Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
March-April 2022 Page No. 1253-1259
Article History: Received: 08 February 2022, Revised: 10 March 2022, Accepted: 02 April 2022, Publication: 30 April 2022

The Performance of China's Environmental Policies for the Livestock and Poultry Farming Industry

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Abstract:

Developing countries around the world are still facing serious agricultural pollution problems. This means that agricultural environmental supervision in developing countries not only requires regulations to force companies to reduce pollution, but also requires subsidies to help them achieve technological upgrading and development. This article uses the DID method to conduct an empirical study on the annual data of 775 listed Chinese agricultural companies. The results prove that the environmental policy of China's livestock and poultry farming industry not only reduces environmental violations of agricultural enterprises through its environmental regulations, but also promotes environmental protection investment and expenditure of enterprises through its subsidy components, and improves the level of enterprise green technology. This approach achieves a win-win outcome.

Keywords: *China's environmental policies for the livestock and poultry farming industry, Economic performance, environmental performance, listed Chinese agricultural firms.*

I. AIMS AND BACKGROUND

Agricultural pollution has replaced pollution from settlements and industries to become the main factor in eutrophication of both inland and coastal waters as well as groundwater pollution by nitrate and salt [1-3]. For developing countries, pollution sources related to agriculture, including the abuse or excessive use of agrochemicals and poorly managed wastewater in livestock production, are selectively ignored to a certain extent[4]. The "Regulations on Pollution Prevention and Control of Pollution from Large-scale Livestock and Poultry Farming" promulgated by China came into effect on January 1, 2014. This is the country's first regulatory document specializing in the prevention and control of pollution from livestock and poultry farming.

This article takes the implementation of the above mentioned "Regulations" as a quasi-natural experiment to explore the impact of industry-level environmental regulatory policies on corporate behaviour. We test our hypothesis based on 775 firm-year observations of 97 A-share agricultural companies on China's Shenzhen Stock Exchange and Shanghai Stock Exchange from 2010 to 2017. In addition, we perform robustness tests in which we replace the dependent variable, control for the influence

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of other events, and change the regression model. The results remain robust. The main research contributions of this article are as follows: It enriches research on agricultural environmental regulations. The solution to pollution requires not only rigid pressure imposed by government-led environmental regulations but also subsidies to make up for the pollution control costs of agricultural enterprises, help them increase their environmental protection expenditures. In addition, our research verifies Porter's hypothesis in the agricultural field, enriching the application scenarios of this theory.

The wastewater treatment and wastewater reuse can maintain nutrients such as nitrogen, phosphorus, potassium and organisms [5,6]; keep soils fertile and productive and decrease emissions of pollutants into the environment[7,8]. Faeces of livestock and poultry bring ammonia emissions and leach nitrate through the soil[9], which leads to environmental problems of eutrophication and soil acidification of forests and aquatic ecosystems[10]. To control agricultural pollution, the EU mandatory nitrate regulations in 1991 took unified pollution limit to control pollution, but it also created a cost problem[11]. Chen et al. (2017) capture the impact of both innovation subsidies and quantity-based subsidies on agricultural pollution[4]. Liang et al. (2019) evaluate the environmental impact of the winter wheat/summer maize rotation system under government subsidies and propose that production and welfare-oriented agricultural subsidies can bring environmental benefits8. Porter and Linde (1995) put forward the hypothesis that pollution is usually a waste of resources and that reducing pollution may lead to improved resource utilization efficiency[12]. Appropriately designed environmental regulations can induce enterprises to innovate. These innovations will produce innovation compensation effects, and the future benefits will partially or completely offset the cost of complying with these environmental regulations[13]. To solve the pollution problem of livestock and poultry farming industry, China's Legislative Affairs Office of the State Council, the Ministry of Environmental Protection, and the Ministry of Agriculture jointly issued the above mentioned "Regulations" to encourage the comprehensive utilization livestock and poultry manure.

II. EXPERIMENTAL

2.1 Sample

Our initial sample is based on 775 firm-year observations of 97 A-share agricultural industry companies listed on China’s Shenzhen Stock Exchange and Shanghai Stock Exchange during 2009-2017. We take animal husbandry companies in agriculture as the sample companies and other agricultural companies as the control group. We choose listed companies in the agricultural farming industry as our sample. The financial information and regional information of listed companies come from the China Securities Market and Accounting Research (CSMAR) database and the Wind database. Green patent data come from the Chinese patent database. We also get data on environmental law enforcement at the city level from the "China Environment Yearbook".

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2.2 Measurement of Variables

2.2.1 Dependent variable:

Economic performance (ROE): This article adopts financial indicators, uses ROE in the benchmark regression, and uses net profit in the robustness test to avoid spurious results caused by the use of a single indicator.

