An Optimal Emission Mechanism of Sustainability of China: How to Achieve a Win-Win Solution Between Economy and Environment?

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Abstract The problem of pollution arises along with the rapid development of economic, and it spread from a regional problem to a nationwide one. It has caught the eyes of Chinese government and people that how to develop Chinese economy without harming environment. In this paper, to obtain a win-win solution between economy and environment, optimal results of unit emission penalty mechanism under different industrial GDP growth rates and the growth rates of industrial technical input is given, which applies multi-objective optimization methods based on an economic-ecological model. The results provide factories a way to maximize the benefits, as well as a scientific basis for government to determine the punishment standard and the technical input growth rate.

Keywords sustainable development; economic-ecological model; multi-objective optimization; industrial GDP; technical input

1 Introduction

Due to the extensive economic development pattern, Chinese environmental problem has become more serious and complicated. The problem in China mainly reflects in three aspects: water pollution, soil pollution and air pollution. Firstly, the average per capita water availability in China is lower than 1/4 of the world average. An alarming proportion of China water resource has been polluted. Secondly, more than 10% of the country's arable land area, covering an area of about 100 thousand square kilometers, has been contaminated by heavy metals. The total number of food contaminated by heavy metals is about 12 million tons annually, resulting in a direct economic loss of more than 20 billion Yuan (3.25 billion dollars). Thirdly, the outdoors air pollution contributes to 1.2 million premature deaths in 2010 and 1.6 million premature deaths in 2014^[1]. Haze, a hidden killer, has been threatening people's health in many cities. For example, the number of haze days which means PM2.5 concentrations exceed local air quality standards reached 189 in Beijing in 2013^[2].

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At present, the worsening trend of China's environment has not been fundamentally curbed. Serious environmental emergencies have become a key factor in threatening people's health, public safety and social stability. However, China lacks enough scientific and powerful supervisory measures. Factories focus more on economic interests and take less environmental action. Faced with this situation, a scientific way to control pollution in the development of economy is needed, which is the aim of this paper.

From the 1970s, economists discussed the problem about the coordinated development of both economy and environment with economic growth theory models, which is divided into the neoclassic growth model and the endogenous growth model. The neoclassic growth model contains two growth models, the neoclassical growth model which includes environmental factors and the neoclassical model which views environment as a factor of production (for example, the study by Chichilnisky and López^[3,4]). In the late 1980s, the endogenous growth model (represented by Romer and Lucas's^[5-7]) appeared. They tried to solve the problem about the coordinated development of both economy and environment by adding environmental factors to the endogenous economic growth model. Brock and Taylor are the main representatives^[8,9]. They established four models: The first is Green Solow model based on the Solow model, the second is the strengthen emissions model based on Stokey model^[10], the third is the head-end model, the fourth is kindergarten rule model based on the framework of endogenous growth model.

Chinese researches in this field start late, which divided into two areas. One is the qualitative study of the coordinated development of both economy and environment using system dynamics, game theory and resource allocation theory. Li built a cooperative game model and analyzed the relationship between economic growth and environmental by means of game theory. He pointed out that economic growth and environmental quality could reach a benefit distribution through effective coordination^[11]. Li analyzed the problem from the perspective of resource allocation. He pointed out that economic activity existed not only an internal but also an outside equilibrium problem^[12]. And the coordinated development of economy and environment is one of the goals of the latter. The other one is the economic growth model with environmental factors including endogenous growth models under the constraints of resource and environmental^[13] and the model of pollution, endogenous population growth and economy growth^[14].

Indexes and correlativities in the majority of researches of coordination between economy and environment, were built by using existing observed data. Researchers drew conclusions through assessment methods or mathematical methods (e.g., comprehensive evaluation, game theory, etc.), and gave opinions in order to improve the reality of the social system at the final. However, in the researches above, a concrete way has not been provided. For example, the conclusion "technological innovation can reduce pollution" has been put forward, while no one gives the answer about the details of optimal input in the technological innovation.

This paper sets up the model of economic development, technical inputs and pollution penalties to find a range of optimal policies. Exceed emission standards and proper punitive tools are set to achieve a win-win solution between economy and environment.

