

FORMATION MECHANISM AND SPATIAL PATTERN OF URBAN AGGLOMERATION IN CENTRAL JILIN OF CHINA

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ABSTRACT: Urban agglomeration is made up of cities with different sizes to be linked by traffic network in a given area, and it is an inevitable result when urbanization reaches a certain level. Taking urban agglomeration in central Jilin (UACJ) as an example, this article analyzes the formation mechanism and spatial pattern of urban agglomeration in the less-developed area. First, the dynamics of UACJ has been analyzed from the aspects of geographical condition, economic foundation, policy background, and traffic condition. Then the development process is divided into three stages—single city, city group and city cluster. Secondly, the central cities are identified from the aspects of city centrality, and the development axes are classified based on economic communication capacity. Finally, the urban agglomeration is divided into five urban economic regions in order to establish the reasonable distribution of industries.

KEY WORDS: urban agglomeration; formation mechanism; spatial structure; urban economic region; Jilin Province

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1 INTRODUCTION

Urban agglomeration researches originated from the concern about the city cluster in the developed areas of western countries. The modern researches have been extended to the specific areas. HALL (2001) summarized the generality and difference of urban metropolitans in Europe, and analyzed the spatial structure of different areas. NAUDE and KRUGELL (2003) analyzed the spatial development of urban agglomeration in South Africa, and thought that the size of the primate city in Johannesburg-east Rand might be relatively too large. KANEMOTO et al. (2005) took Tokyo metropolitan as an example, and analyzed the rational size of Tokyo as the primate city.

In China, metropolitan regions appeared in the developed areas in succession in the end of the 1980s. Using urban agglomeration as a concept, some scholars analyzed the Changjiang (Yangtze) River Delta, the Zhujiang (Pearl) River Delta, Beijing-Tianjin-Tangshan, central Liaoning Province from multiple aspects, including character of regional structure, developing stage, course and development trends, etc. (LI et al., 1998; GU and XU, 1999; XUE and ZHANG, 2002; XU

and ZHOU, 2003). In recent years, some less-developed areas, such as central Hunan Province, central Henan Province, Yinchuan, have formed the metropolitan areas similar to urban agglomeration (YAO et al., 2001; WANG, 2004). These metropolitan areas are playing an important role in the development of these regions, and they are also studied as urban agglomeration. Taking urban agglomeration in central Jilin (UACJ) as example, this article analyzes the formation mechanism and spatial pattern of agglomeration in the less-developed area, and probes into the reasonable distribution of cities and industries.

2 STUDY AREA

The demarcation of urban agglomeration remains a scientific issue. Some scholars confirmed the boundary through analyzing the interactions among cities (XING et al., 2001). However, the boundary that is ambiguous is always developing and changing. The boundary of UACJ is determined mainly based on the views of Jilin Province Urban System Planning.

UACJ includes Changchun, Jilin, Siping, Liaoyuan, Songyuan, and Meihekou, Huinan, Liuhe, etc. (Fig. 1).

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There were 5 prefecture-level cities, 10 county-level cities and 12 counties. The area is $106.6 \times 10^3 \text{ km}^2$, accounting for 57% of the whole area of Jilin Province.

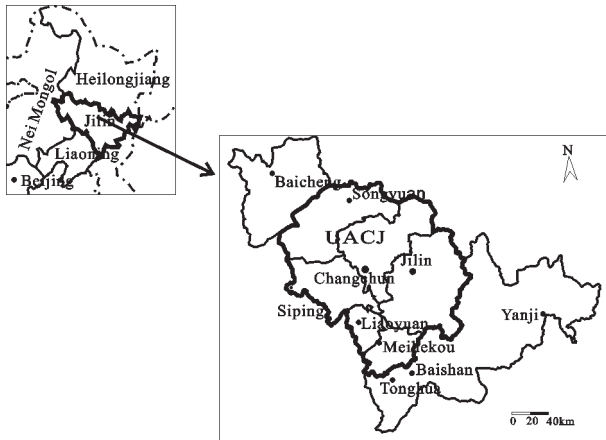


Fig. 1 Sketch of urban agglomeration in central Jilin (UACJ)

3 FORMATION MECHANISM OF URBAN AGGLOMERATION IN CENTRAL JILIN

3.1 Background and Dynamics

3.1.1 Geographical condition

In central Jilin Province, the land resources, illumination and precipitation conditions are favorable to develop agriculture, which promote the development of the cities and counties such as Yushu, Lishu, Gongzhuling, Dongliao, Changling, and Fuyu, etc. Their proportion of primary industry to total GDP all exceeded 40% in 2003. The mineral resources are abundant in UACJ. The exploitation of the coal has promoted the development of the coal-mining cities, including Liaoyuan, Jiutai, Jiahe, Huadian, Shulan, etc. In addition, the oil mining is the main reason that Songyuan City was set up.

