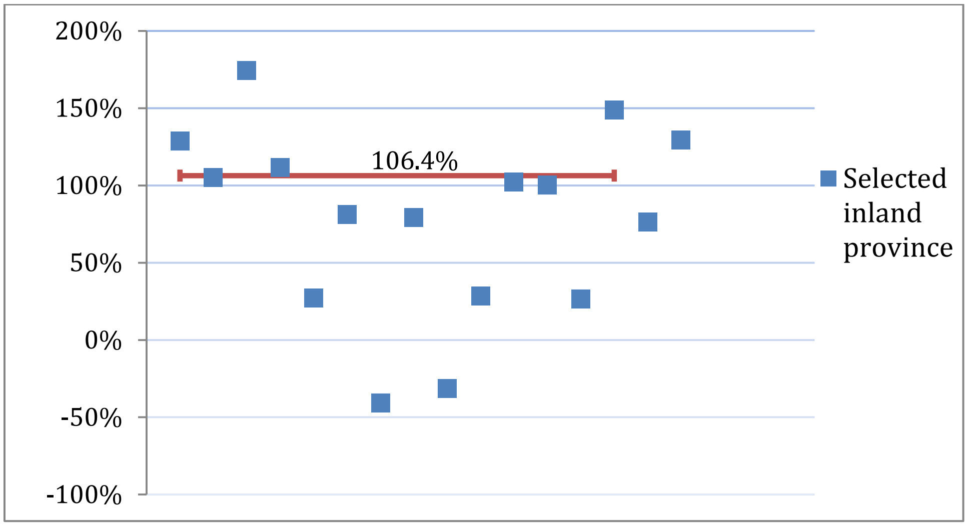
Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

Therefore, there are 16 inland provinces that have poor-condition value-added industries. Compared with other provinces, these inland provinces not only have poor industrial foundations, but also have had much slower industrial development. From 2004 to 2010, the growth rate of the number of factories was 106.4percent, while the average growth rate of employment of the larger factories reached to 56.5percent. The east regions and the four middle provinces mainly drove these tremendous industrial developments. For the selected 16 provinces, according to Figure 22 and Figure 23, about 70 percent of selected provinces had a much slower industrial development. Some west provinces, such as Gansu and Tibet, even had negative growth.

Thus, there are 16 selected inland provinces that have poor development of value-added industries and have great need for industrial relocation. The four inland provinces of Henan, Anhui, Hubei, and Hunan were excluded from the relocation strategies.

Figure 22

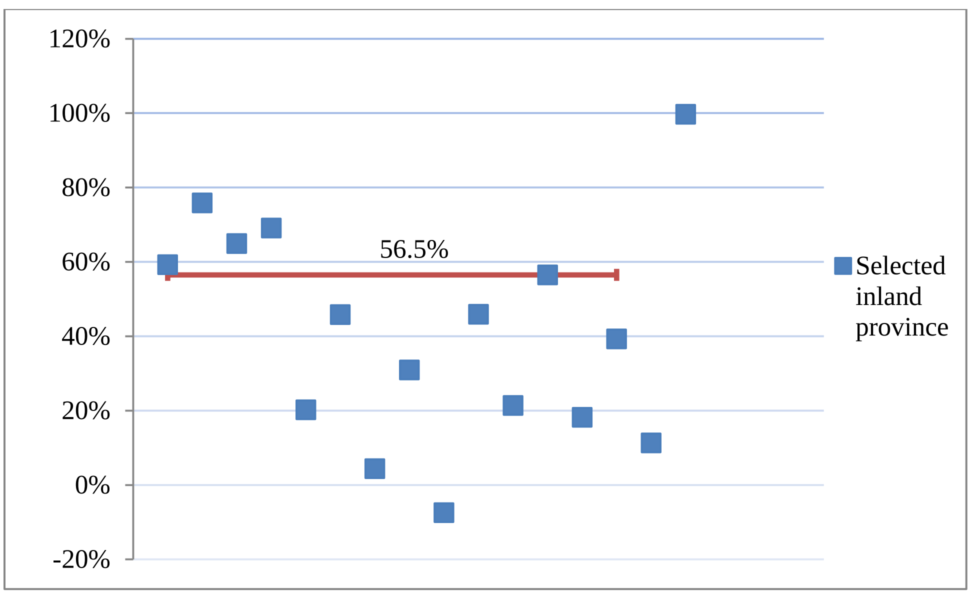
Growth Rates of Western Factories, 2004–2010



Source: China Statistical Yearbooks, 2005–2011.

Figure 23

Growth Rates of Western Employment, 2004–2010



Source: China Statistical Yearbook, 2005–2011.

Selecting Relocated Industries

To identify the available industries for factory relocation, the location quotient analysis is used in the analysis. It can identify the local export industries that are mainly driving the regional economic growth in the different regions. It can estimate the applicable industries that have the potential of development in the near future, and also identify opportunities for economic development strategies such as industrial clustering.

Value-added industries in the East. To determine which value-added industries could be relocated from the coast to inland regions, it is necessary to assess the performance of value-added industries in the coast using location quotient analysis. There are three standards to select available industries. First, the industry should be developed well in the coast, which means employment numbers can continue to grow and can therefore meet the needs of the inland workforce. Second, the industry should have a close relationship with natural raw goods and labor-intensive employment needs. Third, the industry should not be a high-or new-technology industry.

In the east region, the value-added factories grew steadily in the 2000s. According to the location quotient analysis from Table 9**,** the value-added industries on the east region are diversified. To demonstrate the development of value-added industries, using two cutoff points, the location quotient above 1 means the industrial sector is an export industry with development potential, and the location quotient above 2 means the industrial sector is the pillar industry that can drive the local economy with a great development potential. In Table 9, the industrial sectors in each province above these two cutoff points are shaded with different colors. The table indicates that from the whole 39 industrial sectors, in the east region, 36 industrial sectors are the export industries in the coastal provinces, while 26 value-added industrial sectors can mainly drive the local economic development. Performing the same location quotient analysis on the interior, in the middle region, 28 industrial sectors are the export industries, while in the west region, there are only 22. Besides, the pillar industries assemble in the energy industries. Therefore, compared with the middle and west regions, value-added industries on the coast are more diversified. The energy industries such as the mining industry and the electric power and gas industries are developing well in some provinces, but are pillar industries in only two provinces of the east region. In the manufacturing industries, each of the provinces has several categories of value-added export industries. There is a trend for most of the coastal area to develop high-technology industries such as the manufacture of computers, communication equipment, and medicines; these industries should be excluded from consideration for relocation because they do not meet the third standard.

Table 9

Location Quotients of Eastern Provinces by Industry, 2010

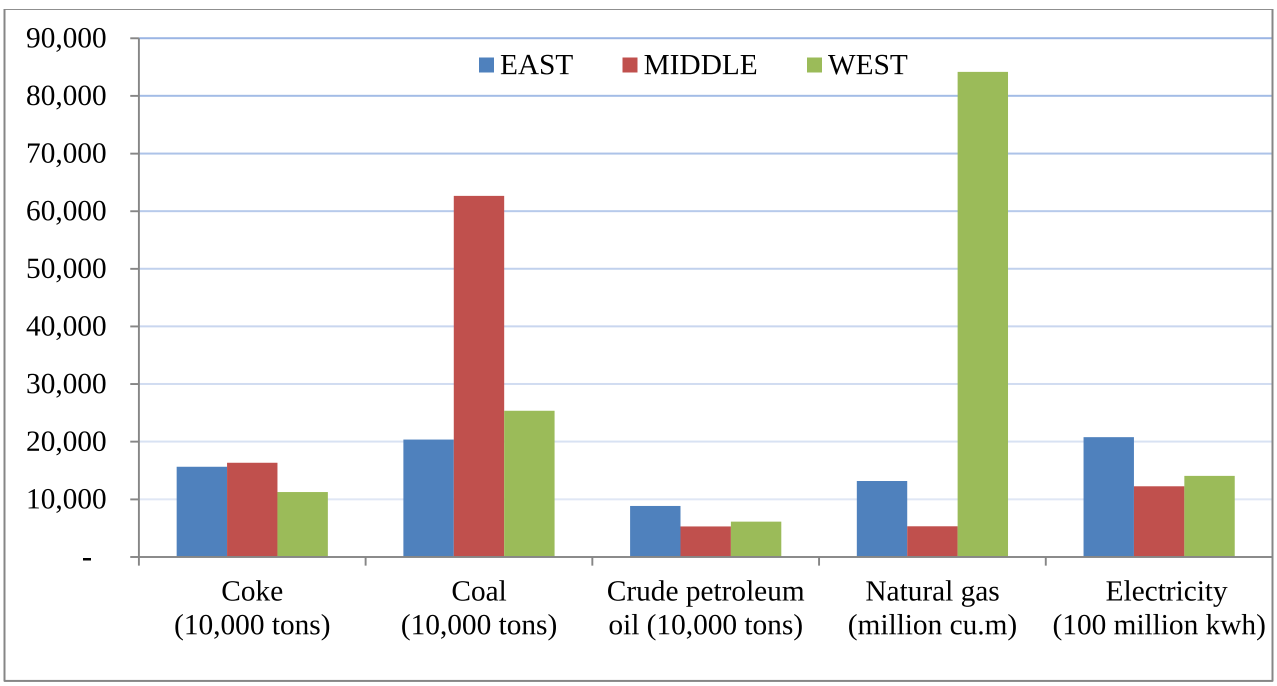
	Sector	Beijing	Tianjin	Hebei	Liaoning	Shanghai	Jiangsu	Zhejiang	Fujian	Shandong	Guangdong	Hainan
Mining	Mining and Washing Coal	0.08	0.03	0.68	0.54	0.00	2.95	0.00	0.66	0.43	0.00	0.14
	Extracting Petroleum and Natural Gas	2.20	2.93	0.26	0.18	0.15	0.00	0.00	0.00	0.73	0.11	0.00
	Mining & Processing Ferrous Metal Ores	0.19	0.08	7.07	5.11	0.00	1.23	0.02	0.29	0.51	0.19	1.74
	Mining & Processing Nonferrous Metal Ores	0.00	0.00	0.49	2.13	0.00	4.31	0.11	0.15	0.51	0.22	3.03
	Mining & Processing Nonmetal Ores	0.05	0.12	0.67	2.04	0.00	1.83	0.41	0.29	1.01	0.56	1.33
	Mining Other Ores	0.00	0.00	0.00	1.41	0.00	1.76		0.00	0.68	0.28	0.00
Manufacturing	Processing of Food from Agricultural Products	0.59	0.42	0.97	1.59	0.26	1.32	0.36	0.59	1.97	0.34	2.89
	Manufacturing Foods	1.51	0.90	0.99	0.93	1.06	1.22	0.44	1.52	1.53	0.69	1.89
	Manufacturing Beverages	0.73	0.48	0.89	0.92	0.35	1.42	0.47	0.89	0.94	0.34	2.91
	Manufacturing Tobacco	0.75	0.00	0.80	0.73	0.62	1.82	0.27	4.10	1.15	1.01	8.18
	Manufacturing Textiles	0.26	0.17	0.88	0.27	0.61	0.29	2.13	1.13	1.08	0.59	0.18
	Manufacturing Apparel, Footwear, & Caps	0.89	0.71	0.44	0.78	1.09	0.27	1.09	2.18	0.89	1.68	0.07
	Manufacturing Leather, Fur, Feather,& Related	0.19	0.30	1.92	0.29	0.64	0.59	1.96	6.19	0.81	1.87	0.14
	Processing Timber; Manufacturing Wood, Bamboo, Rattan, Palm, and Straw Products	0.21	0.20	0.36	0.97	0.33	1.49	0.54	0.61	1.46	0.47	0.98
	Manufacturing Furniture	1.20	0.90	0.80	0.86	1.21	0.68	1.31	1.13	1.09	2.00	0.42
	Manufacturing Paper and Paper Products	0.49	1.07	1.07	0.70	0.90	1.15	1.14	1.01	1.00	1.27	0.84
	Printing, Reproduction of Recording Media	2.15	0.64	0.56	0.46	1.32	0.62	0.77	0.27	0.66	1.32	0.36
	Manufacturing for Culture, Education, & Sport	0.35	0.70	0.40	0.83	1.24	0.21	1.40	1.36	2.78	3.42	
	Processing Petroleum, Coking, &Nuclear Fuel	1.17	1.24	2.23	3.17	0.75	0.50	0.21	0.21	1.59	0.48	2.12
	Manufacturing Raw Chemical Materials and Chemical Products	0.85	1.07	1.09	0.89	1.18	1.86	0.66	0.24	1.50	0.76	0.92
	Manufacturing Medicines	2.69	1.13	1.08	1.03	1.24	1.27	0.74	0.39	1.16	0.51	7.02
	Manufacturing Chemical Fibers	0.18	0.34	0.83	0.28	0.82	0.25	3.10	1.28	0.53	0.34	1.27
	Manufacturing Rubber	0.49	1.04	2.16	4.77	1.41	0.39	1.00	1.61	4.55	0.00	0.76
	Manufacturing Plastics	0.60	0.95	0.71	0.00	1.37	0.42	1.18	1.11	0.00	1.63	0.35
	Manufacturing Nonmetallic Mineral Products	0.88	0.53	1.10	1.24	0.58	1.23	0.49	0.86	1.29	0.66	1.53
	Smelting and Pressing of Ferrous Metals	0.33	3.41	2.18	3.35	0.52	1.65	1.14	0.57	1.37	0.82	0.47
	Smelting and Pressing of Nonferrous Metals	0.68	1.01	0.95	1.07	0.98	2.67	1.15	0.45	0.57	0.87	0.45
	Manufacturing Metal Products	1.01	1.66	1.44	0.98	1.42	0.46	1.03	0.35	0.99	1.40	0.19
	Manufacturing General-Purpose Machinery	0.82	0.86	1.05	1.35	1.52	0.66	1.22	0.25	0.94	0.36	0.03
	Manufacturing Special-Purpose Machinery	1.75	1.34	1.08	1.31	1.62	0.81	0.85	0.31	1.14	0.65	0.18
	Manufacturing Transport Equipment	1.51	1.65	0.96	0.85	1.62	0.54	1.25	0.70	0.89	0.51	1.79
	Manufacturing Electric Machinery & Equipment	1.11	0.99	0.85	0.82	1.63	0.54	1.64	0.63	0.70	1.56	0.22
	Manufacturing Communication Equipment, Computers, and Other Electronic Equipment	2.29	1.74	0.29	0.40	1.58	0.67	0.89	1.34	0.53	2.85	0.33
	Manufacturing Measuring Instruments and Machinery for Cultural Activity & Office Work	3.78	1.01	0.43	0.85	1.68	0.64	1.32	1.00	0.59	0.73	0.42
	Manufacturing Artwork & Other	0.73	1.22	0.52	0.15	0.82	0.41	1.24	2.32	0.14	0.32	0.16
	Recycling and Disposal of Waste	0.78	4.31	0.92	0.84	1.05	1.93	1.51	0.19	0.55	1.77	0.95
Power	Production & Supply of Electric & Heat Power	1.05	0.81	1.63	0.98	0.25	1.37	0.57	1.17	0.78	0.47	5.46
	Production &Supply of Gas	2.22	1.36	1.61	0.96	0.68	1.13	0.71	0.38	1.02	0.82	6.36
	Production &Supply of Water	1.08	0.86	0.51	0.53	0.56	1.11	0.67	0.41	0.54	1.07	4.10

Data source: China Statistical Yearbooks, 2011.

