Empirical Research on the Factors of Chinese City Growth in the Transitional Period

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Abstract Based on the definition of the concept of city growth, the paper mainly discussed the factors which impact the growth of Chinese cities in the transitional period by selecting the proportion of city construction land area to the area of the city X_1(%), green coverage ratio of the built up area X_2(%), the ratio of personnel involved in the secondary industry X_3(%), the GDP per capita X_4($\times 10^4$) and other 43 indicators, by relying on the relevant data from *China Urban Statistical Yearbook*(2008), applying SPSS statistical software and by applying the Factor Analysis and Regression Analysis. The results show that the factors which affect the city growth have four major groups, namely economic and institutional factors, location factors, environmental factors and social cultural services and functions. Among the factors which affect Chinese city growth, the general budgetary expenditures and the general budgetary revenues of local public finance are the most important factors. The general budgetary expenditures of local finance, the general budgetary revenues, the lands of urban construction and other 12 factors obtained by gradually excluding method can be used to present the coefficient of city growth.

Key words Transitional period, City growth, Chinese cities, Factors, China

Since 1980, the research on city growth has been paid much attention to in the academic fields with the widely implemented neo-liberal economic policies in Europe and the United States and the rapidly developed industrialization and urbanization of developing countries. However, the focuses on city growth vary hugely in the south and the north. In western countries, people lay much stress on the quality of city growth, which is closer to the connotation of development, such as the smart growth, sustainable development and other kinds of development. However, in developing countries, the prior targets of city growth are the rapid growth, such as rapid economic growth rate and high population growth rate. In general, most scholars represent the growth of city from the aspects of city development, urban sustainable development, and urban competiveness and so on. They judge the development of the whole city from macroscopic perspective[1-4]. However, few scholars have researched the urban development from the perspective of city growth and few scholars have defined the concept of city growth. In the paper, I defined the concept of city growth in the initial stage, and then I conducted empirical analysis on the influence factors of city growth in the transitional period of China by using the Factor Analysis and Gradually Regression Method.

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1 The concept of city growth

City development refers to the upward trend of a city. The trend describes the process of city movement from small to big, from immature to mature vividly. That is to say, city development refers to the process of change and evaluation after the birth of the city and it is a highly comprehensive vocabulary and basically it can describe the whole process of city evaluation. However, there are still certain shortages in describing the evaluation of city. Firstly, the concept does not cover the process and content of the birth of the city. Secondly, it gives priority to the "upward movement" of city evaluation, but rarely lays stress on the recession and death of city. May be in the mind of human, the city can exist for ever and human do not need to care about its death. At least we do not take it into consideration in the process of planning and management. Thirdly, although we have become aware of that the city evaluation not only concerns the problems in the economic fields, but also concerns various kinds of fields such as economy, society, culture, natural ecology and so on in the late 20th century, however, the definition of city development is the result gradually added and changed after the gradual deepening and perfection of people's awareness of "the phenomenon of development", so hitherto, the society, culture, ecological environment, equality and the like have not been paid enough attention to. Fourthly, the concept does not present the process of organic evolution of nature. In recent decades, the concept of "life" of organizations and collaborations has been introduced, but the development of city still taken the city as inorganic and nonliving individual to plan and construct. Therefore, it is necessary to introduce the concept of city growth.

From the broad sense, city growth is used to describe the whole process of gestation, birth, growth, maturity, fading and

death of cities. While from the narrow sense, it emphasizes the growth of living organisms. The city is in accord with the rule of general evaluation of living organisms, but there are still some discrepancies. The city, which has the general characteristics of individual organism, the features of plant group and ecological system and the complex system of self-evaluation, is the social geographic system formed by the coupling of human in a certain area. Though the city growth follows the fundamental rule of "city growth", it still has certain discrepancy. Hence, generally speaking, city growth refers to the overall development of the birth and evolution of the city and the growth process of a single city, that is to say, any development of a city is part of the important connotation of city growth. City growth can be described by the four indicators, namely urban growth status indicator, growth capability indicator (similar to urban competitiveness), growth capacity indicator (similar to the limited index such as environmental capacity) and the sustainability of growth indicator. Based on the above mentioned theory, I apply the scale of city (GDP, population) to measure the growth status of the city.