2 Model Building

2.1 Theoretical Review

Suppose that there is a manufacturing system (e.g., an industrial branch, a factory, a plant, etc.) produces useful goods. It has a negative environment impact. The fixed assets or equipment in it will be more effective due to materialized technological progress. And at the same time, negative effects will reduce. The following modification of the one-sector integral model with controllable equipment renovation can describe the manufacturing system above^[15]:

$$Q(t) = \int_{a(t)}^t \beta(\lambda(\tau), \tau, t) m(\tau) d\tau, \quad (1)$$

$$P(t) = \int_{a(t)}^t m(\tau) d\tau, \quad (2)$$

with the following additional balance for environment contamination:

$$R(t) = \int_{a(t)}^t r(\lambda(\tau), \tau, t) m(\tau) d\tau. \quad (3)$$

In the equations above, $Q(t)$ is the total output at time t , $P(t)$ is the total required labor at time t , $R(t)$ is the amount of pollutant emission per time unit (the level of environment contamination). $\beta(\lambda(\tau), \tau, t)$ is the specific productivity, $r(\lambda(\tau), \tau, t)$ is the amount of waste produced by one EU (equipment unit) per time unit, $\lambda(t)$ represents the EU, $m(t)$ is the quantity of new EU entered into the system. $a(t)$ is the time limit of EUs use.

1) Optimization with penalty for pollutant emissions (factory)

Assume that the penalty $r(\cdot)$ can be imposed only for exceeding some admissible level $R_{\max}$ for pollutant emissions and the penalty is proportional to the $R_{\max}$ exceeding. Then the objective functional is of the form:

$$I_1 = \int_{t_0}^T \rho(t) [Q(t) - \lambda(t) m(t) + r(t) [R(t) - R_{\max}(t)]_+] dt \rightarrow \max_{a, m}, \quad (4)$$

where

$$[x]_+ = \begin{cases} x, & x \geq 0, \\ 0, & x \leq 0. \end{cases} \quad (5)$$

In (4), $\rho(t)$ is a discounting multiplier, $\rho' < 0$, $0 < m(t) < M(t)$, $0 < \lambda(t) < L(t)$, $a'(t) \geq a_0$, $a(t) < t$.

So solving problem of maximizing the efficiency of factories changed into solve the optimization problem of (4).

2) Technology Optimization in economic-ecological system (government).

Intensification of the economic-ecological system (EES) resources and conservation and enhancement of the environment are the two inherent and contradictory criteria in EES control problems. As a rule, these criteria have different priorities at different management levels. Therefore, it is inevitable to analyze a multi-level hierarchical control system in solving EES control problems. The simplest form is a double control structure described below.

First, consider an optimal control problem of the EES (“Central” - “Factory”). “Central” is on the upper hierarchical level and controls the “Factory” via penalty rules. Factories need to pay a fine for exceeding a prescribed environment contamination level. Function which represents “Central”’s goal is as follows:

$$I_1 = \int_{t_0}^T \rho(t) [Q(t) - \lambda(t)m(t) + r(t)[R(t) - R_{\max}(t)]_+] dt \rightarrow \max_{a,m}. \quad (6)$$

This time, form the optimal control strategy:

(i) “Central” optimal strategy

An optimal penalty r^* is less than $r_{\max}$ on the intervals when $R^*(t) > R_{\max}(t)$. And r^* is determined optimally by taking the “Factory” expenditures into account.

(ii) “Factory” optimal strategy

An accelerated technological renovation with the environmental penalty r^* on the time intervals when the “Factory” pollutant emission $R^*(t)$ exceeds $R_{\max}(t)$.

The switch to an optimal “Factory” renovation rate determined by technological change only when the $R^*(t)$ does not exceed the admissible level.

2.2 Model Settings

It is difficult to obtain a continuous record for industry in practice. So we need to discrete the integral above, to make this model feasible. We also redefine the variables in (4), (6).

In (4), we use the technical input to measure the technological progress of industry. Depreciation rate is not to be considered. Industrial GDP (denoted by G) is chosen to replace $Q(t)$.

