Social Security and Administration Management (2022)
Clausius Scientific Press, Canada

DOI: 10.23977/socsam.2022.030110
ISSN 2523-5796 Vol. 3 Num. 1

Chinese Environmental Regulatory Body Reform: A Study Based on the Dynamic Game Theory and the Reputation Model

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Keywords: Environmental Regulation, Reputation Model, Dynamic Game Theory

Abstract: This paper established a dynamic game model and a reputation model to analyze how to make environmental regulation efficiency considering that regulators behaviors have great impacts on the efficiency of environmental protection in China. We found that the supervisory strength of environmental regulators' authority, cost of regulators' duties, expected future income and degree of punishment for poor performance in work all have important effects on environmental regulators' decision-making, in turn impacting the effectiveness of regulation. Based on this, we suggest that China needs to reform regulation mechanisms to meet the requirements of participation constraint and incentive compatibility constraint to reduce the cost of the environmental law enforcement. We also believe that data centers that capable of unearthing regulatory violations should be constructed and the MEE's function should be transformed into an independent technocratic organization to promote diversification of regulatory bodies as soon as possible.

1. Introduction

Over the past four decades, China has made enviable economic achievements but paid a heavy environmental price at the same time. The 2020 Environmental Performance Index released by Yale University, Columbia University and the World Economic Forum ranked China at 120 with a score of 37.3. The conviction of lucid waters and lush mountains are invaluable assets pointed out by President Xi in 2019 reflects China's introspection on the old way to development the economy and the desire for a better environment. But actions have been taken since almost 10 years ago.

In 2012, the Chinese central government raised the importance of the ecological civilization to the same level as economic, political, cultural and social development for the first time. Later, China continued to put forward the vision of innovative, coordinated, green, open and inclusive development to enhance the importance of environmental protection. Therefore, the environmental regulation has become an important part of its macro-management. Since January 1, 2015, the newly revised Environmental Protection Law has been implemented, which claims to be the most

stringent environmental protection law in history in China. Data from the official website of Ministry of Ecology and Environment of China shows that, in 2017, 233,000 illegal cases have been investigated and punished nationwide, an increase of 180% compared with 2014, and a fine of 11.58 billion yuan, an increase of 265% compared with 2014. It also shows that there were more than 8,600 administrative detention cases and more than 2,700 suspected environmental pollution crimes in 2017, an increase of 112.9% and 35% respectively over 2016. Meanwhile, political accountability has been carried out for local governments' inaction and disorderly actions. We can say that great achievements have been made in the environmental protection since the legislation of Environmental Protection Law.

However, problems still exist. Facing the State's high standard requirements for environmental protection, many local governments adopt one-size-fits-all approach such as "all shut down" or "we will see", which damages the economy and make the environmental pollution worse. According to statistics issued in 2018, the intensity of environmental regulation in China is generally too low in most areas in China, and only when the local government faced with serious environmental problems or specific environmental needs, the intensity of government regulation rises rapidly. So, we can say that the attitude of environmental regulatory bodies to environmental problems and their work initiatives have great impacts on the efficiency of environmental regulation in China.

Scholars around the world have shown great interest in environmental regulation [1-5]. Some scholars focused on the impact of environmental regulation on economic growth [6-11], or the relationship between environmental regulation and competitiveness[4,12-17], and other scholars noticed the impact of the relationship between regulators and regulated on regulatory effectiveness[18-21]. A few attentions were paid to the impact of regulators' behaviours on regulatory efficiency. For example, Shimshack & Ward found that by enhancing the regulators' reputation, the deterrent effect on other factories in a state is almost as strong as that of sanctioned factories[22], Wang & Shen's study shows the relationship between regulation and productivity vary from industry to industry, suggesting flexible regulatory behaviours for individual industries [23].

Environmental regulation is a special government management activity with strong professionalism, the regulators are required to have professional knowledge and to adjust the regulatory methods properly according to the regulated individuals, the regulators need be able to take effective measures in case of industry emergencies[24]. They also need be able to determine the facts of the case, interpret the law, and make decisions appropriately[25]. Regulators collude with the regulated could cause systematic corruption and harm the environmental regulation effectiveness the most[26-27]. Therefore, it is necessary to pay more attention to the behaviours of environmental regulatory bodies to explore the mechanism of environmental regulation efficiency.