For the second standard, it is necessary to combine the categories of value-added industries with the raw goods in the inland regions. The middle and the west regions have rich natural resources, which provide a great amount of raw goods for further processing and make a great foundation for the development of value-added industries. First, the most important natural resource in the inland regions, especially in the west, is energy. The raw goods for the energy industries such as the mining industry and the production and supply of electric power and gas are assembled in the middle and west region. According to the Figure 24**,** in 2010, the middle and the west regions produced the most raw energy goods such as coal and natural gas. In the other categories of major energy goods, like electricity, coke, and crude petroleum oil, the output of the west and middle regions was similar to the output produced by the coast. Besides the energy industries, these energy goods are widely needed in most industries. Therefore, the inland regions can take advantage of the development of value-added industries.

Figure 24

Regional Output of Energy Products, 2010



Source: China Industrial Statistical Yearbook, 2011.

There are several categories of raw goods or preliminarily processed products for which the middle and the west regions have ample resources such as fiber, food, tobacco, timber, and metals. These categories of goods either predominate in the supply of raw materials in the value-added industries or have similar outputs as the coast, which will lead to an equal competitive advantage between the east and inland regions.

Thus, according to the location quotient analysis of the performance of industrial sectors in the east and the three standards discussed previously, seven main categories of value-added industries can be relocated to the inland: manufacturing of food, fiber, timber, tobacco, metals, machinery, and energy industries. The energy industrial sector includes the industries of mining, processing of petroleum, and coking; and the production and supply of electric power, gas, and water. The food sector includes the processing of food from agricultural products and the manufacture of food and beverages. The fiber sector includes the manufacture of textiles and apparel, footwear, and caps. The timber sector includes the processing of timber, the manufacture of furniture, and the manufacture of paper products. The metal sector includes the manufacture of metal products, and the smelting and pressing of metals. The machinery sector includes the manufacture of general-purpose machinery, the manufacture of transport equipment, and manufacture of electrical machinery and equipment.

Selected inland value-added industries. According to the analysis of value-added industries in the east, Location Quotient analysis is used to analyze the seven selected value-added sectors in the inland.

Energy Industries

In the middle region, based on the location quotient analysis of the seven major sectors that have the possibility to relocate from the coast to the inland, it is obvious that the factories have already assembled in the industries of mining, which belongs to the energy industry. The energy industries play a key role in the regional economy, and have developed well in the middle region. In some provinces, the energy industries have already formed the industrial cluster and complete network. For example, in Shanxi, the energy industries are the pillar industries, and produce most of the gross output value.

In the west region, like the middle region, the energy industries of mining and supply of electricity and gas played a key role in the regional economy. In 2010, the output value of mining industries in the inland reached above $540 billion, which accounted for more than 63 percent of the gross output value of this industrial sector in China.

Besides the current development of energy industries in the inland, the inland provinces also have advantages compared with the east region. **Figure 25** shows the distribution of major energy reserves, which include coal and petroleum. All of the major bases with huge energy reserves are assembled in the inland. The distribution of natural gas also follows this trend. The inland energy reserves account for around 92 percent of the national reserves. Therefore, the inland has great potential for further development of energy industries.

In addition, for the further development of value-added factories in the inland, it is also necessary to continue developing the energy industries. The industries that have close relationship with natural raw goods and intensive labor need larger consumption of energy than other industrial sectors. As shown in Table 10**,** the seven selected industrial sectors account for more than 80 percent of the total energy consumption of industry.

Table 10

Consumption of Energy by Sector, 2009

Sector	Energy Consumption (10,000 tons SCE)
Total industrial consumption	**219,197**
Total consumption of selected sectors	**177,609**
Energy	53,929
Food	5,550
Tobacco	234
Fiber	6,964
Timber	5,334
Metals	97,726
Machinery	7,872

Source: China Industrial and Economic Statistical Yearbook, 2011.

This analysis demonstrates that there is no need to relocate the energy industries from the coast to the inland areas. For the further development of regional economies and industrial relocation, the energy industries should continue to be the pillar industries in the inland.

Manufacturing industries. In the middle region, the location quotient results in Table 11 show development potential in processing food, tobacco, timber, and metals although the scales of these industries are smaller than similar factories in the east. Compared with the energy industries in the inland, the location quotient of these industries are much smaller, which indicates that these sectors have growing trend and development potentials, but are not currently pillar industries. The industries of fiber and machinery manufacture are importing industries that did not meet local needs and are the sources of consumption leakage. Compared with the east, the categories of value-added industries in the middle region are more concentrated. For example, only one or two industrial sectors have export industries in Shanxi and Anhui.

Table 11

Industrial Location Quotients of Central Provinces, 2010

Sector	Shanxi	Jilin	Heilong-jiang	Anhui	Jiangxi	Henan	Hubei	Hunan
Mining	4.96	1.50	1.87	2.22	1.33	1.66	1.25	2.46
Electric power & gas	0.87	1.97	3.06	0.59	1.23	0.82	0.97	1.29
Food	0.47	2.26	2.73	0.31	0.72	1.82	1.85	1.31
Tobacco	0.49	3.14	5.43	113.04	0.38	3.04	3.17	1.82
Fiber	0.06	0.16	0.13	0.39	0.75	0.69	1.05	0.28
Timber	0.10	1.43	1.31	0.48	0.82	1.11	0.68	1.19
Metals	0.86	0.77	0.69	0.63	1.10	1.43	1.14	1.17
Machinery	0.20	0.68	0.45	0.48	0.48	0.71	0.92	0.59

Data source: China Statistical Yearbook, 2011.

In the west, according to Table 12, the value-added industries developed more slowly and less effectively than in the middle. Most of the importing industrial sectors, such as fiber, timber, and machinery manufacturing, in most of western provinces did not meet local needs.

Table 12

Industrial Location Quotients of Western Provinces, 2010

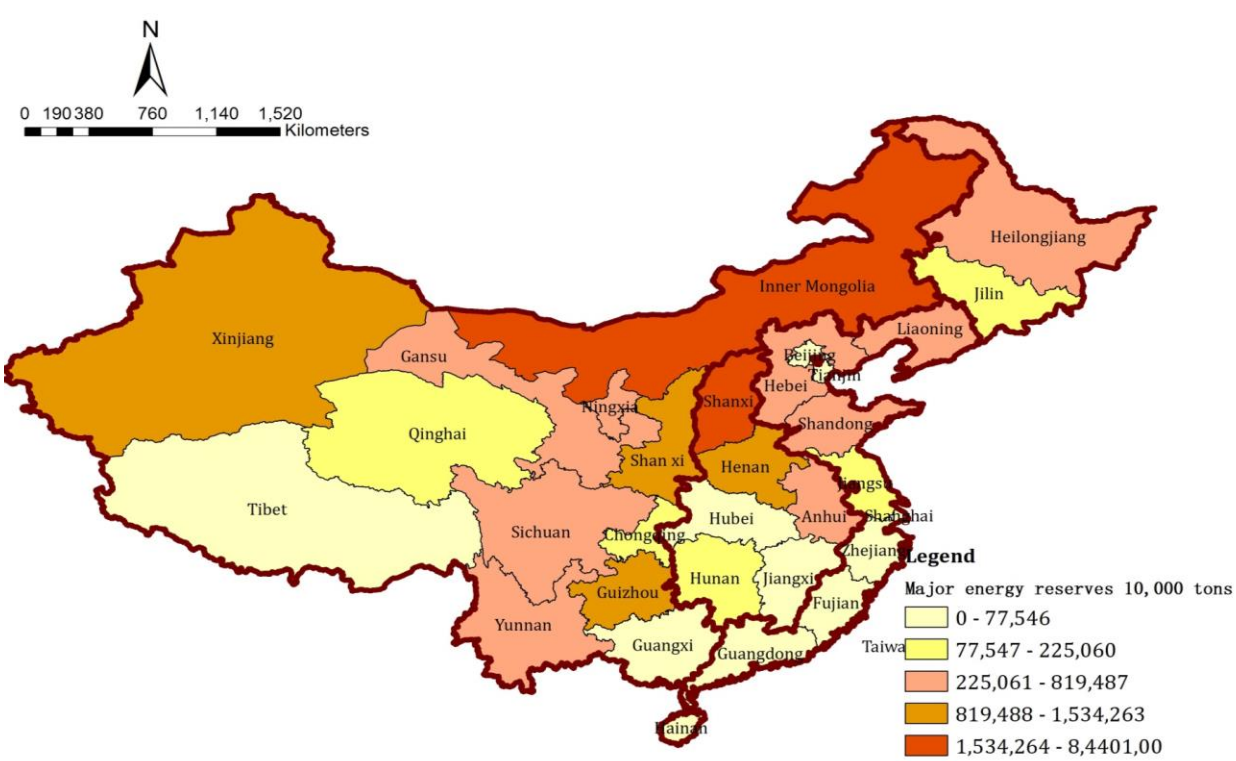
Sector	Inner Mongolia	Guangxi	Chongqing	Sichuan	Guizhou	Tibet	Shan xi	Gansu	Qinghai	Ningxia	Xinjiang
Mining	3.69	2.35	1.89	2.15	4.58	5.35	3.10	2.08	2.61	1.54	2.61
Electric power & gas	3.49	1.48	1.08	1.93	2.15	3.54	1.49	4.24	1.80	2.49	3.36
Food	1.70	0.40	0.87	1.52	0.93	2.90	1.42	1.93	1.20	1.34	2.34
Tobacco	1.17	52.35	2.08	0.88	3.23	0.00	2.05	3.56	0.00	6.23	1.48
Fiber	0.32	0.16	0.29	1.30	0.05	0.33	0.27	0.14	0.24	0.4.	0.37
Timber	0.55	0.65	0.47	0.86	0.43	0.62	0.33	0.19	0.00	0.31	0.32
Metals	0.99	0.40	0.88	1.07	0.84	1.34	0.99	1.13	1.51	1.42	1.05
Machinery	0.24	0.33	1.32	0.62	0.22	0.10	0.33	0.30	0.19	0.27	0.14

Data source: China Statistical Yearbook, 2011.

Thus, from the location quotient analysis, all of the six selected industrial sectors had their foundation in the inland. The selected industries each fit one of two possible characteristics. First, some industries are export industries and operate on smaller scales than those in the east. Second, other industries are import industries and cannot meet the local needs. Both types of industry show the demand and potentials for further development. Therefore, these select value-added industries are available to relocate from the coast to the inland.