Our object is the impact of the technical input in environment, so here we choose R&D funding instead of the cost $\lambda(t)m(t)$, denoted by $M(t)$. In summary, the discretized equation (4) is

$$I_1 = \sum_{i=1}^n [G(t_i) - M(t_i) + r(t_i)[R(t_i) - R_{\max}(t_i)]_+]. \quad (7)$$

In the same way, the discretized equation (6) is

$$I_0 = \sum_{i=1}^n U(G(t_i) - M(t_i), R(t_i)), \quad n = 1, 2, \dots, L. \quad (8)$$

The utility function determines the results of the “Central” objective function, which is pivotal. It needs to meet the requirements that “Central” objective function requires:

$$\frac{\partial U}{\partial Q} > 0, \quad \frac{\partial U}{\partial R} < 0, \quad \frac{\partial^2 U}{\partial Q^2} < 0, \quad \frac{\partial^2 U}{\partial R^2} < 0.$$

The utility function in *Environmental Pollution Abatement and Economic Growth: Model and Evidence from China* (Huang J N, Chen S H) can be used:

$$U(x, P) = \frac{x^{1-\sigma} - 1}{1-\sigma} - \phi \frac{P^{1+\theta} - 1}{1+\theta}. \quad (9)$$

In this paper, $x = G(t) - M(t)$, $P = R(t)$. So when $n = 1$:

$$I_0 = \frac{(G-m)^{1-\sigma} - 1}{1-\sigma} - \phi \frac{R^{1+\theta} - 1}{1+\theta} = U(G(t) - M(t), R(t)). \quad (10)$$

The tests whether the utility function satisfies the requirements of the objective function of “central” are as follows:

$$\frac{\partial I_0}{\partial (G-m)} = (G-m)^{-\sigma} > 0. \quad (11)$$

It shows that the marginal utility of $(G-m)$ is always positive.

$$\frac{\partial^2 I_0}{\partial (G-m)^2} = -\sigma(G-m)^{-\sigma-1} < 0. \quad (12)$$

It shows that marginal utility is diminishing. Then take $-\sigma(G-m)^{-\sigma-1}$'s partial respect to σ :

$$\frac{\partial}{\partial \sigma} \left(\frac{\partial^2 I_0}{\partial (G-m)^2} \right) = -(G-m)^{-\sigma-1} + \sigma(G-m)^{-\sigma-1} \ln(G-m).$$

When $\sigma < \frac{1}{\ln(G-m)}$, $\frac{\partial}{\partial \sigma} \left(\frac{\partial^2 I_0}{\partial (G-m)^2} \right) < 0$. It means $\frac{\partial^2 I_0}{\partial (G-m)^2}$ decreases with σ . The smaller σ is, the faster the marginal utility decreases.

When $\sigma > \frac{1}{\ln(G-m)}$, $\frac{\partial}{\partial \sigma} \left(\frac{\partial^2 I_0}{\partial (G-m)^2} \right) > 0$. It means $\frac{\partial^2 I_0}{\partial (G-m)^2}$ increases with σ . The bigger σ is, the faster the marginal utility decreases.

$$\frac{\partial I_0}{\partial R} = -\phi R^\theta < 0, \quad \frac{\partial^2 I_0}{\partial R^2} = -\phi \theta R^{\theta-1} < 0. \quad (13)$$

It shows that marginal utility of environment pollution is negative. Take $\frac{\partial^2 I_0}{\partial R^2}$'s partial respect to θ :

$$\frac{\partial}{\partial \theta} \left(\frac{\partial^2 I_0}{\partial R^2} \right) = -\phi R^{\theta-1} (1 + \theta \ln R) < 0.$$

$\frac{\partial^2 I_0}{\partial R^2}$ decreases with θ , that is the bigger θ is, the curve of $\frac{\partial^2 I_0}{\partial R^2} = -\phi \theta R^{\theta-1}$ flatter, and the faster the marginal utility of R decreases. Obviously, “Central” hopes that the marginal disutility of R diminishes as faster as possible. Equation (9) meets the requirements, can be used as a utility function of the model. Thus the “central” objective function is

$$I_0 = \sum_{i=1}^n \left[\frac{(G(t_i) - m(t_i))^{1-\sigma} - 1}{1-\sigma} - \phi \frac{R^{1+\theta} - 1}{1+\theta} \right], \quad n = 1, 2, \dots, L. \quad (14)$$

$G(t) - m(t)$ represents the profit without punishment. It has a positive utility to the country. R represents the pollution. It has a negative utility to the country. So the emission $R(t)$ is chosen to measure pollution. What is most important is ϕ which represents a penalty threshold value. It shows whether government pays more attention to the economy or the environment. The smaller ϕ is, the government pays more attention to the economy than the environment.

