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Coupling Trending Analysis about Urbanization and Urban Resource in Beijing

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Abstract

Based on knowing the mechanism of urbanization and urban resource coupling situation, this article constructs urbanization composite index and urban resources comprehensive index, and build Static and dynamic coupling coordination degree evaluation model, calculate and distinguish the two systems in coordination development and coupling situation of Beijing in the past 24 years. It turns out that the degree of coupling the earlier Beijing urbanization and urban resource systems is being strengthen, but overall is being and balanced. But from now then, the degree of coupling is more strengthened, with the lower coordination and unbalanced. So strengthening resource protection, coordinate organization and urban resources have become the center of future urban construction in Beijing.

Key words: Urbanization; City Source; Granger Causality Test; Co-integration Analysis

According to the specific circumstances of Beijing, this article constructs the Beijing urbanization and urban resource coordinative development index system, and based on this, using principal component analysis is nearly 24 years urbanization and urban resources of Beijing development status of comprehensive evaluation, On this basis, this paper builds the static and dynamic coupling coordination degree evaluation model, analyses the two-line classics. Hoping we can understand the coordinated development situation and developing trend of Beijing urbanization and urban resource, for the region to urbanization for the region to urbanization and the coordinated development of the urban resources to provide the reference.

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1. Analysis on comprehensive development level between Beijing urbanization and urban resources

1.1 Construction of evaluation index system

The essay which bases on some references [1~6], combines the intension and feature of urbanization and urban resources, establishes some principles of evaluation index, based on above all principles and measurements, the following are more independence urbanization and urban resources index reference form.

Table 1. The evaluation index system of urbanization and urban resources

Objective-O	Subsystem-A	Evaluation norm-B	evaluation index-C	properties
urbanization and urban resource coupling degree	Urbanization subsystem(A_1)	Population urbanization (B_1)	C_1:rate of population urbanization	positive
			C_2:the rate of people work in service sector	positive
			C_3:per capita GDP	positive
		Economic urbanization (B_2)	C_4:Constructed land area output per unit	positive
			C_5:the addition of service sector accounts GDP	positive
			C_6:the total retail sales of per capita social consumer	positive
		Space urbanization (B_3)	C_7:urban population density	opposite
			C_8:the constructed area of per capita	positive
			C_9 Per capita disposable income of urban people	positive
		Society urbanization(B_4)	C_{10}:Per capita residential area of urban	positive
			C_{11}:Every thousand population own profession (assistant) doctor	positive
	Urban resources subsystem(A_2)	resource development and utilization(B_5)	C_{12}:agricultural acreage	positive
			C_{13}:a forestation area	positive
			C_{14}:yearly water supply	positive
			C_{15}:Energy production volume	positive
			C_{16}:yearly power consumption	positive
		resource consumption (B_6)	C_{17}:water supplying comprehensive productive capacity	positive
			C_{18}:comprehensive energy consumption of every 10thousand Yuan	opposite
			C_{19}:coal consumption of 10thousand Yuan GDP	opposite
			C_{20}:power consumption of 10thousand Yuan GDP	opposite
			C_{21}:petroleum consumption of 10thousand Yuan GDP	opposite
			C_{22}:water supplying of 10thousand Yuan GDP	opposite
			C_{23}:coefficient of elasticity of energy consumption	opposite
			C_{24}:coefficient of elasticity of electric power	opposite

1.2 Standard disposes of raw data

According to the Beijing static marital in 1986-2009, after calculating this figures we know that the primitive index of urbanization and urban resources.

Due to the constructed evaluation index has both positive and opposite, so as to we can analysis and compare, we need standard the static that is the static should be consistency; meanwhile, because among these indexes every unit and order are different, so they cannot be open. .When we comprehensively evaluate this static, in order to reflect the physical truth, we must remove any influence that caused by that every index dimension and numerical value is great disparity, which is raw static should be standard.

