An Analysis of the Coordination between Economy and Environment using an Environmental Entropy Model

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Abstract **— For objective evaluation of the economy–environment system, and based on thermodynamic entropy theory and exergonic analysis, this paper explores the connotation of the Economy–Environment coordination and proposes a quantitative model of environmental entropy to evaluate the collaboration in Economic–Environment system. We test the model by studying the coordination between economic development and the environment based on data from Inner Mongolia from 2000 to 2012. The results show that the 'environmental entropy model' measuring the coordinated development of Economy and Environment is an excellent model. Our empirical studies show that the Inner Mongolia Economy-Environment system was at an extremely uncoordinated level from 2000 to 2005, but was at a high level of coordination from 2006 to 2011.**

Keywords - Economy; Environment; Environmental Entropy; Coordination; Inner Mongolia component;

I. INTRODUCTION

Economy-Environment is a complex system. The phenomenon that the two systems interact with each other is defined as Economy-Environment coupling. On the one hand, Economy has stress effects on the environment; on the other hand, the degradation of the environment has binding effects on the economic growth [1]. Only the coordination effect caused by these interactions between them can promote the development of economic-environmental system to be in a coordinated and orderly direction. The essence of the coordinated development of economic-environmental system is making full use of and promoting the positive relationship between economy and environment to achieve a virtuous cycle between the two, a stable economic development and an ordered state of rational and efficient use of resources and a good environment condition. The question is how to evaluate the effects within such a complex system? Further, suggestions for improvements are one of the hot spots in academic studies.

The economic and environmental data in Inner Mongolia from 2000 to 2013 were selected in the study to explore the succession trajectory between economic growth and environmental pollution level, establish the environmental entropy model of economic growth and environmental pollution level and provide the basis for the evaluation of Inner Mongolia's economic and industrial policies.

Domestic and foreign scholars have many research methods to study the relationship between the economy and environment, focusing, in general, on the following two aspects. First, some researchers establish an economic-environmental evaluation index system, study the coupling of the two systems and calculate the coordination [2]. Such methods need to determine the weights by an analytic hierarchy process (AHP) or expert scoring method in the process of calculating the coordination. The results are often of poor logical consistency and subjective, also there are large differences in the calculation results. Second, other researchers focus on the Environmental Kuznets Curve (EKC). They believe the effects of the economic structure [3-4], the progress of technology [5], the international trade [6] and environmental requirements [7] are the main reasons to form the inverted "U" curve of EKC. But present models of EKC have subjective differences in the selection of measurement indicators and neglect to consider the government's decision-making. They impose too much emphasis on the public as a consumer, neglecting its role as a decision maker in the theoretical study. The article applies methods of the Thermodynamic entropy theory, establishes a model of the environmental entropy, analyses the coordination of the economy and environment, and studies Inner Mongolia policy as an empirical example. The model of the environmental entropy that is used not only overcomes the defect of subjectivity, and introduces government's policy variables as endogenous variables, but also overcomes the defect of ignoring the role of the government in the EKC analysis, and objectively evaluates the coordination of both systems, the economy and environment.

II. RESEARCH METHODS

A. *The theory of entropy*

Entropy is a thermodynamic concept that was proposed by a physicist named Clausius who lived in Germany in mid-19th century. It was mainly used for evaluating the degree of system ordering. Because of the first law of thermodynamics that is Energy conservation and conversion law was insufficient to describe the nature of the energy flow variation, though it was very effective to understand a given process flow of energy, it could not clear the state of system

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under a given set of conditions, so the theory of entropy is put forward. In 1865 Clausius proposed the concept of entropy [8] in studying of the efficiency of a heat engine in a reversible process:

$$\Delta S = S_2 - S_1 = \int_1^2 dS = \int_1^2 \left(\frac{dQ}{T}\right)_R \quad (1)$$

In the formula, ΔS is the entropy change in the system reversible process, S_1 and S_2 is the initial and final states respectively; dS($J \cdot K^{-1}$) is a small change of the entropy; dQ (J) expresses the heat absorbed in a micro reversible process; T(K) is an absolute temperature of the system or environment in a micro reversible process; R is the reversible process.