Figure 25

Distribution of Major Energy Reserves by Province, 2010



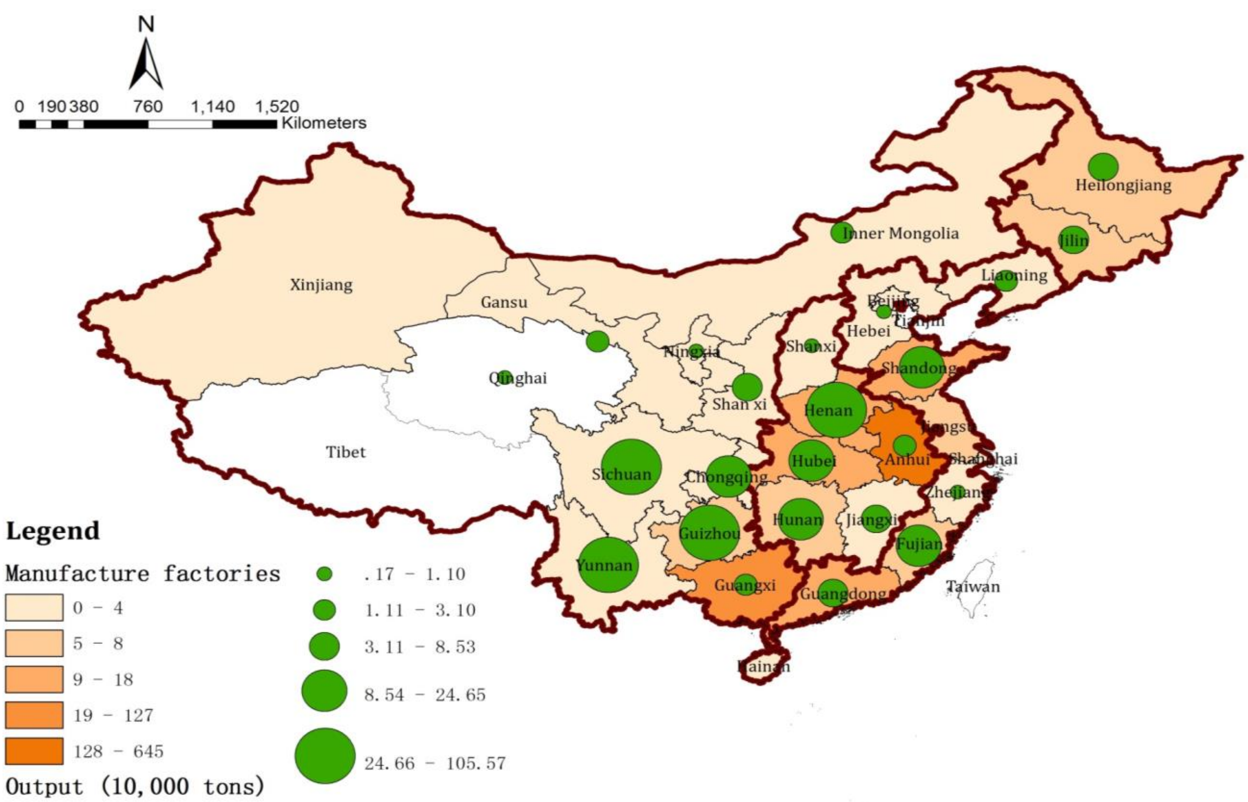
Data sources: China Industrial and Economic Statistical Yearbook, 2011; NFGIS, 2000.

Feasibility of selected value-added industrial locations. Spatial analysis using GIS was made to identify the relationship between the selected value-added industries and the relevant raw goods in the inland, which can show whether the inland provinces have rich resource or underlying reserves for further development. For the different development conditions of value-added industrial sectors, there are two major categories. First, there is a huge gap between the development of raw goods and primary processing outputs, and the deep processing industries, such as the industrial sectors of tobacco, timber, and fiber. Second, the value-added industries have comparatively comprehensive development in both the primary processing industries and the deep processing industries. However, the scale of industries is smaller than the coast, such as the industrial sectors of food, metals, and machinery. Spatial analysis for the selected industries demonstrates that the natural resource and potential reserves can meet the further demand of industrial relocations in both categories of industrial sectors.

Gap between primary processing and deep processing. For the tobacco industrial sector, from the distribution analysis which is shown in Figure 26, the raw material bases of tobacco assemble in the middle and the west regions. Seven inland provinces dominate the supply of tobacco, which has a good foundation for the development of the relevant value-added industry. Linking with the current performance of the value-added industries, although almost all the major bases of tobacco production arelocated in the inland regions, especially in the west region, there are very few tobacco manufacturing factories in the west region, except for Guangxi and some factories in Guizhou. This indicates that the tobacco industrial sector has not had a complete industrial chain for the primary processing industries and deep processing industries.

Figure 26

Tobacco Production and Factories Processing Tobacco, 2010

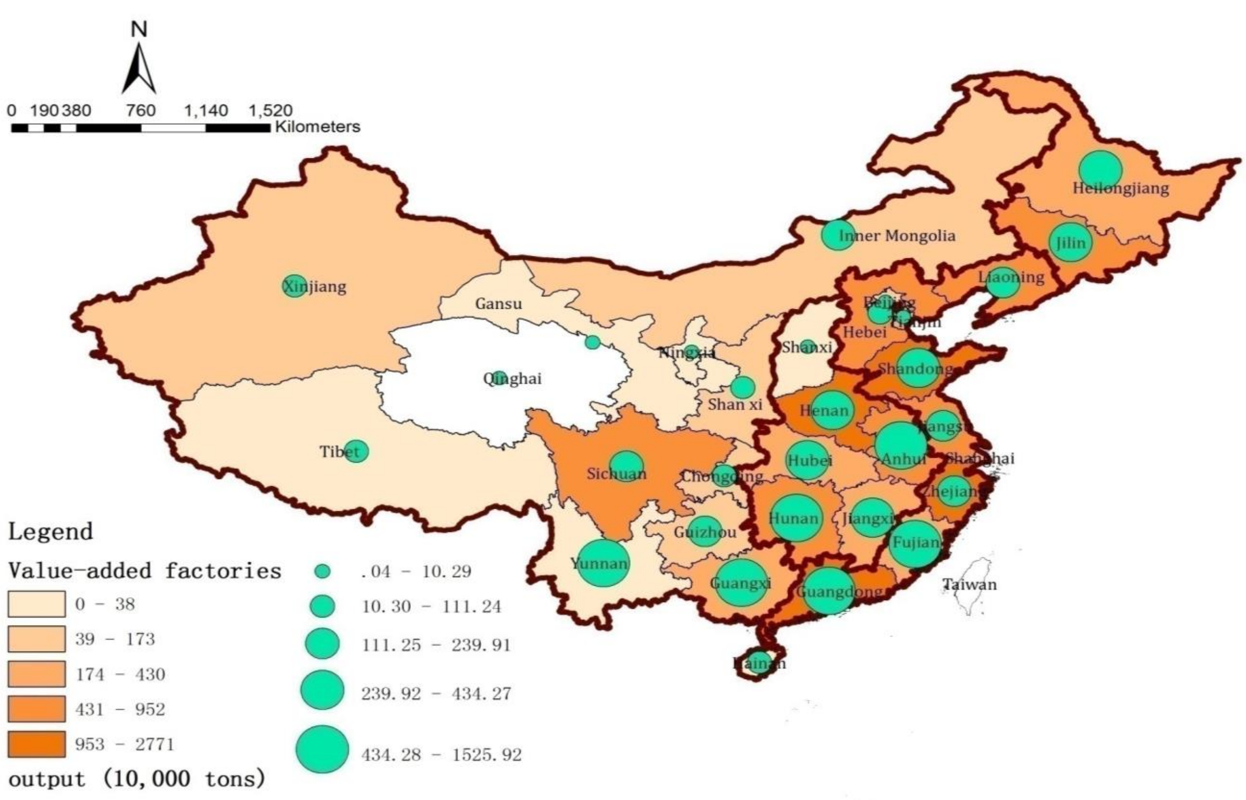


Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

Timber manufacturing is in a similar situation in the selected provinces, especially in the west region. As shown in Figure 27, the western provinces of Yunnan and Guangxi are the largest supply bases of raw timber; however, few value-added factories exist in these two provinces. Besides Yunnan and Guangxi, the other selected provinces have much smaller output of timber raw goods, which led to the undeveloped condition of the relevant value-added industries. However, Figure 28 shows the forest stock by province, and it is obvious that most of the selected provinces had rich potential reserves of timber. The total stock of selected provinces took more than 80 percent of the national forest stock. Combined with the location quotient analysis, all the western provinces have less than one location quotient in the value-added industries of timber, which means that despite the rich potential resource, the whole west region still needs to import the value-added output from the coast and the middle region.Therefore, these selected provinces should develop the relevant industries for processing and exploitation.

Figure 27

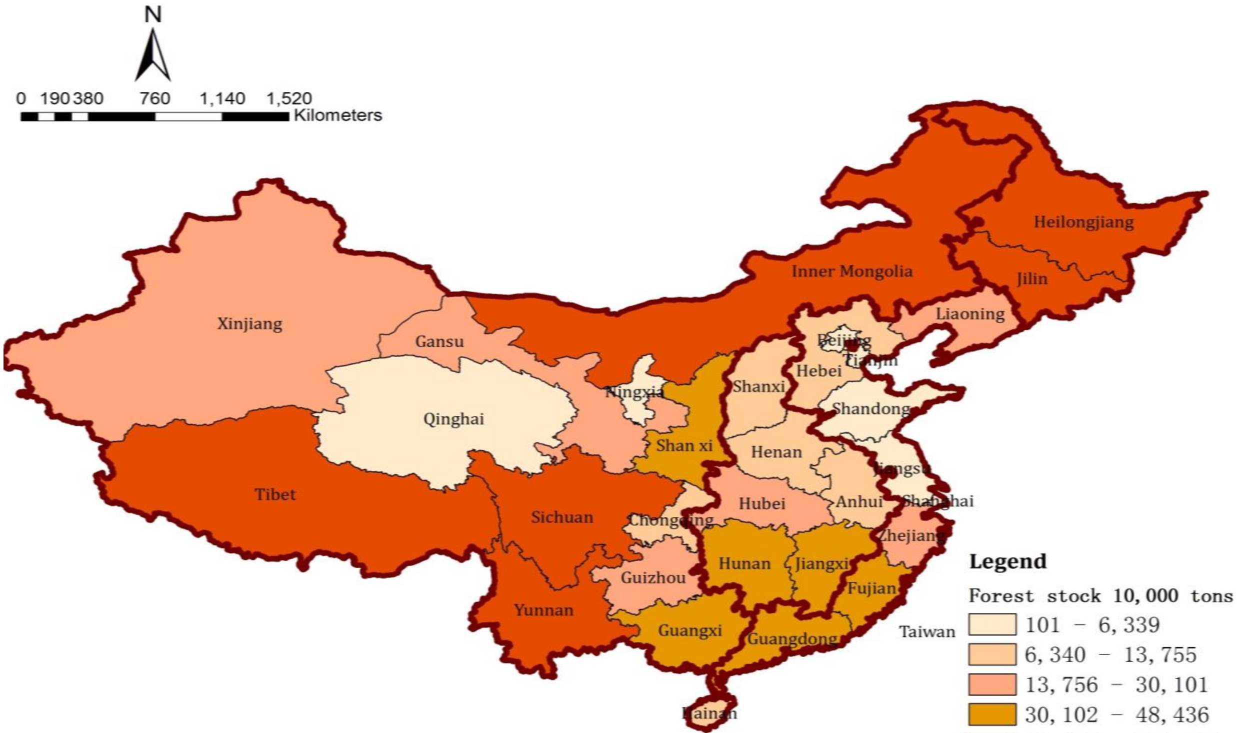
Timber Output and Processing Factories, 2010



Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

Figure 28

Distribution of Forest Stock, 2010

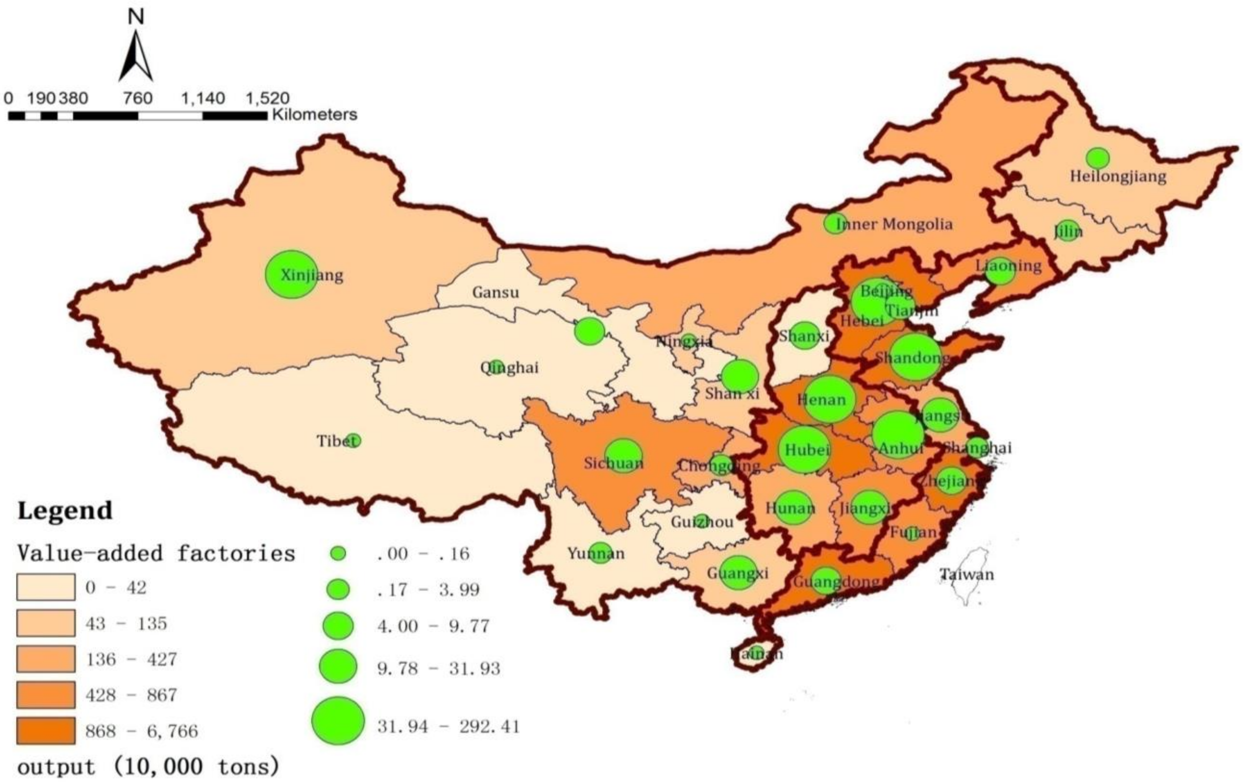


Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

The developing condition of the fiber industrial sector is the most typical case in this category. The raw materials of fiber include plenty of goods, such as cotton, fiber crops, and the silkworm cocoons. According to the spatial analysis, besides Hebei, Shandong, and Jiangsu, which are in the coast, the other raw material bases are assembled in selected provinces, such as Xinjiang and Guangxi. However, as demonstrated in Figure 29, most of the value-added factories of fiber are assembled in the coast. In the selected provinces, only Sichuan and Jiangxi had scale economy of processing industries of fiber. Figure 30 compares the different percentages of three major categories of value-added industries in the fiber industry in each province, from preliminary working to deep processing. It clearly shows that with the deepprocessing, from yarn to printed fabric, the factories gradually changed the locations from the inland to the coast. For the industry of printed fabric, all of the major bases are assembled in the coast, and most of the western provinces have almost no output.