2. Methodology, Modeling and Analysis

A dynamic game model and a reputation model will be established to seek the best decision-making mechanism of the regulators in different situations, and to examine the impact of regulatory reputation on the environmental protection. Income, characters, and technical capabilities of regulators, the level of control exerted by supervisory departments over the environmental protection department, as well as the accomplishments and moral cultivation of regulators are considered as the most important factors that affect regulators' regulation behaviours.

2.1. The Impact of Regulators Behavior on Environmental Regulation

We assumed that environmental regulation is carried out in two stages, period 0 and period 1. In period 0, the prior distribution of regulators that will implement strict supervision is q_0, while the

prior distribution of not strict supervision is $1-q_0$. The probability that strict supervisors successfully punish regulatory violations is represented by the function $P(R/PR)=\delta$, while the probability they will not levy a punishment is $P(NP/IR)=1-\delta$. The probability that lax regulators successfully punish regulatory violations is $P(P/CR)=\varepsilon$, while the probability that they will fail to levy a punishment is $P(NP/CR)=1-\varepsilon$.

Normally, regulators of powerful departments have quasi-judicial and discretionary powers. once environmental violations are discovered, they are able to quickly investigate the matter and take appropriate action. But the regulators from weak departments they will maybe turn big issues into small ones, and ignore the small ones, so $\delta>\varepsilon$.

Although in the 0 period of regulatory enforcement, the regulated being investigated does not know what kind of enforcement it can expect, but in the 1 period, the organization under investigation will revise its judgment and actions according to the manner in which regulators have dealt with past environment violations.

Let us suppose that in the 0 period the regulated under investigation notice that regulators are unable to effectively handle the environment violations, then they will know the change between the posterior probability of regulatory strength and the 0 period prior probability of regulatory strength:

$$\begin{aligned}\Delta q &= q_1^{NP}-q_0=P_1(PR\,|\,NR)-q_0=\frac{P(PR)P(NR\,|\,PR)}{P(NR)}-q_0\\ &=\frac{P(PR)P(NR\,|\,PR)}{P(PR)P(NR\,|\,PR)+P(NPR)P(NR\,|\,NPR)}-q_0\end{aligned}\tag{1}$$

That is

$$\begin{aligned}\Delta q &= \frac{q_0(1-\delta)}{q_0(1-\delta)+(1-q_0)\varepsilon}-q_0\\ &= q_0\left[\frac{q_0(1-q_0)(\varepsilon-\delta)}{q_0(1-\delta)+(1-q_0)(1-\varepsilon)}\right]\end{aligned}\tag{2}$$

$$\because \delta>\varepsilon,\ \ q_0\in[0,1],\ \ \delta\in[0,1],\ \ \varepsilon\in[0,1]$$

$$\therefore \Delta q\le 0$$

$$\therefore q_1^{NP}\le q_0$$

So, if the regulated see that in 1 period the regulators do not take action against violators, the reputation of regulatory organizations will suffer severe damage, and the ability of regulators to protect environment effectively will drop precipitously. If in 1 period the regulated see that regulators are able to effectively regulate and handle violations, then they will adjust their judgement and behaviors on the basis of the change between the posterior probability of regulatory strength and the 0-period prior probability of regulatory strength:

$$\Delta q = q_1^P - q_0 = P_1(PR|R) - q_0 = \frac{P(PR)P(R|PR)}{P(R)} - q_0$$
$$= \frac{P(PR)P(R|PR)}{P(PR)P(R|PR) + P(NPR)P(R|NPR)} - q_0 \tag{3}$$

That is

$$\Delta q = \frac{q_0\delta}{q_0\delta + (1-q_0)\varepsilon} - q_0$$
$$= q_0[\frac{q_0(1-q_0)(\delta-\varepsilon)}{q_0\delta + (1-q_0)(1-\varepsilon)}] \tag{4}$$
$$\because \delta > \varepsilon,\ q_0 \in [0,1],\ \delta \in [0,1],\ \varepsilon \in [0,1]$$
$$\therefore q_1^P \geq q_0$$

If the regulated observes that the regulators punish the environmental violators, its reputation will rise in the 1 period, and the regulated will be more likely to believe that they are capable of regulating effectively. So, we can see that the reputation of regulators is built on their regulatory capabilities and their desire of regulation strictness. The next part will discuss motivation mechanism that affect regulation desire.

