Evaluation of Urbanization Level from the Perspective of Epidemic Situation: A Case Study of Two Major Urban Agglomerations in China

Chong Ye¹, Jian Wei¹ and Tuolei Wu²

¹ School of Economics and Management, Fuzhou University, Fuzhou, China
² School of Electronic and Information Engineering, Tongji University, Shanghai, China
Email: yc_510@163.com; 627704351@qq.com; 771340037@qq.com

Abstract. Since the reform and opening up, the urbanization level of urban agglomerations in China has been significantly improved, but urbanization is affected by various factors, and there are still obvious differences between urban agglomerations. The epidemic can be described as a big test of urbanization. Can cities with short health boards be evaluated as “pseudo urbanization”? Based on the common indicators of population, economy and land, this paper introduces the indicators of “social urbanization” to build the evaluation system of urbanization level from the perspective of epidemic situation. In view of the representativeness of Beijing Tianjin Hebei Urban Agglomeration and Chengdu Chongqing urban agglomeration in the coastal and inland areas, the panel data from 2009 to 2016 are selected to make a preliminary evaluation by using the time series global principal component analysis. Then add the specific indicators such as medical facilities to evaluate the urbanization level of the two urban agglomerations again, and compare the two results. The results show that: from the perspective of epidemic situation, the urbanization water of the two urban agglomerations has decreased on average, the construction speed in the field of health and health is divorced from the rapid economic development, and the phenomenon of “pseudo urbanization” is widespread.

Keywords. Epidemic situation; urban agglomeration; pseudo-urbanization; time series global principal component analysis.

1. Introduction
Since the reform and opening up, China’s economy has developed rapidly, and industrialization has promoted the level of urbanization. From 1978 to 2009, China’s urbanization level increased by 28.7% [1]. At present, the analysis based on the city can’t show the regional differences of urbanization level intuitively. As an important unit of urban economy, urban agglomeration can more vividly show the regional differences of urbanization. In 2014, the national new urbanization plan (2014-2020) repeatedly mentioned the construction of urban agglomerations and issued the new spatial structure planning of urban agglomerations; the national “11th Five Year Plan” and “12th Five Year Plan” have regarded urban agglomerations as the main body to promote new urbanization for ten consecutive years, and the report of the 17th and 18th National Congress of the Communist Party of China has regarded urban agglomerations as the new economic growth pole for ten consecutive years [2-3]. The formulation of a series of policies and documents has further promoted the large-scale construction of urban agglomerations. The improvement of urbanization level is the result of multiple factors [4]. At present, there are still significant differences in the level of urbanization between different regions in...
China, and under the impact of this epidemic, medical institutions are not able to cope with the problem, the gold content of urbanization is also questionable.

2. Brief Overview of the Literature

Urbanization, in short, is a historical process of transition from traditional rural society to contemporary urban society. Traditional rural society is dominated by agricultural production, urban economic development is slow and urbanization level is low. The contemporary urban society takes industry and service industry as the leading industry, the urban economy develops rapidly, and the level of urbanization is high. It is also known as urbanization at home and abroad, including a series of changes in the industrial structure, employment, living space and quality of life of urban residents. Due to the huge difference in population size and urbanization rate, the population difference is very significant [5]. Urbanization is essentially population migration. Since 1990, China’s cities have developed rapidly, but up to now, the theoretical analysis of urbanization lacks an accurate definition [6]. Urbanization is an important indicator of urban development. It is a common method to measure the level of urbanization in a specific way. In the abstract sense, the urbanization process refers to the process in which cities account for an increasing proportion in the development of national economy and society. The research at home and abroad often creates an index evaluation system of urbanization from the perspectives of population, economy and land.

