The Measurement of Urbanization Bubble of Beijing Under the Background of New Urbanization Development

Based on Improved Coordinate Quadrant Method

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Abstract. The bubble of urbanization development mainly refers to the phenomenon that the urban land, population, industry, environment, and social services etc. are not synchronized or coordinated with the development of urbanization. This study established a quality evaluation index system for urbanization development, evaluated and measured the urbanization bubble of Beijing through comprehensive index evaluation method and coordinate quadrant method. The results show that: (1) the urbanization bubble caused by the land is much more serious, the development speed of land expansion and urbanization is not synchronized; (2) the development of agricultural urbanization is deteriorating with a long bubble period, while the development of industrial urbanization is in an intermittent deterioration period with urbanization bubble; (3) the population, environment and social urbanization of Beijing is fairly good, but there comes with a period with urbanization bubble in 2015. Based on this, some relevant policy recommendations are proposed at the end of this study.

Keywords: new urbanization · urbanization bubble · coordinate quadrant method

1 Introduction

Since the reform and opening up nearly 40 years ago, China's urbanization development has achieved a significant leap. However, the rapid development of urbanization inevitably brings problems such as environmental pollution, excessive resource consumption and imbalance of economic structure, which are prominent in the aspects of the unbalanced regional development, incomplete urbanization and excessive urbanization [1, 2]. Actually, the deviation between the speed of urbanization development and that of a city's land, population, economy, environment and social services is the essence of these types of phenomena. At present, China is in an important period of accelerating urbanization and promoting new urbanization [3–6]. Thus, we should pay more attention to the speed and quality of urbanization development, eliminating the urbanization

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bubble, improving the infrastructure and service of cities and promoting the coordinated development in the aspects of economy, society and ecology in urban areas [7, 8]. Therefore, the scientific and reasonable measurement of urbanization bubble is of great significance for recognizing the drawbacks in the process of urbanization, restraining the expansion of the bubble and promoting a healthy development of urbanization.

The connotation of new urbanization is rich, whose purpose is to realize the coordinated and sustainable development of many kinds of factors, so as to expand the coverage of urban factors, and finally promote urban and rural residents to equally enjoy the fruits of urban development. According to some studies, the bubble of urbanization development mainly refers to the phenomenon that the urban land, population, industry, environment and social services etc. are not synchronized or coordinated with the development of urbanization [9, 10]. Correspondingly, the new urbanization emphasizes both the speed and quality of development, and the bubble will appear if too much or too little attention is given to one side. This study starts from the multi-dimensional judgment of the urbanization bubble, through establishing a quality evaluation index system for urbanization development, and through adopting the comprehensive index evaluation method and the coordinate quadrant method, in order to give a comprehensive, objective review of the quality of new urbanization development of a typical city, Beijing, hoping that the paper can provide some decision reference for promoting the development of new urbanization in China.

2 Materials and Methods

2.1 Research Indicators

Based on the actual situation in Beijing and referring to the existing research results, starting from the six urbanization development aspects of land, population, agriculture, industry, environment and society, this study establishes a multi-index comprehensive evaluation system to measure the level of urbanization development in Beijing, and based on this to measure the urbanization bubble. The constructed evaluation index system of urbanization development level is shown in Table 1. The data of this study is from China Urban Statistical Yearbook and other statistical data.

2.2 Research Method

Based on the established evaluation index of the level of urbanization development, the paper measures the deviation between the development of land, population, agriculture, industry, environment and society etc. and the urbanization process through the change of indicators in the period between 2005 and 2015, and then measures the urbanization bubble. In this study, $V_{1t,}$ $V_{2t,}$ $V_{3t,}$ $V_{4t,}$ $V_{5t,}$ V_{6t} and V_{0t} are set as the change rates of Beijing's land index (M_1), population index (M_2), agricultural index (M_3), industrial index (M_4), environmental index (M_5), social index (M_6) and urbanization index (M_0) during t period. The formula of the change rates is as follows:

$$V_{it} = \left(T_{it_n} - T_{it_{n-1}}\right)/(t_n - t_{n-1}) \tag{1}$$

Table 1. Evaluation index system of urbanization development level in Beijing

Criterion layer	Element layer
Land index (M_1)	Land area for towns, villages, industries and mines (10,000 hm^2), land area for transportation (10,000 hm^2), land area for water area and water facilities (10,000 hm^2)
Population index (M_2)	Number of registered residence population (10,000 person), density of urban population (persons/km^2), the natural growth rate of urban population (%), the rural resident population (10,000 persons)
Agricultural Index (M_3)	Proportion of primary industry output value (%), cultivated land area (10,000 hm^2), crop sowing area (10,000 hm^2), total power of agricultural machinery (10,000 KW), grain output (10,000 tons)
Industrial index (M_4)	Proportion of secondary industry output value (%), asset contribution rate (%), asset preservation and appreciation rate (%), asset liability rate (%), cost profit rate (%), total labour productivity (10,000 Yuan/person)
Environmental index (M_5)	End-of-year garden green space area (10,000 hm^2), urban greening coverage (%), sewage treatment rate (%), decontamination rate of domestic waste (%), amount of reclaimed water (100 million m^3), comprehensive utilization of industrial solid waste (10,000 tons)
Social index (M_6)	Proportion of tertiary industry output value (%), Engel coefficient (%), employment rate (%), number of licensed (assistant) doctors (10,000), number of full-time teachers (10,000), number of scientific and technological activities personnel (10,000)
Urbanization rate (V_0)	Urbanization rate (%)

Based on this, the following 6 aspects of urbanization bubble type are set out, namely land bubble (K_1), population bubble (K_2), agricultural bubble (K_3), industrial bubble (K_4), environmental bubble (K_5) and social bubble (K_6). Based on these aspects, K_i is used to express different types of urbanization bubble values, V_{0t} indicates the change speed of urbanization index, and V_{it} indicates the change speed of the index of land, population, agriculture, industry, environment and society ($i = 1, 2, \ldots, 6$). Thus, the calculation method of various types of urbanization bubble is:

$$k_i = V_{0t}/V_{it} \tag{2}$$

Based on the values of urbanization and related researches, this study adopts the improved coordinate quadrant method, and through establishing a coordinate system to embody the coordination relationship between variables of individual speed changes. There are different growth and reduction relationships between variables of individual speed changes in different quadrants. This study sets the calculation of the direction and size of various elements of urbanization deviating from the ideal model state (Table 2). According to Table 2, only when the change speed of urbanization development (V_{0t}) synchronizes and coordinates with that of land (V_{1t}), population (V_{2t}), agriculture

Table 2. Setting of urbanization bubble deviation index

Quadrant	Method	
Quadrant I	V0t > 0 Vit > 0 Kit > 0	①. $K_{it} > 1$ indicates that there exist urbanization bubbles, and measures should be taken to improve the quality of urban development; ②. $K_{it} = 1$ indicates that there is no bubble in urbanization, and also the quality and speed of urbanization coordinates with each other; ③. $0 < K_{it} < 1$ indicates that there is no bubble in urbanization, and also measures should be taken to quicken the pace of urbanization.
Quadrant II	V0t < 0 Vit > 0 Kit < 0	$V_{it} > 0$ indicates that urbanization is in a period of sustainable development without bubbles; $V_{0t} < 0$ indicates that the process of reverse urbanization is accompanied.
Quadrant III	V0t < 0 Vit < 0 Kit > 0	$V_{it} > 0$ indicates that the urbanization development is in a period of constant deterioration releasing bubbles; $V_{0t} < 0$ indicates that the process of reverse urbanization is accompanied.
Quadrant IV	V0t > 0 Vit < 0 Kit < 0	$V_{it} > 0$ indicates that the quality of urban development is in a period of constant deterioration with serious bubbles; $V_{0t} < 0$ indicates that the urbanization process is still advancing.

(V_{3t}), industry (V_{4t}), environment (V_{5t}) and society (V_{6t}) respectively, will there be no urbanization bubble [11].

The above analysis provides a reasonable and accurate mathematical model basis for the coordinate quadrant method. Based on the quadrant of the urbanization bubble value (K_{it}), the direction of urbanization bubble of various types can be judged. Besides, through the trend of the change speed of urbanization development (V_{0t}) and that of dominant factors in the individual urbanization (V_{it}), the size of each type of urbanization bubble can be judged.

3 Results

3.1 Evaluation Results of Urbanization Development Level

The calculated urbanization development level of Beijing from 2005 to 2015 is shown in Fig. 1. It can be seen that in the process of increasing urbanization rate in Beijing, the development of leading urbanization factors such as land, population, industry, environment and society show an upward trend in varying degrees, while only agricultural development shows an obvious downward trend. Generally, with the continuous development of economy and the deepening of urbanization, the proportion of the output value of the primary industry in GDP, cultivated land area and grain output will decline. The possible reason for this downward trend can be seen as the squeeze on agricultural development caused by land, population, industry, etc.

