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Performance evaluation of multi rule constraint game

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Abstract. Industrial enterprises are the source of environmental pollution and the main object of government environmental regulation. The game strategy between government regulatory agencies and enterprises influences the effect of environmental regulation. Based on the static game model of the regulatory agency and the industrial enterprise, this paper analyzes the main factors that affect the effect of environmental regulation, and selects the panel data from 2003 to 2015to carry out VAR analysis and impulse response analysis. The results show that the number of government inspections and the government subsidies for corporate governance is the most important factor affecting the effect of environmental regulation.Based on this, the government should develop a targeted environmental regulation policy, select a reasonable regulatory tools to stimulate enterprises to take the initiative to carry out pollution control and discharge standards ,in order to achieve a win-win situation of economic development and environmental protection.

Key words. Environmental regulation, Game analysis, VAR, Model.

1. Introduction

At present, China's increasingly serious environmental problems have caught widespread attention of the public. Improving life quality of the residents, protecting environment and conducting environmental regulation have been important tasks for Chinese government. Based on the negative externalities of environmental pollution, since 1970s, government management has been a necessary choice in the western developed countries. Hettige.et.al(2000), by the quantitative analysis of industrial waste water discharge data, proved that strict environmental management can effectively reduce the emission of corporate waste water. In order to improve the performance of environmental regulation, Catherine L. Kling (2000) designed theory models related to governmental pollution charging mechanism through constructing the game model of governments and enterprises, created a new way to research environmental regulation. Tietenberg (2001) made a comparison of various

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environmental regulation tools. Ng(2004)put forward using the marginal pollution reducing cost, instead of the gains, as a special tool to solve the pollution charging issue. For the environmental regulation, our government issued Environmental Protection Law (Trial) in March, 1979, and issued the strictest Environmental Protection Law on January 1, 2015. In these thirty years, China's environmental regulation has been strengthened increasingly. But present environmental problems are still serious. Therefore, we must consider the efficiency and effectiveness of present environmental regulation. Xue Weixian and Liu Jing (2010), through the analysis of environmental regulation tools, effects and performance evaluation, thought that China's present environmental regulation efficiency was still low, even though it showed a rising tendency year by year. Why the efficiency is low? Ma Yuan, Yin Hua and Cui Wei (2015) tried to give explanations. They used statistical data to analyze the relations of regulating methods and environmental regulation effects through constructing gray correlation analysis model. By the evolutionary game analysis of central government and local government, Pan Feng, Xi Bao and Wang Lin (2014) proved that the performance of environmental regulation not only depends on the scientific management policies, but also depends on local governments' reasonable behaviors.

2. Game model constructing of environmental regulation

2.1. Basic descriptions of models

In recent years, China's government has given great concern and efforts on the environmental problems. So, environmental regulation has achieved certain effects. But, environmental problem is still serious. China's economic development method belongs to extensive type that takes the factors investing as the main part. With the development of industry, there is plenty of waste water and waste air. The emission of waste water and air is one of the main factors causing environmental pollution. Therefore, industrial pollution is still the main environmental regulation object. How to improve current industrial pollution on the greater extent and regulate the behavior of industrial enterprises become the emergent issues that the governmental regulation departments should solve. To improve environment fundamentally, solve environmental pollution problems, governmental regulation departments that pursue the maximizing social welfare must have a game with industrial enterprises pursuing maximizing personal benefits, make the enterprises increase technological investments or construct sewage discharging facilities to have regulated productions through regulating means, impel these enterprises to satisfy the requirements of environmental regulation. As a result, pollution decreases, effects of environmental regulation are improved, human and nature, society and economy realize sustainable development. Environmental regulation refers to environmental regulation departments, industrial enterprises, the public and other relevant interest objects. They all take part in the game. In order to maximize profits, different profit objects have their own different game strategies and requirements. The targets of governmental environmental regulation departments are to solve outstanding environmental problems, reduce pollution to a great extent and improve environmental quality. For achieving these goals, governmental environment regulating departments can use two types of game strategies. When the gains of environmental regulation are less than the regulating costs, governments don't conduct regulation. When the gains are more than the costs, governments can conduct environmental regulation. To maximize the expected benefits, these industrial enterprises will take the external costs caused by governmental environment regulating into consideration. According to the requirements of the governments, enterprises arrange the production, decrease pollution emission. If the benefits from regulated production are less than that in the past, enterprises will not obey the requirements related to pollution emission. Otherwise, enterprises will obey the requirements and have the regulated production. This article uses the game theory as the analysis tool, constructs game payoff matrix of governmental environment regulating departments and industrial enterprises, introduces the number of governmental supervision and checking, industrial production, products' prices, governmental subsidies and other variables, analyzes the factors that have influences on environmental regulating effects.