Figure 29

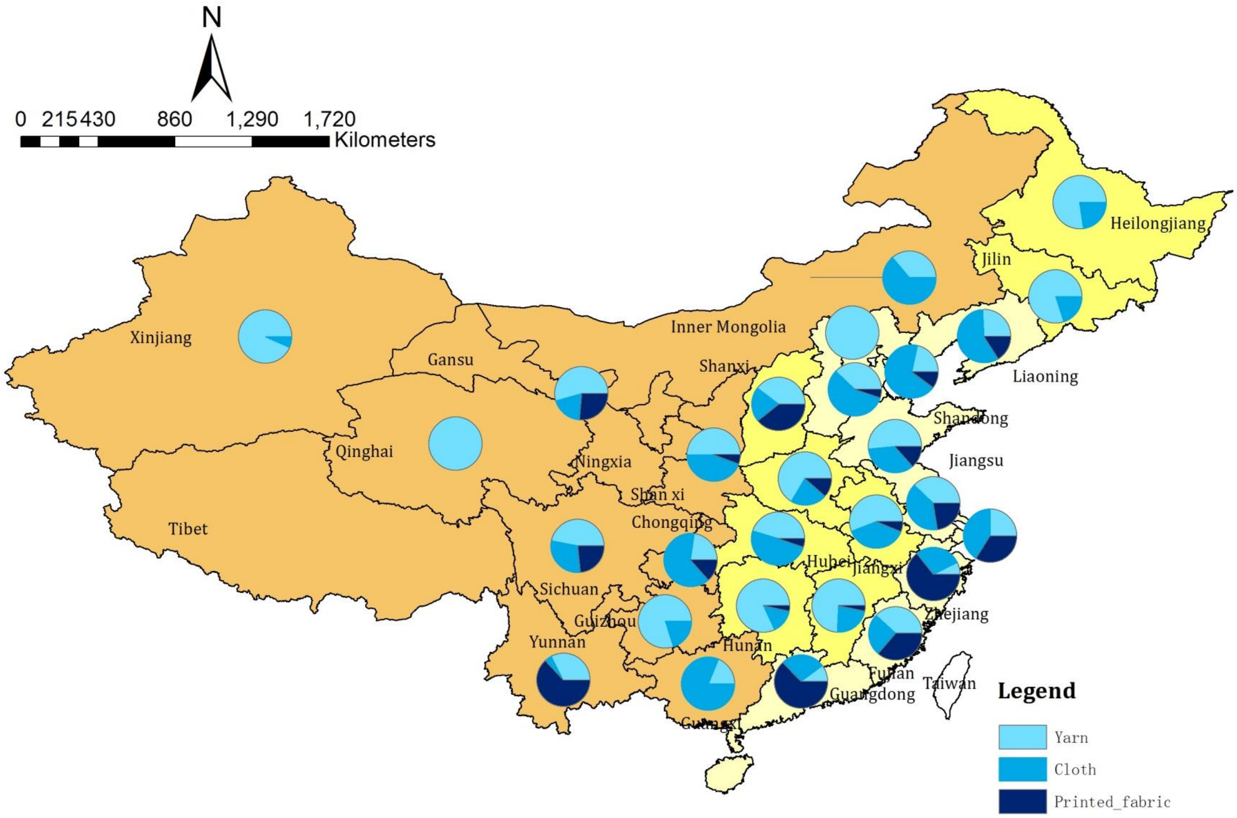
Fiber Production Processing Factories, 2010



Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

Figure 30

Value-added Output of Yarn, Cloth, and Printed Fabric, 2010 (unit: 1 million m)



Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

For some particular raw goods that need special technologies for processing in the fiber industrial sector, such as the silk industry, the gap between the raw goods and deep processing are extreme.Table 13 and Table 14 demonstrate that, compared with the east region, the middle and the west become the prevailing production regions. Guangxi and Sichuan, which are in the west region, are the major producers of cocoon crop.

Table 13

Cocoon-Crop Output of Six Main Production Regions, 2007–2009 (unit: 10,000 tons)

Year	Guangxi	Sichuan	**Zhejiang**	**Jiangsu**	**Shandong**	**Guangdong**
2007	**20.5**	**8.9**	9	10.4	4.1	8.1
2008	**17.1**	**6.9**	7.4	9.5	3.5	6.2
2009	**17.2**	**6.8**	5.3	7.2	2.4	4.6

Source: China Statistical Yearbooks, 2011.

Table 14

Regional Trends in Cocoon Crops, 2000–2006 (unit: 10,000 tons)

Year	2000	2001	2002	2003	2004	2005	2006
East	24.3	27.2	26.6	23.3	25.0	24.2	31.1
Middle and West	22.1	24	27.9	24.7	29.7	34.2	42.8

Source: China Statistical Yearbooks, 2000–2006.

However, in the processing industries, the coastal regions are the prevailing places of silk export. Table 15 and Table 16 show that in 2011, in the top five states exporting silk products, the coastal region took the major proportion. As shown in Table 13, Sichuan is the only province in the interior in the top five for export value of silk products. However, it was still far behind the other four coastal provinces. In the deep processing industry, the east region also took the prevailing proportion. Neither Sichuan nor Guangxi, which are the main interior producers of cocoon crops, was in the list of top five states for the export of silk garments.

Table 15

Export Value of Silk Products, 2011

Province	Export Value ($100 million)	Share
Zhejiang	13.64	38.59%
Jiangsu	5.01	14.17%
Guangdong	4.91	13.89%
Shanghai	3.12	8.83%
Sichuan	2.7	7.64%
Other	5.97	16.89%
Total	**35.35**	

Source: National Bureau of Statistics of China, 2011.

Table 16

Export Volumes of Silk Garments, 2011

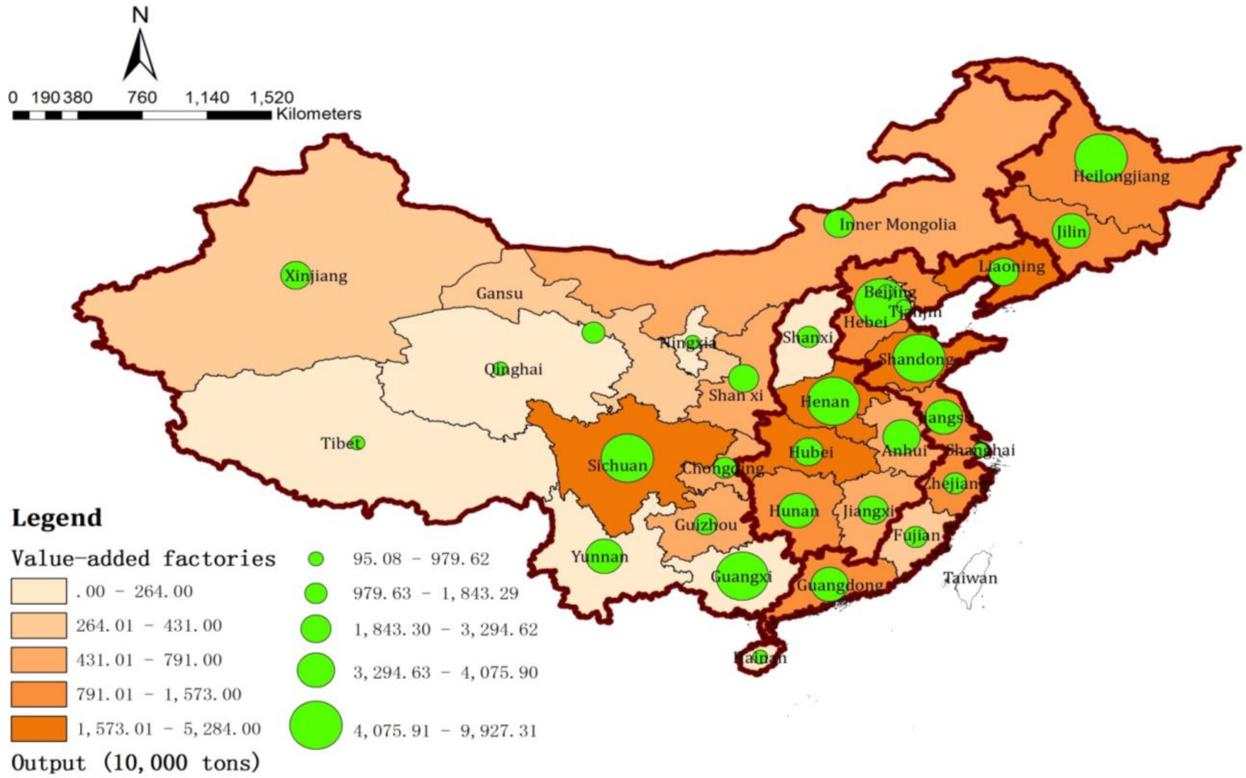
State	Export Volume (unit: 10,000)	Market Share
Guangdong	18,000	65.82%
Zhejiang	2,253	8.24%
Heilongjiang	2,213	8.09%
Fujian	2,038	7.45%
Jiangsu	678	2.48%
Other	2,166	7.92%
Total	**27,348**	

Data sources: China Statistical Yearbooks, 2000–2006; Bureau of Statistics of China, 2011.

Small scale of value-added industries. For the food industrial sector, the raw goods include major categories such as grain, fruit, sugarcane, beetroots, and tea. All of the food materials have a competitive advantage in the inland and increased from 2003 to 2010. Figure 31 shows a gap between the development of material and manufacturing of food in the interior. As shown in the figure, six provinces in the inland are the main material bases for the food industry. However, only four of these provinces have comparatively large-scale economies for manufacturing food. The other provinces with rich natural resources, like Guangxi and Yunnan, also have food manufacturing factories, but the scales are far smaller than the coast. Combined with the location quotient analysis, the manufacturing of food was an import industry, which produced less than is needed to meet local demand in both of the provinces.

Figure 31

Food Production and Processing, 2010

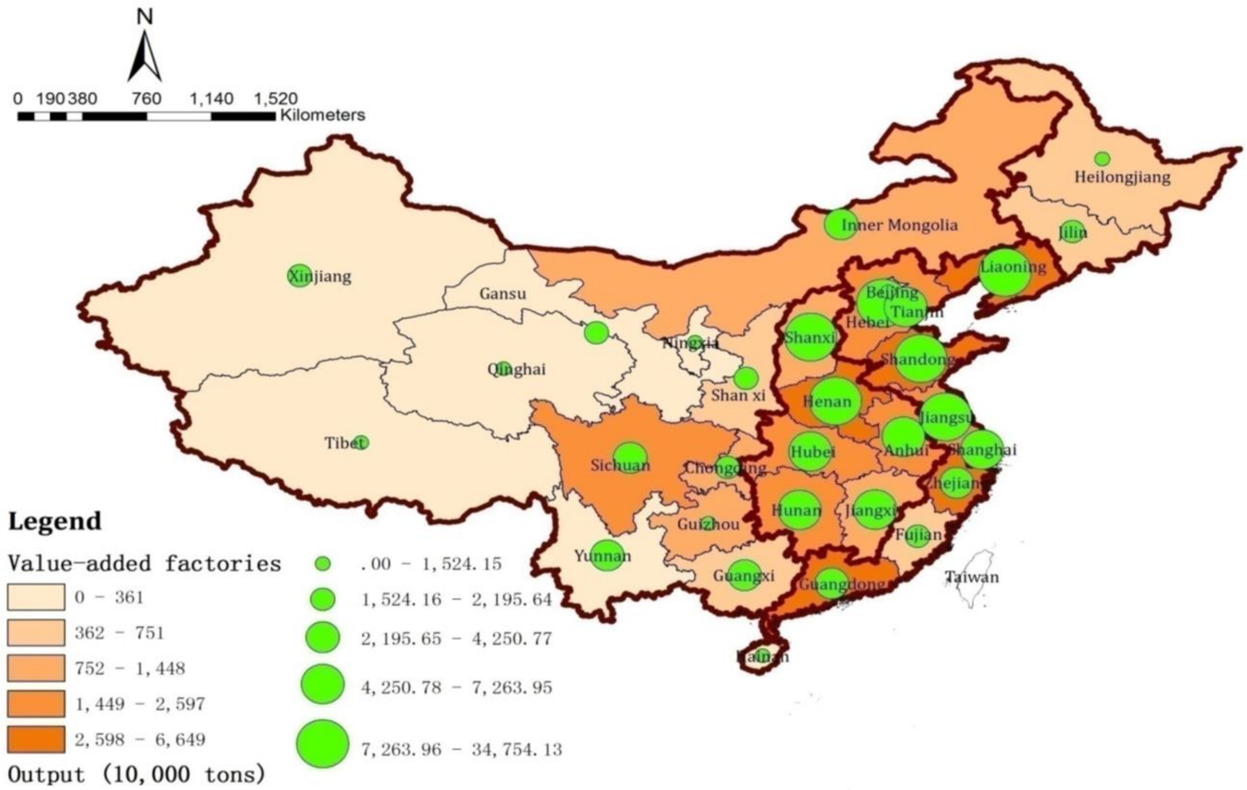


Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

For the metals and machinery industrial sectors, the major raw materials of metals include plenty of preliminarily processed goods, such as pig iron, rolled steel, ten kinds of nonferrous metals, and ferroalloy. Figure 32, which shows the spatial analysis of raw metal goods in the selected province, demonstrates that there are no huge bases such as occur in some coastal provinces. Figure 33 demonstrates that most of the selected provinces have rich potential reserves of the major metals, and have the potential to establish the cluster for the value-added metal and machinery industries. In the metals industries, combined with the location quotient, the scale of industries are so small that half of the selected provinces cannot meet the local demand and need to import metal products from outside. The manufacturing of machineryalso has asimilar situation. Spatial analysis of **Figure 34** shows that there are very few machinery factories in the west except for Chongqing and Sichuan.