2 Empirical analysis of the factors of Chinese city growth in the transitional period

2.1 Index selection, data source and research method

2.1.1 Index selection. In the paper, 44 indicators on city growth are selected to empirically analyze the city growth. The indicators include the proportion of urban construction land to the whole area of the city X_1(%), the green coverage of the constructed area X_2(%), the proportion of personnel involved in the secondary industry X_3(%), the per capita GDP X_4($\times 10^4$ yuan), the total business of telecommunications X_5($\times 10^4$ yuan), the proportion of the people involved in the tertiary industry X_6(%), the growth rate of GDP X_7(%), the actual amount of foreign investment used in the very year X_8($\times 10^4$ dollar), per capita green area X_9(square meters), the number of domestic-funded enterprises X_{10}, the proportion of the secondary industry to GDP X_{11}(%), per capita urban road area X_{12}(m^2), the total input on governing the pollution source in the very year X_{13}($\times 10^4$ yuan), the Hong kong, Macao and Taiwan based enterprises X_{14}, the proportion of the tertiary industry to GDP X_{15}(%), the number of public bus owned by per ten thousand people X_{16}, the investment in the urban infrastructure construction in the very year X_{17}($\times 10^4$ yuan), the number of foreign-funded enterprises X_{18}, the number of self-employed enterprises and people involved in cities and towns X_{19}($\times 10^4$ people), the mobile phone-density X_{20}(%), the comprehensive use rate of industrial solid waste X_{21}(%), the total industrial output X_{22}($\times 10^4$ yuan), the average salary of the workman X_{23}($\times 10^4$ yuan), the density of international internet X_{24}(%), the handling rate of sanitary sewage in cities and towns X_{25}(%), the total amount of social investment in fixed assets X_{26}($\times 10^4$ yuan), the non-agricultural population X_{27}($\times 10^4$ people), the urban construction land area X_{28}(km^2), the non-sanitary handling rate of household waste X_{29}(%), the investment in the finished real estate X_{30}($\times 10^4$ yuan), the industrial electricity X_{31}(KW/hour), the elimination rate of industrial sulphur dioxide X_{32}(%), the income in the budget of local finance X_{33}($\times 10^4$ yuan), the investment in housing X_{34}($\times 10^4$ yuan), the per capita household electricity consumption X_{35}(KW/hour), the elimination rate of industrial smoke dust X_{36}(%), the expenditures of the general budget of local finance X_{37}($\times 10^4$ yuan), various kinds of loan balances of financial institutions at the end of year X_{38}($\times 10^4$ yuan), the total number of bus transportation X_{39}($\times 10^4$ people), the attainment rate of the industrial waste water X_{40}(%), the input on science and technology X_{41}($\times 10^4$ yuan), the balances of the household savings in urban and rural areas X_{42}($\times 10^4$ yuan), the total amount of cargo transportation X_{43}($\times 10^4$ ton) and the personnel involved in units at the end of the year X_{44}($\times 10^4$ people).

At the same time, in order to reflect the spatial features of gradual system reform and the impact of location factors, three self-defined indicators are added to, which are presented by $X_{45} - X_{47}$, namely the minimum straight distance towards Beijing, Shanghai and Guangzhou X_{45}, the straight distance towards the nearest boundary of the country X_{46} and the straight distance towards the nearest provincial capital city X_{47}.

2.1.2 Data source. According to the needs of research, 287 prefecture-level cities and higher level cities are selected from *China City Statistical Yearbook*(2008) and 44 relevant indicators which influence the growth of city are extracted(the data avoids the impacts caused by different indices or the same indices of the different years. The data of the prefecture is applied so as to reduce mistakes).

2.1.3 Research method. In the initial stage, I conduct multivariate analysis by using SPSS statistical software, and then I categorize the determinants. In the end, I conduct regression analysis on the selected indicators and the indicators of city growth status; hence, the formula of the determinants of city growth status in the transitional period can be established.