2.2. Motivation Mechanism for Environmental Regulators to Do Their Duties

2.2.1. The Payoff Matrix and the Game Model

Suppose the model is split into two periods, t and $t+1$, with w_t and w_{t+1} representing the regulator salaries for each period, respectively. u_t is the utility of leisure that is gained because of regulators sloth administration, while c (A, T) is a function representing the cost of positive conduct, which is influenced by ability A and technological conditions T. The average of $\frac{\partial c(A,T)}{\partial A}$ and $\frac{\partial c(A,T)}{\partial T}$ is less than 0, where β represents the discount factor. $a_{t+1}(u_t)$ is a function representing the penalties that occur after dereliction of duty is realized.

Regulators exist in one of three states as shown in figure 1. State 1 shows consequence of positive conduct, which is represented by the equation $U = w_t + \beta w_{t+1} - c(A,T)$. State 2 is negative conduct but escaped notice and punishment, the effects of which is represented by the equation $U = w_t + u_t + \beta w_{t+1}$. The third is a state in which a state of previous dereliction has been discovered and punished, which is represented by the equation $U = w_t + u_t + \beta[Pw_{t+1} - a_{t+1}(u_t)]$.

Due to their misconduct being realized, their wages for t+1 are capped by the factor P, where $0 \leq P \leq 1$. r represents a given organizaition's ability to manage regulatory misconduct, or the mechanisms in place to supervise the regulation department. θ is a variable representing the ability of regulators to make policy decisions via positive conduct, which manifests itself in a sense of professional accomplishment and moral cultivation felt by regulators. $r \in [0,1]$, $\theta \in [0,1]$. The utility value of the average social wage in an industry is U_e.

		Supervisory Organization	
		Supervise(r)	Don't Supervise ($1-r$)
Regulatory Personnel	Positive Conduct (θ)	$w_t+\beta w_{t+1}-c(A,T)$	$w_t+\beta w_{t+1}-c(A,T)$
	Negative Conduct ($1-\theta$)	$w_t+u_t+\beta\left[Pw_{t-1}-a_{t-1}(u_t)\right]$	$w_t+u_t+\beta w_{t+1}$

Figure 1: The payoff matrix of the game model

As a result, the function predicting the effectiveness of regulators' regulation behaviors across time looks like this:

$$E_tU=(1-\theta)\{r[w_t+u_t+\beta(Pw_{t+1}-a_{t+1}(u_t))]+(1-r)(w_t+u_t+\beta w_{t+1})\}+\theta[w_t+\beta w_{t+1}-c(A,T)] \quad (5)$$

The expected utility of positive conduct by regulators can be modeled with the following function:

$$E_\theta U=w_t+\beta w_{t+1}-c(A,T) \quad (6)$$

The expected utility of regulatory misconduct can be modeled with the following function

$$E_{1-\theta}U=r\{w_t+u_t+\beta[Pw_{t+1}-a_{t+1}(u_t)]\}+(1-r)(w_t+u_t+\beta w_{t+1}) \quad (7)$$

2.2.2. Regulator Participation Constraints and Incentive Compatibility Constraints

In conditions of asymmetric information, supervisory organizations are unable to investigate directly whether or not regulators are behaving in a positive manner, and the regulators themselves will act according to the principle of whatever is most effective for them. It is therefore necessary to design mechanisms that will allow regulators to achieve maximum effectiveness in order for regulation to be successful.