The essay will adopt dim membership function to dispose dimensionless. To positive, we will adopt rise ladder-shaped dim membership function to quantify, see form (1); to opposite, falling ladder-shaped dim membership function, see form (2)

$$x_j^{'} = \frac{x_j - m_j}{M_j - m_j} = \begin{cases} 1(x_j \geq m_j) \\ (x_j - m_j)/(M_j - m_j) \\ (m_j \leq x_j \leq M_j) \\ 0(x_j \leq M_j) \end{cases} \quad (1)$$

$$x_j^{'} = \frac{M_j - x_j}{M_j - m_j} = \begin{cases} 1(x_j \leq M_j) \\ (M_j - x_j)/(M_j - m_j) \\ (m_j \leq x_j \leq M_j) \\ 0(x_j \geq M_j) \end{cases} \quad (2)$$

In form: x_j is the specific figure of the jth index, j=1，2，…，n represents the jth index; M_j, m_j distinguishably represents the maximum and minimum of different years in index; x represents the standard figure of the jth index, and the figure is between 0~1.

1.3 The calculation of comprehensive development

The essay adopts analysis of main competent to evaluate urbanization and urban resources and ensure the development level of both. The basic processes are:

Supposing there is total n evaluated unit but p index raw data form: $X= (x_{ij})_{nxp}$, according to （1～2）the standard static form: $Z=(z_{ij})_{nxp}$. Adopt SPSS13.0 the main component is: $y_1, y_2 \ldots y_k$, and among them the y_k represents:

$$y_k = \sum_{j=1}^{p} l_{jk} Z_j \quad (k = 1,2,\cdots, \ p)$$

In this form: l_{jk} is eigenvalue λ_k of correlation matrix R

The sample of the kth main component

$$y_{ik} = \sum_{j=1}^{p} l_{jk} Z_{ij} \qquad (k = 1,2,\cdots, \ p; \ \ i = 1,2,\cdots, \ n)$$

The sample of the ith main component:

$$D_i = \sum_{k=1}^{p} \omega_k y_{ik} = \sum_{k=1}^{p} \omega_k (\sum_{j=1}^{p} l_{jk} Z_{ij})$$

$$= \sum_{j=1}^{p} (\sum_{k=1}^{p} l_k l_{ij}) Z_{ij}$$

$$= \sum_{j=1}^{p} a_j Z_{ij}$$

The form: $a_j = \sum_{k=1}^{p} \omega_k l_{ik}$ ； $\omega_k = \lambda_k / \sum_{l=1}^{p} \lambda_l$

Normalization: $w_j = a_j / \sum_{l=1}^{p} a_l \quad (j = 1,2,\cdots, \ p)$ that is weight of different index. The comprehensive figure:

$$f = \sum_{j=1}^{p} w_j Z_j \quad (3)$$

According to the above process and using SPSS13.0 software, we can know that the total of comprehensive development of urbanization and urban resources. During 1985-2008, the comprehensive development level of Beijing urbanization and urban resources is increasing and it can divide two stages: The first: during 1985-1996, the comprehensive development level is low. Urbanization and urban resources comprehensive level less than 0 and the comprehensive level of urban resources are higher than urbanization. The second stage: during 1997-2008, the comprehensive development level step one forward. The comprehensive development figure of Urbanization and urban resources are greater than 0, and comprehensive development level of urbanization is increasing rapidly. It has increased 1.668 within 12 years, but comprehensive development level of urbanization is still lower than urban resources. However, the comprehensive development level of urban resources is not steady but ups and downs, in 2003 is maximum, then down, and in 2007 began to rise again.

2. Beijing urbanization and urban resources comprehensive development quantitative evaluation

2.1 Model and method

The essay establishes separately the model of the coordination of both state and dynamic coupling. We will adopt the coordination of state to reflect the point of time development trend and adopt the coordination of dynamic coupling to reflect the period of time development trend.