2.2. Model hypotheses and conformity descriptions

For the easy analysis, let's assume that there is a governmental environment regulating institution and one industrial enterprise having a static game. Facing governmental environment regulation, different enterprises adopt different means and measures to deal with. Combining the enterprises' development and requirements of regulating institutes, these polluted industrial enterprises have two choices: standard pollution discharge and substandard pollution discharge. Environmental regulating departments also have two choices: conducting the regulation and not conducting the regulation.

Hypothesis 1: The probability of conducting environmental regulation is p, the probability of not conducting environmental regulation is 1-p; The costs of conducting the regulation to enterprises are C_1 that mainly include labor investments, material costs, financial costs and others; The costs of not conducting the regulation to enterprises are C_2 that mainly include economic and social losses caused by the environmental pollution, the reduction of governmental performance, the expenses used to control the environmental pollution discharged by enterprises, governmental prestige loss and others.

Hypothesis 2: The productions of an enterprise are Q, its production costs are f (Q). When an enterprise conducts standard discharge, for conform to the requirements of the government, the enterprise has to invest external capitals to install devices that are used to solve industrial pollution. External capitals - a should be calculated into the total production costs. In order to encourage and support enterprises to carry out technological transformation and construct environmental protection facilities, the government provide certain subsidies - y. The probability of standard discharge is q, the prices of a product are p_1; the probability of substandard discharge is $1 - q$, the prices of a product are $p_2(P_1 > P_2)$.

Hypothesis 3: When enterprises invest capitals in environmental protection facilities, if governments conduct environmental regulation, governments will give subsidies according to the proportions. Therefore, y=f(a), and $f'(a) > 0$, it means that when the costs of environmental protection facilities - a increase, subsidies from governments - y increase.

Hypothesis 4: When enterprises don't carry out standard discharge, governmental environment regulating institutes impose a fine, its amounts are F. If governmental environment regulating costs increase, F increases. Governmental environmental regulating costs are calculated in accordance with the checking times - x, and governmental subsidies - y, F = F(x, y), and $\frac{\partial F(x,y)}{\partial x} > 0$, $\frac{\partial F(x,y)}{\partial y} > 0$. With the increasing of checking times and governmental subsidies, governments conduct stricter regulation, the costs are higher. Correspondingly, corporate fine will be higher.

3. Game analysis of governmental environment regulating institutes and industrial enterprises

3.1. Game models of government and industrial enterprises

Table 1. The game matrix of environmental regulation

		Industrial Enterprises	
		Standard Discharge	Substandard Discharge
Governmental Regulating Institutes	Regulating	-C_1, P_1Q-f(Q)-a+f(a)	F(x, y)-C_1, P_2Q-f(Q)-F(x, y)
	Not Regulating	0, P_1Q-f(Q)-a	-C_2, P_2Q-f(Q)

Mixed Strategy Nash Equilibrium Analysis: V_1 is the expected utility of governmental regulating institutes, and $V_2$is the industrial enterprises' expected utility.

$$\begin{aligned} V_1 &= q \cdot [p \cdot (-C_1) + (1-p) \cdot 0] + (1-q) \cdot [p \cdot (F(x,y) - C_1) + (1-p) \cdot (-C_2)] \\ &= p \cdot [(1-q) \cdot (F(x,y) + C_2) - C_1] + qC_2 - C_2 \\ V_2 &= q \cdot [p \cdot (P_1Q - f(Q) - a + f(a)) + (1-p) \cdot (P_1Q - f(Q) - a)] \\ &\quad + (1-q) \cdot [p \cdot (P_2Q - f(Q) - F(x,y)) + (1-p) \cdot (P_2Q - f(Q))] \\ &= q \cdot [P_1Q - f(Q) - a + p \cdot f(a)] + (1-q) \cdot [P_2Q - f(Q) - p \cdot F(x,y)] \end{aligned}$$