3.1.2 Economic foundation

The GDP of UACJ was 300.97×10^9 yuan (RMB) in 2004, accounting for 83.94% of Jilin Province. Per capita GDP was 14.907×10^3 yuan, higher than 13.470×10^3 yuan of the whole province. Compared with 1995, the GDP increased 2.40 times, and its average annual growth rate was 14.56%, both higher than the average level (2.13, 13.54%) of the whole province. The economic foundation plays an important role in the formation of UACJ.

There are the leading industries such as automobile industry, petrochemical industry, agroprocessing industry, and the advantage industries such as medical and pharmaceutical industry, electronic information industry in UACJ. They relatively improve the regional industrial

structure. For example, led by China FAW Group Corporation in Changchun, the automobile industry and automobile spare-part manufacture industry are distributed in Changchun, Jilin, Siping, and Liaoyuan; led by the Jilin Chemical Industrial Company, the petrochemical industry, such as petroleum extraction, refining and coking, are widely distributed in cities and towns of UACJ. In addition, UACJ has concentrated such tertiary industries as scientific research, transportation services and social service, etc.

3.1.3 Policy background

By the 1990s, the change of national society situation and the implementation of the reform policy of the state-owned enterprise have promoted the free flowing of the production factors under the market mechanism. The Chinese government put forward the policy for transforming the old industrial bases of Northeast China in 2003. This has strengthened the policy support for the state-owned enterprise's reform and increased the investment in major infrastructures. This also brings new impetus to the development of UACJ.

3.1.4 Traffic condition

The transportation network of UACJ has initially been formed. There are the north-south railways including Shenyang- Jilin line and Beijing- Harbin line, and the east-west railways including Baicheng- Changchun- Tumen line and Siping- Meihokou line. There are also the national highways including No.102, No. 202, No. 203, No. 302, No. 303 lines, and the expressways including Shenyang- Harbin line, Changchun- Yingchengzi line, Changchun- Jilin line. The transportation network conveniently links the cities and towns inside and outside UACJ. In addition, Changchun Longjia International Airport makes exchanges with the wide world convenient.

3.2 Developing Stage

The development process of urban agglomeration mainly follows the evolutionary law, which is from single city, to city group, city cluster, finally urban agglomeration (ZHU et al., 2002). The process is corresponding to the economic growth phases that Friedmann perceived, namely pre-industrial phase, transitional phase, industrial phase and post industrial phase (YAO et al., 2001). UACJ is in the industrial phase. The added value of the industrial sectors counted for 33.23% of UACJ's GDP in 2004. Although UACJ get rapid economic and social development, it is still on the way to developed urban agglomeration.

3.2.1 Single city

Before 1949, the cities and towns of UACJ were in iso-

lated state. Jilin City and Changchun City became the largest cities in the region. Simultaneously, the tertiary industries in the cities were developed to some extent. Resources exploiting promoted the formation and development of large quantities of cities and towns, such as Taojiatun, Hailong, Jiaohe, Shulan, Yingchengzi, Xi'an (now Liaoyuan). However, the interactions between the cities and towns were still weak.

3.2.2 City group

From 1949 to the early 1990s, the industrial functions of the cities and towns of UACJ were strengthened. Changchun, Jilin, Siping and Liaoyuan had become the central cities with characteristic industrial structures. Songyuan had become the new central city with integrated industrial structure of petroleum extraction and refining. In addition, the cities including Yushu, Jiutai, Huadian, Gongzhuling, and Meihekou had been developed rapidly. During this stage, UACJ got preliminary configuration.

3.2.3 City cluster

Since the middle of the 1990s, the central cities have been further raised in the economic strength, and the peripheral cities and towns expanded sharply. The cities, such as, Dehui, Shulan, Panshi, Shuangliao, have become the regional economic growth point. The improvement of transportation network has also consolidated the communications between the cities and towns. The integral urban economic regions have been formed.

4 SPATIAL STRUCTURE OF URBAN AGGLOMERATION IN CENTRAL JILIN

4.1 Central City

The total 27 cities and counties of UACJ are selected, and Gravity Model is used to calculate the city centrality. The equation is:

$$R_i = \sum (P_{ij} / (b_{ij} \times D_{ij})) \quad (1)$$

where, R_i is the city centrality of city i ; P_{ij} is the acting force between the i th city or county and the j th city or county, $P_{ij} = (M_i + M_j) / 2$, M_i , M_j are the urban population of the i th, j th city or non-agriculture population of the county respectively. b_{ij} is the friction coefficient between the i th and j th cities, usually equal to 2. D_{ij} is the traffic distance between the i th and j th cities or counties (ZHOU, 1995). The traffic distance is counted according to Jilin Province Atlas (DU, 2005). The main results are in Table 1.