(IR) Participation Constraint: When regulators participate in regulation, their effectiveness cannot fall below a society's average level of effectiveness. That is,

$$\text{(IR)}\quad \Delta U=E_tU-U_e>0$$

$$\text{Or}\quad \Delta U=(1-\theta)\{r[w_t+u_t+\beta(Pw_{t+1}-a_{t+1}(u_t))]+(1-r)(w_t+u_t+\beta w_{t+1})\}+\theta[w_t+\beta w_{t+1}-c(A,T)]-U_e>0 \quad (8)$$

(IC) Incentive Compatibility Constraint: supervisor is unable to observe the real actions and behavior of every regulator (θ). So, if they want to make regulators behave in a positive manner, they must find a way to ensure that $E_\theta U$ exceed $E_{1-\theta}U$.

That is,

$$\text{(IC)}\quad E_\theta U>E_{1-\theta}U$$

Or $w_t + \beta w_{t+1} - c(A,T) > r\{w_t + u_t + \beta[Pw_{t+1} - a_{t+1}(u_t)]\} + (1-r)(w_t + u_t + \beta w_{t+1})$ (9)

Function (9) shows the difference between regulator's predicted effectiveness across time and the effectiveness of an average social wage in the industry is as follows:

$$\begin{aligned}\Delta U &= E_t U - U_e \\ &= (1-\theta)\{r[w_t + u_t + \beta(Pw_{t+1} - a_{t+1}(u_t))] + (1-r)(w_t + u_t + \beta w_{t+1})\} + \theta[w_t + \beta w_{t+1} - c(A,T)] - U_e\end{aligned} \tag{10}$$

As far as regulators are concerned, the function of the effectiveness of the time they spend in the regulatory department is equivalent to the function of the effectiveness of the average social wage in the industry. That is to say,

When $\Delta U = 0$, we can find the critical value of their negative neglect via the function:

$$1-\theta = \frac{U_e - [w_t + \beta w_{t+1} - c(A,T)]}{r\{w_t + u_t + \beta[Pw_{t+1} - a_{t+1}(u_t)]\} + (1-r)(w_t + u_t + \beta w_{t+1}) - [w_t + \beta w_{t+1} - c(A,T)]} \tag{11}$$

We argue that if the utility function of the time regulators spend in their regulatory department is the same as the utility function of the average social wage, then the regulators' decision variable will be θ^*.

Because $\Delta U = E_t U - U_e > 0$, If we derive the participation constraint, we get:

$$\frac{\partial \Delta U}{\partial \theta} = -\{r[w_t + u_t + \beta(Pw_{t+1} - a_{t+1}(u_t))] + (1-r)(w_t + u_t + \beta w_{t+1})\} + [w_t + \beta w_{t+1} - c(A,T)] \tag{12}$$

Because $w_t + \beta w_{t+1} - c(A,T) > r[w_t + u_t + \beta(Pw_{t+1} - a_{t+1}(u_t))] + (1-r)(w_t + u_t + \beta w_{t+1})$, So $\frac{\partial \Delta U}{\partial \theta} > 0$.

When $\theta = \theta^*$, then $\Delta U = 0$, So $\theta > \theta^*$

As long as the regulatory mechanism fulfills both the participatory constraint (IR) and the incentive compatibility constraint (IC), then the condition of regulators' positive conduct should be better than $1-\theta$ that represents their critical condition. Therefore, designing a rational contract or mechanism that leads to the fulfillment of the participatory constraint (IR) and the incentive compatibility constraint (IC) should be the primary task of the supervisory organizations.

If the participatory constraint (IR) and the incentive compatibility constraint (IC) are met, then the regulator's ideal action can be solved for by the following problem:

$$\begin{aligned} MAXE_t U &= (1-\theta)\{r[w_t + u_t + \beta(Pw_{t+1} - a_{t+1}(u_t))] + \\ &(1-r)(w_t + u_t + \beta w_{t+1})\} + \theta[w_t + \beta w_{t+1} - c(A,T)] \\ \text{s.t (IR)} \quad &(1-\theta)\{r[w_t + u_t + \beta(Pw_{t+1} - a_{t+1}(u_t))] + (1-r)(w_t + u_t + \beta w_{t+1})\} \\ &+ \theta[w_t + \beta w_{t+1} - c(A,T)] - U_e > 0 \end{aligned} \tag{13}$$