Environmental performance (EP): We refer to an independent third-party evaluation's environmental responsibility score as a measure of corporate environmental performance[14]. In the robustness test, corporate environmental investment data was used to measure corporate environmental performance.

2.2.2 Independent variable:

Change*treat: Treat is a dummy variable. If a company is in the livestock industry (industry code A03) or agricultural and sideline product processing industry (industry code C13), where agricultural and sideline product processing industry refers to the processing of livestock and poultry, meat and by-products, this variable takes 1. Other agriculture (industry code A01), forestry (industry code A02), fishery (industry code A04), and food manufacturing (industry code C14) enterprises take the value of 0. The pre-policy period is 2010-2013, with a change value of 0, and 2014-2017 is the post-policy period, with a change value of 1.

2.2.3 Control variables:

On the basis of previous research, we also control for some corporate characteristics to capture the impact of other possible environmental disclosure performance determinants. In addition, fixed effects for provinces, industries, and years are further included in the benchmark regression model to control for potential influences.

Firm size (Size): natural logarithm of the company's total assets

Firm age (Age): It subtracts the listing time from the time when the listed company issues a report each year during the sample period.

Financial leverage (Lev): the asset-liability ratio

Independence from board of directors (Independence): the proportion of independent di-rectors on the board of directors.

Institutional ownership (ownership): the proportion of institutional investors to measure this variable.

Research and development intensity (R&D): We divide R&D expenditure by total assets to measure R&D intensity.

Per capita economic development level (per-gdp): Per capita GDP is introduced to control for the impact of regional development on corporate pollution.

Industrial structure (indstru): the proportion of industrial added value to GDP

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III. RESULTS AND DISCUSSION

3.1 Empirical Result

3.1.1 Descriptive statistic

Table 1 reports descriptive statistics of all variables involved in our benchmark re-gression. We also report Pearson correlation coefficients between variables. There are no high correlations between variables.

TABLE I Descriptive Statistics

	1	2	3	4	5	6	7	8	9	10	11	12	13
ROE	1												
Greenscore	0.179***	1											
change	-0.0520	-0.0340	1										
treat	0.110***	0.145***	-0.00100	1									
Firm age	-0.0420	-0.0170	0.421***	0.0100	1								
Firm size	0.094***	0.190***	0.179***	0.0470	0.169***	1							
LEV	0.096***	0.137***	0.132***	0.086**	0.175***	0.796***	1						
R&D	0.185***	0.0550	0.128***	0.091**	0.198***	0.482***	0.394***	1					
Nature	0.120***	0.0220	0.00100	-0.060*	-0.0100	-0.064*	0.081**	0.0350	1				
Institutional	0.163***	0.0420	0.132***	0.0570	0.173***	0.313***	0.343***	0.216***	0.079**	1			
Independence	0.0270	0.084**	0.087**	0.0280	0.123***	0.086**	0.100***	0.0580	-0.0210	-0.0460	1		
Indus-share	0.139***	0.0390	-0.208***	0.096***	-0.164***	-0.064*	-0.099***	0.0250	0.077**	-0.060*	-0.0150	1	
Per-GDP	0.0440	-0.0320	0.138***	0.065*	0.075**	-0.068*	-0.061*	0.062*	0.0300	-0.076**	0.0320	0.0320	1
Mean	0.077	2.231	0.499	0.443	16.302	21.754	0.398	11.534	1.723	4.898	0.385	45.857	95644.250
S.D.	0.103	4.899	0.500	0.497	4.756	0.968	0.211	3.771	0.685	5.379	0.064	13.066	74393.070

3.1.2 Benchmark regression

The first column of Table 2 includes control variables and the second column adds the independent variables, including firm and year fixed effects to control for the impact on environmental disclosure of unobservable factors that do not change with time. The coefficient of change * treat in column 2 is 0.038, a positive number and significant at the 5% level, indicating that the economic performance of the treatment group is generally 3.8% higher than that of the control group. The third column is again a control variable model without independent variables. The coefficient of change * treat in column 4 is 2.260, which is positive and significant at the 1% level, indicating that the post-period environmental performance of the treatment group is generally 226% higher than that of the control group. This shows that compared with the firms not impacted by the policy, the breeding environmental protection policy significantly promotes the economic and environmental performance of livestock and processing firms.

