Analysis of Environmental Regulation Policy for Chinese Paper Enterprises

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In the past decade, the Chinese paper industry, which is highly polluting and energy intensive, has shown overall increases in production, sales, income, and profit, although the growth rate has declined. Overall, China's paper industry exhibits small-scale and scattered distribution, characterized by continuous overcapacity and outdated technical knowledge. This has inevitably resulted in a variety of serious environmental problems during its development. Owing to the environmental problems resulting from the development of the paper industry, various environmental regulatory policies and measures have been adopted in China, mainly command-and-control, market-based, and voluntary policies and measures. This study identifies and analyzes particular issues inherent to China's environmental regulatory policies and measures regarding the paper industry and proposed policy suggestions for improving the environmental regulation of China's paper industry.

Keywords: Environmental regulation policy; Chinese paper enterprises; Analysis

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INTRODUCTION

The paper industry in China, which includes the manufacturing and production of pulp, paper, and paper products, is a highly polluting industrial sector and is one of the main sources of pollution in the country (Zheng and Lin 2017). In 2015, wastewater emissions from China's paper industry amounted to 2.367 billion tons and represented 13% of the total industrial wastewater emissions. The chemical oxygen demand (COD) in wastewater amounted to 335,000 tons and represented 13.1% of the total industrial COD emissions in China (CPA 2016). Furthermore, the paper industry is an energy-intensive industry that contributes substantially to CO_2 emissions. The pulp and paper industry accounted for 1.5% of industrial energy consumption in China in 2017, which was approximately 1.7% of the energy consumed by manufacturing industries in China in 2017(DES 2018).

This article reviews the development and environmental management of the Chinese paper industry by analyzing relevant environmental management policies in this sector. By analyzing production growth, profitability, industrial wastewater emissions, investment in environmental facilities, and command-and-control, market-based, and voluntary environmental policies regulating paper enterprises in China, this article focuses on the effectiveness of environmental regulation policies affecting this industry.

The Development Status of Paper Enterprises

Production growth of paper enterprises

Since the reform and opening up, China's paper industry has moved away from decentralization and extensive production and toward intensive production. With the introduction of technical equipment and independent technological innovation, China has become the most important growing market in the global paper industry. In 2018, China had the highest production and consumption of paper and paperboard worldwide, accounting for approximately one-fourth of the global total (CPA 2019).

The National Bureau of Statistics of China (NBS 2017) clearly defined forestry enterprises with operating income greater than or equal to 200 million yuan as large enterprises, those with operating income greater than or equal to 5 million yuan and less than 200 million yuan as medium-sized enterprises, those with operating income greater than or equal to 500,000 yuan and less than 5 million yuan as small enterprises, and those with operating income less than 500,000 yuan as micro enterprises. In terms of competition patterns, small and medium-sized enterprises dominate the Chinese paper industry, which is characterized by small-scale and scattered distribution. Therefore, Chinese paper companies face urgent problems such as low industry concentration, strong competition, overcapacity, and the weaker pricing power of most enterprises due to more intense homogenization of products. According to statistics from the China Paper Association, there were approximately 2,791 paper and paperboard enterprises above scale in China in 2015, 517 of which (only 18.5%) were large and medium-sized paper enterprises (CPA 2015).

As shown in Fig. 1, China's paper and paperboard output and consumption increased overall from 2009 to 2019, although the growth rate decreased (as shown in Table 1), especially compared to the previous year. The annual growth was between 7% and 8% from 2009 to 2011 and fell below 3.6% from 2012 to 2016; negative growth was observed in 2013 and 2018.

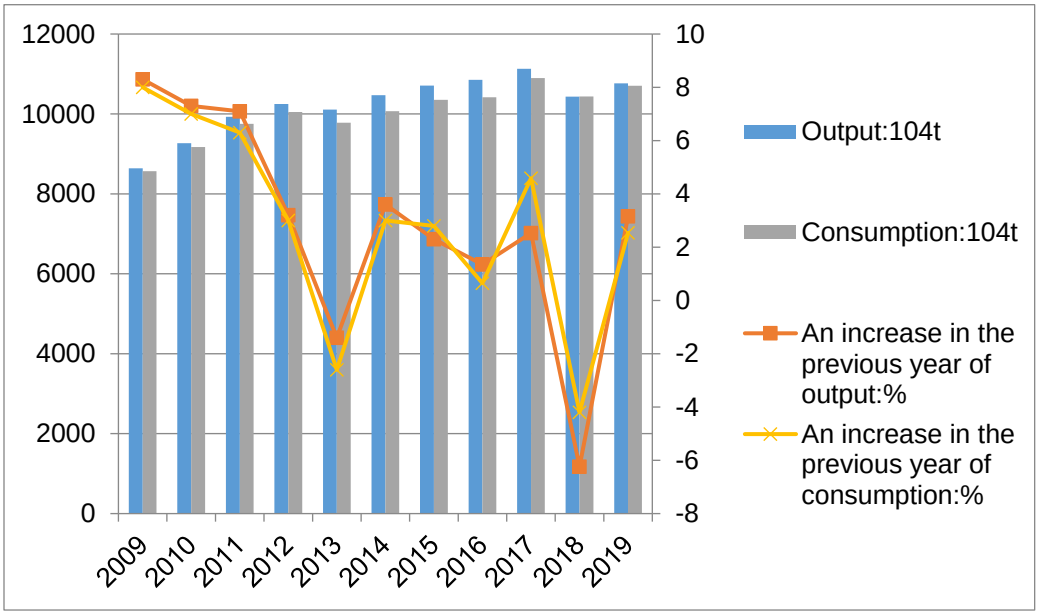

Fig. 1. National output and consumption of paper and paperboard from 2009 to 2019 (Unit: t)

Table 1. Statistics on Production and Consumption of Paper and Paperboard in China (Unit: 10^4 t)