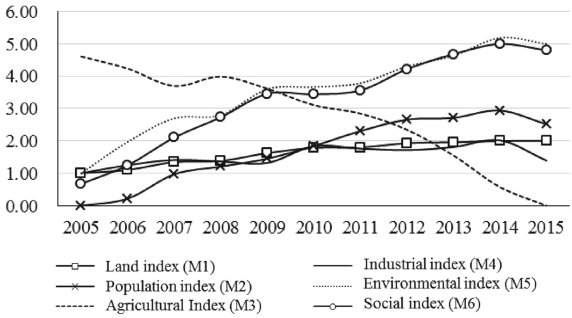

Fig. 1. The urbanization development level in Beijing from 2005 to 2015 (Photo credit: Original)

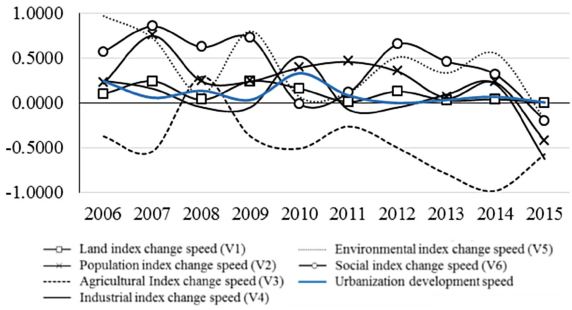

Fig. 2. The urbanization development speed in Beijing from 2005 to 2015 (Photo credit: Original)

Based on the calculation results of urbanization development level, this study further calculates the change speed of each urbanization index (Fig. 2). As can be seen from Fig. 2, the change of land, population, environment and social urbanization index in Beijing is basically positive, indicating that the land scale, population, environment and social service construction in Beijing have shown different degrees of growth and improvement in recent years; at the same time, the change speed of Beijing's industrial development index shows a large inter-annual fluctuation, while that of agricultural development index shows a perennial decreasing trend.

3.2 Results of Urbanization Bubble Calculation

According to the calculation, the bubble value of urbanization in Beijing from 2005 to 2015 under different dominant factors and its changing trend are shown in Table 3 and Fig. 3. Thus, the distribution of the bubble value of urbanization in Beijing can be divided into 4 parts: The bubble value of land urbanization is in the first quadrant of the coordinate system, and there exists urbanization bubble ($K_{it} > 1$). The bubble value of agricultural urbanization is mainly in the fourth quadrant, indicating that the development quality of it is deteriorating and foaming. The bubble value of industrial urbanization mainly changes between the first quadrant and the fourth quadrant. The bubble value of population, environmental and social urbanization is mainly in the first quadrant, but generally fells to the fourth quadrant in 2015.

Table 3. Results of urbanization bubble in Beijing

Year	Land bubble (K_1)	Population bubble (K_2)	Agricultural bubble (K_3)	Industrial bubble (K_4)	Environmental bubble (K_5)	Social bubble (K_6)
2006	2.4167	1.1243	−0.6545	0.9786	0.2520	0.4265
2007	0.2396	0.0782	−0.1087	0.3631	0.0810	0.0684
2008	3.9556	0.5732	0.4724	−2.9897	1.3839	0.2202
2009	0.1421	0.1425	−0.0919	−0.7505	0.0429	0.0475
2010	2.0375	0.8403	−0.6528	0.6394	5.0012	−27.1557
2011	6.0753	0.1805	−0.3174	−1.1209	0.6885	0.7115
2012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	1.2388	0.6131	−0.0434	0.3648	0.1031	0.0744
2014	1.7086	0.3032	−0.0705	0.3322	0.1247	0.2185
2015	2.1084	−0.0162	−0.0120	−0.0110	−0.0373	−0.0352

(1) The land bubble value (K_1) is basically in the first quadrant of the coordinate system, indicating that the quality of land urbanization is constantly improving. Besides, the coordination between urbanization and urban land development was the best in 2009 and 2013, which was the closest to the ideal state ($K = 1$); at the same time, according to the fluctuation of the bubble value, the bubbles in most periods all showed sharp rebound ($K > 1$), indicating that the speed of land expansion and urbanization were different, and the urbanization bubble caused by the land problem was more serious.

(2) The agricultural bubble value (K_3) varies little over the years, but its development quality is in a period of intermittent deterioration and foaming. Under this unstable situation, the urbanization development is still advancing, highlighting the disharmony between agricultural development and urbanization. Firstly, the agricultural bubble value is only in the first quadrant in 2008, indicating that the agricultural development is not good in the process of urbanization. Secondly, the agricultural bubble values was −0.6545 and −0.6528 in 2006 and 2010 respectively, indicating that the development of agricultural and urbanization were the most disjointed during this period.

(3) The industrial bubble value (K_4) showed intermittent deterioration and foaming characteristics, and appeared in the fourth quadrant 3 times in 2008, 2011 and 2013, indicating that the industrial development in the urbanization process is not good, and industrial development and urbanization were most disjointed in 2008. The reason is that although the urbanization process in Beijing has been advancing steadily in recent years under the guarantee of policies, Beijing's industrial development mainly depends on migrant labor and resources, which lead to the mismatch between the development speed of industry and that of urbanization together.