The city centralities of Changchun and Jilin are apparently higher than the other cities. They are considered as the regional central cities, and the centrality of Chang-

Table 1 Main result of city centrality

City	R_i	City	R_i	City	R_i
Changchun	17.63	Gongzhuling	3.53	Yushu	1.88
Jilin	9.86	Jiutai	3.51	Huadian	1.85
Siping	4.77	Dehui	2.77	Shulan	1.75
Songyuan	3.98	Meihekou	2.40	Shuangliao	1.66
Liaoyuan	3.57	Panshi	1.97		

Source: Statistical Bureau of Jilin Province, 2005

chun is the highest. Prefecture-level cities such as Siping, Songyuan, and Liaoyuan are located in the surrounding areas, but each centrality of them is relatively high. They are also considered as the regional central cities.

The centralities of Gongzhuling, Jiutai, and Dehui are also relatively high. They are located near the regional central cities (Changchun and Jilin). Therefore, they are considered as the regional secondary central cities.

The centrality of Meihekou is relatively low, but the city's economic strength is quite strong, and it takes an important role in communicating Changchun with Tonghua, Baishan, and Liaoning Province. So Meihekou is considered as the regional central city of UACJ.

The centralities of Panshi, Yushu, Huadian, Shulan, and Shuangliao are also higher than those of other cities or counties, but their economic quantities are quite small. So they are identified just as the important cities or towns (Fig. 2).

4.2 Developing Axis

Economic communication capacity is used to judge the communication intensity among cities. It is the base to analyze the developing axis inside UACJ. Total 15 cities of UACJ are selected. The equation is:

$$R_{ij} = (\sqrt{P_i G_i} \times \sqrt{P_j G_j}) / D_{ij}^2 \quad (2)$$

where, R_{ij} is the economic communication capacity between i th and j th cities; P is the urban population and G is the GDP of the cities; D_{ij} is the same to that in Equation (1) (ZHENG and ZHAO, 2004). The economic communication capacities of main cities below 100×10^9 yuan·person/km² are neglected, and the main results are shown in Table 2.

The communication capacities of Changchun with other cities are the highest, and those of Jilin are following. It is consistent with the results of city centrality. The communication capacities of other prefectural cities with surrounding cities and towns are relatively low, which restricts the formation of regional economic network.

Through analyzing the communication capacities, we can conclude that the main axes are Gongzhuling-Siping-Changchun-Fuyu-Dehui and Songyuan-Changchun-Jilin-Jiaohe. The secondary development axes are

Table 2 Economic communication capacities of main cities ($\times 10^9$ yuan(RMB) · person/km²)

	Changchun	Jiutai	Yushu	Dehui	Jilin	Huadian	Siping	Liaoyuan
Jiutai	8330.1	-	-	-	-	-	-	-
Yushu	872.4	-	-	-	-	-	-	-
Dehui	4184.6	887.8	-	-	-	-	-	-
Jilin	9490.0	1506.1	695.4	784.4	-	-	-	-
Jiaohe	396.2	-	-	-	936.4	-	-	-
Huadian	558.0	-	-	-	670.8	-	-	-
Shulan	410.5	-	253.8	-	1288.7	-	-	-
Panshi	981.7	-	-	-	337.4	222.1	-	-
Siping	2562.6	-	-	-	206.5	-	-	144.9
Gongzhuling	9286.4	165.0	-	117.9	346.9	-	1001.2	-
Shuangliao	655.1	-	-	-	-	-	-	-
Liaoyuan	707.6	-	-	-	171.8	-	262.5	-
Meihekou	462.6	-	-	-	194.5	-	-	425.1
Songyuan	1564.5	-	110.1	170.4	220.3	-	-	-