Urbanization is an important indicator to measure the urban economy. The improvement of urbanization level will attract more industries, funds, talents and technologies for the region, which will greatly enhance the demand for transportation infrastructure in the region and promote the further improvement of regional infrastructure. There are different perspectives of urbanization research. Liu et al. [7] describe the level of regional urbanization from the perspective of population urbanization, and explore the spatial and temporal differences of urbanization in terms of provinces; Guo et al. [8] use a single indicator, namely population urbanization rate, to analyze the coordinated development of urban innovation and urbanization. Liang [9] and others analyzed the degree of coordination among various factors of urbanization; Yao [10] and others focused on the impact of urbanization on urban economy and ecological environment. On the research of social urbanization, Zheng et al. [11] analyzed the coordinated development of Chengdu Chongqing Urban Agglomeration on the basis of traditional research, taking into account the social urbanization level such as the number of hospital beds. When Pan [12] measured the coordinated development of urban agglomeration system, the number of medical beds owned by 10000 people was taken into account as the content of social urbanization. Ji et al. [13] put the number of health institutions and doctors per thousand people into the scope of social urbanization, and analyzed the coordinated development of new urbanization and tourism in Fujian Province. It can be seen that more and more domestic scholars are interested in bringing health institutions into the scope of social urbanization.

There are several deficiencies in the previous study. First of all, some studies only measure the level of urbanization from the perspective of population and economy, and lack of Diversified Perspectives; second, data collection is based on provinces and regions, and the research object is limited to a certain city group, which is easy to lead to a general view. Therefore, on the basis of summing up the existing research results, aiming at this epidemic situation, this paper introduces social indicators to carry out a comparative study on the urbanization of two major urban agglomerations in China.

3. The Evaluation of Urbanization Level of Two Urban Agglomerations

3.1. Selection of Urbanization Indicators

There is a lack of a unified definition of the concept of urbanization in China, so there are many difficulties in selecting the indicators of urbanization. At present, it is not objective for many domestic literatures to establish the index system of urbanization only from the aspects of population and economy. The selection of urbanization indicators should not only reflect the level of urbanization, but also consider the comparative nature of indicators. At the same time, the indicators of urbanization
should also be selected in different levels. There is an important link between the indicators of each level, so that we can more comprehensively investigate the level of urbanization.

Therefore, based on the research of some domestic scholars on the measurement of urbanization evaluation indicators [14], this paper first creates the evaluation system of urbanization indicators of two major urban agglomerations in 2009-2016 from the three directions of population urbanization, Economic Urbanization and land urbanization, as shown in table 1. Secondly, based on the perspective of the current epidemic situation, considering the importance of health for urban construction, combined with the availability principle of data, on the basis of creating the above-mentioned evaluation indicators, make corresponding adjustment and add the indicators of social urbanization, and get the evaluation system of urbanization indicators of two major urban agglomerations in 2019, as shown in table 2.

### Table 1. Evaluation indicators of urbanization in 2009-2016.

| First level indicators | Second level indicators | Third level indicators | Variables |
|------------------------|-------------------------|-----------------------|-----------|
| Population urbanization| Total urban population  | X1                    |
|                        | Percentage of employment in tertiary industry | X2 |
| Economic Urbanization  | Proportion of secondary industry in GDP  | X4 |
| Land Urbanization      | Proportion of tertiary industry in GDP      | X5 |
|                        | Population density       | X6                    |
|                        | Built up area            | X7                    |

### Table 2. Evaluation indicators of urbanization in 2019.

| First level indicators | Second level indicators | Third level indicators | Variables |
|------------------------|-------------------------|-----------------------|-----------|
| Population urbanization| Total urban population  | Y1                    |
| Economic Urbanization  | GDP                     | Y2                    |
| Land Urbanization      | Population density      | Y3                    |
| Social urbanization    | Number of hospitals     | Y4                    |
|                        | Number of doctors       | Y5                    |

3.2. Comprehensive Evaluation of the Urbanization Level of Two Urban Agglomerations

In order to better analyze the urbanization level of the two urban agglomerations, a comprehensive evaluation of the urbanization level is needed. Therefore, this paper uses SPSS software to select time series global principal component analysis and principal component analysis to get the comprehensive scores of urbanization level of the two major urban agglomerations in 2009-2016 and 2019. Time series global principal component analysis is the combination of principal component analysis and time series analysis. Its process is to conduct principal component analysis on panel data of multiple evaluation indexes, so as to establish a comprehensive evaluation index.