2.2 Factor analysis The basic aim of factor analysis is to describe the relations among many indicators and factors by using small number of factors, that is to say, categorizing the variables which are closely related to each other and each kind of variables will become a factor (it is regarded as factor, because it is unpredictable and it is not specific variable), then the major information of the original data will be reflected by using a small number of factors.

There are wide ranges of factors which affect city growth, but the research chooses the data from *China City Statistical Yearbook* as the subject. In order to further specifically categorize all the factors and achieve the comprehensive analysis of the factors of China city growth, the research conduct factor analysis on the selected data.

2.2.1 Factor selection. By using SPSS statistical analysis and after the standard handling the original data, the Eigen value, contribution rate and total contribution rate of the relevant coefficient can be calculated. According to the principle of the eigenvalue is bigger than 1 to select 10 factors, and their total contribution rate is 78.168%(Table 1).

Table 1 The Eigen value, Contribution rate and Total contribution rate of Chinese City growth in 2007

Serial number of factors	Eigen value	Contribution rate//%	Total contribution rate//%
1	18.326	38.991	38.991
2	3.713	7.899	46.890
3	3.352	7.132	54.022
4	2.307	4.908	58.930
5	2.025	4.309	63.239
6	1.778	3.784	67.023
7	1.427	3.036	70.059
8	1.302	2.770	72.828
9	1.270	2.702	75.530
10	1.240	2.638	78.168

2.2.2 The calculation of factor loading. a_{ij} is the factor loading. It is the loading of the number *i* variable in the number *j* principal factor or the weigh of the number *i* variable in the number *j* principal factor. It reflects the relative importance of the number *i* variable in the number *j* principal factor. If *xi* is regarded as a variable in the *m*-dimensional factor space, then a_{ij} means the projection of *xi* in the coordinate axis. Table 2 is the factor loading of each factor after calculation.

2.2.3 The result analysis of each common factor. From Table 2 it can be seen that there are 22 big factors loading in the first common factor, namely general budgetary expenditure of local government, the general budgetary revenue of local government, the urban and rural residents' savings deposits, urban