- 2.1-1. the coordination of state

According to dim membership function, establish coordinate coefficient computational formula

$$C_s(i,\ j) = \frac{\min\{C(i/j),\ C(j/i)\}}{\max\{C(i/j),\ C(j/i)\}} \quad (4)$$

$$\text{In: } C(i/j) = \exp\left[\frac{(-2)(x - x')^2}{s^2}\right] \quad (5)$$

$C_s(i, j)$ represents the comprehensive development of coordinate coefficient of i system and j system ; C(i/j)represents the comprehensive development of coordinate coefficient of i system to j system; the C(j/i) represents the comprehensive development of coordinate coefficient of j system to i system; X represents the comprehensive development index of i system; x' represents the comprehensive development of coordinate figure of j system to i system; s^2 represents the mean-square deviation of comprehensive development index of i system. Among them the ratio calculation of x' of i system to j system can be gained by regression analysis method ,and using the i system as dependent variable, j system as independent variable, then using linear equation $j=a+bj$, $j=a+bi+ci^2$ and at last combine polynomial over three times. Among them, we just need elect smaller fitted curve of the residual sum of squares as the most fitted matched equation.

The coordinate coefficient shows the degree of coordinate. The different interval of coordinate coefficient regards as the coordinate standard of different degree of coordinate. According to referent research and expert, we divide it as: $0 \le C_s(i, j) < 0.1$represents the biggest incongruous; $0.1 \le C_s(i, j) < 0.35$represents very incongruous, $0.35 \le C_s(i, j) < 0.6$represents not too congruous; $0.60 \le C_s(i, j) < 0.75$represents less congruous; $0.75 \le C_s(i, j) < 0.9$ represents congruous; and $0.9 \le C_s(i, j) \le 1$represents very congruous.

- 2.1-2. the degree of dynamic coupling

According to the above main component analysis result, we can establish the systematic evaluation model among them.

$$f(UR)=\sum_{i=1}^{n}a_i x_i;\ \ f(CS)=\sum_{j=1}^{n}b_i y_j$$

Among them, f (UR) is the comprehensive development level of urbanization, f (CS) is the comprehensive development level of urban resources. x_i, y_j are evaluation index, a_i, b_j are the weight of evaluation index. Due to the urbanization and urban resources force each other, so we take them as a multiplexed systemto consideration, apparently, f (UR) and f (CS)are leading part of this system. According to general theory of systematic, the evolution formulate is

$$A=df(UR)/dt=\alpha_1 f(UR)+\alpha_2 f(CS),\ \ V_A=\frac{dA}{dt} \tag{6}$$

$$B=df(CS)/dt=\beta_1 f(UR)+\beta_2 f(CS),\ \ V_B=\frac{dB}{dt} \tag{7}$$

In (6~7), shows that the evolution state of the subsystem of urbanization and urban resources mainly affected by itself and outside, any subsystem changes can lead to the whole system change. V_A, V_B are evolution speed of two subsystems affected by it and outside. T is time factor. Just because it only has two element f (UR) and f (CS), when f (UR) and f(CS are coordinate ,the whole system is ; on the other hand ,we can see the whole system as the function of V_A and V_B, so there is $V=f(V_A, V_B)$. Through using the formulation and changing V_A and V_B, we can research the two systems and f (UR) and f (CS) coupling degree.

Assuming the entire system evolution satisfy combination s-type development mechanism, and the relation of dynamic coupling between urbanization and urban resources fits present cyclical change, so in each cycle, because that V's change is V_A and V_B causes, so we can put the V_A with V_B evolution locus projection in a two-dimensional graphic (V_A, V_B) to analyze V, and supposing V_A and V_B Angle α satisfy $tg\alpha=V_A/V_B$, called $\alpha=arc\ tg\ (V_A/V_B)$ coupling. According to the alpha value, the whole system can determine the evolution of the state and the coupling between them.

2.2 Assessment process and outcome

- 2.2-1. the calculation of Static coordination degree

According to the urbanization and urban resources comprehensive development level, using SPSS13.0 software to analyze comprehensively the urbanization and urban resources, we can get the smaller optimum fitting equations of residual sum of squares. Supposing urbanization system A_1 as dependent variable, urban resource system A_2 as independent variable of optimum fitting equations:

$$A_1=-0.23984+1.309551A_2+0.495753A_2^2 \tag{8}$$
$$(-2.3106)^{***}\ \ (11.8919)^{***}\ \ (2.8752)^{***}$$