When the objective utility function of “Central” is positive, the entire industrial production brings a positive utility to the country. When it is negative, the utility is negative. More efforts

should be made on controlling pollution and improving industrial technology such as purchasing pollution controls and increasing technical input in environment.

Thus, the model has been established. It is a model about the industrial GDP, technical input in industry and pollution penalty function. The purpose of it is: When given an expected industrial GDP, finding the proper technical input, obtaining industrial pollutant emissions standards and the penalty on excessive pollution factories with the aim of achieving “Central”’s maximum utility and “Factory”’s maximum benefits.

3 Analyze

Data in these paper comes from China Statistical Bureau data and the website, including industrial GDP data, R&D funding data, environment investment data, pollution emission data, excessive pollution fines. In this paper, the base year is year 2000, and the following data are the actual data eliminated inflation factors.

3.1 Analyze of Technical Input in Environment, Industrial GDP and Environment Investment

We got the industrial GDP data, R&D funding data with the year 2000 as the base period. R&D funding, industrial GDP, environmental protection investment and investment in industrial pollution is increasing. $R = 0.97$ shows a high correlation between R&D funding and industrial GDP, and the correlation is significant. With the increase of R&D funding, the scientific and technological level of industrial will be greatly improved, and industrial GDP will increase naturally. When the R&D funding amount exceeds a certain value, its impact on the industry’s GDP will gradually diminish. At this point, factories will not spend more capital to improve technique, because it does not bring a corresponding income. We obtained: To some extent, industrial technological innovation can promote the development of industrial.

3.2 Analyze of the Growth Rate of R&D Funding, Industrial GDP and Environment Investment

In order to study if there is a certain relationship between the growth rate of R&D funding and industrial GDP growth rate, R&D funding growth rate, industrial GDP growth rate, environmental protection investment growth rate, ratio of R&D funding to industrial GDP and other industry data are given.

Clearly, the growth rates maintain at a high level, especially R&D funding. The increasing ratio of R&D funding to industrial GDP shows that China is in a transition from labor-intensive to technology-intensive. According to the data, there is no correlation among industrial GDP growth rate, R&D funding growth rate and environmental protection investment growth rate. In other words, the determination of industrial GDP growth rate does not affect the determination of R&D funding growth rate. Environmental investment and R&D investment is irrelevant. It is worth mentioned that a sudden increase in investment in environmental protection to 82.64928 in 1999, the growth rate of is 584.33%, which is inseparable from the flood in 1998. This shows that China’s current environmental monitoring still lags. Investment in technological innovation is a very important in the transition period. But not the more investment the better, technology has its specific development process.

Table 1 Industrial GDP, R&D funding and environment protecting investment data

Year	R&D funding (billion)	Industrial GDP (billion)	Environmental protection investment (billion Yuan)	Investment in industrial pollution (billion Yuan)
1990	10.57	1374.98	9.10	
1991	13.83	1568.09	11.58	
1992	15.91	1874.21	13.52	
1993	15.27	2254.20	13.08	
1994	16.99	2494.05	11.94	
1995	18.04	2727.88	10.79	10.79
1996	20.93	2972.80	19.75	9.65
1997	22.00	3232.96	37.33	11.43
1998	24.40	3367.63	12.08	12.26
1999	30.57	3600.49	82.65	15.31
2000	35.34	4003.36	101.49	101.49
2001	43.92	4327.77	109.90	17.33
2002	56.08	4748.14	136.86	18.86
2003	71.30	5435.14	161.01	21.94
2004	90.86	6208.36	181.82	29.33
2005	116.93	7222.80	223.33	42.85
2006	150.21	8413.40	236.43	44.59
2007	185.73	9718.23	297.84	45.93
2008	222.61	10814.43	372.79	45.05
2009	268.51	11307.00	378.35	37.00
2010	324.99	13008.23	538.56	32.13
2011	460.26	14472.52	506.26	34.13
2012	533.72	15160.91	572.46	37.46
2013	603.89	15772.61	643.34	63.30

3.3 Results and Analyze

Through the analysis of the growth rate of science and technology investment, industrial GDP and environmental investment, government got the way that how to set the growth of technical input in industry, emission standards and penalty when given an expected GDP growth rate. This set of values makes “factory” and “central” optimal at the same time. The data is as shown in Tables 3 and 4.