Table 2 Factors' Loading of Chinese cities' growth in 2007

Indicators	1	2	3	4	5	6	7	8	9	10
X_1	0.281	0.410	0.117	0.133	0.314	−0.098	−0.028	−0.345	0.075	0.302
X_2	0.064	0.211	0.091	0.691	0.059	−0.060	0.122	−0.068	−0.007	0.003
X_3	0.074	0.576	−0.002	0.034	−0.214	0.020	−0.101	−0.052	−0.160	−0.181
X_4	0.766	−0.003	0.089	0.060	−0.045	0.167	0.311	−0.097	0.125	0.077
X_5	0.866	0.265	0.008	0.083	0.054	0.066	0.086	−0.015	0.061	0.041
X_6	0.087	0.009	−0.140	0.451	0.143	0.287	0.394	−0.153	−0.452	−0.113
X_7	0.150	0.162	0.102	0.503	−0.006	0.215	−0.020	−0.071	0.250	0.422
X_8	0.104	0.101	0.042	0.508	0.158	0.075	0.036	0.082	−0.091	0.494
X_9	0.975	0.077	−0.019	0.020	0.011	−0.041	0.038	−0.026	0.017	0.027
X_{10}	0.982	0.069	−0.022	0.024	0.019	−0.026	0.009	−0.019	0.011	0.020
X_{11}	0.945	0.109	−0.046	−0.014	−0.025	−0.119	0.009	−0.033	−0.008	0.005
X_{12}	0.009	0.211	0.839	0.206	0.183	0.033	−0.053	−0.028	−0.015	−0.033
X_{13}	0.011	−0.171	−0.847	−0.080	−0.205	0.015	0.033	0.050	0.054	0.032
X_{14}	0.863	0.043	0.087	0.061	0.072	0.169	0.188	0.005	0.027	0.027
X_{15}	0.590	0.479	0.056	−0.056	−0.036	0.075	0.414	−0.079	0.061	−0.026
X_{16}	0.875	0.103	0.072	0.006	−0.074	0.054	0.346	−0.070	0.046	0.053
X_{17}	0.912	0.241	0.103	0.030	0.010	0.101	0.207	−0.034	0.053	0.033
X_{18}	0.923	0.070	−0.003	0.140	0.154	0.195	−0.067	0.087	0.007	0.037
X_{19}	0.901	0.075	−0.098	0.115	0.176	0.132	−0.198	0.108	−0.025	0.002
X_{20}	0.887	0.122	−0.082	0.129	0.194	0.183	−0.149	0.099	−0.018	0.026
X_{21}	0.965	0.110	−0.066	0.038	0.095	0.056	−0.032	−0.009	0.033	0.019
X_{22}	0.967	0.120	−0.050	0.045	0.090	0.062	−0.038	0.002	0.027	0.001
X_{23}	0.334	0.444	0.412	0.263	0.096	0.166	0.109	0.278	0.198	0.149
X_{24}	−0.006	0.037	0.119	−0.011	−0.046	−0.018	0.021	0.770	−0.040	0.110
X_{25}	−0.042	0.072	0.869	0.160	−0.047	−0.042	0.038	0.136	0.039	0.070
X_{26}	0.186	0.261	−0.752	0.101	0.137	0.064	−0.156	−0.087	0.073	−0.032
X_{27}	0.871	0.257	−0.049	0.078	0.148	0.149	−0.083	0.056	0.007	−0.027
X_{28}	0.542	0.319	0.159	0.167	0.116	0.192	0.085	0.316	0.236	0.008
X_{29}	0.895	−0.014	−0.009	0.129	0.182	0.165	−0.098	0.008	0.009	0.023
X_{30}	0.814	0.201	0.192	0.050	0.031	0.14	0.204	−0.056	0.140	0.057
X_{31}	0.346	0.767	0.041	0.051	0.155	0.039	0.175	0.029	0.062	−0.003
X_{32}	0.314	0.134	−0.046	0.006	0.149	0.838	−0.034	−0.023	0.073	−0.021
X_{33}	0.520	0.029	−0.005	−0.066	0.041	0.696	0.026	0.020	0.067	0.085
X_{34}	0.856	0.275	−0.094	0.058	0.118	0.016	−0.049	0.034	0.019	−0.029
X_{35}	0.897	0.158	0.002	0.087	0.061	0.105	0.134	0.044	0.011	0.035
X_{36}	−0.136	−0.183	−0.082	−0.084	−0.345	0.138	−0.560	−0.402	−0.090	0.058
X_{37}	−0.235	−0.020	−0.093	−0.040	−0.724	−0.143	0.091	0.155	−0.048	0.008
X_{38}	−0.018	0.017	0.021	0.081	0.067	0.020	0.029	−0.080	0.032	−0.737
X_{39}	0.552	0.570	0.075	0.138	0.127	−0.030	0.143	−0.087	0.135	0.131
X_{40}	−0.232	−0.101	−0.093	−0.062	−0.851	−0.055	−0.230	−0.120	−0.010	0.026
X_{41}	0.099	0.024	−0.078	0.196	0.087	0.124	0.073	−0.063	0.831	−0.052
X_{42}	0.126	0.107	0.346	0.361	−0.010	0.073	−0.151	0.108	0.216	−0.066
X_{43}	0.123	0.061	0.218	0.693	−0.018	−0.112	−0.080	0.057	0.146	−0.106
X_{44}	0.920	0.101	−0.038	0.095	0.164	0.064	−0.214	0.043	0.003	−0.011
X_{45}	0.950	0.075	0.014	0.033	0.072	0.054	0.009	−0.054	0.015	0.034
X_{46}	0.047	0.684	0.140	0.271	0.042	0.116	0.165	0.195	0.050	0.126
X_{47}	0.360	0.746	0.103	0.165	0.178	0.036	−0.192	0.030	0.038	0.091

land use for construction, expenditure on science and technology, the total social investment in fixed assets, number of persons employed at the end of year, gross industrial output value, investment completed in real estate development, actually utilized overseas fund, non-agricultural population, housing, foreign-funded enterprises, private enterprises in cities and towns, investment completed in infrastructure construction of urban environment, domestic-funded enterprises, business volume of telecommunications, industrial electricity, the total investment in handling the source of pollution, the Hong Kong, Macao and Taiwan-based enterprises and the average salary of workman.