(1) KMO and Bartlett spherical test

Before analyzing the data of the two urban agglomerations, we should test them. This paper uses SPSS23.0 software to carry out kMO test and Bartlett spherical test on the data of the two indexes. The test results are shown in tables 3 and 4.

It can be seen from the above test results that the kMO test values are 0.741 and 0.702 respectively; meanwhile, the Bartlett spherical test statistics are 1969.373 and 183.933 respectively, and the corresponding probability p values are close to 0. Taking 0.01 as the evaluation standard of significance level, the probability p value is obviously lower than the significance level, so the original hypothesis should be rejected. Therefore, two kinds of variables describing the urbanization level of the two urban
agglomerations are suitable for the time series global principal component analysis and principal component analysis respectively.

Table 3. The results of KMO and Bartlett spherical test from 2009 to 2016.

| KMO Sampling Suitability Quantity | 0.741 |
|----------------------------------|-------|
| Bartletlet spherical test        |       |
| Approximate chi square           | 1969.373 |
| Freedom                          | 21    |
| Saliency                         | 0.000 |

Table 4. The results of KMO and Bartlett spherical test in 2019.

| KMO Sampling Suitability Quantity | 0.702 |
|----------------------------------|-------|
| Bartletlet spherical test        |       |
| Approximate chi square           | 183.933 |
| Freedom                          | 10    |
| Saliency                         | 0.000 |

(2) Time series global principal component analysis

In this paper, SPSS23.0 software is used to analyze the data from 2009 to 2016. The variance contribution rate of each component is shown in table 5.

Table 5. Contribution rate of variance of each component.

| Component | Initial Eigenvalue | Sum of Load Squares Sum of Squares of Rotating Loads |
|-----------|--------------------|----------------------------------------------------|
|           | Sum Variance       | Cumulative Sum Variance Cumulative Sum Variance Cumulative |
| 1         | 4.45763.675        | 63.675                                             |
| 2         | 1.38219.747        | 83.422                                             |
| 3         | 0.6999.986         | 93.408                                             |
| 4         | 0.3114.437         | 97.845                                             |
| 5         | 0.0901.293         | 99.137                                             |
| 6         | 0.0500.712         | 99.849                                             |
| 7         | 0.0110.151         | 100.000                                            |

It can be seen from table 5 that the variance contribution rate of the first two factors is 53.010% and 30.411% respectively, and the ratio of the two factors to the total variance is 83.422%. Therefore, the first two factors are selected as the first principal component and the second principal component in this paper, which are represented by $F_1$ and $F_2$. The variance of these two main components accounts for a large proportion of the total variance, and they basically have the ability to explain the original indicators. Next, the score coefficient matrix of each component can be obtained by SPSS23.0:

The linear combination of the two main components can be obtained from table 6.

$$F_1 = 0.905X_1 + 0.389X_2 + 0.935X_3 - 0.805X_4 + 0.926X_5 + 0.477X_6 + 0.937X_7$$ (1)

$$F_2 = 0.195X_1 - 0.835X_2 + 0.239X_3 + 0.473X_4 - 0.169X_5 + 0.537X_6 + 0.220X_7$$ (2)

By substituting each variable into equations (1) and (2), we can get the scores $F_1$ and $F_2$ of each principal component, and then sum the weights of $F_1$ and $F_2$, and the interpretation rate multiplied by their respective variances, and finally divide the cumulative weights of the variances of the two principal components to get the comprehensive scores $F_m$ of each prefecture level city in different years. The specific formula is as follows:

$$F_m = (0.53010F_1 + 0.30411F_2)/0.83422$$ (3)
Table 6. The results of Component score coefficient matrix.