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Output	8640	9270	9930	10250	10110	10470	10710	10855	11130	10435	10765
An increase in the previous year	8.3	7.3	7.1	3.2	-1.4	3.6	2.3	1.35	2.53	-6.24	3.16
Consumption	8569	9173	9752	10048	9782	10071	10352	10419	10897	10439	10704
An increase in the previous year	8.0	7.0	6.3	3.0	-2.6	3.0	2.8	0.65	4.59	-4.2	2.54

Source: Annual Report of China's Paper Industry (2009-2019**)**

According to the China Paper Association, the national output of paper and paperboard in 2013 was 1.4% below that in 2012. Specifically, the output of tissue paper increased by 1.92%, whereas that of most other types of paper decreased (CPA 2013). According to a report by the Japan Paper Association (2013), paper and paperboard production and consumption showed negative growth in 2013 in many major countries, largely because the persistent downturn in the global economy from late 2012 had a direct negative impact on the production and sales of paper and paperboard. However, in 2018, China's domestic supply-side reform, more intense environmental regulations, and reduced downstream demand caused China's paper and paperboard production and consumption to decline (CPA 2018).

Income and profitability of paper manufacturing companies

Table 2 shows that the main business income and gross profit increased rapidly overall, although the growth rates of both measures decreased.

However, the main business income and total profit in 2008 decreased significantly, by 38.69% and 38.88%, respectively, compared to those in 2007. This may be explained by the fact that the global financial crisis resulted in a sharp decrease in demand. In 2009, the main business income and total profit rebounded significantly. By 2010, the main business income reached 1,020.182 billion yuan, and the total profit reached 72.708 billion yuan, which were 27.49% and 44.06% higher, respectively, than those of the previous year. Thus, these two indicators fluctuated considerably during 2008 to 2010.

As shown in Table 2, the growth rate of the main business income and total profit decreased significantly after 2011, and the total profit exhibited negative growth in 2013 and 2014, indicating that the Chinese paper industry was leaving a period of rapid development (2005 to 2007) and entering a period of higher fluctuation (2008 to 2010), which was followed by a period of markedly slow development (2011 to 2016). The decline in the rate of development is explained as follows. First, the sharp decrease in the demand for paper products in response to the 2008 global financial crisis resulted in a sharp decline in exports by the Chinese paper industry.

Second, China's paper industry faces various problems, including an unreasonable product structure dominated by low-end traditional products and insufficient high-end

products, a lack of independent innovation, and intense homogenization of product development. Third, the paper industry continues to deal with relative overcapacity, which results in a surplus of low-end traditional products and insufficient R&D for high-end products.

Table 2. Income and Profits of the Paper and Paper Products Industry in China (2005 to 2016) (Unit: 10^8 yuan)

Year	Total asset	Main business income	Growth rate for main business income (%)	Total profit	Growth rate for total profit (%)	Industrial profit margin, with respect to costs incurred (%)
2005	4904.06	3806.39	-	182.94	-	5.13
2006	5325.50	4944.48	29.90	262.56	43.52	5.67
2007	6115.13	6151.49	24.41	381.23	45.20	6.71
2008	5062.31	3771.45	-38.69	233.00	-38.88	6.54
2009	8084.38	8001.90	112.17	504.71	116.61	6.76
2010	9655.29	10201.82	27.49	727.08	44.06	7.64
2011	10933.74	11807.01	15.73	760.41	4.58	6.78
2012	11862.73	12501.49	5.88	774.21	1.81	6.49
2013	12940.17	13471.58	7.76	749.61	-3.18	5.93
2014	13413.75	13535.18	0.47	726.99	-3.02	5.61
2015	14024.04	13942.34	3.01	792.82	9.06	6.59
2016	14117.32	14622.82	4.88	866.87	9.34	6.87

Source: China Statistical Yearbook (2006-2017)

Status Quo of Environmental Pollution and Environmental Management in Paper Manufacturing Companies

Table 3 shows that industrial wastewater emissions by the paper industry tended to increase from 2004 to 2007, whereas they tended to decrease from 2008 to 2014. This indicates the effectiveness of wastewater treatment measures in the paper industry in China during 2008 to 2014 (Fig. 2).

The decreasing trend from 2008 may be explained by the issuance of the Emissions Standards for Waste Water Pollutants in Pulp and Paper Industry (GB3544-2008) ("the 2008 Standard" hereafter) in China on June 25, 2008(MEE 2008). The standard proposed that existing pulping companies be allowed 80 t of water emissions for each ton of pulp produced, whereas the standard for existing papermaking companies is 20 t. All companies that do not meet the requirements of the standard must stop production and make changes within a limited time. This encourages enterprises to implement emission reduction measures.

The implementation of the 2008 Standard effectively reduced the amount of effluent produced by the paper industry. Moreover, it contributed to the upgrading of the industrial structure, the modification of the structure of raw materials and technology in the paper industry, and the exploration of the potential for greatly reducing the emissions of paper enterprises.

Table 3. Statistics for Wastewater Emissions of the Paper Industry in China (2004 to 2014) (Unit: 10^8 t)

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Wastewater Emissions: 10^8t	31.87	36.74	37.44	42.50	40.77	39.26	39.37	38.23	34.27	28.55	27.6
Growth rate (%)	-	15.29	1.90	13.51	-4.07	-3.70	0.28	-2.90	-10.36	-16.69	-3.3

Source: China Environment Yearbook (2005-2015)