Figure 32

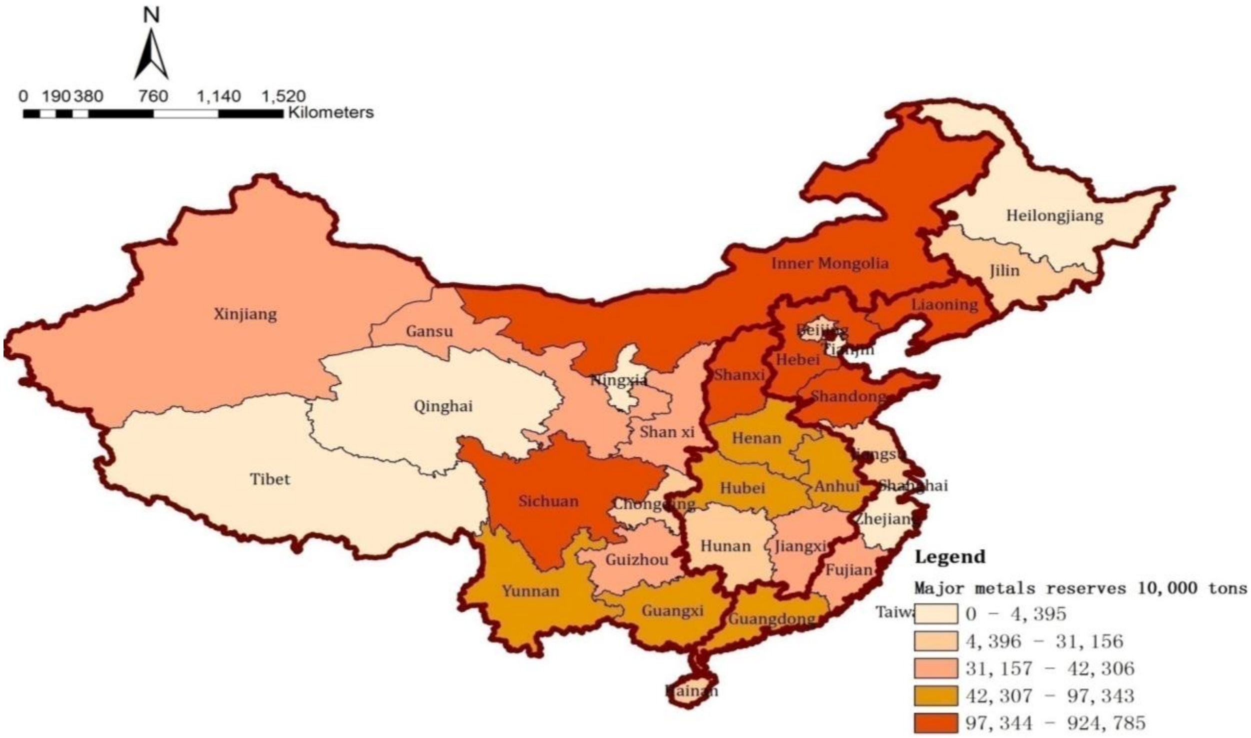
Metal Extraction and Value-Adding Factories, 2010



Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

Figure 33

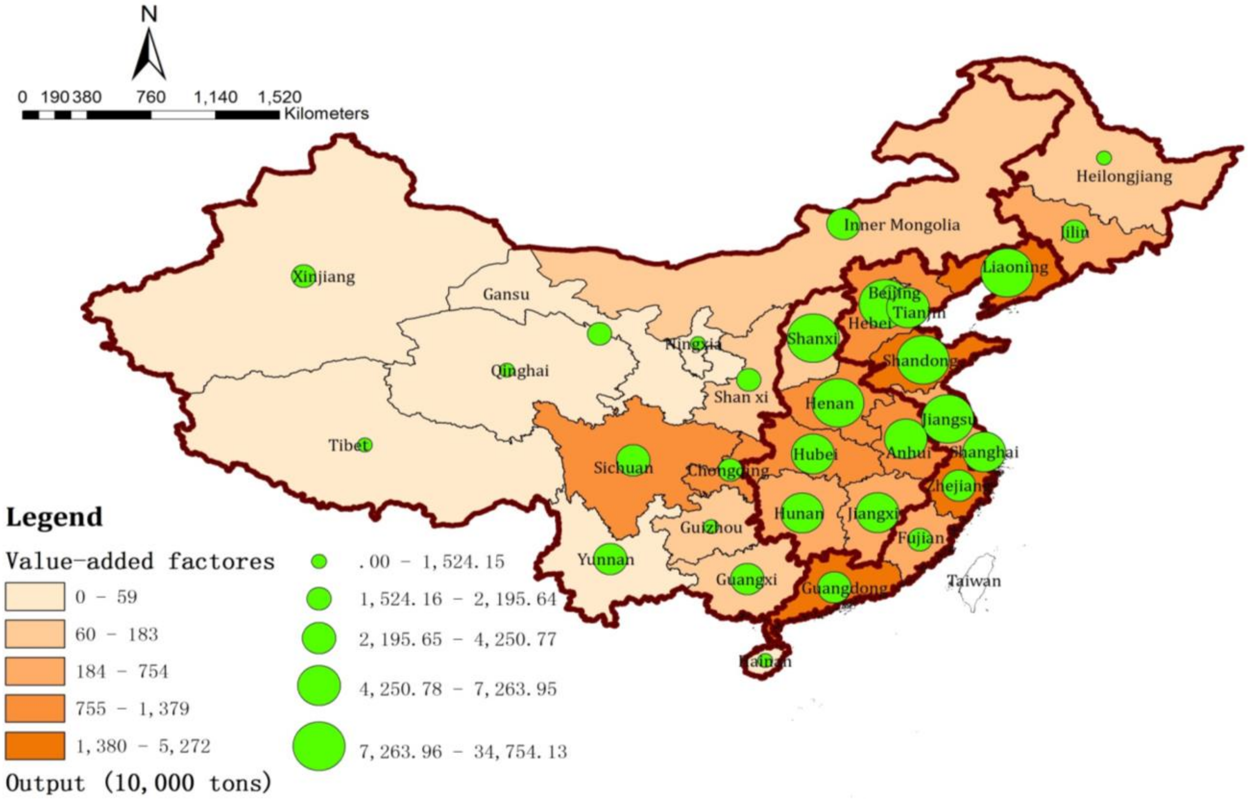
Distribution of Major Metals Reserves, 2010



Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

Figure 34

Metals Extraction and Machinery Factories, 2010



Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

In conclusion, for both situations, it is possible to relocate the value-added industries inland. For the first condition, the local provinces have rich natural resources and primary processing products, which provide the good bases to develop the deep-processing industries and establish the clusters and industry chain. For the second condition, since there were already value-added factories, the selected provinces have a foundation for further development. According to the spatial analysis, the six selected industries are available for the relocation from the coast to the inland.

Table17 shows the details of the industrial relocation strategies of the raw goods and value-added industries by selected provinces. Conclusions of resource production are based on the distribution of raw material output, the location of industry, and the potential reserves of the natural resource. The conclusion of value-added manufacturing includes the current industry development, location advantage of each province, and location quotient analysis. The location advantage is based on the railway accessibility to other areas, the development of relevant industries in the surrounding provinces, and the volumes of freight exchange to other provinces. The assessment of opportunity for vertical industry is based on the relationship between the current raw material and value-added industries. The previous six variables are taken into account as the main factor for the evaluation. The resource reserve and the location advantage are the fundamental factors. If the province performed poorly in both variables, the opportunity for vertical industry will be insignificant in this industrial sector, and will be not applicable for future development. A poor performance in four or more of the six variables can also indicate the unsuitability of this industry. If a province performed well in more than four of the six factors in one industrial sector, the opportunity for vertical industry should be tapped, which means the province can have a quick development for the value-added industries, and can develop an industry chain in the near future. If a province has rich natural resources and good location, and performed well in two to four variables, the opportunity for vertical industry will be untapped. If the local government can carry out preferential policies, it is still possible for this industrial sector to develop well in the long term.

According to Table17, for the six selected industrial sectors, only eight provinces had tapped more than 50 percent of the selected categories. However, 12 provinces showed that more than 80 percent of resource production or extraction had strong location advantage and rich potential reserves of the local resource, which indicated the great potential capacity for the future value-added industries. From the local resource and the current industrial condition, 13 selected provinces are available for at least four major industrial sectors’ relocation. There are still some industries that are not suitable for some particular provinces because of the poor locations with a lack of natural resources. Some provinces, like Qinghai and Heilongjiang, which had poor location advantages and weak potential reserves of local resources for most of the selected industrial sectors can choose to focus on the major sectors with rich natural resources like food, and continue to develop the energy industries as the local pillar industries.

Table 17

Detailed Strategies of Industrial Development in Selected Provinces

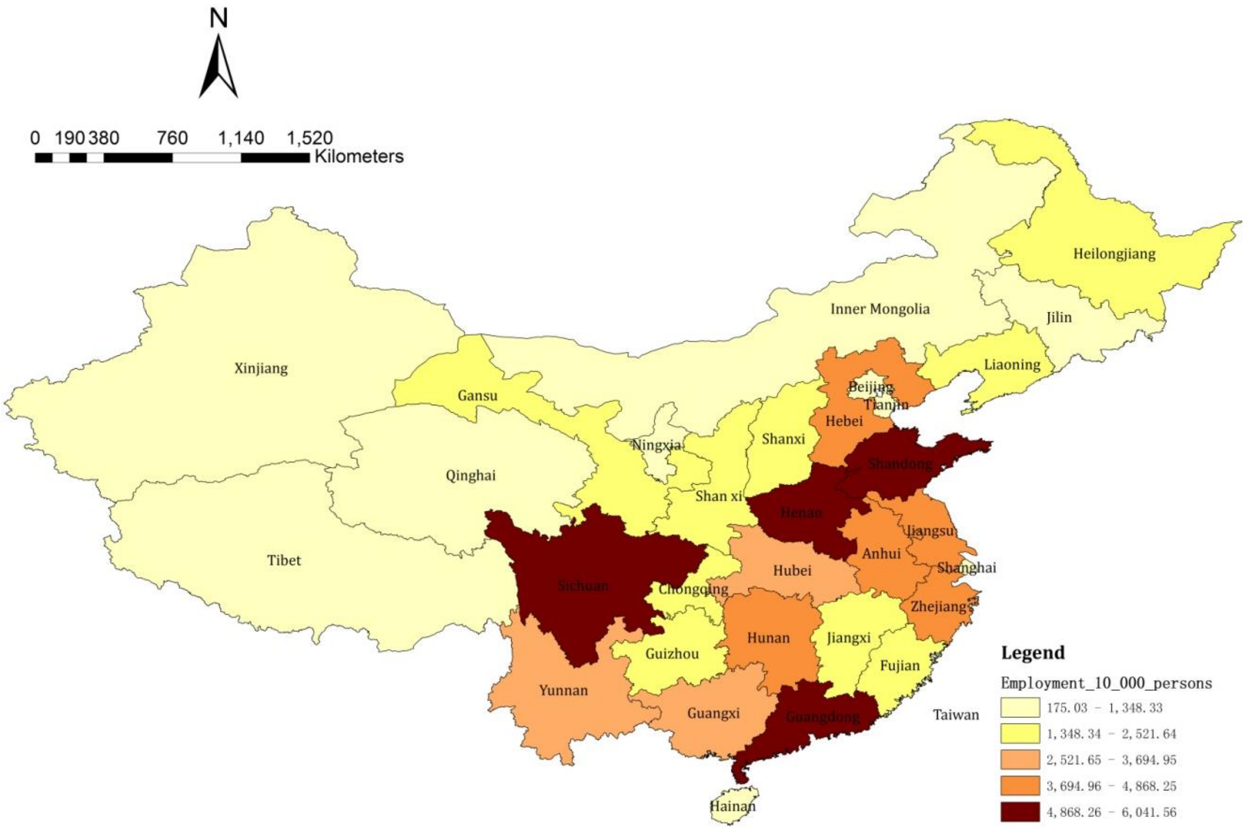
		Resource Production / Extraction			**Value-Added Manufacturing**			**Opportunity for Vertical Industry**
		Location Advantage	Location Industry	Potential Resource	Location Advantage	Location Industry	Location Quotient	
Shanxi	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	0.47	Tapped
	Fiber → Textile	Strong	Tapped	Strong	Strong	Untapped	0.06	Untapped
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.10	Untapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.20	Untapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	0.86	Tapped
	Tobacco	Weak	N/A	Weak	Strong	Untapped	0.49	Insignificant
Jilin	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	2.26	Tapped
	Fiber → Textile	Weak	N/A	Weak	Strong	Untapped	0.16	Insignificant
	Timber → Wood Products	Strong	Tapped	Strong	Strong	Tapped	1.43	Tapped
	Metals → Machinery	Strong	Tapped	Strong	Strong	Tapped	0.68	Tapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	0.77	Tapped
	Tobacco	Strong	Tapped	Strong	Strong	Tapped	3.14	Tapped
Heilongjiang	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	2.73	Tapped
	Fiber → Textile	Weak	N/A	Weak	Strong	Untapped	0.13	Insignificant
	Timber → Wood Products	Strong	Tapped	Strong	Strong	Tapped	1.31	Tapped
	Metals → Machinery	Weak	N/A	Weak	Strong	Untapped	0.45	Insignificant
	Metals	Weak	N/A	Weak	Strong	Untapped	0.69	Insignificant
	Tobacco	Strong	Tapped	Strong	Strong	Tapped	5.43	Tapped
Jiangxi	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	0.72	Tapped
	Fiber → Textile	Strong	Tapped	Strong	Strong	Tapped	0.75	Tapped
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.82	Untapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.48	Untapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	1.10	Tapped
	Tobacco	Weak	N/A	Weak	Strong	Untapped	0.38	Insignificant
Inner Mongolia	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	1.70	Tapped
	Fiber → Textile	Weak	N/A	Weak	Strong	Untapped	0.32	Insignificant
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.55	Untapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.24	Untapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	0.99	Tapped
	Tobacco	Strong	Untapped	Strong	Strong	Untapped	1.17	Untapped
Guangxi	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	0.40	Tapped
	Fiber → Textile	Strong	Tapped	Strong	Strong	Tapped	0.16	Tapped
	Timber → Wood Products	Strong	Tapped	Strong	Strong	Tapped	0.65	Tapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.33	Untapped
	Metals	Strong	Untapped	Strong	Strong	Untapped	0.40	Untapped
	Tobacco	Strong	Tapped	Strong	Strong	Tapped	52.35	Tapped
Chongqing	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	0.87	Tapped
	Fiber → Textile	Strong	Tapped	Strong	Strong	Tapped	0.29	Tapped
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.47	Untapped
	Metals → Machinery	Strong	Tapped	Strong	Strong	Tapped	1.32	Tapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	0.88	Tapped
	Tobacco	Weak	N/A	Weak	Strong	Untapped	2.08	Insignificant