Table 2 Growth rate of R&D funding, industrial GDP, environmental protection investment

Year	Growth rate of R&D funding (%)	Growth rate of industrial GDP (%)	Growth rate of environmental protection investment(%)	R&D funding / industrial GDP (%)	Environmental protection investment / industrial GDP(%)
1990				0.77	0.66
1991	30.94	14.04	27.17	0.88	0.74
1992	14.99	19.52	16.81	0.85	0.72
1993	-4.03	20.27	-3.30	0.68	0.58
1994	11.27	10.64	-8.65	0.68	0.48
1995	6.18	9.38	-9.66	0.66	0.40
1996	16.01	8.98	82.99	0.70	0.66
1997	5.11	8.75	89.03	0.68	1.15
1998	10.93	4.17	-67.64	0.72	0.36
1999	25.28	6.91	584.33	0.85	2.30
2000	15.60	11.19	22.80	0.88	2.54
2001	24.29	8.10	8.29	1.01	2.54
2002	27.68	9.71	24.53	1.18	2.88
2003	27.14	14.47	17.64	1.31	2.96
2004	27.44	14.23	12.93	1.46	2.93
2005	28.69	16.34	22.83	1.62	3.09
2006	28.46	16.48	5.87	1.79	2.81
2007	23.65	15.51	25.97	1.91	3.06
2008	19.86	11.28	25.17	2.06	3.45
2009	20.62	4.55	1.49	2.37	3.35
2010	21.03	15.05	42.35	2.50	4.14
2011	41.62	11.26	-6.00	3.18	3.50
2012	15.96	4.76	3.77	3.52	3.78
2013	13.15	4.04	12.38	3.83	4.08

From Table 3, when $\phi = 0.1$, 1 unit of positive utility (generated by economic profit) corresponds to 10 units of disutility (generated by environmental pollution). This time, government has a serious balance bias in economic development. So under various GDP growth rate conditions, there is not so much difference among the optimal technical input growth, the penalties and the emissions standard. That is, it is invalid to increase investment in technological innovation and the penalties. When $\phi = 0.5$, 1 unit of positive utility corresponds to 2 units of disutility. This time, government has a slight balance bias in economic development. So under various GDP growth rate conditions, increasing technical input and the penalties is useful, but the total amount is not significant. When $\phi = 1$, 1 unit of positive utility corresponds to 1

Table 3 Optimization results of simulation (1)

ϕ	Growth rate of industrial GDP	Growth rate of technical input in environment	Wastewater punishment (million Yuan / million ton)	Waste gas punishment (million Yuan / Standard million cubic meters)
0.1	4.00%	17.00%	137.85	0.000582
	8.00%	17.00%	331.26	0.000602
	12.00%	17.00%	353.94	0.000602
	16.00%	17.00%	346.05	0.000602
	20.00%	17.00%	311.90	0.000602
	22.00%	17.00%	99.54	0.000602
0.5	3.09%	18.45%	8.96	0.005406
	7.13%	17.46%	7.92	0.001821
	11.02%	18.00%	7.92	0.001482
	15.63%	18.24%	8.48	0.003831
	19.15%	19.08%	8.00	0.001885
	21.96%	19.01%	6.74	0.001136
1	3.38%	18.42%	12.96	0.000928
	6.82%	18.46%	29.16	0.001879
	11.24%	20.09%	41.42	0.001006
	15.31%	20.70%	97.53	0.001226
	19.14%	20.42%	29.36	0.0010402
	21.99%	17.18%	8.67	0.000938
1.25	3.66%	23.06%	44.41	0.0008552
	6.81%	20.75%	6.95	0.000502
	11.84%	17.35%	20.97	0.001135
	15.51%	18.18%	39.44	0.001426
	19.58%	17.54%	1.12	0.00115
	21.94%	16.72%	3.79	0.000502
1.75	2.69%	19.74%	58.30	0.0005
	7.24%	23.26%	79.86	0.0005
	11.14%	24.01%	72.11	0.000516
	15.22%	20.67%	137.35	0.0047
	18.94%	19.78%	39.37	0.000562
	22.00%	17.11%	2.33	0.00167

Table 4 Optimization results of simulation (2)