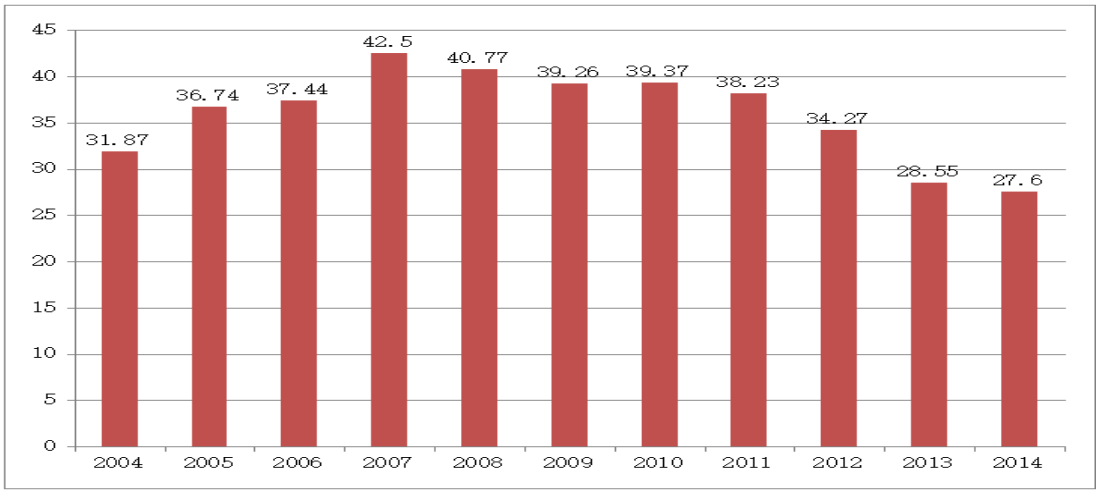

Fig. 2. Wastewater emissions of the paper industry from 2004 to 2014 (Unit: 108t)

Table 4 and Fig. 3 show that the annual operating costs (here operating costs include investment costs) of wastewater treatment facilities in the national paper industry increased from 2.77 billion yuan in 2005 to 6.49 billion yuan in 2010. Figure 3 indicates that the annual operating costs tended to decrease from 2010, exhibiting a total decrease of 12.33%. This finding suggests that from 2005 to 2010, increasing environmental regulation of the paper industry significantly increased the annual operating costs of wastewater treatment facilities. A decrease in environmental regulation resulted in a decrease in the annual operating costs in 2010 to 2014, which is consistent overall an analysis of industrial wastewater discharge. This finding, in addition to the analysis of industrial wastewater discharge, suggests that as industrial wastewater discharge by the paper industry increases, the annual operating costs of wastewater treatment facilities in the industry tend to increase. Conversely, as wastewater discharge by the paper industry decreases, the annual operating costs ultimately tend to decrease, although a lag was observed, suggesting that both indicators shifted in the same direction.

Table 4. Annual Operating Costs of Wastewater Treatment Facilities in China's Paper Industry (2005 to 2014) (Unit: 10^8 yuan)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Annual operating cost	27.7	31.6	43.4	46.2	51.0	64.9	61.0	60.4	57.9	56.9
Growth rate (%)	-	14.08	37.34	6.45	10.39	27.25	-6.00	-0.98	-4.14	-1.73

Source: Annual Report of China's Paper Industry (2006-2015)

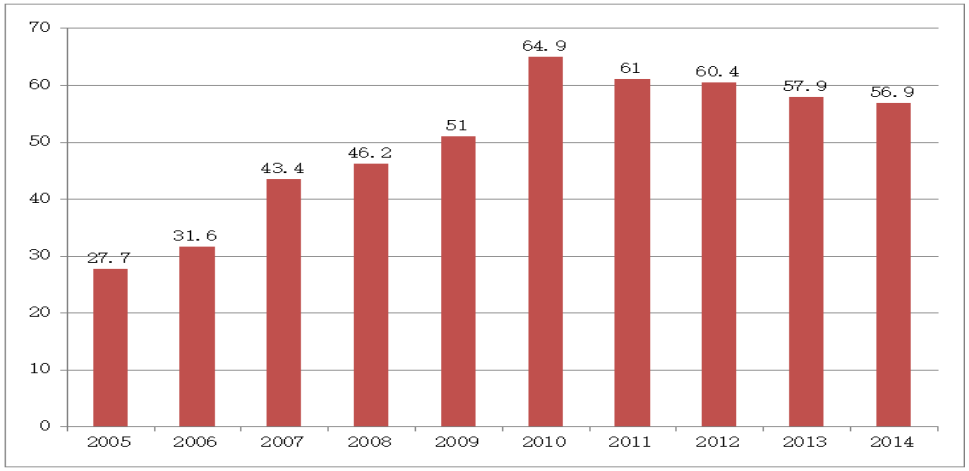

Fig. 3. Annual operating costs of wastewater treatment facilities in China's paper industry from 2005 to 2014 (Unit: 10^8 yuan)

Analysis of Environmental Regulation Policy for Paper Industry

Environmental regulation has significantly affected the industrial structure of the paper industry (Brännlund *et al*. 1995; Gomez *et al*. 1998). Unified environmental regulation, in particular, adversely affects small firms (Pashigan 1984; Markusen *et al*. 1993). CR4 refers to the output of the four largest enterprises as a percentage of the total output of the industry. CR4 can reflect the degree of competition and monopoly in an industry. According to the CR4 index, the output of Jiulong Paper, Liwen Paper, Shanying Paper, and Sun Paper accounted for only 27.58% of the total output of the paper industry in 2018, indicating that the market concentration of China's paper industry is low owing to the dispersed competitive market structure (QZIRI 2019). It implies that there are many paper enterprises in the market, and the output of each enterprise is very small compared with the total output of the industry. For example, in 2017, there were 2,754 paper enterprises above scale in China, among which only 19 enterprises reached a production capacity of more than 1 million tons of paper and paperboard. Thus, the market competition is extremely fierce. Research showed that the policy of eliminating backward capacity and environmental regulation policy positively affect the market concentration of the paper industry, thus promoting structural adjustment and the transformation and upgrading of the entire paper industry (Song and Xu 2018).

The environmental regulation policies affecting China's paper industry can be divided into three types: command-and-control, market-based, and voluntary policies (Sun 2013). These three types differ in terms of their environmental performance, implementation costs, major instrument types, and stimulus for emission reduction techniques, as shown in Table 5.