The second law of thermodynamics can be expressed as follows, introducing the entropy function:

$$dS \geq \frac{dQ}{T} \quad (2)$$

In this law, the equation represents a reversible process, while the inequality represents an irreversible process. For an isolated system, the entropy can never decrease. In a reversible process, the entropy of the system is unchanged; in an irreversible process, the entropy of the system increases, saying the conclusion of the principle of entropy increase. In a real world, the entropy of an isolated system always monotonically (spontaneously) increases until reaching the maximum entropy.

In 1887, Boltzmann first gave a microscopic definition of entropy based on the probability theory and linked entropy S and thermodynamic probability of the system, namely:

$$S = K \ln W \quad (3)$$

In this formula, K is the Boltzmann constant, W is the thermodynamic probability of the system, that is a microscopic number of the state. This is the famous Boltzmann relationship [9]. The entropy is defined as microscopic Boltzmann entropy, also known as the statistical entropy.

Boltzmann relationship links macroscopic quantity S and microscopic state number W, giving the microscopic meaning of entropy quantitatively, the entropy is in proportional relationship to the logarithm of the number of system microstates. Boltzmann's statistical interpretation of the entropy made people recognize the deeper concept of entropy, namely, that the entropy is a measure of the system disorder. The system disorder corresponds to the number of microstates, smaller number of microstates corresponding to a smaller degree of disorder, and larger number of microstates corresponding to a larger degree of disorder. The microscopic definition of the entropy, that is Boltzmann's entropy, also satisfies the principle of entropy increase. In other words, the disorder in an isolated system can only increase.

In 1848, the founder of the information theory C.E. Shannon used the probability theory to define uncertainty as a measure of the probability distribution on the information source system.

$$H = -C\sum_{i=1}^{n} P_i \ln P_i \quad (4)$$

In this formula, n is the number of signal sources, Pi is the appearing probability of the signal. Using the principle of equal probability, it can be proved that the statistical expressions for H and entropy S can be converted to each other, so the amount H defined this way was called information entropy.

The emergence of the information entropy made the concept of entropy, in general, widely promoted, which was used to express or measure the uncertainty or degree of disorder of movement in many other applications. According to statistics, there are 70-80 types of entropy used in various fields such as gene entropy, topological entropy, fuzzy entropy, social entropy and so on[10]. When the system entropy changes, the total amount of energy does not change, but the quality of the energy contained in the system changes. So the concept of “exergy” was born to describe this phenomenon. “Exergy” is a physical quantity that combines quality and quantity to evaluate energy. In 1868, a British scientist Tate (Tait) used the concept of energy availability for the first time. In 1856, Bronte (Z. Rant) from former Yugoslavia first proposed the concept of exergy, defined as that part of energy which changes most into useful work under ambient conditions [11].

Chinese scholar X.Y. XIANG defined the exergy as [12] the maximum useful work that energy or the substance referred to in the process of certain forms of energy or certain condition of substance achieved a complete balanced state to the environment after the completely reversible changing process. Exergy is an indicator of the system deviating from the degree of environmental parameters; it is a relative amount using environment as a parameter. The exergy value of the system depends on the state of the system and environment, regardless of the path used to reach this state. The relationship between entropy and exergy is given by the Gouy-Stodola equation [13].

$$E_L = T_0 \Delta S \quad (5)$$

In this formula, E_L is the loss of exergy, T_0, T_0 is the temperature in the initial state, ΔS is the total entropy change.