| Component | 1     | 2     |
|-----------|-------|-------|
| Total urban population | 0.905 | 0.195 |
| Percentage of employment in tertiary industry | 0.389 | -0.835 |
| GDP | 0.935 | 0.239 |
| Proportion of secondary industry in GDP | -0.805 | 0.473 |
| Proportion of tertiary industry in GDP | 0.926 | -0.169 |
| Population density | 0.477 | 0.537 |
| Built up area | 0.937 | 0.220 |

According to the above steps, we can get the scores of urbanization level of two major urban agglomerations in 2009-2016. Watch tables 7 and 8 for the specific scores:

Table 7. Urbanization level of Beijing Tianjin Hebei urban agglomeration.

| Region            | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|-------------------|------|------|------|------|------|------|------|------|
| Beijing           | 2.39 | 2.60 | 2.56 | 2.66 | 2.77 | 2.91 | 3.04 | 3.31 |
| Tianjin           | 0.64 | 0.73 | 0.74 | 0.83 | 0.93 | 1.04 | 1.25 | 1.55 |
| Shijiazhuang      | 0.11 | 0.16 | 0.16 | 0.17 | 0.23 | 0.41 | 0.49 | 0.52 |
| Tangshan          | 0.21 | -0.18 | -0.21 | -0.17 | -0.13 | -0.08 | 0.00 | 0.02 |
| Zhangjiakou       | -0.04 | -0.08 | -0.11 | -0.08 | -0.05 | -0.04 | 0.05 | 0.15 |
| Chengde           | -0.32 | -0.30 | -0.38 | -0.34 | -0.31 | -0.26 | -0.16 | -0.12 |
| Cangzhou          | -0.07 | -0.10 | -0.16 | -0.16 | -0.12 | -0.09 | 0.01 | 0.04 |
| Langfang          | -0.17 | -0.21 | -0.24 | -0.22 | -0.17 | -0.01 | 0.14 | 0.18 |
| Qinhuangdajing    | 0.16 | 0.12 | 0.14 | 0.12 | 0.15 | 0.20 | 0.29 | 0.33 |
| Baoding           | -0.14 | -0.15 | -0.27 | -0.31 | -0.27 | -0.18 | -0.10 | -0.03 |

Table 8. Urbanization level of Chengdu Chongqing urban agglomeration.

| Region           | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|------------------|------|------|------|------|------|------|------|------|
| Chongqing        | 0.62 | 0.67 | 0.80 | 1.02 | 1.16 | 1.46 | 1.63 | 1.80 |
| Chengdu          | 0.59 | 0.67 | 0.68 | 0.75 | 0.85 | 0.92 | 1.05 | 1.31 |
| Deyang           | -0.46 | -0.52 | -0.57 | -0.54 | -0.54 | -0.48 | -0.35 | -0.27 |
| Mianyang         | -0.24 | -0.29 | -0.37 | -0.36 | -0.33 | -0.29 | -0.27 | -0.15 |
| Meishan          | -0.34 | -0.45 | -0.47 | -0.47 | -0.48 | -0.42 | -0.40 | -0.28 |
| Suining          | -0.32 | -0.34 | -0.34 | -0.36 | -0.38 | -0.36 | -0.35 | -0.31 |
| Leshan           | -0.59 | -0.64 | -0.67 | -0.66 | -0.62 | -0.51 | -0.51 | -0.32 |
| Ziyang           | -0.33 | -0.41 | -0.46 | -0.47 | -0.50 | -0.46 | -0.40 | -0.31 |
| Zigong           | -0.32 | -0.33 | -0.38 | -0.37 | -0.39 | -0.34 | -0.29 | -0.27 |
| Luzhou           | -0.39 | -0.49 | -0.56 | -0.57 | -0.55 | -0.55 | -0.51 | -0.48 |
| Yaan             | -0.42 | -0.48 | -0.54 | -0.56 | -0.52 | -0.49 | -0.46 | -0.37 |
| Yibin            | -0.55 | -0.63 | -0.69 | -0.68 | -0.58 | -0.52 | -0.47 | -0.35 |
| Dazhou           | -0.25 | -0.35 | -0.41 | -0.38 | -0.43 | -0.37 | -0.25 | -0.04 |
| Guangan          | -0.02 | -0.12 | -0.18 | -0.19 | -0.13 | -0.12 | -0.12 | -0.08 |
| Neijiang         | -0.42 | -0.54 | -0.56 | -0.55 | -0.55 | -0.55 | -0.50 | -0.39 |
| Nanchong         | -0.10 | -0.10 | -0.13 | -0.16 | -0.22 | -0.15 | -0.10 | 0.02 |
It can be seen from the above results that the urbanization level of most areas of Chengdu Chongqing urban agglomeration has improved from 2009 to 2016. Chongqing and Chengdu have the highest level of urbanization, and Luzhou has a downward trend of urbanization. The level of urbanization in most regions fluctuated from 2009 to 2012, but increased year by year after 2012.