The environmental regulation of China's paper industry is currently dominated by command-and-control policy and is gradually transitioning toward market-based and voluntary policies. These three types of policies generally coexist (Li *et al*. 2013). A command-and-control policy is an environmental regulatory standard that enacts and enforces environmental laws and regulations that companies must obey. Command-and-control policy seems to play a major role in driving environmental process innovation in the paper industry; indeed, clear signals are very important for the development of new technologies (Kivimaa 2007).

Additionally, a command-and-control policy such as a performance standard gives

enterprises a certain degree of flexibility and allows them to choose appropriate measures to comply with the corresponding environmental regulations (Bergquist *et al.* 2013).

Table 5. Comparison of Environmental Regulation Policies in China's Paper Industry

Environmental regulation policy	Environmental performance	Implementation costs	Main instrument types	Stimulus for emission reduction techniques
Command-and-control type policy	Significant	Relatively high	Environmental laws and standards	Very small
Market-based type policy	Uncertain	Relatively high	Emission tax、Tradable emission rights	Relatively high
Voluntary type policy	Uncertain	Low	Environmental management system	High

Source: (Sun 2013)

The Paper Industry Development Policy (MIIT 2008) released on October 15, 2007, was the first document that comprehensively standardized the development of China's paper industry. First, the policy clearly regulated the initial scale of a single production line for new and expanded pulp and paper manufacturing projects and also raised the threshold of access. Second, it aimed at encouraging the paper industry to implement effective measures to reduce water resource consumption and pollutant emissions.

Since then, the gradual promulgation of environmental policy documents related to the paper industry has played a positive role in the standardization of environmental regulation in the industry. This article aims to analyze the command-and-control policy implemented in China's paper industry by examining environmental laws and standards as well as environmental management policy.

Command-and-Control Policy

Environmental laws and standards

The Environmental Protection Law (EPL) of the People's Republic of China (PRC) was amended on April 24, 2014, and it was implemented on January 1, 2015. In accordance with the basic conditions of the EPL, enterprises and institutions that violate the relevant laws are likely to be shut down. The second amendment to the law on the Prevention and Control of Water Pollution was approved on June 27, 2017. The law clearly states that newly built production projects that may seriously pollute water resources, such as small paper-manufacturing projects, should conform to the industrial policies. Note that these types of paper enterprises are legally obligated to comply with policies relating to water pollution.

Environmental standards contain provisions that are bound by environmental law and relevant policies to protect public health, prevent and control environmental pollution, promote a virtuous ecosystem cycle, and encourage the effective utilization of resources (Wang 2012). Environmental standards can also be subdivided into environmental quality standards, pollutant emission standards, basic environmental standards, environmental methodology standards, environmental protection technology standards, cleaner

production standards, resource consumption standards, and so on. This article summarizes recently established environmental standards specific to the paper industry, as shown in Table 6.

Table 6. Environmental Standards Related to the Paper Industry in China

Standard No.	Name of the Standard	Dates of Implementation
	Evaluating Indicator System for Cleaner production of Pulp and Paper Industry (Revised Edition)	2015-04-15
GB/T 18916.5-2012	The Fifth Part of Water Intake Quota: Paper Products	2013-01-01
HJ 2011-2012	Technical Specification for Waste Water Treatment Projects of Pulp and Paper Industry	2012-06-01
HJ 468-2009	Cleaner production Standard for Paper Industry (Waste Water Pulping)	2009-07-01
GB 3544-2008 substitute for GB 3544-2001	Emissions Standards for Waste Water Pollutants in Pulp and Paper Industry	2008-08-01
HJ/T 408-2007	Technical Standards for Construction Projects Completion and Acceptance of Environmental Protection Paper Industry	2008-04-01
HJ/T 340-2007	Cleaner production Standard for Paper Industry (Production Process of Sulphate Chemical Wood Pulp)	2007-07-01
HJ/T 339-2007	Cleaner production Standard for Paper Industry (Production Process of Wheat Straw Pulp using the Bleaching Chemical Caustic Soda Method)	2007-07-01
HJ/T 317-2006	Cleaner production Standard for Paper Industry(Production Process of Bagasse Pulp using the Bleaching Alkali Method)	2007-02-01

Source: Ministry of Ecology and Environment of the PRC

In April 2015, the National Development and Reform Commission, Ministry of Ecology and Environment, and State Ministry of Industry and Information Technology jointly promulgated the Evaluation Indicator System for Cleaner Production in the Pulp and Paper Industry. The promulgation of this environmental standard was accompanied by the simultaneous revocation of the following standards (Table 6): HJ468-2009, HJ/T339-2007, HJ/T340-2007, and HJ/T317-2006. The implementation of the indicator system helped to unify environmental standards in China's paper industry and actively promote the sustainable and healthy development of the industry.

This system proposes specific requirements for clean production in pulp and paper enterprises; in particular, it proposes the following six types of indicators of cleaner production: indicators for production processes and equipment requirements, indicators for resource and energy consumption, indicators for the comprehensive utilization of resources, indicators for pollutant production, indicators for product features, and indicators for clean production management. The system classifies cleaner production according to three levels: the leading level for international cleaner production (Level I), the leading level for domestic cleaner production (Level II), and the basic level for domestic cleaner production (Level III). This classification helped to encourage pulp and paper companies to strive toward achieving a higher level of clean production. In contrast

to the four cleaner production standards that were concurrently abolished, the system takes into account the technological characteristics of different types of pulp and paper enterprises and proposes more stringent benchmark values for pulp products, such as sulfate chemical wood pulp and waste paper pulp.

By the end of 2012, The Fifth Part of the Water Intake Quota: Paper Products (GB/T 18916.5-2012) (which replaced GB/T 18916.5-2002) was jointly issued by the General Administration of Quality Supervision, Inspection, and Quarantine of the PRC and the Standardization Administration of the PRC, and was implemented on January 1, 2013. The standard gives the terms, definitions, and calculation methods for a water intake quota for paper products that is suitable for newly built paper enterprises (Liang 2014). According to the statistics, the average comprehensive water intake quota per ton of pulp paper was as high as 197.5 m^3 in 2000.