Calculate the derivatives of utility function V1 and V2, get the optimal first-order condition:

$$\frac{\partial V_1}{\partial p} = (1-q) \cdot (F(x,y) + C_2) - C_1 \, .$$

$$\frac{\partial V_2}{\partial q} = P_1Q - P_2Q + p \cdot F(x,y) - a + p \cdot f(a) \, .$$

It can be solved as the followings:

$$q^* = 1 - \frac{C_1}{C_2 + F(x, y)}.$$

$$p^* = \frac{(P_2 - P_1) \cdot Q + a}{f(a) + F(x, y)}.$$

Therefore, Mixed Strategy Nash Equilibrium is: $q^* = 1 - \frac{C_1}{C_2+F(x,y)}$, $p^* = \frac{(P_2-P_1)\cdot Q+a}{f(a)+F(x,y)}$. The probability of choosing the standard discharge for industrial enterprises is 1- $\frac{C_1}{C_2+F(x,y)}$, the probability of conducting environmental regulation for governments is $\frac{(P_2-P_1)\cdot Q+a}{f(a)+F(x,y)}$.

3.2. Conclusion of game analysis

Firstly, the probability of choosing the standard discharge for industrial enterprises is related to C1 (costs of conducting environment regulation for governmental environment regulating institutes, C2 (the costs of not conducting environment regulation) and F (x, y) (the fine because enterprises don't carry out standard discharge). From $\frac{\partial q^*}{\partial x} = \frac{C_1 \cdot \frac{\partial F(x,y)}{\partial x}}{[C_2+F(x,y)]^2} > 0$ and $\frac{\partial q^*}{\partial y} = \frac{C_1 \cdot \frac{\partial F(x,y)}{\partial y}}{[C_2+F(x,y)]^2} > 0$, we can get that under the certain condition, C_1 and C_2 increase with the increasing of governmental checking times and subsidies, the probability of choosing the standard discharge for enterprises also rises. As a result, industrial pollution emissions decrease, all have positive impacts on the effects of environment regulating.

Secondly, the probability of conducting the environment regulation for governmental environment regulating institutes is related to P_1, P_2 (products' prices), Q (quantity), a (costs used to purchase environmental protection facilities), f (a) (governmental subsidies), F (x, y) (governmental fines). From $\frac{\partial p^*}{\partial Q} = \frac{P_2-P_1}{f(a)+F(x,y)} <0$, we can get that when industrial production increases, the probability of choosing to conduct the environment regulation for governments will decrease. The increasing of industrial production makes the regulation dynamics decline, the probability of choosing substandard discharge become greater. As a result of it, the effects of environmental regulation decrease.

In summary, whether the effects of environmental regulation can achieve the expected goal not only depends on the regulation institutes' behavior, regulation dynamics and other governmental efforts, but also relies on industrial enterprises and other relevant factors. Only when we take all factors into consideration, we can get the operation rules of governmental environment regulation. On the base of it, we can evaluate the effects of environmental regulation accurately.

4. Effects of environmental regulation and empirical analysis of influencing factors

4.1. Index selecting

(1) Index selection of environmental regulation effects

Environmental regulation can decrease pollution emission of enterprises, treat environmental pollution, protect environment, achieve the goals that make the economy develop, meanwhile, environment is protected well. But the effects of environmental regulation are hard to get accurate quantization. Therefore, a lot of scholars choose environmental regulation dynamics, environmental pollution degree and other indexes to measure the effects of environmental regulation. For example, Yuan Yijun and Xie Ronghui (2014) used the integrated measurement system constructed by single index that refers to standard-reaching rate of waste water emission, SO_2 removal rate, the removal rate of smoke and (powder) dust and comprehensive utilization rate of solid wastes as the effects index of environmental regulation. Lin Jihong and Liu Ying (2013) mainly referred to Zhao Xikang's integrated evaluation system of industrial environment regulating that concludes 12 evaluating indexes. In it, there are 7 indexes related to pollution's emission dynamics, 3 indexes related to pollution solving rate, 2 indexes related to emission's standard-reaching rate. Peng Wenbin, Li Haokuang (2016) learned index selection methods of Yuan Yijun and Zhang Yan, adopted 4 important indexes that conclude environmental regulation intensity, environmental loss degree, resources' richness degree and environmental support ability. Based on the above analysis, my own research thoughts and data availability, this article selects three evaluating indexes - emission quantity of industrial waste water, emission amounts of industrial waste air, quantity of industrial solid wastes as the intensity index of industrial pollution emission to measure the effects of environmental regulation.