Since the 1960s, the exergy analysis method has been widely used in the energy science. Stepanov [14] analyzed the influence of waste that chemical industrial processes discharged in the environment; Rosen [15] pointed out that the industrial waste discharged contained physical and chemical exergy that can cause changes in the environment and cause environmental pollution. Many scholars have studied the basic material exergy and obtained hundreds of exergy values of substances, some of exergy values are shown in Table Ⅰ [16]. An American scholar Owen showed that the formula of the total organic matter in sewage is $C_{10}H_{18}O_3N$, bacterial cells is $C_5H_7O_2N$. He linked the fuel value and theoretically calculated Chemical oxygen demand

(COD) of the two substances, and derived that sewage chemical energy formula is 13.9KJ/g COD, bacterial cells chemical energy formula is 14.8KJ/g COD. Loll from German measured the thermal output of stable sludge, 14.7KJ/g.

TABLE I EXERGY VALUE OF SOME MATERIAL

Litter Emissions kinds	Exergy value (KJ/g)	Litter Emissions kinds	Exergy value (KJ/g)	Litter Emissions kinds	Exergy value (KJ/g)
Sulfate	1.139	Sulfide	23.999	HCI	2.318
Dust	7.878	NO_X	1.209	HF	3.999
SO_2	5.892	CO	9.821	Phenol	33.242
CH_4	51.842	CO_2	0.451	Grease	37.450
Total Suspended Solids	7.878	H_2S	23.826	Fluorine	2.829
Ammonia	19.841	Chlorine	1.341		
Cyanide	32.478	Benzene	42.292		

B. The Coordination Analysis of Economy and Environment

Collaborative development aimed at comprehensive development for human formed simultaneous development of benign evolution trend by systems that contains regional resources, social, environmental, economic and so on, and the various elements within the systems[18] that have mutual adaptation, mutual coordination and mutual coupling.

As an input-output system, the economic system changes resources as input elements into products and materials needed and waste into the environment. In the production process, exergy contained in the raw materials and energy is passed, transferred and lost due to irreversible processes. As passed and untapped exergy emissions in the environment, the abandoned exergy breaks the balance of environment itself, causes adverse environmental change. The larger the degree of imbalance, the greater harm to the environment. The exergy value of the emission can characterize the imbalance of emissions and environment [19].

Based on the views of scholars above, this paper argues that the coordination of economic and environment refers to the synchronization status of the economic development and environmental quality changes. This synchronization status contains six cases as follows. When the economy grows, there are three cases: economic growth, environmental quality degradation; economic growth, environmental quality stability, economic growth, environmental quality increase. When the economy declines, there are three cases: declining economy, environmental quality degradation; declining economy, environmental quality stability; declining economy, environmental quality increase. In what follows we provide an in-depth analysis of these six cases above.

C. Environmental Entropy Model

1) The order parameter selection

The paper takes into account the factors such as the level of economic development, industrial structure and main pollutants in the environmental system and so on, and determines system order parameters which describe the coordination between economics and the environment.

(1) The order parameter of the economic system mainly contains: GDP, per capita GDP, industrial value added, the two or three industry output values accounting for the proportion of GDP, the two or three industry labor shares and the urbanization rate.

(2) The order parameter of the environmental system contains : SO_2 emission, dust emission, smoke emission, COD emission.

2) The definition and physical meaning of environmental entropy

According to the connotation of the collaborative analysis of economy and environment, the paper uses the existing research on entropy and exergy [8,10,11-19], defining the environmental entropy as a synchronous state function of the economic development and environmental quality change ("EE") as follows:

$$EE = \frac{\Delta Q}{\Delta K} = \frac{Q_n - Q_{n-1}}{K_n - K_{n-1}} = \frac{\Delta \sum \alpha_i Q_{in}}{\Delta \sum \beta_j E_{jn}} \quad (6)$$

In this formula, Q is the pollution exergy, K is the comprehensive index of the level of industrialization, n is the time, Q_{in} is the exergy value of the i-th order parameter in environmental system in the N year, α_i is the harm coefficient of the i-th order parameter in the environmental system. E_{jn} is the value of the j-th order parameter in the N year in economic system. β_i is the weight of j-th order parameter in the economic system.