(IC) $w_t + \beta w_{t+1} - c(A,T) > r[w_t + u_t + \beta(Pw_{t+1} - a_{t+1}(u_t))] + (1-r)(w_t + u_t + \beta w_{t+1})$

First order partial derivatives:

$$\frac{\partial E_t U}{\partial \theta} = r\beta w_{t+1} - u_t - c(A,T) + r\beta a_{t+1}(u_t) - r\beta p w_{t+1} = 0$$

So,

$$r\beta w_{t+1} - u_t - c(A,T) - r\beta[a_{t+1}(u_t) - p w_{t+1}] = 0 \tag{14}$$

The first part of the equality is the regulator's expected future salary, the second part is the effect from the negative neglect, and the third is the costs to be paid for positive conduct. This cost is constrained by the regulator's ability and technical skills. The fourth part represents the potential penalties of negative neglect. Therefore, regulators will decide whether or not they will act in a positive manner, and to what degree they should act in a positive manner based on the marginal utility of the decision variable of positive conduct θ. There are definite uncertainties in the equation $\frac{\partial E_t U}{\partial \theta} = r\beta w_{t+1} - u_t - c(A,T) + r\beta a_{t+1}(u_t) - r\beta p w_{t+1}$.

$$\frac{\partial E_t U}{\partial \theta} = r\beta w_{t+1} - u_t - c(A,T) + r\beta a_{t+1}(u_t) - r\beta p w_{t+1}$$

We can see:

$$\text{if} \quad r\beta w_{t+1} - u_t - c(A,T) - r\beta[a_{t+1}(u_t) - p w_{t+1}] < 0 \quad \text{then} \quad \frac{\partial E_t U}{\partial \theta} < 0 \tag{15}$$

$$r\beta w_{t+1} - u_t - c(A,T) - r\beta[a_{t+1}(u_t) - p w_{t+1}] > 0 \quad \text{then} \quad \frac{\partial E_t U}{\partial \theta} > 0 \tag{16}$$

A critical value $u_t^*(\beta)$ will affect the critical value. The larger the value, the more the supervisor values the future, and the smaller the value, the more willing to enjoy the present. However, as it reflects the life attitude of the supervisor, it has nothing to do with the system construction. We pay more attention to discuss how to build a system environment in which people dare not to be greedy, cannot be greedy and do not want to be greedy.

When this value u_t^* is not exceeded or matched, $\frac{\partial E_t U}{\partial \theta} < 0$, then the efficiency of regulators $E_t U$ is the decreasing function of its positive decision making θ. This causes $\theta^* \to 0$, which means that regulators will spend their time neglecting their duties. But when these combined factors exceed u_t^*, $\frac{\partial E_t U}{\partial \theta} > 0$, then the efficiency of regulators $E_t U$ is the increasing function of its positive decision making θ. This means that $\theta^* \to 1$, and that regulators will behave in a positive manner, completely fulfilling their regulatory duties. $\theta^* \to 1$ is the result we want to see, causing $r\beta w_{t+1} - u_t - c(A,T) - r\beta[a_{t+1}(u_t) - r w_{t+1}] > 0$ to be transformed into:

$$r\beta w_{t+1} - c(A,T) > u_t + r\beta p w_{t+1} - q\beta a_{t+1}(u_t) \tag{17}$$

The left-hand side represents regulators' future salaries, the right-hand side represents the differences between the gains and penalties of taking bribes, or the opportunity cost of taking bribes.

In certain circumstances the inequality $\beta w_{t+1}, c(A,T), u_t, r, \beta a_{t+1}(u_t)$ contains a critical value r^*, which results in the formation of $r^*\beta w_{t+1} - c(A,T) = u_t + r^*\beta p w_{t+1} - r^*\beta a_{t+1}(u_t)$. When $r > r^*$, the greater r^* is, the more able we are to ensure the formation of this inequality, which means that environmental protection supervisory organizations are more capable of ensuring their supervisory functions are effectively carried out, that is $\theta^* \to 1$.