Calculate adjustment coefficient of each indicator, and give different weight (W_{ij}) to different years of waste water, waste gas and solid waste and other indicators:

$$W_{ij} = E_{ij}/\Sigma E_{ij}\,.$$

E_{ij} is the emission quantity of the pollution material $-j$ of the year i, ΣE_{ij} is total emission quantity of pollution materials in the year i. After calculating the weight of waste water, waster gas and solid wastes, choose the average value $\overline{W_{ij}}$ as the weight of j. Use standard deviation standardization to treat all single indicators. Each indicator through standardization treatment multiplies their average weight, then add together to get emission intensity of industrial pollution in each year that is regarded as an indicator to evaluate environmental regulation effects in that year.

(2) Indicator selection of environmental regulation influencing factors

This article selects three variables - governmental checking times, industrial production and governmental subsidies as the indicators related to the influence.

About the indicators of governmental regulation behaviors in the management, this article chooses two indicators - checking times and governmental subsidies to measure. About the indicators related to the governmental subsidies, this article uses pollution investment rate. The key issue is eliminating in-comparability of governmental subsidy intensity caused by different economic scales, improve the consistency of data. The calculation formula is that:

Investment rate of pollution treatment (Yuan/100 Yuan) = pollution treatment investment div variable total production value $\times 100$.

In addition to governmental regulation behaviors, other factors also have impacts on the effects of environmental regulation. In this article, the researcher uses the variable - total production values to measure industrial production. In order to eliminate the impact of prices, variable total production values are calculated with total production value in each year/ consumer price index (CPI) of this year. By above game theory analysis, we can know that the increasing of industrial production quantity can decrease the effects of environmental regulation. We can test whether the theory is correct by adding the variable - total production values in the model.

4.2. Data sources

All data used as indicators in this article are from 2003 - 2015. Data of three evaluation indicators related to pollution emission intensity - emission quantity of industrial waste water, emission amounts of waster gas, amounts of solid wastes and investments of industrial pollution treatment are from Annual Statistic Report on Environment in China; Data of industrial production values and CPI are from China Statistical Yearbook; the data of governmental checking times are from China Environmental Condition Bulletin. From the table 2, you can know the variables and their descriptions in the research.

Table 2. Definition of Variable

Name of Variable	Symbol of Variable	Descriptions of Variable	Expected Direction
Investment rate of industrial pollution treatment	LnEI	Representing governmental subsidies, namely the governmental environment regulating behavior	+
Variable total production values	LnQ	Representing industrial production	-
Checking times	LnEF	Representing governmental environment regulating behavior	+
Emission intensity of industrial pollution	LnPI	Measuring the effects of environmental regulation	-

Notes: "-" indicates that the variables have a negative impact on environmental regulation effects, "+" indicates that the variables have a positive impact on environmental regulation effects. To avoid heteroscedasticity, data of all variables have the logarithmic processing in this article.

4.3. Empirical analysis

(1) ADF unit root test

Because there is a spurious regression and a pseudo regression, impulse response analysis is also established on the base of steady. To make the VAR model avoid having this condition, the model must be subjected to a stability test of the data before regression. It is ADF unit root test. Researchers need to make stability test for investment rate of pollution treatment (LnEI), constant total production values (LnQ), checking and supervision times (LnEF), emission intensity of industrial pollution (LnPI).

Table 3. Unit root test results of original variables in the time series

Variable	Test Type	ADF Test	Critical values at different significant levels			p values	Conclusion
	(c, t, q)	(Statistics)	1%	5%	10%		
LnEI	(c, 0, 1)	-2.010769	-4.200056	-3.175352	-2.728985	0.2785	(unstable)
LnQ	(C, T, 0)	2.365212	-4.992279	-3.875302	-3.388331		(unstable)
LnEF	(C, T, 1)	-2.108826	-5.124875	-3.933364	-3.42003	0.4861	(unstable)
LnPI	(C, T, 0)	-1.137297	-4.992279	-3.875302	-3.38833	0.8758	(unstable)

Table 4. The first order differential variable unit root test result of time series

Variable	Test Type	ADF Test	Critical values at different significant levels			p values	Conclusion
	(c, t, q)		1%	5%	10%		
DLnEI	0, 0, 0 -	2.037556	-2.792154	-1.97773 8	-1.602074	0.0446	(steady)
DLnQ	0, 0, 0 -2.137657	-2.792154	-1.977738	-1.602074	0.0402	(steady)	
DLnEF	C, T, 0	-4.98906	-5.124875	-3.933364	-3.42003	0.0119	(steady)
DLnPI	0, 0, 0	-1.817498	-2.792154	-1.977738	-1.602074	0.0675	(steady)

Notes: D indicates first-order difference.