The physical meaning of the environment entropy is as follows: when the environment entropy is positive, the economic development has a negative impact on the environment, leading to the environmental degradation and poor degree of harmony during the synchronization of the economic development and environmental quality change; when the environment entropy is negative, the economic development has a positive impact on the environment, leading to good environmental quality standards; when the environment entropy is zero, in the process of the economic development, the environmental quality levels stabilize. See specific states of coordination of the economic and environment in Table II.

TABLE II . THE STANDARD OF DEGREE OF COORDINATION OF ECONOMY AND ENVIRONMENT

Environmental entropy(EE)	EE>1	1≥EE>0	EE=0	EE<0
Coordination degree	Extreme imbalance	Serious imbalance	Good coordination	Good quality coordination

III. EMPIRICAL ANALYSIS

A. Overview of the Study Area

The Inner Mongolia Autonomous Region is located in the northern part of China, closer to Mongolia and Russia, and covers an area of 1,180,000 square kilometers with a population of 24,706,300.

TABLE III. THE STANDARD OF DEGREE OF COORDINATION OF ECONOMY AND ENVIRONMENT

	Per capita GDP (Yuan)	Industrial added value of a share of GDP (%)	The proportion of tertiary industry in GDP (%)	The proportion of the labor force and tertiary industry (%)	Urbanization Rate (%)
2000	6502.00	31.46	77.21	47.80	42.20
2001	7139.00	31.57	79.06	48.40	43.54
2002	8081.00	31.68	80.70	49.10	44.05
2003	9722.00	32.39	82.41	49.60	44.74
2004	12007.00	33.39	82.81	48.10	45.86
2005	15002.00	37.85	84.90	46.17	47.20
2006	18627.00	40.97	87.16	46.20	48.64
2007	23012.00	43.31	88.14	47.36	50.15
2008	28624.00	45.66	89.31	49.60	51.72
2009	32717.00	46.23	90.46	51.20	53.40
2010	37776.00	48.14	90.62	51.80	55.53
2011	43802.00	49.45	90.90	54.13	56.62
2012	46816.00	48.71	90.88	55.30	57.74

Inner Mongolia has rich grassland, forest and mineral resources, and it is especially rich in coal resources. As of July 2009, the region has coal reserves of 701,600 million tons, in 12 Union City of Inner Mongolia, 67 banners (county, city and district) in 101 banners (county, city and district) have coal resources, coal bearing area occupies a land area of 1/10. It becomes an important base of national energy, new chemical industry, non-ferrous metals and green agricultural and livestock production and processing. Providing the materials guarantee the rapid economic development of the national economy. According to statistics, the annual GDP growth rate of Inner Mongolia ranks first in the country from 2000 to 2009, being more than 15% for ten consecutive years from 2003 to 2012, and 16.9% in 2009, the year affected by the impact of the international financial crisis.

B. Date source

In the paper the data on the economic system mainly obtained from the Inner Mongolia Autonomous Region statistical yearbook from 2000 to 2013. The data on COD, smoke and SO_2 in the economic system mainly obtained from the Inner Mongolia Autonomous Region environmental quality bulletin of Statistics from 2000 to 2012. The data on CO_2 was obtained based on the PCC carbon emission factor, comprehensive energy consumption calculation (GB-T2589) and the Inner Mongolia Autonomous Region Statistical Yearbook. The exergy value of the environmental system is estimated as in Table Ⅰ, using the formula:

$$Q_{in} = C_{in} Q_i \tag{7}$$

Q_{in} is the exergy value of the i-th order environmental system parameter in the N year, C_{in} is the emission of the i-th environmental system parameter in the N year, Q_i is the unit exergy value of the i-th environmental system parameter.

C. Date Processing

In order to have comparable data, the article adjusts the per capita GDP using the price index taking 1999 as its base year.

1) Data Standardization

In order to eliminate the effect of data units, the paper, first, applies dimensionless processing of the economic and environmental system parameters using formula (8).

$$X_{in} = \frac{(x_{in} - \overline{x_i})}{S_i} \tag{8}$$

In the formula, X_{in} is the standard value of the i-th section parameter in the n year, x_{in} is the value of the i-th section parameter in the n year, $\overline{x_i}$ is the average value of the i-th section parameter, S_i is the standard deviation of the i-th section parameter.