Since the 11th Five-Year Plan period (2006 to 2010), China's paper industry has adjusted its industrial layout and optimized its product structure. Moreover, technological improvements and the popularization and implementation of advanced water conservation technology have significantly improved the efficiency of water utilization in the industry; the average comprehensive water intake quota decreased to 85 m^3.

The 12th Five-Year Plan period (2011 to 2015) was a critical timeframe during which China's paper industry strove to transform its mode of development and build a modern, environmentally friendly paper industry characterized by scientific and technological innovation and resource conservation. The 12th Five-Year Plan proposed a control target, suggesting that the water resource consumption indicator should be reduced by 18%, that is, that by 2015, the national average comprehensive water intake quota per ton of pulp paper should be decreased to 70 m^3 (Sang *et al*. 2012). By contrast, the comprehensive water intake of the paper industry in developed countries was 35 to 50 m^3 per ton of pulp paper, and the Chinese target in 2015 was still 1.4 to 2 times that of the advanced level in foreign developed countries. Thus, owing to this sizable disparity between China and foreign developed countries, the Chinese paper industry faces a very difficult task with respect to water conservation.

The announcement of the new water intake quota for paper products in 2012 raised the industry entry threshold, which is beneficial to the paper industry as a whole, as it improves the overall efficiency of water consumption and alleviates the dual constraints involving resources and the environment. The implementation of the new water intake quota supported the vigorous development and adoption of new water conservation technologies and production processes.

The 2008 Standard for the paper industry (GB3544-2008) was implemented on August 1, 2008. The implementation of this standard set a high barrier to entry and inevitably raised the production costs of paper enterprises. In addition to increasing the cost of newly built enterprises, the sharply rising cost forced existing small to medium-sized paper enterprises out of business. As it is easier for large-scale paper enterprises than for their small to medium-sized counterparts to transfer cost pressures, larger companies realized higher profit margins when faced with stricter environmental standards. In addition, the new standard alleviated overcapacity in the paper industry to some extent, which was conducive to orderly competition and ultimately proved beneficial to the long-term sustainable development of the industry.

Environmental Management Policy

This section reviews the environmental management policy related to China's paper industry and outlines an analysis of relevant policies, as shown in Table 7.

Since 2016, these environmental management policies have focused mainly on pollution prevention and control in the paper industry, the recycling of waste paper, and import restrictions on waste paper. On July 27, 2017, the General Office of the State Council formally issued the Reform Implementation Plan for Prohibiting Foreign Garbage Entry and Promoting an Imports Management System for Solid Waste [Document No.70 (2017)], which adjusted the catalog of imported waste management and explicitly proposed the prohibition of imported, unclassified waste paper, waste textile materials, vanadium residue, and other solid wastes. This policy was scheduled to be formally implemented by the end of 2017. To implement the Law on the Prevention and Control of Environmental Pollution from Solid Waste in the PRC and Document No. 70 (2017), the Ministry of Ecology and the Environment adjusted the Environmental Protection and Control Standards for Solid Waste imported for Raw Materials on August 10, 2017 [Document No.1292 (2017], which greatly increased the requirements for the quality of imported waste paper and significantly affected the importation of waste paper. On January 12, 2018, the Ministry of Ecology and the Environment announced the list of the third batch of approved import licenses for solid waste materials in 2018. This list included a total of seven enterprises that were approved to import waste paper; the total import volume of waste paper was approximately 466,000 t. In comparison to the approvals in 2017, the import volume of approved waste paper and the list of approved enterprises were dramatically reduced. This finding demonstrates China's determination to enforce environmental protection measures in the paper industry and promote its sustainable development.

In general, most enterprises in China's paper industry are small in scale, experience financing difficulties, and show an overall pattern of low industrial concentration and scattered distribution. In this context, many small and medium-sized paper enterprises in China tend to adopt a passive attitude toward environmental standards, despite the pressures of a command-and-control policy. However, the strong leading paper enterprises have very large mills, better solvency and profitability, and a shorter capital turnover period; thus, they are more willing to invest in environmental protection and adopt a more positive attitude toward environmental regulation, so as to more effectively reduce the water effluent and achieve higher environmental performance (Xu and Xiao 2018).

Overall, the policy of environmental regulation in China's paper industry is dominated by command-and-control instruments that rely primarily on the promulgation of environmental laws, standards, and environmental management policies issued by the government in an effort to compel paper enterprises to adopt environmentally oriented measures.

Table 7. Environmental Management Policies Related to the Paper Industry in China

Date of Issue	Policy	Institution	Content and analysis related to the paper industry
Feb. 2001	"Some Opinions on the Construction of the Raw Materials Forest Base in the Paper Industry"	The State Planning Commission	The planning, management, construction, financing, forest logging management, and other related preferential policies for the paper forest base. This policy generated new mechanisms for the development of the integration of forest and paper, which fundamentally reversed the unsatisfactory