Source: Statistical Bureau of Jilin Province, 2005

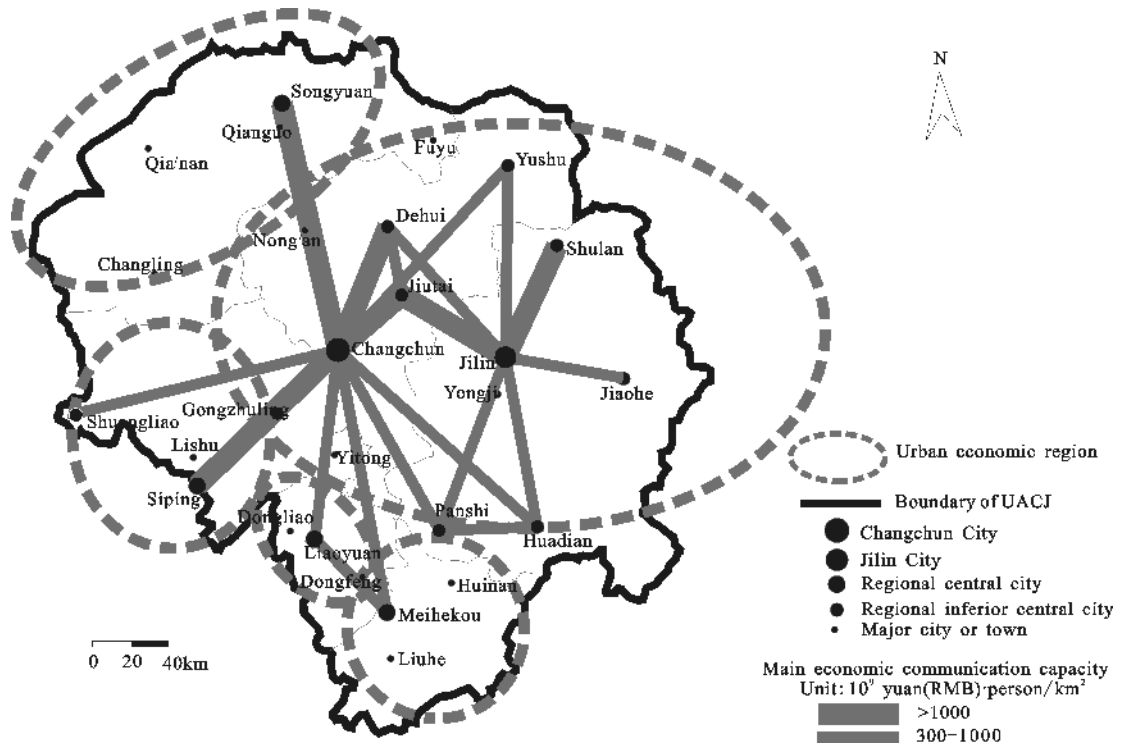


Fig. 2 Spatial pattern of urban agglomeration in Central Jilin

Yushu- Shulan- Jilin- Huadian- Panshi - Meihekou and Shuangliao- Siping- Liaoyuan- Meihekou (Fig. 2).

4.3 Characteristics of Spatial Structure

The spatial structure of UACJ is typical point-axis pattern. First, the spatial distribution shows obvious polarized feature. The metropolitan area centered Changchun appears gradually. The other regional central cities get rapid development too. Second, the development axes show convergent feature. Siping- Gongzhuling- Changchun- Dehui- Fuyu axis has formed the belts of auto-

mobile industry, agroprocessing industry, etc. The Songyuan- Changchun- Jilin axis has formed the belts of petrochemical industry, medical and pharmaceutical industry, electronic information industry, and scientific research. The secondary development axes have formed the industry belts including industries such as resources extraction and refining industry, food processing industry and manufacturing industry.

However, urban system of UACJ is not mature. Changchun is just a central city in the middle of North-east China, whose influence is smaller than those of

Shenyang and Harbin. The other cities' economic strengths are relatively weak, and the competition powers are quite low. The exchanges of cities (towns) mainly depend on administrative management.

5 URBAN ECONOMIC REGION

On the basis of the analysis of the central cities and development axes, we can find that the spatial structure of UACJ shows clear convergent feature. Urban economic regions, which are made up of central cities and their hinterlands, can be used to reveal convergent feature of UACJ (QI, 2003).

The city centralities of Changchun and Jilin are high, and their influences to UACJ are expanded constantly. The two main development axes and the Yushu-Jilin-Meihekou secondary development axis have linked Changchun and Jilin with other cities and towns closely. The city centralities of Siping, Liaoyuan, Meihekou and Songyuan, which lie in the marginal area of UACJ, are relatively high. The urban economies of them are the relatively separate units, and their influences are strong enough to drive the development of their administrative region. But the economic communication capacities between them are relatively low. Only did the communication capacity between Liaoyuan and Meihekou reach 425.1×10^9 yuan·person/km² in 2004. So we divide UACJ into five urban economic regions (Fig. 2).