As a whole, Beijing Tianjin Hebei Urban agglomeration has the highest level of urbanization, followed by Chengdu Chongqing urban agglomeration. Among them, most areas of Beijing Tianjin Hebei Urban Agglomerations scored positive in 2016, with a good trend of urbanization development; while most areas of Chengdu Chongqing urban agglomerations were still negative in 2016, with a slow development speed.

(3) Principal component analysis

In this paper, after the preliminary evaluation of the urbanization level of the two major urban agglomerations in 2009-2016, we further add the indicators of social urbanization health, and use spss23.0 software to analyze the data in 2019 by the time sequence global principal component analysis. The variance contribution rate of each component is shown in table 9.

| Component | Initial eigenvalue | Sum of load squares | Cumulative Sum of load squares |
|-----------|-------------------|---------------------|--------------------------------|
| 1         | 3.679             | 73.587              | 73.587                          |
| 2         | 1.007             | 20.145              | 93.731                          |
| 3         | 0.244             | 4.882               | 98.613                          |
| 4         | 0.065             | 1.291               | 99.904                          |
| 5         | 0.005             | 0.096               | 100.000                         |

It can be seen from table 7 that the variance contribution rate of the first two factors is 73.584% and 20.147% respectively, and the ratio of the two factors to the total variance is 93.731%. Therefore, the first two factors are selected as the first principal component and the second principal component in this paper, which are represented by F3 and F4. The variance of the two main components accounts for a large proportion of the total variance, and they basically have the ability to explain the original indicators. Next, the score coefficient matrix of each component can be obtained by SPSS23.0.

The linear combination of the two main components can be obtained from table 10.

| Component | 1      | 2      |
|-----------|--------|--------|
| Total urban population | 0.900  | -0.089 |
| GDP       | 0.993  | 0.014  |
| Population density | -0.006 | 0.999  |
| Number of hospitals   | 0.961  | 0.019  |
| Number of doctors     | 0.980  | 0.035  |

\[ F_3 = 0.900Y_1 + 0.993Y_2 - 0.006Y_3 + 0.961Y_4 + 0.980Y_5 \]  \hspace{1cm} (4)

\[ F_4 = 0.014Y_2 - 0.089Y_1 + 0.999Y_3 + 0.019Y_4 + 0.035Y_5 \]  \hspace{1cm} (5)

By substituting each variable into equations (4) and (5), the score sum of each principal component can be obtained, and then the weight of \( F_3 \) and \( F_4 \) multiplied by the respective variance interpretation rate can be summed up. Finally, the comprehensive score \( F_m \) of each prefecture level city in different
years can be obtained by dividing the cumulative weight of the variance of the two principal components. The specific formula is as follows:

$$F_m = \frac{(0.73584F_3+0.20147F_4)/0.93731}{(6)}$$

According to the above steps, we can get the scores of the urbanization level of the two major urban agglomerations in 2019, and compare the urbanization level in 2016. Watch tables 11 and 12 for details.