R^2=0.8889; Adj-R^2=0. 8783; F=83.9679***

Supposing the city resources system A_2 as the dependent variable, urbanization system A_1 as independent variable of optimum fitting equations:

$$A_2=0.249824+0.839259A_1-0.34642A_1^2 \tag{9}$$
$$(6.5432)^{***}\ \ (25.5480)^{***}\ \ (-9.1611)^{***}$$

R^2=0.9690; Adj-R^2=0. 9661; F=328.1805***

The above model, A_1, A_2 separately represents urbanization and urban resources comprehensive development level, R^2 is coefficient of determination; under the regression coefficients is t Check values; * * * shows that it is remarkable over 0.01. Coefficient of determination R2 are all are larger than 0.8; indicating that the two combined equations fits at high degree; F statistics are significant in 0.01 level indicated that the two regression equations are remarkable.

From 1985 to 1990, static coordination degree rises gradually; to 1999 urbanization and urban resources achieve very harmonious development degree. But since 1990, its coordination degree began to drop, but declines not quite, and it has remained at more than 0.9, is still very harmonious state. Since 2001, urbanization and urban resources static coordination degree has dropped sharply, to the 2002 appeared minimum (this is because Cs (I/r) only 0.5591). Although coordination degree picks up gradually, it still has the volatility, and basically they are all less than 0.9, in basic coordination or coordinate developmental state. This is mainly because since 2002, Cs (I/m) the numeric values are small, in 2007 to minimum (0.4724), meanwhile, the corresponding static coordination degree Cs (I, j) fells to their lowest value (0.4764) in history record. During 1985-2000 16 years, Beijing urbanization and urban resources static coordination degree is 0.9697 (more than 0.9), and standard deviation is smaller (urbanization on urban resources standard deviation is only 0.02). This suggests that in this period Beijing urbanization and urban resources of coordinated development condition overall is good, and development status is relatively balanced. However, since 2001, the coordination degree between them begins to drop, their average value is 0.6749 (less than 0.75), and standard deviation increased obviously (the standard deviation of urbanization to urban resources is 0.16), which shows that since 2001 Beijing urbanization and urban resources of coordinated development conditions is broken progressively , and whose development status become imbalanced.

Table 2. Beijing 1985-2008 urbanization and urban resources static coordination degree

Year	C_s(i/j)	C_s(j/i)	C_s(i，j)	Year	C_s(i/j)	C_s(j/i)	C_s(i，j)
1985	0.9509	0.9072	0.9541	1997	0.9501	0.9992	0.9509
1986	0.9892	0.9648	0.9753	1998	0.9395	0.9998	0.9397
1987	0.9999	0.9903	0.9904	1999	0.9987	0.9777	0.9790
1988	1.0000	0.9878	0.9879	2000	0.9799	0.9263	0.9454
1989	0.9998	0.9890	0.9892	2001	0.8993	0.9997	0.8996
1990	0.9116	0.9029	0.9906	2002	0.5591	0.9322	0.5997
1991	0.9119	0.9280	0.9827	2003	0.5723	0.9317	0.6143
1992	0.9228	0.9450	0.9765	2004	0.8631	0.9838	0.8773
1993	0.9875	0.9733	0.9857	2005	0.7427	0.9308	0.7979
1994	0.8686	0.9059	0.9588	2006	0.5170	0.9338	0.5537
1995	0.9277	0.9779	0.9487	2007	0.4724	0.9916	0.4764
1996	0.9573	0.9972	0.9600	2008	0.5482	0.9455	0.5798

- 2.2-2. Calculation of the dynamic coupling

According to Figure 1, the first comprehensive development level of urbanization (A) and integrated development of urban resources (B) Two non-linear curve fitting, select the most accurate curve fitting, the fitting expression by the two evolutions as:

$$A = -1.30875 + 0.072585t + 0.001966t^2 \quad (10)$$
$$(-29.3033)^{***}\ (8.8180)^{***}\quad (6.1510)^{***}$$

R^2=0.9946； Adj-R^2=0. 9941； F=1920.753**

$$B = -1.62507 + 0.194536t - 0.00395t^2 \quad (11)$$
$$(-18.1341)^{***}\ (11.7783)^{***}\ (-6.1598)^{***}$$

R^2=0.9674; Adj-R^2=0. 9643; F=311.2898***

On the formula, A, B respectively, represents urban comprehensive development level of resources; R^2 is coefficient of determination; under the regression coefficient for the t test value; *** indicates 0.01 significance level; t corresponds to 1985-2008.