Second, in order to eliminate the negative section, order $Z_{in} = X_{in} + A$, according to the data, make $A = 3$, by eliminating the negative section, this article can solve some extreme value problem [20].

2) Determining the weight of the order parameter in economic system

In the paper, we determine the weights of the order parameters of the economic system by using the information entropy theory [11] and the entropy weight method. The entropy weight method can possibly eliminate the subjectivity in the determination of weights, making the results of evaluation more objective [21-23].

(1) Calculate the weight value Pin of the indicators i-th section order parameter in the n year:

$$P_{in} = \frac{X_{in}}{\sum X_{in}} \tag{9}$$

(2) Calculate the entropy ε_i of the i-th section order parameter according to the formula (4):

$$\varepsilon_i = -C\sum_{i=1}^{n} P_{in} \ln P_{in}, C = \frac{1}{\ln n} \tag{10}$$

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TABLE Ⅳ. THE ORDER PARAMETER VALUE OF THE ENVIRONMENT SYSTEM   UNIT: MILLION TONS

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
COD	25.6	28.1	23.8	27.5	27.5	29.7	29.8	28.77	28.01	27.85	27.51	26.94	26.24
Smoke	65.9	54.1	56.4	60.3	101.9	123.4	93.1	86.45	78.85	65.78	80.73	74.37	83.3
SO2	66.4	64.6	73.1	80.8	117.9	145.6	155.7	145.5	143.1	139.8	139.4	140.9	138.4
CO2	11980	13672	16075	18127	20385	26825	33006	41099	50834	54230	62076	56085	58505

TABLE Ⅴ. THE ORDER PARAMETER WEIGHTS OF THE ECONOMIC SYSTEM

order parameter	Per capita GDP	Industrial added value of a share of GDP	The proportion of tertiary industry in GDP	he proportion of the labor force and tertiary industry	Urbanization rate
weights	0.19	0.21	0.18	0.22	0.20

(3) Calculate the coefficients g_i of the i-th section index. The smaller entropy value, the greater difference between the indexes, the more important indicators.

$$g_i = 1 - e_i \tag{11}$$

(4) Calculate the weight value of the i-th index

$$\gamma_i = \frac{g_i}{\sum g_i} \tag{12}$$

The order parameter weights of the economic and environmental systems can be obtained by formula (9), (10), (11), (12) (see Table Ⅳ).

3) Determination on risk index weight of environmental system order parameter

Because the exergy itself cannot express biological toxicity of substances, it is insufficient to fully characterize the environmental effects of the environmental order parameters. Therefore, the paper identifies damage coefficient weights of the environmental order parameters by introducing damage coefficients of biological toxic effects of reactive chemicals. The paper uses potential harm coefficients of the American Environmental Protection Agency (EPA) as environmental harm coefficients of emissions. The harm coefficients of SO_2 and CO_2 are 15 and 4, respectively, using the potential harm coefficients of EPA [24].

In the paper, the toxicity of COD is determined mainly by the biological toxicity testing technology to determine its impact on biology. In the raw water aniline, nitrobenzene, methylbenzene compounds, nitriles, phenols, acids, alcohols, esters, styrene, nonane, indole, quinoline, tetrahydrofuran and other organic matters can be detected, where the chlorinated aniline, nitrobenzene and heterocyclic chlorinated organics are toxic/biodegradable organic pollutants. A lot of aniline, nitrobenzene and heterocyclic compounds are detected in the water, which are the main component of the effluent COD [26-29]. The article assumes that the contents of aniline and nitrobenzene in COD are equal, and determines that the hazards coefficient of COD is 13 according to the Environmental Assessment data sheet [24]. According to the Formula 13 we determine the hazards coefficient weights of order parameters of the environment. Specific results are present in Table V. a_i represents the i-th hazards coefficient of order parameter in Formula 13.

$$\alpha_i = \frac{a_i}{\sum a_i} \tag{13}$$

As shown in Table VI, among the environmental system order parameters, smoke (powder) dust comprehensive harm to the natural environment and the body is the largest, the next is SO2, again as COD, relative to the other three substances, the comprehensive harm of Carbon dioxide to the natural environment and the human body is the smallest.