		Resource Production / Extraction			Value-Added Manufacturing			Opportunity for Vertical Industry
		Location Advantage	Location Industry	Potential Resource	Location Advantage	Location Industry	Location Quotient	
Sichuan	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	1.52	Tapped
	Fiber → Textile	Strong	Tapped	Strong	Strong	Tapped	0.30	Tapped
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.86	Untapped
	Metals → Machinery	Strong	Tapped	Strong	Strong	Tapped	0.62	Tapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	1.07	Tapped
	Tobacco	Strong	Untapped	Strong	Strong	Untapped	0.88	Untapped
Guizhou	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	0.93	Tapped
	Fiber → Textile	Weak	N/A	Weak	Strong	Untapped	0.05	Insignificant
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.43	Untapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.22	Untapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	0.84	Tapped
	Tobacco	Strong	Tapped	Strong	Strong	Tapped	3.23	Tapped
Tibet	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	2.90	Tapped
	Fiber → Textile	Strong	Tapped	Strong	Strong	Tapped	0.33	Tapped
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.62	Untapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.10	Untapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	1.34	Tapped
	Tobacco	Weak	N/A	Weak	Strong	Untapped	0.00	Insignificant
Shan xi	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	1.42	Tapped
	Fiber → Textile	Strong	Tapped	Strong	Strong	Tapped	0.27	Tapped
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.33	Untapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.33	Untapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	0.99	Tapped
	Tobacco	Strong	Untapped	Strong	Strong	Untapped	2.05	Untapped
Gansu	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	1.93	Tapped
	Fiber → Textile	Strong	Untapped	Strong	Strong	Untapped	0.14	Untapped
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.19	Untapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.30	Untapped
	Metals	Strong	Untapped	Strong	Strong	Untapped	1.13	Untapped
	Tobacco	Weak	N/A	Weak	Strong	Untapped	3.56	Insignificant
Qinghai	Agriculture → Food	Strong	Untapped	Strong	Strong	Untapped	1.20	Untapped
	Fiber → Textile	Weak	N/A	Weak	Strong	Untapped	0.24	Insignificant
	Timber → Wood Products	Weak	N/A	Weak	Strong	Untapped	0.00	Insignificant
	Metals → Machinery	Weak	N/A	Weak	Strong	Untapped	0.19	Insignificant
	Metals	Strong	Untapped	Strong	Strong	Untapped	1.51	Untapped
	Tobacco	Weak	N/A	Weak	Strong	Untapped	0.00	Insignificant
Ningxia	Agriculture → Food	Strong	Untapped	Weak	Strong	Untapped	1.34	Untapped
	Fiber → Textile	Strong	Tapped	Weak	Strong	Tapped	0.40	Tapped
	Timber → Wood Products	Strong	Untapped	Weak	Strong	Untapped	0.31	Untapped
	Metals → Machinery	Weak	N/A	Weak	Strong	Untapped	0.27	Insignificant
	Metals	Weak	N/A	Weak	Strong	Untapped	1.42	Insignificant
	Tobacco	Strong	Tapped	Strong	Strong	Tapped	6.23	Tapped
Xinjiang	Agriculture → Food	Strong	Tapped	Strong	Strong	Tapped	2.34	Tapped
	Fiber → Textile	Strong	Untapped	Strong	Strong	Untapped	0.37	Untapped
	Timber → Wood Products	Strong	Untapped	Strong	Strong	Untapped	0.32	Untapped
	Metals → Machinery	Strong	Untapped	Strong	Strong	Untapped	0.14	Untapped
	Metals	Strong	Tapped	Strong	Strong	Tapped	1.05	Tapped
	Tobacco	Weak	N/A	Weak	Strong	Untapped	1.48	Insignificant

Supporting workforce. According to Figure 35, under the current situation, the workforce is assembled in the east region and in most of the provinces in the middle. In the west, three selected provinces, Sichuan, Yunnan, and Gansu, all have rich labor resources. In the selected provinces, the rapid growth of urbanization and the faster natural growth rate will motivate the growth of workforce to meet the increasing demand of relocated value-added factories.

Figure 35

Distribution of Employment by Province, 2010 (unit: 10,000 persons)

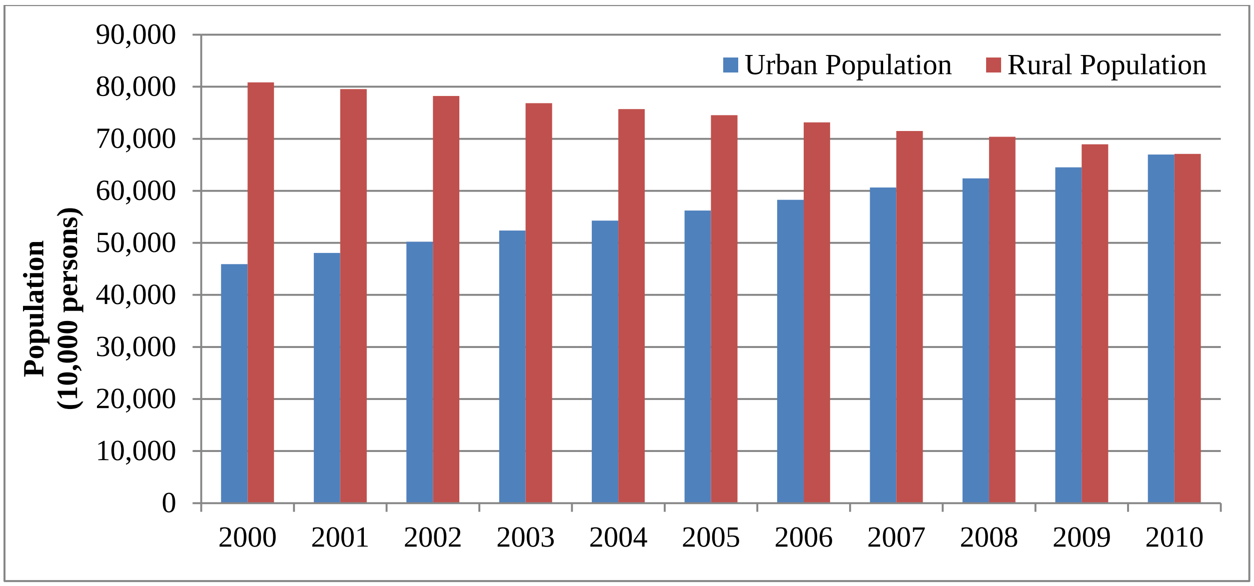


Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

Rapid urbanization. China is experiencing rapid urbanization. In2007, China's urbanization rate was around 30 percent. The central government estimates that this rate will increase to 65 percent in 2030 (China's Urbanization Rate Investigation Report, 2008). Figure 36 demonstrates that the rural population continues to decline while the urban population has increased sharply. In the west region, the rural population occupied the main proportion. In 2010, the number of rural employees was more than 160 million, while the urban population was only 23 percent of the total employment in the west region. Therefore, under the current policy of urbanization, huge western rural areas will become urban areas with a tremendous number of previously rural populations becoming urban population. The new urban areas will greatly increase the number of rural workforces for the value-added industries.

Figure 36

Urban and Rural Populations, 2000–2010



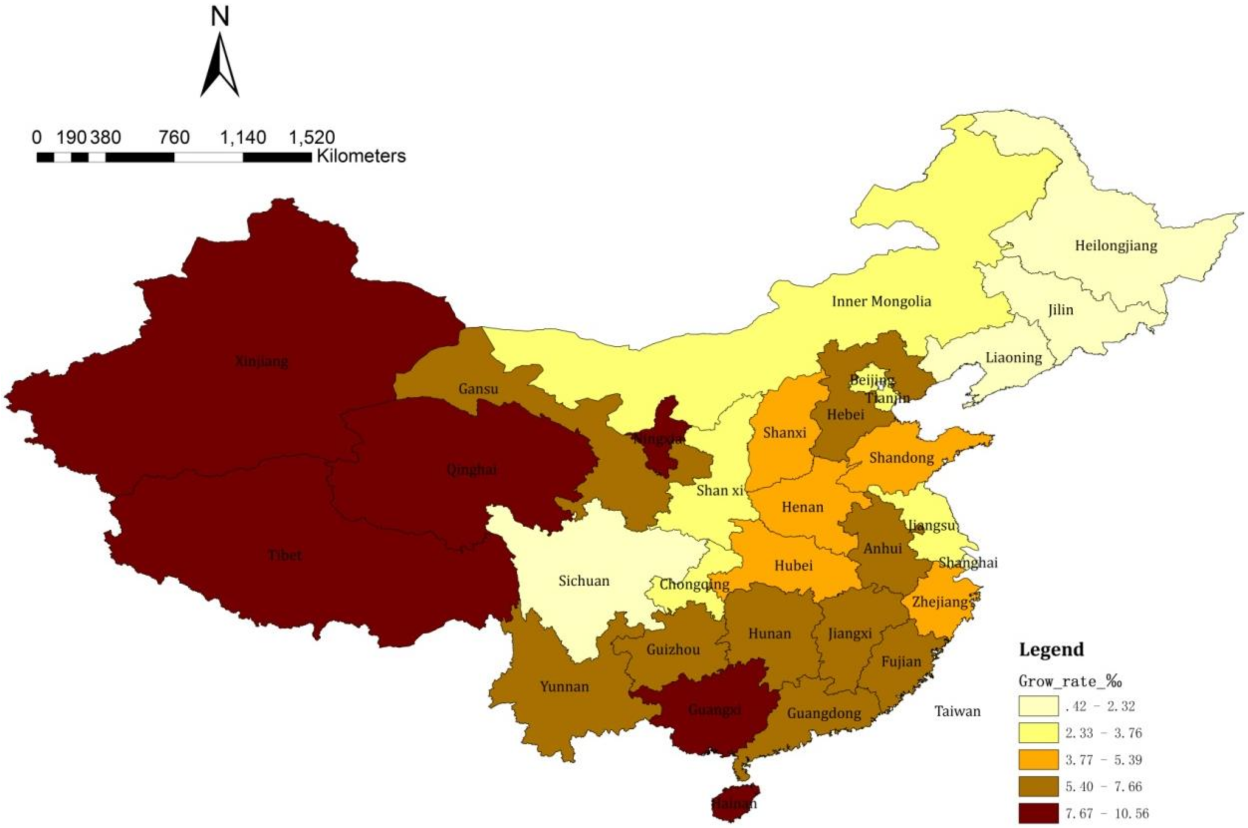
Data source: China Statistical Yearbooks, 2001–2011.

Growth rate in the western region. Second, currently the population in the west region is smaller compared with the other two regions. According to the growth rate shown in Figure 37, most provinces of the west region have a faster growth than the other areas, which will also result in a quick growth of workforce in the near future.

Thus, according to the analysis of the workforce, both the middle and west region have rich labor resources, and will provide a huge workforce in the future. On the other hand, if there is no change in the industry distribution and factory locations, the migratory population from the inland regions will keep increasing, which will increase the Spring Festival traffic problems, especially in the west region.

Figure 37

Population Growth by Province, 2010



Data sources: China Statistical Yearbooks, 2011; NFGIS, 2000.