In the same way, for the costs of positive conduct $c(A,T)$, in certain circumstances the inequality $r, \beta w_{t+1}, u_t, r, \beta a_{t+1}(u_t)$ also contains a critical value $c^*(A,T)$ that causes the formation of $r\beta w_{t+1} - c^*(A,T) = u_t + r\beta p w_{t+1} - r\beta a_{t+1}(u_t)$. When $c\ (A,T) < c^*(A,T)$, the smaller $c^*(A,T)$ is, the more able we are to ensure the formation of this inequality. Whether the environment is regulated effectively is decided in large part by the regulatory philosophy, experience, professional capabilities. Proper regulatory econcept, rich experience and high supervise capacity cause $\theta^* \to 1$.

3. Conclusion and Discussion

Using dynamic game model and reputation model, and starting from participatory constraint and incentive compatibility constraint, we found the optimal decisions making mechanism influenced by supervision capabilities, costs of positive conduct, and the power of future salary increases and penalties. We also found that a rational mechanism should be invented to ensure regulatory organizations fulfilling regulatory participation constraint and incentive compatibility constraint their primary missions. we believe whether the goal is to ensure that lucid waters and lush mountains to be true or to penalize those who violate regulations, it is vital to construct an active and highly effective environmental regulation apparatus.

In China, although the Ministry of Ecology and Environment (MEE) is the main regulatory agency for environmental protection, several other governmental agencies, such as the National Development and Reform Commission, the Ministry of Finance, the Ministry of Industry and Information Technology, and the Ministry of Natural Resources, are partly responsible for environmental protection at the same time. The interests of cross-department corporations are rarely fully considered and the complexity, overlapping and dispersion of environmental regulations pose many obstacles to the improvement of environment regulatory efficiency. It is also clear from China's byzantine regulatory system that local governments do not always have the right incentives to enforce environmental rules, and their practices are often more command-and-control than problem driven.

It is obvious that in the process of reducing corporate emissions, companies' profits, capital, and market share could all reduced. Therefore, enterprises complying with environmental protection supervision should be compensated to a certain extend by central and local government, which may improve the enthusiasm of emission reduction around the country. China should increase investment in research and development of environmental protection technologies to reduce emission reduction costs.

According to our analysis, we think there are 4 steps worth to take to improve the regulation efficiency and reduce the costs of misconduct. First, income incentive mechanisms in environmental regulatory organizations need to be reformed to meet the average social wage, in order to attract technical elites with frontline experience, environmental risk recognition, and early intervention capabilities to implement environmental regulations around China. Second, regulators should be granted certain judicial authority and discretion to increase their independence from other official bodies, social groups, or individuals as they carry out their duties to ensure that regulators are able to protect the value of the laws and regulations pertaining to environmental regulation.

Third, investment in science and technology should be increased to make full use of big data and the internet to construct data centers capable of unearthing regulatory violations. China should also build a whistleblower system and a supervision prize fund, in order to increase information sources and decrease regulatory costs. Fourth, reform the present system of the regulators by decreasing the Ministry of Ecology and Environment of China's administrative scrutiny function and turning it into an independent technocratic organization. China should also consider giving some of its environmental inspection authority to certain non-governmental environmental protection organizations, the industry associations and other self-regulatory institutions.

Acknowledgement

The authors would like to thank for the support from the research project of Humanities and Social Sciences in Colleges and Universities of Anhui Province (Grant No. SK2020A0018)