TABLE Ⅵ. THE WEIGHT OF HARM COEFFICIENT OF THE ENVIRONMENTAL ORDER PARAMETER

Order parameter	COD	Smoke(dust)	SO_2	CO_2
Weights	0.22	0.45	0.26	0.07

D. Result Analysis

The article normalizes the data of the economic and environmental systems of Inner Mongolia from 1999 to 2012, determining the weights of each order parameter of the economic and environmental systems using the entropy method and determines the composite index of the level of industrialization, exergy of pollutions and environmental entropy using the Formula (6).

1) The level of industrialization

From Figure 1, the level of industrialization of Inner Mongolia from 1999 to 2012 had an upward trend which was mainly affected by the adjustment of the industrial structure in Inner Mongolia. From 1999, Inner Mongolia increased the industrial restructuring, transformed economic growth, exploited mineral resources, advancing the process of industrialization. The development of economy had entered a rapid growth. The first industry output value accounting for the proportion of GDP dropped from 24.9%

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in 1999 to 9.1% in 2012. The second industry output value accounting for the proportion of GDP increased from 37% in 1999 to 55.4% in 2012. Among them, the industrial added value accounting for the proportion of GDP increased from 30.8% in 1999 to 48.7% in 2012. The third industry output

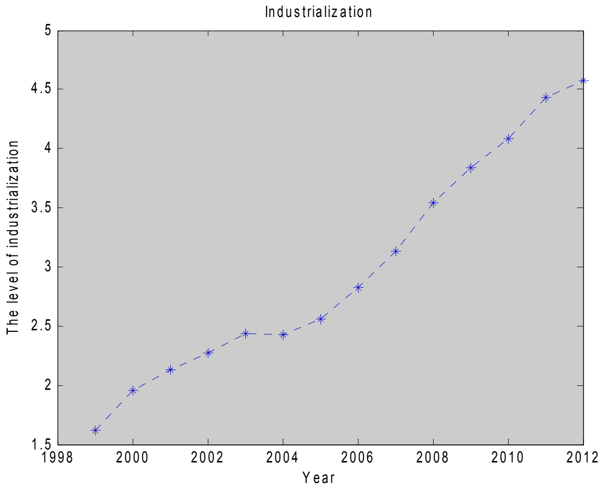

Figure 1. The composite index of Inner Mongolia industrialization level from 1999 to 2012

value accounting for the proportion of GDP decreased from 38.1% in 1999 to 35.5% in 2012. Per capita GDP (with 1999 as the base year) increased 7 times from 5861 yuan in 1999 to 46816 yuan in 2012. Urbanization rate increased from 40.975% in 1999 to 57.737% in 2012.

2) Analysis of collaborative of economy and environment in Inner Mongolia

By standardizing the data in Table 3 and Table 4, we calculate weights of order parameters, then calculate the environmental entropy from 2000 to 2012 according to Formula (6), with the results shown in Figure 2.

The environmental entropy was positive from 2000 to 2005 (except 2002). Except for 2001, all the other environmental entropy values are greater than 1. The environmental entropy tends to increase from 2000 to 2005, suggesting that the economic-environmental system of Inner Mongolia was at extremely uncoordinated level. Environmental entropy was negative from 2006 to 2011(except 2010), suggesting that the economic-environmental system of Inner Mongolia was at high quality level of coordination. The environmental entropy was greater than zero in 2012, suggesting that the economic development had a negative impact on the environmental quality.