In the second common factor, there are seven bigger factors loading, namely household electricity consumption per capita, the number of buses owned by per ten thousand people, per capita urban road, per capita green area, internet popularization, per capita GDP and the population of urban construction land use to the area of the city.

In the third common factor, there are four relatively larger factors loading, covering the proportion of the secondary industry to GDP the proportion of personnel involved in the tertiary industry, the proportion of personnel involved in the secondary industry and the proportion of the tertiary industry to GDP.

In the fourth common factor, there are five larger factors loading, namely the attainment of the industrial waste water, green coverage of built-up area, harmless treatment rate of garbage, treatment rate of urban sewage and industrial dust removal rate.

In the fifth common factor, there are two bigger factors loading, namely the minimum straight distance towards Beijing, Shanghai and Guangzhou and the straight distance towards the nearest provincial capital city.

In the sixth common factor, there are two bigger factors loading, including passenger transportation and cargo transportation.

In the seventh, eighth and tenth common factor, there is only one bigger factor loading, it is the straight distance towards the nearest boundary, the growth rate of GDP and the penetration rate respectively.

In the ninth common factor, the indicators of industrial removal rate of CO_2 and comprehensive utilization rate of industrial solid waste.

2.3 Regression analysis Generally speaking, regression analysis is to determine the causality among variables through determining the dependent variable and independent variable, and then establish the regression model. Each parameter will be calculated according to the actual data and then whether the regression model fits the actual data well or not can be evaluated. If it can fit well, the further forecast can be conducted according to independent variable. The research applies the regression analysis to analyze the determinants of city growth in China in the transitional period.

2.3.1 Establishment of model. The indicator of city growth status is defined as Y, and $Y = P * G$, among which, P represents the total population in a city at the end of year, G represents GDP of a city.

Taking Y as a dependent variable; selecting 47 selected indicators as independent variables; selecting the value of F to test by using SPSS statistical software (the value of F less than 0.05 will be introduced into and that bigger than 0.10 will be excluded); applying the gradual introduction of variables and then get the value of R comes to 0.979, which proves that the independent variable and variable are highly correlated. In the end the following formula can be obtained:

$$\begin{aligned} Y = {} & 0.000\,000\,051\,59 * V_1 - 0.001\,000\,000\,00 * V_2 + \\ & 0.000\,075\,91 * V_3 - 0.000\,000\,000\,771\,2 * V_4 - \\ & 0.000\,000\,007\,633 * V_5 + 0.000\,000\,221\,4 * V_6 - \\ & 0.000\,000\,094\,9 * V_7 + 0.000\,008\,211 * V_8 + \\ & 0.000\,000\,020\,97 * V_9 + 0.000\,020\,86 * V_{10} - \\ & 0.000\,000\,017\,33 * V_{11} - 0.000\,000\,011\,360 * V_{12} + \\ & 0.000\,300\,000\,00 * V_{13} - 0.018\,000\,000\,00 * V_{14} - \\ & 0.005 * V_{15} - 0.007\,000\,000\,00 \end{aligned}$$

In the formula, $V_1 - V_{15}$ represents the general budgetary expenditure of local government, the number of bus own by per ten thousand people, area of city land use for construction, gross industrial output, total business volume of telecommunications, total volume of passengers, actually utilized overseas fund at the very year, domestic-funded enterprises, total investment in controlling pollution source at the very year, the minimum straight distance towards Beijing, Shanghai and Guangzhou, the investment completed in the urban infrastructure construction at the very year, the general budgetary revenue of local government, per capita urban road area, the penetration rate of internet and the removal rate of industrial SO_2.

2.3.2 The analysis of regression result. Among the 15 factors obtained by regression, nine of them belong to the first common factor (aggregate 22 items) of the results of factor analysis, including the general budgetary expenditure of local government, general budgetary revenue of local government, area of city land use construction, industrial GDP, the actually utilized overseas funds at the very year, investment completed in the construction of urban infrastructure, domestic-funded enterprises, total business volume of telecommunications, total investment in controlling the source of pollution and so on; the second common factors include the public bus owned by per ten thousand people, per capita urban road, penetration rate of internet and so on (17 items in total); the fifth common factors include the minimum straight distance towards Beijing, Shanghai and Guangzhou and so on (two items in total); the total volume of passengers belong to the sixth common factor (two items in total); the removal rate of industrial SO_2 belong to the ninth common factor (two items in total), therefore, the analyses of the two kinds are close to each other.