References

[1] Richard R.L. (1992) Rehabilitating Interstate Competition: Rethinking the Race-to-the-Bottom Rationale for Federal Environmental Regulation. NYUL Rev, 6, 1210.
[2] Berman E. and Bui L.T. (2001) Environmental Regulation and Productivity: Evidence from Oil Refineries. Review of Economics and Statistics, 3, 498-510.
[3] Krutilla K. (1991) Environmental Regulation in an Open Economy. Journal of Environmental Economics and Management, 2, 127-142.
[4] Jaffe A.B., Peterson S.R., Portney P.R. and Stavins R.N. (1995) Environmental Regulation and the Competitiveness of US Manufacturing: What Does the Evidence Tell Us? Journal of Economic Literature, 1, 132-163.
[5] Zhang H., Zhu Z. and Fan Y. (2018) The Impact of Environmental Regulation on the Coordinated Development of Environment and Economy in China. Natural Hazards, 2, 473-489.
[6] Jorgenson D.W. and Wilcoxen P.J. (1990) Environmental Regulation and US Economic Growth. The Rand Journal of Economics, 2, 314-340.
[7] Lucas R.E., Wheeler D. and Hettige H. (1992) Economic development, environmental regulation, and the international migration of toxic industrial pollution:1960-88. Policy Research Working Paper Series 1062, The World Bank.
[8] Suri V. and Chapman D. (1998) Economic Growth, Trade and Energy: Implications for the Environmental Kuznets Curve. Ecological economics, 2, 195-208.
[9] Albrizio S., Kozluk T. and Zipperer V. (2017) Environmental Policies and Productivity Growth: Evidence across Industries and Firms. Journal of Environmental Economics and Management, 81, 209-226.
[10] Yijun Y. and Liu L. (2013) Environmental Regulation and Economic Growth: A Research Based on Different Kinds of Economic Regulation. Economic Review, 1, 27-33.
[11] Adetutu M., Glass A.J., Kenjegalieva K. and Sickles R.C. (2015) The Effects Of Efficiency and TFP Growth on Pollution in Europe: A Multistage Spatial Analysis. Journal of Productivity Analysis, 3, 307-326.
[12] Rubashkina Y., Galeotti M. and Verdolini E. (2015) Environmental Regulation and Competitiveness: Empirical Evidence on the Porter Hypothesis from European Manufacturing Sectors. Energy Policy, 83, 288-300.
[13] Ambec S., Cohen M.A., Elgie S. and Lanoie P. (2013) The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness? Review of environmental economics and policy, 1, 2-22.
[14] Stewart R.B. (1992) Environmental Regulation and International Competitiveness. YALE Law Journal, 102, 2039 -2106.
[15] Iraldo F., Testa F., Melis M. and Frey M. (2011) A Literature Review on the Links between Environmental Regulation and Competitiveness. Environmental Policy and Governance, 3, 210-222.
[16] Ford J.A, Steen J. and Verreynne M.L. (2014) How Environmental Regulations Affect Innovation in the Australian Oil and Gas Industry: Going beyond the Porter Hypothesis. Journal of Cleaner Production, 84, 204-213.
[17] Konur D. and Schaefer B. (2016) Economic and Environmental Comparison of Grouping Strategies in Coordinated Multi-Item Inventory Systems. Journal of the Operational Research Society, 3, 421-436.
[18] Amacher G.S.and Malik A.S. (1996) Bargaining in Environmental Regulation and the Ideal Regulator. Journal of Environmental Economics and Management, 2, 233-253.
[19] Stamenković U., Andrejić G., Mihailović N. and Šinžar S. J. (2017) Hyperaccumulation of Ni by Alyssum Murale Waldst. & Kit. from Ultramafics in Bosnia and Herzegovina. Applied Ecology and Environmental Research, 3,

359-372.
[20] Fredriksson P.G, Neumayer E. and Ujhelyi G. (2007) Kyoto Protocol Cooperation: Does Government Corruption Facilitate Environmental Lobbying? Public Choice, 1, 231-251.
[21] Graafland J. (2019) Economic Freedom and Corporate Environmental Responsibility: The Role of Small Government and Freedom from Government Regulation. Journal of Cleaner Production, 218, 250-258.
[22] Shimshack J.P. and Ward M.B. (2005) Regulator Reputation, Enforcement, and Environmental Compliance. Journal of Environmental Economics and Management, 3, 519-540.
[23] Wang Y. and Shen N. (2016) Environmental Regulation and Environmental Productivity: The Case of China. Renewable and Sustainable Energy Reviews, 62, 758-766.
[24] Landis J.M. (1939) The Administrative Process. Yale University Press.
[25] Warp G.A. (1941) The Law and Administration of Municipal Tort Liability. Va. L. Rev., 28, 360.
[26] Myerson R.B. (1993) Effectiveness of Electoral Systems for Reducing Government Corruption: A Game-theoretic Analysis. Games and Economic Behavior, 1, 118-132.
[27] Rose A. S. and Palifka B.J. (2016) Corruption and Government: Causes, Consequences, and Reform. Cambridge University Press.