ϕ	Solid Waste gas punishment (million Yuan / million ton)	Wastewater emissions (million ton)	Waste gas emissions (Standard million cubic meters)	Solid Waste emissions (million ton)
0.1	642.44	1306.61	6907250.00	364.38
	335.38	1060.37	6907250.00	137.21
	298.73	1061.82	6907250.00	109.38
	268.06	1090.56	6907250.00	99.65
	382.53	1060.24	6907250.00	157.24
	200.82	1000.06	6907250.00	3.69
0.5	531.41	6918.60	33509019.74	66.71
	875.85	13714.85	33604632.58	146.89
	910.08	14849.22	33548091.33	109.33
	873.72	15534.32	33804441.17	115.25
	900.98	13732.91	33592643.26	172.15
	11825.80	2229.30	33949809.11	5.82
1	42580.70	3549.68	67171470.79	24.50
	31925.90	5757.37	67001850.93	79.34
	46691.10	1839.50	67161444.40	38.18
	228568.00	1572.05	67208866.25	28.73
	42210.30	1826.53	67114428.53	19.18
	181104.00	4258.06	67518789.11	4.33
1.25	15371.30	11920.18	83914715.06	10.84
	23328.20	13383.10	83646837.16	83.20
	29588.10	12832.63	84262921.45	2.40
	32909.10	10845.14	84076807.64	2.17
	31896.50	13232.52	84153393.20	2.64
	1734.22	2950.67	84157165.83	24.68
1.75	77037.00	1508.12	116854287.90	2.33
	91195.90	3522.53	117108453.90	0.27
	47560.00	7407.31	116891721.70	0.70
	72897.50	6939.78	116985256.00	5.11
	117364.00	1244.73	117036283.10	4.40
	899.84	5938.51	107845487.60	19.13

unit of disutility. This time, government has a balance in economic and environment. When the GDP growth rate at the range of 3%~19%, gaining technical input and increasing penalty is has slight benefit for economy development and emissions decrease. When the expected GDP growth rate is 21.99%, the emissions increase. It takes some time to get a higher technology level would be a proper explanation. When $\phi = 1.25$ or 1.75, government has a balance bias in environment. The penalty for unit emission and the change of technical input changes greater, and the penalty for unit emission play a larger role. There is better control of emission by reducing technical input to some degree.

Tables 3 and 4 are the results obtained by Matlab. Optimized solutions of the two objective functions under different constraints are show in these two tables. The two tables are essentially identical. ϕ represents a penalty tendency, which measures government's emphasis on the environment in some sense. What can be seen in Table 4 is that different values of ϕ correspond to different combinations of penalties and the growth rate of technical input, thought in the condition of approximate GDP. The emission combinations (including wastewater, waste gas, and Solid Waste gas) corresponded by different technical input growth are different significantly. A scientific setting of penalties is valid to reach equilibrium between environmental protection and economic growth. The optimization results in Table 3 and Table 4 are represented visually in the following three-dimensional figures:

Figure 1 The relationships among growth of industrial GDP, technical input growth rate and emissions

From the figures above, the technical input growth rate is one of the factors that reduce emissions punishment, and the impact of the technology investment growth rate is more significant when industrial GDP growth rate is in a lower degree (Figure 1(a)). The solid waste emissions punishment is proportional to the growth rate of technical input inversely, and proportional to industrial GDP growth rate directly (Figure 1(c)). Decreasing technical input can control the wastewater emissions and waste gas emissions effectively at the same industrial GDP growth rate (Figure 1(d) and Figure 1(e)). Solid waste emissions reduce with the improvement of industrial GDP growth rate, but the impact of technical input growth rate is weak.

4 Conclusions and Improvement

Based on the analysis above, unit emission penalty mechanism plays a greater roll, when government pays more attention to environment than economy development. We all know that preferences of the government depends on the level of economic development, when the economy develops to a certain stage, the relative utility of the economy will reduce, government pays more attention to emission control. Therefore, the higher the level of economic development, the greater the relative disutility of emissions, and the greater the role played by unit emission penalty mechanism. This conclusion has a great impact on economic development and environment. And it is also a very good advice to the current social sustainable development.

Several problems can be found during the research. First, there are a lot of loopholes and shortcomings exist in China's environmental monitoring system. Regulatory authorities should increase the intensity of supervision and inspection frequency. Second, in China, concentration has been a main measuring index of pollution. It is unscientific, as concentration will be diluted with water and may back to normal after a period of time. To measure the total amount of emissions is a more scientific approach. In this way, factories will be more likely to make efforts in industry innovation. Government will enjoy the positive utility by industry development.

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