The total final consumption of energy (equivalent value) in Inner Mongolia in 1999 was 36,348,800 tons, and 221.033 million tons in 2012, increased nearly five times during the 5 years. The energy consumption had also increased the pressure on the environment. Inner Mongolia environmental order parameters of SO_2, COD, smoke (powder) dust emissions were increasing especially in 1999-2006 period. Pollution loss of exergy value was on a growing trend. Resources exploitation was the main driving force of the economic development. The economic development of Inner Mongolia was in the extensive growth mode, resulting in a poor economic-environmental coordination. Inner Mongolia has been increasing the industrial restructuring since 2007, promoting the resource type industrial transformation, increasing investments into the environmental protection and strengthening pollution

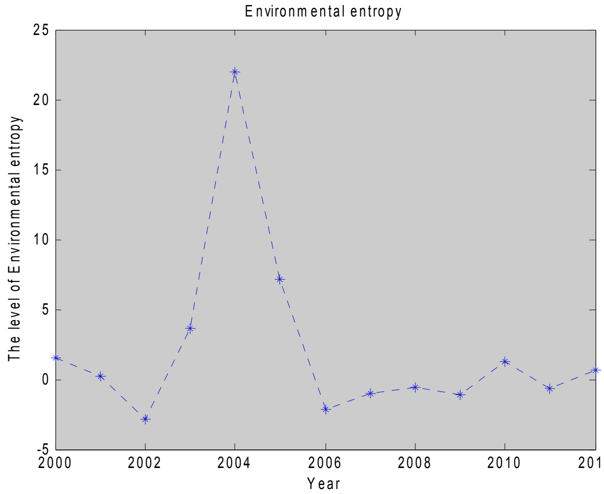

Figure 2. The trend of graph Inner Mongolia environmental entropy from 1999 to 2012

control efforts. SO2, COD, smoke (powder) dust emissions decreased, and the economic-environmental coordination became better. Due to the continued increase in energy consumption from 1999 to 2012, carbon dioxide emissions had a rising trend. Inner Mongolia was under a larger pressure to reduce the carbon dioxide emission.

IV. CONCLUSIONS

In the article, we used the notion of thermodynamic entropy, combined with exergy analysis, and analyzed the connotation of the economic-environmental collaboration. We introduced the level of industrialization and pollution exergy loss, constructed an environmental entropy model of evaluation of economic-environmental collaboration and conducted empirical analysis of the data on Inner Mongolia. The paper is based on the data on economic and environmental variables for Inner Mongolia from 1999 to 2012. Using a data standardization process, we determined the weights of each order parameter using the entropy method, and obtained the environmental entropy value of Inner Mongolia from 2000 to 2012. Based on the results, we believe that the economic-environmental system of Inner Mongolia was in an extremely uncoordinated level from 2000 to 2005, and was at a high quality level from 2006 to 2011, due to the factors of mode of economic character.

The results of the empirical analysis of the economic-environmental collaboration using the environmental entropy model are more objective and practical. The environmental entropy model has certain reference importance for evaluation of the economic-environmental collaboration in the other areas.

The Inner Mongolia Autonomous Region has a vast territory, rich mineral, grassland and forest resources, but the twelve Union City have each identical natural resource conditions, implying that the economic development should correspond to the unique characteristics of the country economy, rather than the development of a heavy industry with no difference.

Now many industrial parts of autonomous regions have implemented industrial plans of circular economies to improve the utilization of raw materials and primary products and reduce emissions. But from the research point of view, most of the industrial regions efforts were not sufficient, and the circular economy efforts were not obvious, suggesting that in their planning, industrial parks should learn lessons from the atomic economic theory, from the design phase of chemical reaction, selecting those less polluting output materials or regulating the design phase of chemical reactions to the control of pollution emissions.

In 2012, Inner Mongolia the environmental entropy was positive, and economic-environmental coordination was poor, mainly because of the increase in smoke (powder) dust emissions, suggesting that in the development of economy, the environmental protection should be strengthen, encourage enterprises to carry out technological transformations and increase the costs of breaking environmental laws.

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