From Table 3 and Table 4, it can be found that the investment rate of pollution treatment (LnEI), the constant industrial output values (LnQ), the number of inspection and supervision (LnEF) and the industrial pollution emission intensity (LnPI) in the time series are non-stationary sequences. While the variables - DLnEI, DLnQ, DLnEF reject the hypothesis that there is unit root at the 5% of significance level. The variable DLnPI rejects the original hypothesis that there is the unit root at the 10% of significance level. So it can predict that the sequences - DLnEI, DLnQ, DLnEF, and DLnPI are stable.

(2) Granger Causal Relation Test

VAR model requires to take the variables having causal relations as dependent variables. Therefore, before having the analysis, it is necessary to analyze whether there is correlation relation among the variables - DLnEI, DLnQ, DLnEF and DLnPI. It needs Granger Causal Relation to ascertain. According to the AIC and SC minimum information guidelines, the lag phase is ascertained as 1 in this article.

From the Table 5, it can be seen that DLnEI is the Granger cause of DLnPI at the 5% of significance level. Otherwise, it is not right. At the 10% of significance level, DLnQ and DLnEF are the Granger causes of DLnPI, conversely, it is wrong. That is to say, the investment efficiency of industrial pollution control, constant industrial production values, inspection, and supervision times will lead to the changes of industrial pollution emissions in the intensity.

Table 5. Granger Causal Relation Test Results

Original Hypothesis	F Statistics	P values	Whether to accept the original hypothesis
LnPI is not the Granger cause of LnEF	0.23343	0.6405	Accept
LnEF is not the Granger cause of LnPI	4.82524	0.0556	Reject
LnPI is not the Granger cause of LnEI	0.58607	0.463	Accept
LnEI is not the Granger cause of LnPI	5.33401	0.0478	Reject
LnPI is not the Granger cause of LnQ	0.80166	0.3939	Accept
LnQ is not the Granger cause of LnPI	3.46817	0.0955	Reject

(3) VAR model valuation

According to the stability and causality test results of each variable, the following VAR model is established: $Z_t = A(L)Z_{t-1} + \varepsilon$, in this formula, $Z_t =$ [DLnEI, DLnQ, DLnEF, and DLnPI], and it is the column vector of the 4-dimensional endogenous variable; A (L) is the 4 × 4-dimensional parameter matrix of the hysteresis operator L; ε_t is the 4-dimensional perturbation vector. In the Z_t, and D represents the first-order difference of the variable. By considering LR, AIC, SC, FPE, HQ information criteria, the lag order is determined to be 1.

In order to make the model meaningful, the stability of the model must be tested. As the Figure 1, the reciprocal of the roots of the characteristic polynomial of the model is all within the unit circle, so the estimated VAR model is stable.

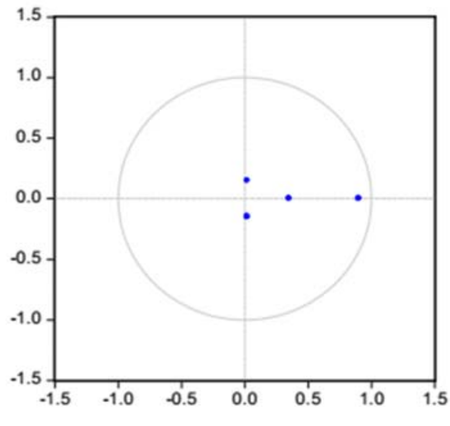

Fig. 1. AR Root Test

(4) Impulse response analysis

The impulse response function analysis method can be used to describe the response of an endogenous variable to the shock caused by the error term. The followings are the response functions of industrial pollution emission intensity (LnPI) caused by the shock of investment rate of pollution treatment (LnEI), constant industrial output values (LnQ), and checking and supervision times (LnEF).

