

A STUDY ON THE FORECAST AND REGULATION OF COORDINATED DEVELOPMENT OF URBAN ENVIRONMENT AND ECONOMY IN GUANGZHOU

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ABSTRACT: This article introduces the concepts of coordinated development of economy and environment and formulas of coordinated degree. Results obtained are that the coordinated degree in 1992 is over 0.87. The variation tendencies on coordinated development of urban environment and economy are forecasted upto the year 2010 in Guangzhou by adopting formula GM(1,1). It is considered that not only the index of environment quality in Guangzhou will come down to 0.31, but also coordinated degree which is equal to 0.64 will lower to middle level. Therefore, some effective countermeasures have to be taken to accomplish the coordination development of urban environment quality and economy.

KEY WORDS: urban environment, urban economy, coordination development, coordination degree

I. THEORY FOUNDATION OF THE COORDINATED DEVELOPMENT OF URBAN ENVIRONMENT AND ECONOMY

Judgement about the coordinated condition of environment and economic development in Guangzhou is based on the following theories:

1. Coordinated Development

"Coordinated development" refers to the total change process from simplicity to complex and from out-of-order to in-order on the basis of well coordination and harmony. Coordinated development is a polymerization emphasizing

entirety nature, synthesization and internal growth^[1]. City is a big complex system of nature, economy and society. It is not only restricted by the natural environment, but also limited by human activities. So, in order to develop continually, we must adjust our activities to make nature environment and social economy coordinated.

2. Coordinated Degree

Coordinated degree is a quantitative index which is used to measure the degree of coordination between systems or among key elements in a system. It measures the coordination condition of environment and economy for city in different periods. According to the definition, we can give the following formula of coordinated degree:

$$C = \left[\frac{f(x) \cdot g(y)}{\left[\frac{\alpha f(x) + \beta g(y)}{2} \right]^2} \right]^k \quad (1)$$

in this formula, C is the coordinated degree; x is an index which is used to describe the feature of city environment; $f(x)$ is a function about synthetic benefit of city environment (or synthetic environment function); y is an index describing the feature of city economy; $g(y)$ is a function about the benefit of city synthetic economy (or synthetical economy function); k is an adjusting coefficient, $k \geq 2$; α and β are respective proportions.

The first formula reflects the quantity degree of the coordination of environment and economic benefit and for making compound environmental economy benefit the most under the given conditions of economy-environment synthetic benefit^[2]. Coordinated development shows as continuous improvement of synthetic environment-economy benefit when environmental and economic benefit keeps a hoping coordinated level. Obviously, $0 \leq C \leq 1$, thus coordinated degree C can gain the value from 0 to 1. It is the best coordinated condition when C is equal to 1. The smaller the C is, the worse the coordination is. In the ecosystem of a city we hope that the coordinated degree can not be less than 0.6, thus we can design the following rank of coordinated degree (Table 1).

We can know from Table 1, according to the analysis of the synthetical benefit of environment-economy and coordination degree, we can judge the development's state of environmental-economic system. There is not only the state which is coordinated but not developed, but also the state which is devel-

oped but not coordinated.

Table 1 Grade of coordination and coordinated degree

Grade of coordination	Serious disorder	Middle disorder	Disorder	Bare coordination	Middle coordination	Good coordination	High coordination
Coordinated degree(C)	≤ 0.3	0.3—0.39	0.4—0.49	0.5—0.59	0.6—0.69	0.7—0.79	≥ 0.8

II. THE PRESENT SITUATION EVALUATION OF COORDINATION DEVELOPMENT OF ENVIRONMENT AND ECONOMY IN GUANGZHOU CITY

1. Evaluation Index and Standard

Index system is the foundation of evaluating coordinated development. It should synthetically reflect the benefit of urban environment and economy. Evaluation standard is the relative scale of measuring the condition of environmental and economic development in Guangzhou. According to the available data and the trait of environmental and economic development in Guangzhou, we choose and establish the following evaluation index system and standard (Table 2), and make a parametric statistics of urban environment and economy (Table 3).

2. Evaluation Method and Results

We calculate the synthetic index of environment quality (or synthetic evaluation function of environment) and synthetic index of economy development (or synthetic evaluation function of economy) by the following formula:

$$f(x) = \sum_{i=1}^m a_i \hat{x}_i \quad g(y) = \sum_{j=1}^m b_j \hat{y}_j \quad (2)$$

In this formula, $f(x)$ is the synthetic index of environment quality and $g(y)$ is the synthetic index of economy development. x_i is the parameter of number i index, y_j is the parameter of number j index. a_i and b_j are respective index proportions. We evaluate it by equal proportion. \hat{x}_i can be gained by the following formula:

**Table 2 Index and Standard of Evaluation for Urban Environment
and Economy in Guangzhou**

Environment			Economy		
Index	Standard		Index		Standard
Emission volume of waste gas per 10,000 yuan industrial output value	x_1	20,000m ³	National income per capita	y_1	10,000 yuan
Emission volume of waste gas per unit area	x_2	$2,000 \times 10^4 \text{m}^3$	Industrial output value per unit area	y_2	4,000 yuan
Consistency of SO ₂ in air	x_3	0.02mg/m ³	Industrial output value per worker	y_3	40,000 yuan
Consistency of TSP in air	x_4	0.15mg/m ³	Profit per worker	y_4	4,000 yuan/person
Water consumption per 10,000 yuan industrial output value	x_5	100t	Output value per 100 yuan fixed asset	y_5	400 yuan
Discharge volume of waste water per 10,000 yuan industrial output value	x_6	100t	Profit per 100 yuan fixed asset	y_6	50 yuan
Discharge volume of waste water per unit area	x_7	3,000t	Gross retail volume of commodities per capita	y_7	4,000 yuan/person
Waste residue per 10,000 yuan industrial output value	x_8	1t	Proportion of commerce servers to urban population	y_8	10%
Waste residue per unit area	x_9	500t	Pork and beef output per capita	y_9	25 kg/person
Regional noise	x_{10}	45dB(A)	Fowl and egg output per capita	y_{10}	25kg/person
Vegetation area per capita	x_{11}	20m ² /person			
Rate of plant cover	x_{12}	40%			

$$\hat{x}_i = \begin{cases} x_i / \lambda_{max} & \text{the bigger the } x_i, \text{ the better} \\ \lambda_{min} / x_i & \text{the smaller the } x_i, \text{ the better} \end{cases} \quad (3)$$

in this formula, λ_{max} and λ_{min} are programme value and expectation value corresponding to x_i . y , can be gained in the same way, the $[f(x) + g(y)] / 2$ reflects the synthetic index of economy and environment.

Table 3 Parametric statistics of urban environment and economy in Guangzhou

Code of index	1985	1986	1987	1988	1989	1990
$x_1(\times 10^4 \text{m}^3)$	3.8	6.1	5.3	4.3	4.2	4.6
$x_2(\times 10^4 \text{m}^3/\text{km}^2)$	3,518	5,324	5,457	5,208	4,903	5,950
$x_3(\text{mg}/\text{m}^3)$	0.080	0.087	0.085	0.092	0.100	0.090
$x_4(\text{mg}/\text{m}^3)$	0.27	0.23	0.23	0.29	0.28	0.27
$x_5(\text{t})$	1,110	1,091	860	769	846	877
$x_6(\text{t})$	304	320	250	210	220	178
$x_7(\times 10^4 \text{t}/\text{km}^2)$	21	23	20	20	22	20
$x_8(\text{t})$	1.21	1.42	1.14	1.04	1.03	1.18
$x_9(\text{t}/\text{km}^2)$	860	858	866	949	990	1,239
$x_{10}(\text{dB(A)})$	61.4	64.1	62.6	62.1	60.5	60.1
$x_{11}(\text{m}^2/\text{person})$	5.71	5.79	5.87	3.62	3.73	3.88
$x_{12}(\%)$	26.0	24.6	23.7	23.7	19.4	19.4
$y_1(\text{yuan})$	2,602	2,679	3,189	4,319	4,518	4,745
$y_2(\times 10^4 \text{ yuan}/\text{km}^2)$	1,020	1,060	1,255	1,548	1,600	1,732
$y_3(\text{yuan}/\text{person})$	21,884	22,508	26,491	32,780	33,438	34,096
$y_4(\text{yuan}/\text{person})$	2,668	2,380	2,782	3,257	3,519	3,780
$y_5(\text{yuan})$	218	195	196	199	204	208
$y_6(\text{yuan})$	28	22	22	22	22	22
$y_7(\text{yuan}/\text{person})$	1,963	2,078	2,419	3,217	3,484	3,464
$y_8(\%)$	8.7	9.1	10.8	11.4	11.9	11.6
$y_9(\text{kg}/\text{person})$	12	13	14	18	18	20
$y_{10}(\text{kg}/\text{person})$	14	22	22	31	32	41

According to formula (1) we can calculate the coordinated degree. We know the development of economy and improvement of environment quality are equally important, so $k=2$ in formula(1), the results are shown in Table

4.

We know from the Table 4, during 1985—1990 the synthetic economy development index isn't high. And the yearly speed of increase is averagely 3.7%. The environment quality index isn't high either and has descending trend yearly. The yearly rate of descending is 0.7%. So the synthetic index of environment and economy is growing yearly. C is more than 0.87 and belongs to the high-quality coordination level, by comparison the economy development is advanced than environment quality, so we can name it the coordinated development model of environment delaying.