**Table 11. Urbanization level of Beijing Tianjin Hebei urban agglomeration.**

| Region      | 2016 | 2019 |
|-------------|------|------|
| Beijing     | 3.31 | 2.30 |
| Tianjin     | 1.55 | 1.40 |
| Shijiazhuang| 0.52 | 0.20 |
| Tangshan    | 0.02 | 0.25 |
| Zhangjiakou | 0.15 | -0.50|
| Chengde     | -0.12| -0.59|
| Cangzhou    | 0.04 | 0.17 |
| Langfang    | 0.18 | 0.16 |
| Qinhuangdap | 0.33 | -0.42|
| Baoding     | -0.03| -0.12|

**Table 12. Urbanization level of Chengdu Chongqing urban agglomeration.**

| Region      | 2016 | 2019 |
|-------------|------|------|
| Chongqing   | 1.80 | 2.07 |
| Chengdu     | 1.31 | 1.17 |
| Deyang      | -0.27| -0.45|
| Mianyang    | -0.15| -0.40|
| Meishan     | -0.28| -0.46|
| Suining     | -0.31| -0.43|
| Leshan      | -0.32| -0.48|
| Ziyang      | -0.31| -0.49|
| Zigong      | -0.27| -0.34|
| Luzhou      | -0.48| -0.41|
| Yaan        | -0.37| -0.60|
| Yibin       | -0.35| -0.44|
| Dazhou      | -0.04| -0.45|
| Guangan     | -0.08| -0.45|
| Neijiang    | -0.39| -0.40|
| Nanchong    | 0.02 | -0.29|

It can be seen from the above results that, considering the health aspects of social urbanization, the urbanization level of most areas of Beijing Tianjin Hebei Urban Agglomeration in 2019 is still positive, and the urbanization level of urban agglomeration is high. Among them, Beijing and Tianjin have the highest level of urbanization; in 2019, the level of urbanization in most areas of Chengdu Chongqing urban agglomeration is still in a negative value. Among them, Chongqing and Chengdu have the highest level of urbanization.

By comparing the urbanization level of the two evaluation methods, it can be seen that except Tangshan, Cangzhou and Chongqing, the urbanization water in other regions of the two urban
Agglomerations has declined on average, which is contradicted with the increasing trend of the urbanization level of health and health in 2009-2016 without considering social urbanization, which can be understood as the "pseudo urbanization" Elephant. It can be seen that the level of urbanization of the two urban agglomerations will be generally reduced, not as high as the conclusions of previous studies, when considering health care. Among these data, the urbanization of Beijing, Tianjin, Chongqing and Chengdu are in the high level of the two major urban agglomerations. However, the urbanization level of Beijing has declined significantly after taking health care into account, which is due to the imbalance between the rapid economic development and the construction speed of health institutions, thus showing a significant "pseudo urbanization". According to the common phenomenon of pseudo urbanization in the two urban agglomerations, it is not difficult to speculate that the construction of health institutions in most areas cannot keep up with the speed of regional economic development, which makes it present a phenomenon of "pseudo urbanization" in the process of urban development.

4. Conclusion and Prospect

Based on whether to consider the health aspects of social urbanization, this paper makes a comprehensive evaluation and comparative analysis on the urbanization level of each urban agglomeration in 2009-2016 and 2019. The main conclusions of this paper are as follows:

(1) Without considering health, there is a significant regional difference between the two urban agglomerations in 2009-2016. The data with a positive urbanization score of Beijing Tianjin Hebei urban agglomerations is significantly higher than that of Chengdu Chongqing urban agglomerations. The analysis shows that the urbanization level of Beijing Tianjin Hebei Urban Agglomeration is relatively high, and the urbanization process of Beijing and Tianjin is relatively fast; while the urbanization level of Chengdu Chongqing urban agglomeration is relatively low, which obviously lags behind the urbanization speed of Beijing Tianjin Hebei. In Chengdu Chongqing urban agglomeration, the urbanization process of Chongqing and Chengdu is relatively fast.