			situation with respect to the structure of raw materials within the paper industry (No.141 Document.2001).
June 2007	"The Comprehensive Work Plan for Conserving Energy and Reducing Emissions"	The State Council	The paper industry mainly eliminated the straw pulp production device, which has an annual output of less than 34 thousand tons, a chemical pulp production line with an annual output of less than 17 thousand tons, a pulp and paper factory with an annual output of less than 10 thousand tons or less, and which utilizes waste paper as its main raw materials.
August 2007	"The Comments of China Paper Association on the Development of the Paper Industry in 11th Five-Year-Plan"	China Paper Association	Pollution controls within the paper industry should first of all adhere to the guideline of prevention first and comprehensive management, improving the environmental regulatory system, strengthening environmental law enforcement, improving pollution control measures, and strict control of total emissions and emissions concentrations in order to successfully achieve the transformation from end-of-pipe treatment to pollution prevention.
Oct. 2007	"Paper Industry Development Policy"	The National Development and Reform Commission	The guiding policy for the development of the paper industry focuses on industrial layout, the structure of raw materials, product structure, and enterprise structure adjustment.
March, 2008	"Ten Major Measures for Energy Conservation, Emission Reduction and Environmental Protection"	Report on the government work of the first session of the 11th National People's Congress	The first task requires that the paper industry complete the plan to eliminate the existing backward capacity and establish an exit mechanism to achieve this.
May,2014	"Action Plan for Energy Saving and Emission Reduction and Low Carbon Development during 2014-2015 period"	The State Council	The 8th article proposes that the prevention and control of water pollution should be strengthened to ensure enhanced control of pollutant discharge within key industries, such as the paper, printing, and dyeing industries.
April, 2015	"Action Plan for the Prevention and Control of Water Pollution"	The State Council	Production projects that are high polluters of the water environment, such as small papermaking projects which do not conform to the national industrial policy, should be banned. By the end of 2017, the pulp and paper industry had strived to complete the transformation of the pulping process without elemental chlorine or the adoption of other low-polluting pulping technologies.
August, 2017	Technical Policy of Pollution Prevention and Control in Paper Industry (Document No.35[2017])	Ministry of Ecology and Environment	The pollution prevention and control work of the paper industry is guided by four aspects: production process, comprehensive utilization, the prevention and control of secondary pollution, and the encouragement of new technology and R&D.
December, 2017	Regulations on the Environmental Protection and Management of Imported Waste Paper (Document No. 5[2017])	Ministry of Ecology and Environment	The licensing conditions for enterprises to import waste paper should be adjusted. It is clearly stipulated that the production capacity of imported enterprises should be no less than 50,000 tons per annum.

Analysis of market-based environmental regulation policy

Although the environmental regulation policy for China's paper industry is currently dominated by a form of command-and-control policy, it is transitioning to a form of market-based policy. The principal market-based policy instruments include environmental taxes, environmental subsidies, and tradable emission permits. These instruments may provide enterprises with direct incentives to reduce their emissions at the lowest cost, improve the environment, and encourage enterprises to adopt advanced environmental technology (Stavins 2003; Xu *et al*. 2003; Cui 2010), especially if a perfectly competitive market is assumed (Biglaiser and Horowitz 1995). This article analyzes two main types of market-based environmental regulation policy: environmental taxes and emissions trading.

Environmental taxes

The theoretical basis of the environmental tax policy is the Pigou tax, which was proposed by Pigou as an economic means of controlling the negative externalities of environmental pollution. More specifically, the Pigou taxis a tax on the polluter that is calculated according to the harm caused by the pollution. The gap between the private cost and social cost of the polluter's production is compensated by the tax so as to equalize the two costs (Zhao and Tao 2011). According to the Pigou tax theory, the government can internalize the negative environmental externality by setting the environmental tax rate to the marginal social loss caused by pollution.

A pollution charge policy for large and medium-sized paper enterprises was established in China in 1978. Since the 1980s, the policy has gradually been implemented nationwide and has achieved certain results in the control of the environmental pollution of enterprises. Thus, in the 30 years since reform and opening up, the environmental tax policy for paper enterprises in China is primarily a pollution charge policy, and the collection of environmental taxes by relevant government departments has been added to the agenda, although the specific timeframe, tax rate, and object of taxation have yet to be determined.

Until June 10, 2015, the legal office of the State Council promulgated the Environmental Protection Tax Law (Draft). The second article of the Draft stipulates that enterprises and institutions that discharge pollutants directly into the environment shall be liable to an environmental protection tax. The third article stipulates that the taxable pollutants are atmospheric pollutants, water pollutants, solid waste, construction noise, industrial noise, and other pollutants (People 2015).

The Draft defines key monitoring taxpayers as those taxpayers who operate in the 14 key polluting industries, *e.g*., the thermal power, steel, cement, electrolytic aluminum, coal, metallurgy, building materials, mining, chemical, petrochemical, pharmaceutical, and light industries (*e.g*., brewing, paper, fermentation, sugar processing, vegetable oil processing, textiles, and tanning) and key monitoring enterprises in other polluting industries. Note that the paper industry, which is a highly polluting industry that produces a high concentration of water pollutants, constitutes a key target for the levy of environmental taxes.

In addition, the Draft proposed that provincial governments should consider the environmental carrying capacity, pollutant emission status, and economic and ecological development goals of their regions when determining the appropriate amount of tax for taxable pollutants in the prescribed tax standards. Consequently, local governments can develop the levy standard for the local environmental tax in accordance with the local environmental protection targets.

The levy standard for the environmental tax should generally be in accordance with the levy standards for the pollution charge; thus, the implementation of the environmental tax has not significantly increased the tax burden on enterprises. A unified environmental tax system, including carbon taxes and ecological taxes, will ultimately replace pollution charges. Thus, China's environmental regulation of the paper industry is currently transitioning from a command-and-control policy to a market-based policy.

On December 25, 2016, the Environmental Protection Tax Law of the PRC was approved. The purpose of the law is to convert the current pollution charge into an environmental tax in accordance with the principle of tax burden shifting. The formal environmental tax was imposed on January 1, 2018. It was the first single tax law issued after the establishment of the principle of statutory tax revenue in China in March, 2015. To promulgate this law, the government attempted to employ more market mechanisms to solve environmental problems. The promulgation of environmental taxes was aimed to force highly polluting enterprises into automatic bankruptcy while creating greater development opportunities for enterprises that implement cleaner production, thus incentivizing enterprises to achieve sustainable and healthy development. Regarding paper enterprises in China, the enactment of the law has helped to reduce the production of solid waste by paper enterprises and urge them to use clean waste paper materials for pulping.

Emissions trading

The emissions trading system has introduced market mechanisms that enable the main economic actors to freely trade pollution permits. These mechanisms encourage the optimal allocation of environmental resources, thus urging economic actors to adopt the most effective means of reducing emissions. Some academics have argued that a tradable permit system offers the desired environmental quality at the lowest cost (Baumol and Oates 1985; Brännlund *et al*. 1995; Brännlund *et al*. 1998) and can promote technological advancement during the second phase of the Emissions Trading System (Fontini and Pavan 2014).