5.1 Changchun-Jilin Dual-nuclei Urban Economic Region

Changchun and Jilin are the core cities of UACJ. In 2004, the GDP of Changchun was 112.37×10^9 yuan, accounting for 31.34% of the Jilin Province and 37.34% of UACJ. The GDP of Jilin City was 37.03×10^9 yuan, accounting for 10.33% and 12.30%, respectively. The leading industries of Changchun are automobile industry, agroprocessing industry, medical and pharmaceutical industry and electronic information industry. The industries such as commerce, service, education, scientific research, and cultural center, etc. have also been developed rapidly. The leading industries of Jilin are petrochemical industry, metal products industry, medical and pharmaceutical industry. The industries such as chemical fiber, production and supply of electric power, food production, etc. have also been developed.

The Marginal areas of UACJ are affected deeply by Changchun and Jilin, and their developments have certain foundations. The cities and towns of those areas have developed such industries as agroprocessing, automobile fitting, resources exploiting and processing and

tourism, etc.

5.2 Siping Urban Economic Region

Siping is the core region of sub-region UACJ. However, its central dominance is not apparent. In 2004, the GDP of Siping proper was 4.86×10^9 yuan, accounting for 25.4% of the whole Siping Prefecture. The population of Siping proper was 518×10^3 . In addition, the population of Fanjiatun, Gongzhuling, and Guojiadian in the Changchun - Siping development axis all exceeded 100×10^3 in 2004. These cities or towns have developed the industries such as agroprocessing and mechanical production. Equipment manufacturing industry supply Changchun with preliminary works or intermediate products. Basing on the location and traffic dominances, the region can develop modern logistics industry.

5.3 Liaoyuan Urban Economic Region

Liaoyuan is an important nodal point in secondary development axis of Siping-Meihekou. It has formed the industrial structure mainly by the traditional industries such as mining, electric power, coal gas producing, etc. The subsequent industries such as new material, machine processing and manufacturing, textile clothing, food processing have also been developed. Dongliao is located near Liaoyuan, and it have become one of the satellite towns of Liaoyuan.

5.4 Meihekou Urban Economic Region

Meihekou urban economic region includes Meihekou, Huinan, and Liuhe. It is important passageway between UACJ and Liaoning Province. In 2004, the population of Meihekou proper was only 177.8×10^3 , but the total GDP had reached 6.25×10^9 yuan. It shows great development potential. The traditional industries are resources exploiting and processing, smelting and pressing of metal, chemical material and forage production. Meanwhile the region has developed the new industries such as food processing and production, machinery, material packaging. With the development of transportation, commerce, and service industry, it would be the traffic and trade centre.

5.5 Songyuan Urban Economic Region

The population of Songyuan proper was 518.2×10^3 in 2004, whose influence has extended to the area of Baicheng Prefecture. Songyuan is the most important central city in the western Jilin Province, and it has formed the integral industrial system with oil exploiting and processing, chemical production, construction materials, and food processing. In the future, more attention

should be paid to cultivating and strengthening the leading industries, in order to accelerate the technical innovation and optimize industry structure.

6 DISCUSSION

The formation and development of UACJ is due to the rebuilding and transforming of old industrial bases in Northeast China. The complex process is influenced by different dynamics. In the first stage, the geographical conditions played an important role by providing the basic conditions for economic development and infrastructure construction. Some cities and towns that have favorable geographical conditions developed in advance. In the second stage, economic and policy conditions became increasingly evident. The economic growth which promoted the development of the cities and towns was a key factor in the formation of the city group. Economic condition was also an important basis for state's investment projects, which contributed to the improvement of infrastructure. In the third stage, the different backgrounds and dynamics influenced each other deeply. The status of economic and policy conditions was promoted. The transportation network linking the cities and towns played an important role in the formation of city cluster. In the future, with the diffusion of economic globalization and new technology, the technical condition will be another important factor. It is an effective measure for UACJ to make further improvement in the technology of industries.

However, in the current situations, spatial structure of UACJ is far to be perfect, and there are a lot of things to do. Besides the central cities should be improved, the small cities and towns' economy should be strengthened, so that the links between cities and towns are strengthened simultaneously. This can shift the spatial structure from point-axis pattern to network. At present, the low industry quality is a major obstacle to the development of UACJ. The traditional leading industries are facing multiple challenges, and new leading industries have not grown. So it is a reasonable measure to develop the characteristic industries in the different urban economic region. The regions connected by the development axes are the integral parts of the whole area. The development of the regions and axes will speed up the integration process of UACJ. With the policy supporting, the infrastructure building and the

technology updating, UACJ will develop rapidly. It is required to plan the urban agglomeration as a whole body, and to design the reasonable policy to ensure the development of UACJ.

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