TABLE II. Benchmark Regression

	(1)	(2)	(3)	(4)
	Roe	**roe**	**greenscore**	**greenscore**
Firm age	-0.001	-0.000	-0.077	-0.092
	(0.001)	(0.001)	(0.072)	(0.073)
Firm size	-0.004	-0.002	1.129***	1.317***
	(0.008)	(0.008)	(0.419)	(0.437)
LEV	-0.000	-0.000	-0.000	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
R&D	0.000**	0.000**	-0.000**	-0.000**

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	(0.000)	(0.000)	(0.000)	(0.000)
Firm nature	0.001	0.001	1.839***	1.489**
	(0.011)	(0.011)	(0.590)	(0.718)
Institutional	0.002**	0.002**	-0.017	0.003
	(0.001)	(0.001)	(0.040)	(0.044)
Independence	0.059	0.054	4.063	5.296
	(0.085)	(0.083)	(4.280)	(4.909)
Indus-share	0.001	0.001	0.019	0.041
	(0.002)	(0.002)	(0.073)	(0.084)
Per-GDP	-0.001	-0.001	-0.001	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
changetreat		0.038**		2.260**
		(0.019)		(0.904)
Year FE	Y	Y	Y	Y
Indus FE	Y	Y	Y	Y
City FE	Y	Y	Y	Y
N	775	775	775	775
R^2	0.295	0.303	0.309	0.322

Notes: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

3.1.3 Robustness checks

Propensity score matching DID (PSM-DID) approach: To reduce the endogeneity between the experimental group and the control group, this paper uses the PSM-DID method to rematch the samples. It takes total assets, liabilities, age, R&D and the nature of the enterprise as the covariates and includes industry, annual and province fixed effects. It uses logit regression to estimate the propensity score, that is, the probability that an enterprise is affected by the breeding environmental protection policy. It can be found that before PSM matching, there are significant differences in other covariates except for financial leverage between the experimental group and the control group. After PSM matching, the t test is not significant, which indicates that there are no significant systematic differences between the experimental group and the control group after PSM matching. Based on the new matching samples, the results are significant and consistent with the benchmark regression results.

Alternative measures: We further consider the sensitivity of variable measurement and retest the estimated results of this study with alternative measures: the logarithm of net profit and environmental protection expenditure. As the net profit of some enterprises is negative, we do not include them in our sample. The results are still significant.

3.1.4 Heterogeneity analysis

Drawing on Huang & Chen (2015), we use the number of environmental administrative punishment cases in a province to measure the stringency of enforcement[15]. To measure the degree of oversight of formal system elements in the region where the company is located, we divide it into two groups based on below-average and above-average values. The result is that when environmental law enforcement is stronger, policies are more effective.

3.1.5 Further mechanism tests

(1) Environmental violations

To respond to and comply with the requirements of government regulations and policies, the

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companies may increase their environmental protection expenditure. The increase in environmental efforts means that companies are increasingly compliant, which is accompanied by a reduction in corporate environmental violations. Through the IPE (The Institute of Public and Environmental Affairs) website, we inquired about the number of times that listed companies were fined by the Environmental Protection Agency in corresponding years as a measure of compliance. Its estimation result is significant. ($\beta = -5.311, \rho < 0.05$).

(2) Government environmental protection subsidies

The government seeks to affect the economic performance of enterprises through environmental protection subsidies. As environmental problems have negative externalities. The environmental efforts of enterprises are non-profit gains with public welfare attributes. Second, the failure of externalities in the allocation of innovation resources makes corporate environmental investment riskier and more uncertain. So the government can provide subsidies through industrial and fiscal policies to be part of the company's total profit. Since government environmental protection subsidies do not need to be disclosed in annual reports, we use the government subsidy amount in the company's annual report as an alternative measure. The data come from the CSMAR database. Its estimation result is significant ($\beta = 0.864, \rho < 0.05$).

(3) Green Innovation

This article posits that environmental protection policies for the livestock and poultry industry have effects on corporate environmental performance through technological upgrading and green innovation. Firstly, environmental innovation can solve environmental problems in a long-term and fundamental way and help companies reduce or eliminate the harmful burden on the natural environment in the production process. Secondly, environmental regulations enable enterprises to continuously accumulate environmental technologies. Thirdly, when waste is discharged into the environment, it usually represents an incomplete and inefficient use of resources (Porter, M. E. et al. 1995). Its estimation result is significant. ($\beta = 0.837, \rho < 0.05$).

IV. CONCLUSION

This article examines the policy “Regulations on Prevention and Control of Pollution from Large-scale Livestock and Poultry Farming” promulgated by the Chinese government in 2014 as an environmental regulation method and uses the DID method to examine the impact of environmental regulations on the economic and environmental results of agricultural enterprises. It finds that the environmental regulation has effectively improved corporate environmental performance. In addition, this environmental regulation policy also has a subsidy effect, which improves green technology upgrades, thereby improving their economic performance. In terms of theoretical contributions, the paper verifies the validity of the Porter hypothesis in the agricultural field. Our research conclusions theoretically enrich this hypothesis [10].

ACKNOWLEDGEMENTS

This research was funded by “Double First-Class" Applied Disciplines in Hunan Provincial Colleges and Universities, grant number [2018]469 and Innovation Platform Project of Hunan Provincial Department of Education, grant number 19K052.

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