The implementation of the emissions trading policy for China's paper industry adopted an approach in which experimentation precedes popularization across the entire country. The pilot of the policy was conducted in the paper industry in Hubei province. In 2007, Hubei promulgated the Management Measures for Main Pollutant Emissions Trading in Hubei Province, which marked the establishment of the main pollutant emissions trading market in the entire province, and the launch of a pilot project in the paper industry (Li 2012a).

The emissions trading policy in Hubei province was highly effective. More specifically, because their pollutant emissions exceeded the standard outlined by the emissions trading system, some highly polluting small paper enterprises were obliged to purchase pollutant emission indicators. These enterprises were thus eliminated from competition owing to a sharp increase in production costs, whereas high-performing large and medium-sized paper enterprises could afford to invest in R&D for emission reduction technology, as they could enjoy considerable economic benefits from the auction of the remaining emission permits. Note that the emissions trading policy has played a regulatory role in the market by encouraging enterprises to reduce emissions, which has contributed substantially to reaching the goal of controlling total pollution levels (Li 2012a).

In September 2015, in the Joint Statement of the Heads of China and the United States on Climate Change, the Chinese government formulated a plan to launch a national carbon emissions trading system covering key industries such as the steel, electric power,

chemical, and papermaking industries in December 2017. China's paper industry is one of the key industries covered by China's unified carbon market. Among the seven carbon trading pilot areas, 71 paper enterprises in Guangdong and 6 paper enterprises in Shanghai are included in the carbon emissions trading system. As China's carbon trading market gradually improves, paper enterprises will face more stringent carbon emission constraints. The key strategy for paper enterprises to take the initiative in the emissions trading market is carbon management (Wu and Xu 2019). China's carbon management activities are currently government-led, and large enterprises are the main focus of exploratory action.

By analyzing the annual reports, social responsibility reports, environmental reports, and websites of listed paper enterprises, Wu and Xu (2018) summarized six carbon management measures for Chinese paper enterprises, as follows: setting emission reduction targets, the development of low-carbon products, improving the process flow and supply chain, new market and business development, organizational participation, and the development of external relations. Among the environmental management measures, China's paper enterprises prefer to improve the process flow and supply chain to reduce carbon emissions, whereas most enterprises are not willing to set emission reduction targets and take relevant measures (Jeswani et al. 2008).

The Ministry of Ecology and the Environment of the PRC integrated all existing environmental management systems, implemented "one-certificate" management of pollution emission permits, and developed a new model of pollution source management that reflects a comprehensive system. One-certificate management treats the pollution emission permit system as the core and integrates all types of environmental management systems for point-source pollution into a whole, which is effective for improving the overall efficiency of point-source environmental management.

The General Office of the State Council issued the Implementation Scheme for the Emissions Permit System for Controlling Pollutants [Document No. 81 (2016)] in November 2016. In accordance with the implementation scheme, emission permits were first issued to thermal power companies and paper industry enterprises. To implement Document No. 81 (2016), the Ministry of Ecology and the Environment issued the Measures for the Management of Pollutant Emissions Permits [Trial Implementation, Document No. 48 (2018)] in January 2018. These measures establish an approval procedure for pollution emission permits; define the legal responsibilities of the environmental protection department, pollutant emission unit, and third-party organizations; and represent a definitive step toward the reform and improvement of the pollution emission permit system.

Analysis of voluntary environmental regulatory policy

Voluntary environmental regulatory policy is not enforced, and many specific policy instruments reflect agreements or ethical advice. The government usually influences voluntary environmental regulatory policy for China's paper industry, which is implemented mainly by appeals by the government and the use of indirect pressure and moral persuasion to urge enterprises to adopt an ethical environmental attitude toward pollution control or cleaner production. Therefore, voluntary environmental regulatory policy is typically used in conjunction with command-and-control environmental policy, highlighting the complementary roles of command-and-control regulation and voluntary regulations (Korhonen *et al*. 2015). At the international level, the more mature and voluntary environmental regulatory policy instruments include the environmental management system standard ISO14001, standards for cleaner production and

environmental labeling, and the EU Eco-Management and Audit Scheme (Ma and Zhao 2005). Since the 1990s, China's voluntary environmental regulatory policy system (which includes cleaner production, ISO14001, and the information disclosure system) has been incrementally developed and improved.

The voluntary environmental regulatory policy outlined in the Paper Industry Development Policy states that "the environmental indicators announcement" and enterprise environmental protection information disclosure system should be implemented to encourage the public to participate and encourage enterprises to adopt ethical environmental behavior, to actively implement environmental certification, environmental labeling, and the performance appraisal system for environmental protection. This policy is neither mandated by an oversight body nor binding; thus, its implementation depends mainly on the voluntary participation of enterprises. To implement voluntary environmental regulation, the government usually encourages enterprises to actively participate in adopting the agreements, standards system, or information disclosure mechanism outlined by voluntary environmental regulatory policies by awarding regulatory exemptions.

ISO14001, the environmental management system standard, is mainly adopted for the voluntary environmental regulation of the paper industry. This system is designed to certify the environmental management procedure and management structure of enterprises. Many paper enterprises are attempting to obtain certification according to the ISO14001 environmental management system standard, and many large enterprises have obtained certification. For example, Ningbo Paper Co. Ltd. is not only one of the largest Chinese paper packaging and manufacturing enterprises, but also the first enterprise in China to obtain this certification. By obtaining ISO14001 certification, paper enterprises have transitioned from the passive control of pollutant emissions and shifted toward the control and prevention of pollutant emissions throughout the entire production process, thereby providing a new framework characterized by ecological environmental regulation for traditional environmental regulations in the paper industry.

However, when voluntary compliance by enterprises is not realized, the government lacks executive power for mandatory regulation. Only when voluntary regulation reaches a certain level can the effectiveness of mandatory regulation be improved (Hoffman *et al*. 2015).