Using (6～7) obtained between 1985-2008 V_A, V_B: V_A = dA/dt = 0.003932t +0.072585; V_B = dB/dt =-0.0079t +0.194536 finally obtained α shown in Table 3.

Table 3 Urbanization and urban resource dynamic coupling of Beijing, 1985-2008

Year	V_A	V_B	tgα	α	Year	V_A	V_B	tgα	α
1985	0.1316	0.0760	-6.2162	-80.86	1997	0.0922	0.1550	0.6768	34.09
1986	0.1355	0.0681	-2.2524	-66.06	1998	0.0962	0.1471	0.7660	37.45
1987	0.1394	0.0602	-1.0866	-47.38	1999	0.1001	0.1392	0.8753	41.19
1988	0.1552	0.0286	-1.1732	-49.56	2000	0.1040	0.1313	1.0136	45.39
1989	0.1670	0.0049	-0.9021	-42.05	2001	0.1080	0.1234	1.1968	50.12
1990	0.1434	0.0523	-0.4256	-23.05	2002	0.1119	0.1155	1.4547	55.50
1991	0.1630	0.0128	0.1347	7.67	2003	0.1512	0.0365	1.5488	57.15
1992	0.1473	0.0444	0.1749	9.92	2004	0.1158	0.1076	1.8542	61.66
1993	0.0765	0.1866	0.4346	23.49	2005	0.1198	0.0997	2.5787	68.80
1994	0.0804	0.1787	0.4832	25.79	2006	0.1237	0.0918	4.3930	77.18
1995	0.0844	0.1708	0.5384	28.30	2007	0.1591	0.0207	5.4378	79.58
1996	0.0883	0.1629	0.6022	31.05	2008	0.1276	0.0839	19.9047	87.12

Table 3 shows that since 1985, Beijing's urbanization and urban resources system coupling rose rapidly, and the stage characteristics is obvious. In accordance with the "regional system by coupling state of the stage," urbanization and urban resources, Beijing, the system plays from 1985 until 1990, still in the low-level coordination of symbiosis, the period of time was longer; from 1991 to 1999 in a healthy state of development; from 2000 to 2004 in the coordinated development of the state; since 2005, the city has entered the overexploitation of resources, unsustainable development stage. Beijing as a resource input type of mega-cities, 98% of the energy transferred by the field, but in 20-year period it is just to be walking across the road quite a long time in the history section of the three stages (low-level coordination of symbiosis, healthy development, coordination of development). Measurement software in the study area by 24 years of urbanization- urban resources to fit the coupling system is obtained α=13067×Ln(t)-99275, R^2=0.9174, log-type coupling was the rapid growth of urbanization, the limit problem has been that In Beijing there, and the last is the hard constraints of water resources, power supply this type of resource and infrastructure constraints.

3. Conclusion

3.1 During 24 years, Beijing urbanization and urban resources between static coordination degree on time sequence in volatility Early the Coordinated development condition between is overall in a very harmonious development state; But since 2001, the Coordinated development condition among them is progressively broken, and become imbalanced development status.

3.2 Just 20 years period, change between Beijing urbanization and urban resources dynamic coupling has experienced by low-level coordination symbiosis - benign development - coordinated development three stages of crossing. At present, both are in unsustainable development stage, and Coordination state still have a worsen trend.

3.3 Comprehensive analysis the change trend of static and dynamic coupling coordination degree we can found: The present Beijing urbanization and urban resources development have entered into antagonist state, the strength of urbanization and urban resources coupling obviously increase, but coordination continued to have the trend. of reduce .Further according to the coupling evolution curve, can expect the next few years the bottleneck of Beijing city resources to support urbanization will further narrowing, urban resources shortage problem in Beijing will gradually become the main factor of restraints of urbanization development .

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