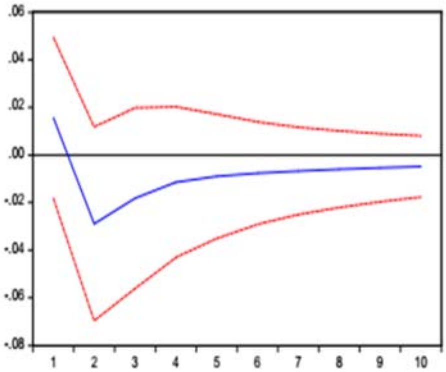

Fig. 2. Response function of DLnPI caused by the shock of DLnEF

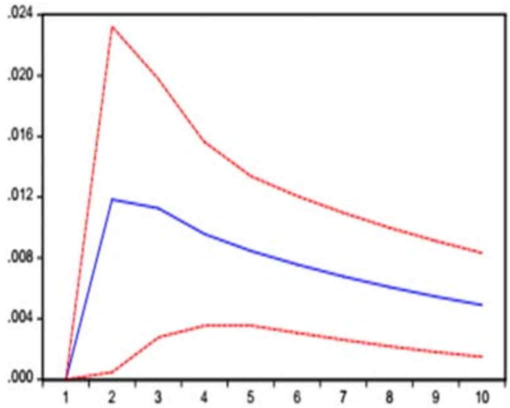

Fig. 3. Response function of DLnPI caused by the shock of DLnQ

1) In the impulse response function of DLnPI caused by the shock of DLnEF, the long-term response of checking and supervision times to the emission intensity of industrial pollution is negative. About a standard deviation of positive shock to checking and supervision times, the industrial pollution emission intensity in the first phase has a positive reaction, then it turns to be negative. In the second period, it reaches the maximum negative reaction, then the negative reaction gradually weakens. It starts to be stable from the 5th period. That is to say, the number of inspection and supervision will reduce the emission intensity of industrial pollution.

2) In the impulse response function of DLnPI caused by the shock of DLnQ, the long-term response of constant industrial production values to industrial pollution emission intensity is positive. About a standard deviation of positive shock to con-

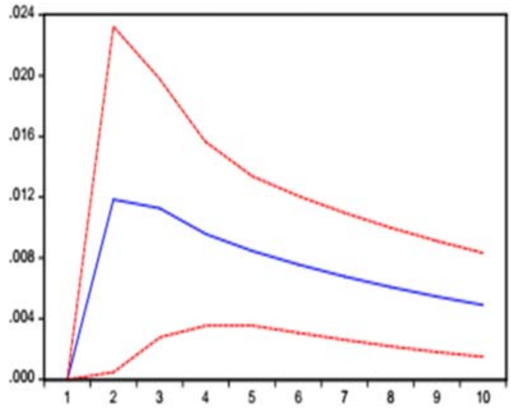

Fig. 4. Response function of DLnPI caused by the shock of DLnEI

stant industrial production values, the industrial pollution emission intensity reaches the maximum positive reaction in the second period, which indicates that the increasing of constant industrial production values enhances the emission intensity of industrial pollution. Since then, this positive reaction has the tendency of gradual weakening. This shows that in the long run, the increasing of constant industrial production values increases the emission intensity of industrial pollution.

3) In the impulse response function of DLnPI caused by the shock of DLnEI, the long-term response of the investment rate of industrial pollution control to industrial pollution emission intensity is negative. About a standard deviation of positive shock to the investment rate of industrial pollution treatment, the emission intensity of industrial pollution reaches the largest negative reaction in the first period, and then gradually weakens with time, it tends to be stable. This shows that the increase of investment rate in industrial pollution control will reduce the emission intensity of industrial pollution.

(5) Variance Decomposition

The variance decomposition provides another method to describe the dynamic changes of the system. The method decomposes the predictive variance of the system into the contribution of each variable in the system to evaluate the influence of each endogenous variable on the system. Based on the established VAR model, researchers make the variance decomposition of the prediction error of industrial pollution emission intensity, which is used to analyze the situation that the emission intensity of industrial pollution is explained by each variable.

From the Table 6, it can be seen that the emission intensity of industrial pollution is subjected to its self shock. In addition to that, checking and supervision times reaches 14.75% in the second period, that is, 14.75% of the change of industrial pollution emission intensity can be explained by the change of checking and supervision times. Then, the contribution rate increases, and in the 10th period, the contribution rate reaches 18.46%; the contribution of investment rate of industrial pollution treatment to industrial pollution emission intensity increases gradually, and at the third period, it has a rapid development. At the 10th period, it reaches 18.46%.