Therefore, the fifteen factors can be divided into 4 types, namely the factor of economy and system (general budgetary expenditure of local government, industrial GDP, general budgetary revenue of local government, domestic-funded enterprises, the actually utilized overseas funds at the very year, investment completed in the construction of urban infrastructure and area of city land use construction); location factors (the minimum straight distance towards Beijing, Shanghai and Guangzhou); environmental factor (per capita urban road area, total investment in controlling the source of pollution at the very year, the removal rate of industrial SO_2; social cultural services and functions (the total volume of passengers, the to-

tal volume of telecommunications, the penetration rate of interment and the public bus owned by per ten thousand people.

3 Conclusions and discussions

Based on the comprehensive analysis of the above research, the following judgment and explanation can be obtained: firstly, in the factors which affect the growth of cities in China, the general budgetary expenditure of local government and the general budgetary revenue of local government are the primary factors. That is because in the current political and economical system of China, the government still controls and dominates a large amount of key resources, acts as a participant in the market economy operation (the government also takes the responsibility of supervision and fair judgment) and nearly completely takes the charge of urban infrastructure construction, cultural and educational enterprises, management of state-owned enterprises, land management, well-being of residents and so on. All of the above mentioned functions must be reflected from the financial revenue and financial budget, which leads to the important role of the two factors in the growth of city. Secondly, since China is in a rapid industrialization period, the industrial GDP and the number of the domestically funded enterprises will inevitably become an important influence factor and a revealed indicator. Thirdly, China is in the rapid urbanization period and the urban governments adopt the entrepreneurial government of operating the cities as the strategy for the development of cities. The sharp growth of urban population and accelerated update of old cities lead to the rapid expanding of urban space (at the same time high land transfer revenue can be obtained), then the indicators of area of city land use for construction and the investment completed in the construction of urban infrastructure are inevitably become the directivity factor of city growth. Fourthly, guided by the policy of reform and opening up, foreign funds play a significant role in promoting the growth of Chinese cities; hence, it is not hard to understand why the foreign funds used at the very year have become an important factor in the growth of Chinese cities. In addition, many literatures have proved it, for example, LIAO Ming-zhong think that " a city with full development of non state-owned enterprises and higher degree of opening up, then its level of marketization and its efficiency of elements allocation are higher, and its functions on promoting the growth of cities are more significant "[5]. HAO Tao-yi and NI Peng-fei list the degree of opening as one of the six first-level indicators. They believe that " the opening degree of a city shows the expansion and radiation functions of the city to the outside areas of the city" , which includes the proportion of foreign trade import and export to GDP and per capita actual use of foreign investment[6]. Fifthly, as a primary choice and experimental area of the reform and opening up, eastern China has become the prior experimental area of many policies. it means the spatial difference s of the gradual reform(of course, the original differences of developmental level of eastern and western China before the reform should be taken into consideration) , which further widen the gap among the development level and speed of east, central China and west. Obviously, it can be reflected from the location factor, that is to say, the minimum straight distance towards Beijing, Shanghai and Guangzhou becomes an important factor in affecting the growth of Chinese cities. Sixthly, with the expansion of the scale of city, the improvement of quality of life(such as the access to the automobile society), the increasingly strict policy of national environmental protection and the increase of residences' demands on environment, then the influences of environmental factors and social service and functions on the growth of city has increased greatly. For example, per capita urban road area(the demand of transportation and traveling), the investment completed in handling the source of pollution, the removal rate of industrial SO_2(environmental handling), the volume of passengers, total business volume of telecommunications, the penetration rate of internet, public bus owned by per ten thousand people and so on. All of these indicators are regarded as the factors which influence the growth of city and have certain correlation, in fact, the rapid growth of city also stimulate the changes of these factors. The two aspects are complementary to each other.

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