Table 4 Coordinated development index of urban environment and economy in Guangzhou

Item	Particular year					
	1985	1986	1987	1988	1989	1990
Environment quality index $f(x)$	0.47	0.46	0.45	0.45	0.44	0.43
Economy development index $g(y)$	0.49	0.51	0.53	0.64	0.66	0.71
Synthetic index of environment and economy	0.48	0.49	0.49	0.55	0.55	0.57
Coordination (C)	0.99	0.99	0.99	0.94	0.92	0.87

III. TREND FORECAST OF COORDINATION DEVELOPMENT OF ECONOMY AND ENVIRONMENT OF GUANGZHOU CITY

Forecast is the foundation of policy-making and adjustment. Not only can it give out the advice of prevention and the choice scheme in order to realize a given aim, but also it can show the grand trend of a phenomenon and give its realization direction. For this, according to the results of the present evaluation we use the model of GM(1, 1) to forecast $f(x)$ and $G(y)$ and C , by testing the results^[4], we know C is less than 0.35. Small error probability P is equal 1, so it is the superior forecast accuracy.

From the forecast results of Table 5, according to the present policy of economy and environment protection and developmental condition of productive technology, the coordination condition of environment and economy in Guangzhou will descend from the present high quality level to good coordination level. At the end of this century, it will descend to the middle coordination level. After first ten years of next century, it will appear the middle imbalance condition. So we must adjust the policy of economy development and

environment protection and accomplish superior adjustment in order to develop environment and economy continually.

Table 5 Forecast values of coordinated development for urban environment and economy in Guangzhou

Item	Particular year						
	1985	1986	1987	1988	1989	1990	
Index of environment quality	0.47	0.42	0.42	0.40	0.37	0.34	0.31
Index of economy development	0.49	0.71	0.77	0.85	0.97	1.12	1.31
Synthetic index of environment and economy	0.48	0.57	0.60	0.63	0.67	0.73	0.81
Coordination	0.99	0.87	0.83	0.76	0.64	0.51	0.38

IV. ADJUSTMENT COUNTERMEASURES OF COORDINATION DEVELOPMENT OF ENVIRONMENT AND ECONOMY

1. Establishing the Strategic Thought of Coordination of Environment Protection and Economy Development

From the analyses of Table 4 and 5, we see that the economy and environment quality indexes change adversely, which shows the fact that the more seriously the environment is destroyed, the more dis-coordinated the environment and economy are. But the coordination of environment and economy development is all more than 0.8 during 1985—1992, and belongs to the high quality grade, which results from paying attention to the coordination of environment protection and economy development. With economy development, Guangzhou has put into a great deal of funds to the construction of environment.

2. Making Great Efforts to Improve the Synthetic Strength of Economy and Environment

We know from Table 4 and 5, the synthetic development index of environment and economy is not high, the economy development index will be 0.97 at the end of this century in Guangzhou. This has reached to the advanced level of the world at present. But because of the economy development, these must stress on the environment, causing the descending of environment quality index. Not only it affects the improvement of the synthetic index of environment

and economy, but also it can affect the coordination degree. So, in order to improve the synthetic strength of economy and environment, we must pay attention to improving the environment of city, make great efforts to raise the index of environment quality.

3. Countermeasures of Raising Urban Environment Quality

Guangzhou city is an old city which is along the coast and has higher population density. Distribution of industry isn't rational, so the pollution of environment is serious. From Table 3 and 4, we see the reasons of environment quality descending as follows: first, the pollution of waste water is serious, second, the SO₂ concentration of atmosphere is higher, third, noise is so high as to disturb resident, fourth, the rate of plant cover is not high. As a result of forecasting, we know that the key for raising the environment quality is coordinated development. Then we put forward following countermeasures.

3.1 *Grasping firmly the prevention of industrial pollution with advanced technology*

As mentioned above, the reasons of pollution are mainly the backward in technique, the old equipment of industrial production and so on. So the industry enterprise and managing department must push the technology reform and pollution prevention with advanced technique. Enterprises must adopt the new advanced technology which has no pollution and reform the old equipment, vanish the pollution during the production procession, make the synthetical utilization as the key content of management, develop the estate of environmental protection, and improve the benefit of management funds.

3.2 *Adjusting urban planning and industrial layout timely*

We should revise the whole planning of city and carry out program of environment according to the law of city planning. We should insist on the direction of synthetical regional management and focus control of pollution. All kinds of function area of environment should be managed respectively. Distribution of industry and water factory should be adjusted. Area of water foundation should be protected stressly.

3.3 *Adjusting the estate structure and putting emphasis on developing new hi-tech estate with high benefit and little pollution.*

Improvement of the city's environment quality index depends on the adjusting of structure of industry. We should develop the light industry of high technology, traffic trade, business, financial insurance, landed estate, tourist trade and make these six the mainstay of Guangzhou's economy. We should pay more attention to the layout of large enterprise and management of pollu-

tion. The industry which consumes a lot of water should be forbidden.

3.4 *Quickening the construction of basis installation and improving the level of synthetical management*

In order to make Guangzhou City a national big city which has beautiful environment and high developing economy, we must carry out the synthetical environment management deeply, speed up construct of basis facilities, tight up the afforestation and construction of city environment in order to coordinate the economy and environment.

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