(2) Considering health, the urbanization level of Beijing Tianjin Hebei Urban Agglomeration in 2009 is still higher than that of Chengdu Chongqing urban agglomeration. However, it is not difficult to compare the data from the two evaluation methods, and it is found that the level of urbanization in most regions has declined with the consideration of health. This is contrary to the conclusion that the average of urbanization water increases gradually by analyzing the data of 2009-2016. The phenomenon of “pseudo urbanization” generally exists in the two urban agglomerations. In the process of regional urbanization, the construction of health institutions in most regions fails to keep up with the speed of urbanization. This makes most areas present a high level of urbanization only considering economic development, while the urbanization level when considering social welfare facilities such as health and health construction does not reach that high level. Therefore, while speeding up the economic development, the construction of health should not be ignored.

In the current situation of such severe epidemic situation, the anti-risk ability of cities in the face of natural disasters such as viruses has naturally become an important part of the urbanization process. Urban construction should not only take into account the rapid economic development, population growth and land expansion, but also take into account the social welfare brought by urban construction from the health level of social urbanization. The establishment of a perfect urbanization evaluation index is conducive to providing constructive suggestions for the development of cities, avoiding and avoiding more “pseudo urbanization” phenomena. To sum up, this paper proposes the following research prospects:

First of all, urbanization is the result of many factors, and the evaluation of urbanization is quite complex. Considering the important role played by the current health construction and urban emergency management in the future development of the city, the future research on urbanization should not only consider the urbanization of population, land and economy, but also from social urbanization and other aspects. The selected indicators are more comprehensive, covering medical and health care, urban emergency management, and transportation shortcut Secondly, for the huge differences in the level of urbanization in China, the selected research area will be expanded to nine
urban agglomerations nationwide, and the conclusions of the study can provide reference for the development of urbanization in more regions.

References

[1] Cheng Y and Ye H 2013 Change of circulation cost and spatial agglomeration of manufacturing industry: Theoretical and practical analysis based on local protection policy China Industrial Economy (4) 146-158.

[2] Zhao N, Wang B and Liu Y 2017 Urban agglomeration, agglomeration effect and “investment rush”—An empirical study based on 20 urban agglomerations in China China Industrial Economy (11) 81-99.

[3] Fang C, Zhou C and Gu C 2016 The overall goal and strategic focus of urban development spatial pattern optimization in China Urban Development Research 23 (10) 1-10.

[4] Zhu L 2016 Study on the Influence of Regional Transportation Facilities on Urbanization (Beijing: Capital University of Economics and Trade).

[5] Sun J, Wang J and Wang T 2019 Urbanization, economic growth and environmental pollution Management of Environmental Quality: An International Journal 30 (2) 1-9.

[6] Li Q, Chen Y and Liu J 2012 Research on “promotion mode” of China’s urbanization China Social Sciences (7) 82-100 + 204-205.

[7] Liu S, Wang X and Qi W 2019 Temporal and spatial differences in the development of urbanization in China Geographic Research 38 (1) 85-101.

[8] Guo F, Yang D and Liu Y 2019 A study on the coupling and coordination of urban innovation output and urbanization in the Yangtze River Delta Journal of Ningbo University (Science and Engineering Edition) 32 (3) 108-114.

[9] Liang D, Luo J and Guo Y 2019. Study on the coordination of urbanization quality and urbanization scale in Shandong province Journal of Central China Normal University 53 (1) 112-120.

[10] Yao R, Cao J and Wang L 2019 Urbanization effects on vegetation cover in major African cities during 2001-2017 International Journal of Applied Earth Observations and Geoinformation 75 (10) 44-53.

[11] Zheng X and Fan B 2019 Study on the coordinated development of land use efficiency and new urbanization level in Chengdu Chongqing urban agglomeration Architectural Design Management 36 (7) 83-89.

[12] Pan Z 2017 Measurement and Optimization of Coordinated Development of Urban Agglomeration System (Chongqing University).

[13] Ji Z, He D and Wu L 2018 Quantitative research on the coordinated development mechanism of new urbanization and tourism in Fujian province Science and Technology and Industry 18 (7) 8-14.

[14] Tian L 2018 Research on the Impact of Transportation Infrastructure Investment on Urbanization in Hebei Province (Baoding: Hebei University).