(4) The population bubble value (K_2), the environmental bubble value (K_5) and the social bubble value (K_6) was mainly in the first quadrant bubble-free zone from 2005 to 2014 ($0 < K < 1$). The reasons are: The population bubble between 2005 and 2014

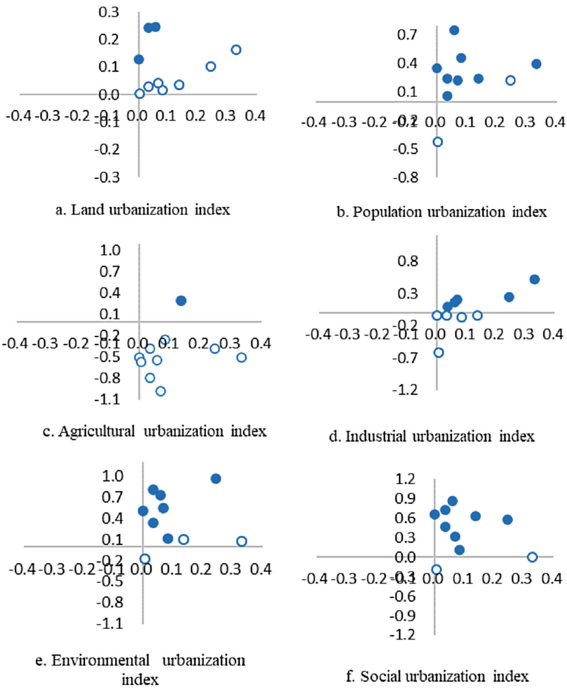

Fig. 3. The trend of urbanization development level in Beijing in 2005–2015 (Photo credit: Original)

basically showed a bubble-free state, which mainly benefited from the effective acceptance and management measures on labor force from outside Beijing; the environmental bubble value fluctuated seriously between 2008 and 2012, which shows that the 2008 Olympic Games promoted the urbanization of Beijing; the fluctuation range of social bubble value is relatively small, indicating that the overall situation of social service and infrastructure construction in Beijing is more synchronized with the development of urbanization.

4 Conclusion

Firstly, research shows that the urbanization bubble caused by land problems in Beijing city is serious. Therefore, on the one hand, we should rationally plan urban land, gradually change the development mode, alleviate and eliminate the negative effects brought by land finance and over occupied farmland; on the other hand, while reasonably increasing the supply of urban construction land, actions should also be taken on actively promoting rural land circulation and increasing farmers' land differential income, in order to enable farmers to share the dividends of urbanization development; in terms of population urbanization, the population urbanization of Beijing basically showed a no-bubble state between 2005 and 2015, but Beijing still has great potential pressure on city population expansion. Beijing needs to focus on solving the problem of

farmer-citizenization and ensure the synchronization of citizenization and urbanization; in addition, Beijing needs to impose policy restrictions on the urban population scale to solve the excessive population expansion of large cities.

Secondly, from 2005 to 2015, the development of Beijing is in a worsening period with serious bubble, which is reflected in the uncoordinated development of agriculture and urbanization. New urbanization requires the coordinated development of urbanization and agricultural modernization, which means to promote the reform of rural land system, promote the transfer of rural surplus labour force, and improve the technical level of agricultural development, so as to ensure the healthy development of agriculture in the process of urbanization; similarly, the development of industry in Beijing is not synchronized with the process of urbanization. At present, China's new urbanization is an urbanization development process suitable for new industrialization, while needing to increase its industrial output and expand its size, Beijing also needs to pay attention to green and low-carbon development, adhere to innovation-driven and intensive development, and implement high-end development in key areas and links based on the actual situation of Beijing's industrial development, so as to make new industrialization provide power for new urbanization.

Finally, Beijing should reduce the environmental urbanization bubble by combining new urbanization construction with sustainable development in resources and environment. On the one hand, while continuing to strengthen urban landscaping construction and increasing the urban greening coverage rate, measures should also be taken on vigorously promoting pollution reduction and strengthening environmental protection law enforcement and supervision; on the other hand, actively developing economy while considering the sustainable development of ecology and resources and strengthening the publicity of the concept of green development in the whole society in order to guide the whole society to form a lifestyle such as green travel and green consumption. Besides, the urbanization development is more coordinated with Beijing's social services and infrastructure construction etc. but there still exist some development bubbles. Thus, actions are still needed on creating a good urban public service system and consolidating urban infrastructure construction in the future, so as to cope with the increasing pressure of urbanization.

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