It can be understood that 18.46% of the forecast variance of industrial pollution emission intensity can be explained by the change of investment rate of industrial pollution control. The effect of constant industrial production values on industrial pollution emission intensity is relatively small, reaching 2.14% in the second period. Then it gradually increases, and it is 7.1% in the 10th period. That is to say, 7.1% of the predicted variance of industrial pollution intensity can be explained by changes of constant industrial production values.

Table 6. Variance decomposition results

Forecast period	Standard error				
1	0.203828	0.000000	0.000000	100.0000	0.000000
2	0.225158	14.75810	12.34898	70.74372	2.149200
3	0.234460	17.13313	15.50064	63.70423	3.661997
4	0.235379	17.76698	16.60446	60.97526	4.653301
5	0.235551	18.07172	17.21289	59.34413	5.371264
6	0.235706	18.26028	17.62257	58.20401	5.913141
7	0.235853	18.39146	17.92122	57.35867	6.328654
8	0.235981	18.48895	18.14783	56.71254	6.650674
9	0.236087	18.56387	18.32342	56.21042	6.902294
10	0.236174	18.62239	18.46104	55.81642	7.100158

4.4. Conclusion

In this paper, through empirical analysis, it is found that there is a stable relationship between industrial pollution intensity and industrial output, governmental subsidies, checking and supervision times in the long run. The increasing of industrial production increased the emission intensity of industrial pollution, and has a negative effect on the effect of environmental regulation, which is consistent with the results of the game analysis. The number of inspection and governmental subsidies has a positive impact on the effect of environmental regulation. Through variance decomposition, we can get that the contribution rate of governmental checking and supervision times, subsidies is bigger than the contribution rate of industrial production. Governmental environment regulation agencies can increase the times of checking and supervision and governmental subsidies to decrease industrial pollution intensity, and improve the effect of environmental regulation.

5. Suggestions on improving environmental regulation

5.1. The government increases financial investment in environmental regulation, improve the use efficiency of regulatory resources

Through the above empirical analysis, we can get that with the development of the economy, the increasing of industrial production, in order to achieve the goal of environmental regulation, to prevent environmental problems from intensifying, the government must increase the intensity of regulation, conduct strict supervision and inspection to enterprises and deal with environmental cases. Correspondingly, governmental regulation costs increase. Therefore, in order to make these measures and actions be carried out, we must increase the financial investment in the regulation, increase supervision and inspection times to enterprises to reduce pollution emissions, while the government also should increase investment in the corporate pollution treatment to help enterprises install various environmental protection devices, to promote enterprises' technology improvement, environmental protection, even industrial upgrading. All are to transfer the production model - "treatment after pollution" to environment-friendly production. When the government imposes restrictions on the enterprises, the government also should encourage enterprises to choose standard discharge positively. But how to distribute the government's subsidies is a key issue that depends on whether these subsidies can be used in environmental treatment effectively. Relevant government should take it into consideration seriously.

5.2. Improve the evaluation system of environmental regulation and supervision mechanism

The effect of environmental regulation depends on the intensity of law enforcement. Whether environmental regulation policy can be implemented exactly depends on administrative means. So strengthening the intensity of environmental regulation can constrain enterprises' pollution emission behavior, promote green production. The relevant government can carry out various regulating policies, strengthen law enforcement intensity from many aspects to constrain enterprises' pollution emission, decrease pollution emission. From the empirical analysis, it can be found that more governmental supervision and inspection times, indicating governmental law enforcement intensity continues to increase, make the effect of environmental regulation be higher. However, the reality is that many governmental regulation behaviors are ineffective, although the government has paid a lot of manpower, financial and material resources, but they failed to achieve the desired environmental regulatory objectives. The problem lies in the efficiency of inspection and supervision, that is, the efficiency of regulation, so how can we really evaluate the effect of environmental regulation, whether the regulation is conducted, which regulatory means are more beneficial to the environmental governance, which depend on the perfect environmental regulation evaluation system; which method should be used by the government to monitor enterprises effectively depends on perfect and fair supervision mechanism. Only by improving the ability to supervise, encouraging enterprises to carry out industrial upgrading, protect the environment, recognize environmental responsibility can achieve the goals of reducing industrial pollution and improving the effect of environmental regulation.

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