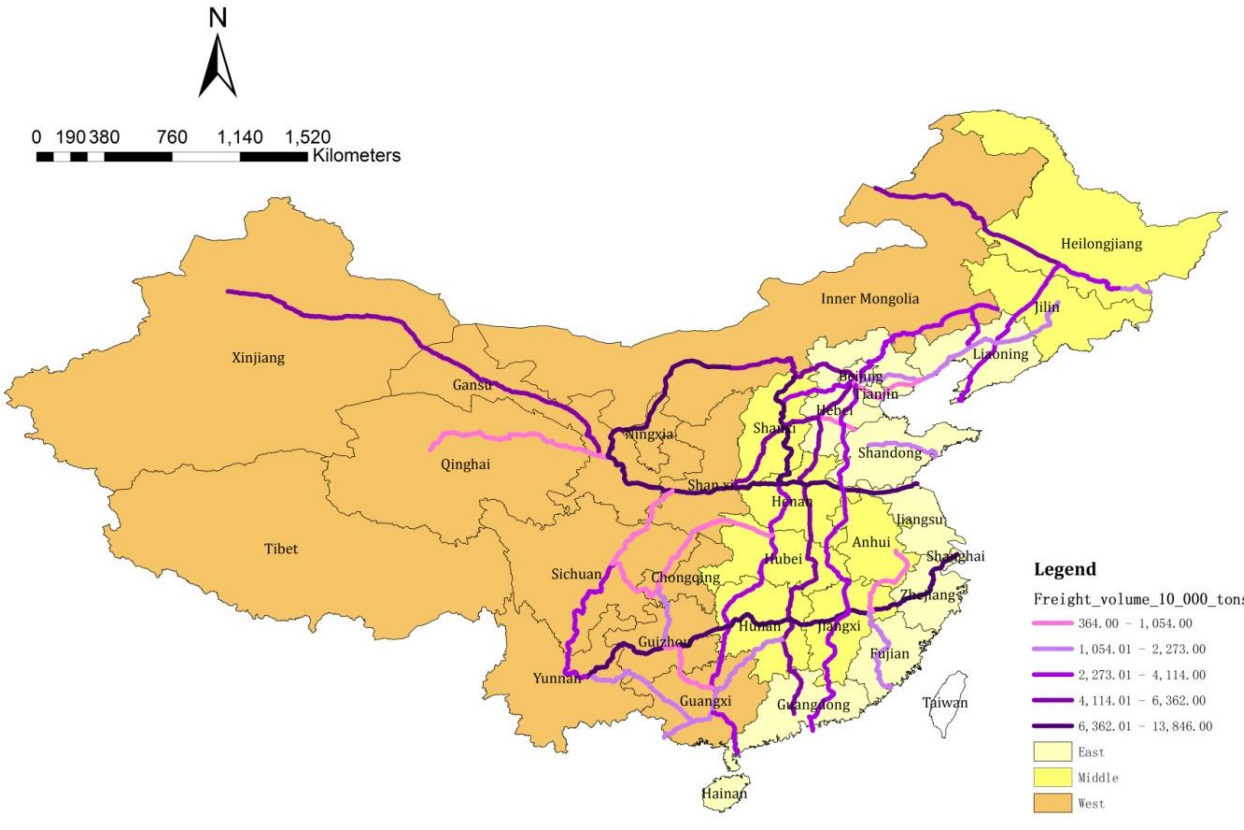
Influence of inland industrial development on the rail system. Relocating the value-added factories from the coast to the inland will have great impact on both the freight rail and the passenger rail system. The analysis of the influence and feasibility of railway includes two components, spatial analysis and quantitative analysis.

Spatial analysis. For the passenger railway network, relocating the factories can straightforwardly increase the employment of factories, and can decrease the surplus labor force to become the migratory population in the east region. As mentioned in the previous analysis, during the Spring Festival travel season, the laborers account for more than half of the whole travel flow. Therefore, the relocation of industries will lead to the decline of the seasonal passenger traffic demand.

There are few trunk railways linking the coast and the west. Only three north-south and three east-west railways run through the inland regions and the coast. Figures 38 and 39 show the freight and passenger transport of trunk lines; there are differences of the six trunk lines in passenger and freight rail. Two of the north-south railways, the Beijing-Guangzhou Railway and the Beijing-Kowloon Railway, had huge traffic volumes on the passenger transport. Therefore, the three east-west railways are a heavy burden on the freight traffic. Besides the trunk railway across regions, the other trunk railways that had huge freight volumes, such as Datong-Taiyuan Railway, Baotou-Lanzhou Railway, and Taiyuan-Jiaozuo Railway, were responsible for the freight transport within one region.

Figure 38

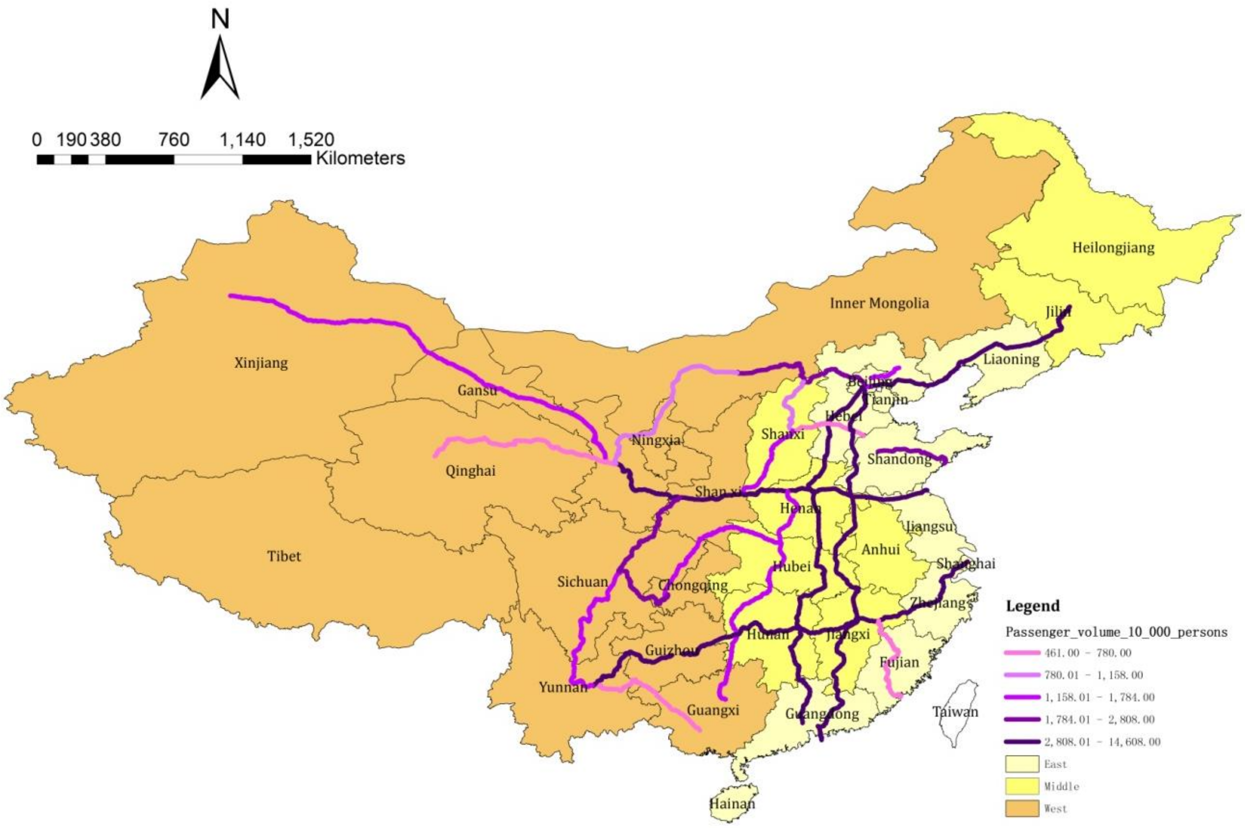
Freight Volumes on Trunk Railways, 2010



Data sources: China Statistical Yearbook, 2011; NFGIS, 2000.

Figure 39

Passenger Volumes on Trunk Railways, 2010



Data sources: China Statistical Yearbook, 2011; NFGIS, 2000.

There are six major types of railways based on the functions and operation of each corridor: a dedicated freight line, a dedicated passenger line, a freight emphasis line, a passenger emphasis line, a freight and passenger line, and an inactive line that has low traffic volume in both freight and passenger transportation. To identify the different types, it is necessary to use the Z score of traffic volume based on the 2020 data, and standard normal distribution in statistics. If there is no volume in freight transportation, the railway belongs to the dedicated passenger line and vice versa. For the railways used in both freight and passenger transportation, given that the significant B area is above 25 percent, as shown in Table 18, if both the freight B area and passenger B area are significant, the railway is a freight and passenger line. If the B area of freight is below 25 percent and the B area of passenger transport is above 25percent, the railway is a passenger emphasis line, and vice versa. If both of the B areas are below 25percent, the railway is an inactive line.

Table 18

Types of Service on Trunk Lines, 2010

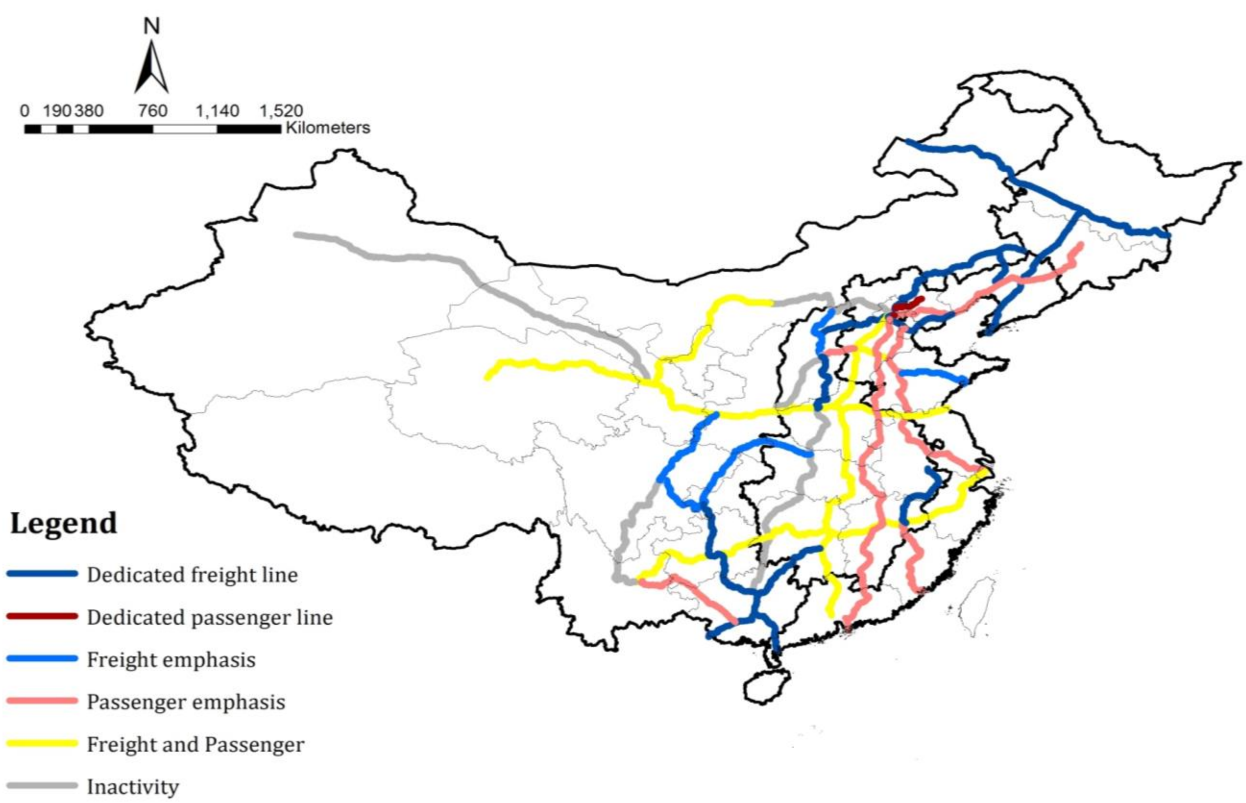
Trunk Line	Passenger-B Area	Freight-B Area	Type
Baotou–Lanzhou	0.25	0.43	Freight and passenger
Baoji–Chengdu	0.09	0.32	Freight emphasis
Taiyua–Datong	0.23	0.49	Freight emphasis
Harbin–Suifen	—	0.26	Dedicated freight line
Harbin–Manzhouli	—	0.09	Dedicated freight line
Changchun–Dalian	—	0.09	Dedicated freight line
Chengdu–Kunming	0.20	0.13	Inactive
Chengdu–Chongqing	0.09	0.29	Freight emphasis
Sichuan–Qianjiang	—	0.25	Dedicated freight line
Shanghai–Kunming	0.36	0.40	Freight and passenger
Beijing–Shanghai	0.49	0.17	Passenger emphasis
Qingdao–Jinan	0.15	0.27	Freight emphasis
Jiaozuo–Liuzhou	0.19	0.03	Inactivity
Beijing–Baotou	0.14	0.23	Inactivity
Beijing–Chengde	0.19	—	Dedicated passenger line
Beijing–Guangzhou	0.49	0.27	Freight and passenger
Beijing–Kowloon	0.28	0.02	Passenger emphasis
Beijing–Shanhaiguan	—	0.32	Dedicated freight line
Datong–Qinhuangdao	—	0.10	Dedicated freight line
Lanzhou–Qinghai,	0.27	0.34	Freight and passenger
Lanzhou–Urumqi	0.19	0.09	Inactivity
Litang–Zhanjiang	—	0.11	Dedicated freight line
Lianyungang–Lanzhou	0.40	0.50	Freight and passenger
Nanning–Kunming	0.27	0.24	Passenger emphasis
Fenglingdu–Taiyuan	0.18	0.13	Inactivity
Qianjiang–Guiyang	—	0.34	Dedicated freight line
Shenyang–Shanhaiguan	0.29	0.18	Passenger emphasis
Shijiazhuang–Dezhou	0.26	0.34	Freight and passenger
Shijiazhuang–Taiyuan	0.28	0.23	Passenger emphasis
Anhui–Jiangxi	—	0.31	Dedicated freight line
Hunan–Guangxi	—	0.22	Dedicated freight line
Xiangfan–Chongqing	0.18	0.30	Freight emphasis
Yingtan–Xiamen	0.26	0.19	Passenger emphasis
Taiyuan–Jiaozuo	—	0.41	Dedicated freight line

Data sources: China Transportation and Communication Yearbook, 2011.

Figure 40 demonstrates the result of Table 18. According to Figure 40, there are three corridors for both passenger and freight from the coast to the west. There is also a dedicated passenger corridor to link the three regions. However, there is a complete dedicated freight corridor directly linking the west with the coast. That is because in the current situation of industrial locations, there are not many freight exchange volumes between the east region and the west region, except for the exporting of raw materials from Inner Mongolia to some coastal areas. After the industrial relocation, the demand of inter-region freight transport will notably increase, which will put pressure on the current corridors, and require further construction on the corridors across the regions and improvement of operational performance through higher net loads, longer trains, and longer hauls.

Figure 40

Types of Service on Trunk Railways, 2010



Data sources: China Statistical Yearbook, 2011; NFGIS, 2000.

Thus, the relocation of factories will directly reduce the passenger traffic demand, especially during the Spring Festival travel season. On the other hand, moving factories from the coast to the west will increase the freight transport across regions, which will produce pressure on the current freight railway network.

Quantitative analysis. The quantitative analysis estimates the possible impacts of the relocation on both the freight rail and passenger rail network. The situation uses estimates based on the railway performance in 2010.

For the decreasing passenger seasonal demand, based on the previous analysis, the inland regions have richer resources in terms of natural raw goods and primary processing goods of the six main industrial sectors. Therefore, the raw goods are not a limiting factor for the development of value-added industries. So it is reasonable to choose the workforce as the factor to estimate the employment of value-added factories. In the east region, the total employment figures of these six industrial sectors were around 20 million in 2010. Thus, using the quotient of the population between the coast and the inland as the factor, the total employment figures in the middle and the west regions are estimated to be around 30 million, which takes about 15 percent of the passenger flow of the railway during the Spring Festival travel season in 2010. The total passenger flow includes all types of railway travel such as short-distance travel, long-distance inner-region travel, and long-distance travel across the regions. Thus, relocation of value-added factories will make great positive impact on decreasing the seasonal traffic demand of the passenger railway system.

Increased freight volumes of the value-added outputs in inland regions are estimated using the quotient of the employments of the six sectors between the coast and the inland as the factor. In 2010, in the east region, the main value-added outputs of these six industrial sectors are around 260 million tons. Therefore, the outputs in the middle and the west regions are estimated to be around 370 million tons. There are 11 trunk lines of the six corridors across the regions, which had a total freight volume of about 580 million tons in 2010. Thus, it is necessary to establish the infrastructure of the freight railway system across the regions. Considering the decrease of interprovincial passengers, China’s government can establish dedicated freight lines to meet the growing freight demand. Besides, with the development of value-added industry inland, the decrease of freight volume of raw materials from inland to the coast can mitigate the pressure of freight railway.

Conclusion

Unlike previous literature that focused on expanding the passenger railway transportation to solve China’s seasonal supply-and-demand gap, this analysis examines the feasibility of relocating value-added factories from the coast to the inland regions to finally thoroughly solve or at least largely mitigate the Spring Festival travel problem. Spatial analysis of potential relocated factories demonstrates that there are 16 provinces in the inland available for the industrial relocation. Six main categories of value-added industries can be relocated from the coast to the inland: manufacturing of food, fiber, timber, tobacco, metals, and machinery. For the influence on the railway system, the value-added industrial relocation will directly reduce the notable volume of seasonal passenger demand during the Spring Festival travel season, while increasing the freight volume across regions, which will produce pressure on the current freight railway network. To meet growing demand of interprovincial freight rail, it is recommended to establish the infrastructure of freight railway system across the regions, such as the dedicated freight lines.

References

Asian Development Bank. (2004). Strengthening the competitiveness of the western region. In *The 2020 project: Policy support in the People's Republic of China.* Manila, Philippines: Author.

Baldwin, R.E. (2005). Industry location: The causes. *Swedish Economic Policy Review,12,* 9–27.

Barrow, K. (2012, July 31). London aims for gold medal performance. *International Railway Journal.* Retrieved from http://www.railjournal.com/index.php/metros/london-aims-for-gold-medal-performance.html#.UCUVdKOWyi0

Bin Jiang & Prater, E. (2002).Distribution and logistics development in China: the revolution has begun. *International Journal of Physical Distribution and Logistics Management, 32*(9), 783–798.

Bovy, P. (2006). Solving outstanding mega-event transport challenges: The Olympic experience. *Public Transport International,* TPI-No 06.

Brief report of export value of silk products in 2011. (2012). Compiled by China Chamber of Commerce for Import and Export of Textiles (CCCT). Retrieved from http://www.silk-online.net/2012/0214/14467.htm

Chen Yao &Chen Yu. (2011).Analysis of China's industrial allocation and transfer. *Contemporary Economy and Management,33*(10), 38–48.

China industrial and economic statistical yearbook. (2011). Compiled by the Division of Industrial Statistics of the National Bureau of Statistics of China. China Statistics Press, No.57.YuetanNanjie, Sanlihe,Beijing, 100826.

China statistical yearbooks. (2000–2011). Compiled by the National Bureau of Statistics of China. China Statistics Press, No.57.YuetanNanjie, Sanlihe,Beijing, 100826.

China transportation and communication yearbooks. (2000–2010). Compiled by China Transportation and Communication Yearbook Press, No. 23.Dongchengqu, Beijing, 100007.

China's urbanization rate investigation report. (2010, December). China International Urbanization Development Strategy Research Committee. Retrieved from http://bbs.pinggu.org/a-1383638.html

China's 11th five-year comprehensive plan for economic and social development. (2005, October). 16th Conference of Central Committee of the Communist Party of China. Central Committee of the Communist Party of China.

Cui Haichao. (2009). *Study of industrial migration, changes of world manufacturing center and development of China's manufacturing industry* (Unpublished dissertation).Xibei University, Xi'an, Shaanxi, China.

Congressional Budget Office. (2006). *Freight rail transportation: Long-term issues.* Retrieved from http://www.cbo.gov/publication/17597

DeJong, G.F., &Fawcett, J. T.(1981). Motivations for migration: An assessment and a value-expectancy research model. In De Jong, G.F., &Gardner, R.W. (Eds.): *Migration decision making.* New York: Pergamon.

Ding Yuewei. (2006). Discussion on the economic effect of ticket price strategy during spring festival. *Finance and Accounting Monthly, 6,* 16–17.

Dou Guili, Dai Xinliu, & Sun Xiaofeng. (2009). Characteristics of railway development in USA, Japan, Russia, and India. *Railway Economic Research,* 1004-9746(2009)02-007-04.

Dunning, J. H. (2000). The eclectic paradigm as an envelope for economic and business theories of MNE activity. *International Business Review, 9*(2), 163–190.

Eff, E. A. (1999). Myrdal contra Ohlin: Accounting for the sources of U.S. county per capita income convergence using a flexible decomposition approach. *Review of Regional Studies, 29*(1), 13–36.

Feng Jicai. (2010). Spring Festival travel problem is a cultural phenomenon. *Business Week, 2,* D669.3.

Gao Shenhong. (2002).*Regional economics.* China:Renmin University Press.

He Yulong&Yang Zhongli. (2007).The comparative advantages of railway in the comprehensive transportation system. *Railway Transport and Economy, 5*(2), 25–27.

Koning, P. (2012).*UK rail reform: An insider perspective.* Los Angeles: AECOM.

Kun-Chin Lin. (2010).*Development of road networks in China: Miscalculations and inequalities.* Paris: The Institute Francais des Relations(IFRI).

Lan Zhe & Wen Li. (1998). The railway reforms in Europe and Japan, and the enlightenment in China. *Journal of Theory Studying and Exploration,2.*

Lewis, P. (2012).*Rail freight traffic: An analysis to better understand the industry and the factors that influence traffic*. Washington, DC: Eno Center for Transportation.

Li Hongchang. (2009). Investigation report of railway in India. *Railway Economic Research,2,* 1–6.

Li Yinan. (2001, May). Monopoly, competition and regulation: China railroad reform. *Economic Problems,* 15–18.

Liu Li. (2012). An analysis in aspect of economics on countryside labor flow in passenger transport market during Spring Festival.*Railway Transportation and Economy,* 25(8), 10–12.

Liu Jin, Tao Ran, &Jin Zude. (2003). Analysis and reflection on the reform and development mode of DBAG. *Railway Transport and Economy Journal, 25*(10). DOI: 10.3969/j.issn. 1003-1421/2003.10.028.

L'Harmet, C. (1998). The organization of industry and location: Alfred Weber revisited. In Bellet, M., &L'Harmet, C. (Eds.), *Industry, space and competition: The contribution of economists of the past*(pp. 122–140). Cheltenham, UK: Elgar.

Mao Baohua, Peng Hongqin, &Jia Shunping. (2010).Trend analysis of 2009 integrated transport systems of China. *Journal of Transportation Systems Engineering and Information Technology*, *10*(2), 17–22.

Mao Baohua, Sun Quanxin, &Chen Shaokuan. (2009).Structural analysis on 2008 intercity transport system of China .*Journal of Transportation Systems Engineering and Information Technology, 9*(1), 10–18.

Martland, C. D. (2012). Productivity improvements in the U.S. rail freight industry, 1980–2010. *Journal of the Transportation Research Forum,51*(3).

National Bureau of Statistics of China. (2011). Brief report of export value of silk products in 2011. Retrieved from http://www.silk-online.net/2012/0214/14467.htm

National Fundamental Geographic Information System Database. Retrieved from http://nfgis.nsdi.gov.cn/nfgis/chinese/c_xz.htm

Njord, J. R. (2002). An Olympic event: Handling transportation during the Olympics. *Public Roads, 65*(4).Retrieved from http://www.fhwa.dot.gov/publications/publicroads/02janfeb/olympics.cfm

Peng Hengwen. (2006).*The analysis of demand-supply gap of Chinese railway transportation and relevant industrial policies based on SCP framework.* Jinan, China: Shandong University, F532, F224.

Philippe, B. (2006). Solving outstanding mega-event transport challenges: the Olympic experience.*Public Transportation,6*, 32–34.

Shao Cen. (2008). A discussion on migrant worker flow in Spring Festival. *Journal of Anhui Agricultural University (social science edition), 17*(6).

Shen Xilai. (2011). Frequent accidents in India Railway. *Transportation and Freight Journal, 1,* 23.

Steinemann, A. C. (2011). *Microeconomics for public decisions*(2nd ed.). Menlo Park, Calif: Askmar Publishing.

Tian Shengkui. (2007).*Research on China's current freight railway market and developing strategies*(Unpublished master's thesis).University of International Business and Economics, Beijing.

Tolliver, D., Bitzan, J., &Benson, D. (2010).Railroad operational performance in the United States. *Journal of the Transportation Research Forum, 49*(3), 87–100.

Park, R. (2001). *Olympic spectator transportation system, Utah Transit Authority: After-action report.* Salt Lake City, Utah Transit Authority.

Van Aalst, I., Van Melik, R. (2012). City festivals and urban development: Does place matter? *European Urban and Regional Studies, 19*(2), 195–206.

Vernon, R. (1966). International investment and international trade in the product cycle. *The Quarterly Journal of Economics, 80*(2), 190–207.

Wang Luolin, &Wei Houkai. (2003).The progress and effect evaluation of western region development in China. *Finance and Trade Economics*, 10.

Wang Qingyun. (2007). Progress of Transportation Development in China. *Journal of Transportation Systems Engineering and Information Technology, 7*(1), 1–11.

Webber, M. (1987). Rates of profit and interregional flows of capital. *Annals of the Association of American Geographers, 77*(1), 63–75.

Wei Zhou, Szyliowicz, J. S. (2006). The development and current status of China's transportation system. *World Transport Policy and Practice, 12*(4), 10–16.

Wen Hai. (2012).World experience of how to guide festival travel issues. *Journal of Disaster Reduction in China, 2.*

World Bank. (2009).*World development report 2009: Reshaping economic geography*. Washington, DC: Author.

Xiao Chunmei. (2011). The development, problem, and strategies of optimization of China's industrial location. *Contemporary Economic Research*, 1005-2674(2011)01-0073-06.

Xie Linxia. (2008). Discussion on the Spring Festival travel issues from cultural perspective. *Journal of Xinyu College, 1.*

Yan Haifeng &Peng Qiyuan. (2006). Characteristic comparison between railway passenger and freight transportation organizing systems. *Journal of Transportation Engineering and Information*, 4(3).

Zhao Jian. (2009). Enlightenment from Investigation of railway in India. *Comprehensive Transportation Journal, 7.*

Zhao Rongzhi. (2011, January). Microeconomic analysis about the Spring Festival travel season. *Business and Management,* 246.

Zhou Ying. (2012, February).*Shortage and injustice: Sociological analysis about the phenomenon of "Spring Festival" transportation*(Unpublished dissertation). East China University of Science and Technology.