CONCLUSIONS

This study considers the status quo of environmental management in China's paper industry. On the basis of an analysis of the environmental regulation policies (*i.e.*, command-and-control, market-based, and voluntary policies), the effects of the policies can be summarized as follows.

1. The environmental regulation policy for China's paper industry is not sufficiently independent from the industry and has a low regulation standard.

   The effects of the environmental regulatory policy for China's paper industry are unsatisfactory, for the following reasons. First, environmental regulatory agencies lack independence from the paper industry, which diminishes the effectiveness of environmental regulations (Chen *et al.* 2016). Second, the standard of environmental

regulation is relatively low (Liu 2014). The lack of independence of environmental regulatory agencies in the paper industry has a direct negative impact on the regulatory effect (He *et al.* 2018). The Ministry of Ecology and Environment of the PRC is the main body regulating the paper industry, and the laws and regulations department is responsible for drafting environmental laws, regulations, and policies. However, this department should refer to the legislative suggestions of the local government when formulating specific environmental regulations. Considering the contribution of paper enterprises to the local GDP, local governments have proposed relaxing the regulation standards for paper enterprises, which inevitably results in lower standards for the environmental regulation of the paper industry (Sun 2013).

2. Although the environmental regulation of China's paper industry is dominated by a command-and-control policy, it is gradually transitioning toward market-based and voluntary policies.

   Environmental regulatory instruments include pollution emissions standards, cleaner production standards, measures of energy savings and emission reductions for production, and pollution charges (Cui 2010). Those for the paper industry in China are mainly command-and-control regulatory instruments, and the application and innovation of market-based regulatory instruments are inadequate (Liu 2014).

3. As the paper industry produces more pollution, the government has reinforced environmental regulation in this sector in terms of the regulatory system and methods used and also strengthened the environmental investment of the paper industry.

   In fact, the present study confirmed the hypothesis of Porter and Van Der Linde (1995), that is, that appropriate environmental regulation can encourage enterprises to increase their environmental innovation investment, thus offsetting the cost of environmental regulation and enhancing their competitiveness. In addition, environmental regulation has a significant positive effect on the environmental investment of enterprises in China, as reported by Jiang and Xu (2015) and Wang (2018).

4. In comparison with other highly polluting industries in China, the regulatory performance in the paper industry is still low.

   Compared with other manufacturing industries, the global paper industry has a large pollution discharge capacity (Toczyłowska-Mamińska 2017). The paper industry in China is highly polluting, and thus it is a key industry for the implementation of environmental regulations. However, the ability of environmental regulations to motivate Chinese paper enterprises to fulfill their environmental responsibilities is very limited; that is, environmental regulations have not yielded the expected results (He *et al.* 2018).

POLICY IMPLICATIONS

To improve the performance of environmental regulation policies in China's paper industry, we propose the following policy initiatives.

1. Ensure the independence of environmental regulatory agencies and determine the

most appropriate regulation standard for the paper industry.

Because the independence of environmental regulatory agencies is the key to avoiding "regulatory failure", the central government should promote the integration and establishment of new comprehensive regulatory bodies and ensure the independence of environmental protection legislative bodies from other government agencies and local governments (Zheng 2014). In addition, the government should consider the costs and benefits when formulating the regulation standards for the paper industry and strive to establish the most suitable regulation standards for the development of paper enterprises on the basis of cost–benefit optimization (Thomas 2016).

2. Accelerate the transition from command-and-control regulation to market-based regulation and self-regulation.

   Newell (2008) believed that, among various types of environmental regulation instruments, market-based instruments can play a greater role in increasing environmental investment by enterprises than command-and-control instruments. Thus, the emissions trading policy in China should first establish the total amount of pollution control, determine the initial emission permit quota for each economic entity, and then establish a trading platform that allows emission permits to be freely traded between economic entities to effectively meet the total emission reduction targets and urge individual economic entities to reach their own emission reduction targets using the most efficient means.

   In addition to these policies, voluntary regulation and self-regulation, which are important components of the sustainability strategies of enterprises, play an increasingly important role in increasing the environmental investment and improving the environmental performance of enterprises (King *et al.* 2012; Bergquist and Keskitalo 2016). Effective measures should be taken to improve the level of voluntary regulation and self-regulation. For example, the current environmental disclosure and participation mechanism for Chinese paper enterprises should be further improved (Hou *et al.* 2012); the active participation of small and medium-sized enterprises in environmental activities can be fostered using incentivized market instruments (Xing 2018). Because voluntary and command-and-control regulation are complementary approaches, the role of additional voluntary alternatives to implementing command-and-control regulation is emphasized to complement government legislation and gain market benefits from greening the entire supply chain of the paper industry (Korhonen *et al.* 2015).
3. Appropriately improve the intensity of environmental regulation and promote environmental investment by enterprises by combining command-and-control regulation with market-based regulation.

   First, because the intensity of China's existing environmental regulations is far from the inflection point at which environmental investment is discouraged, the government can moderately improve the intensity of environmental regulation and effectively enhance the positive effect of environmental regulation on environmental investment by enterprises (Zhang 2018). Second, owing to the different implementation effects of various regulation instruments, regulations should be implemented according to local conditions, giving full play to government plus market regulation to promote environmental investment by paper enterprises.

4. Promote the green development of paper enterprises and improve regulation performance.

   Effective measures can be taken to promote the green development of paper enterprises and improve regulatory performance, for example, eliminating backward capacity and improving the clean production and green innovation capability of paper enterprises. Moreover, forest–pulp–paper integration is also an effective strategy for improving regulatory performance (Qin *et al.* 2019). In recent years, the central government has issued a series of policies to eliminate backward production, including industrial access management, compulsory administrative elimination, economic restrictions, incentive measures, and the supervision, assessment, and accountability of local governments.

   Overall, although the policy of eliminating backward production has had certain results, other problems remain, such as an overemphasis on administrative means (Li 2012b). To eliminate backward paper production, paper mills in China producing 37.31 million tons were ordered to shut down between 2010 and 2015 because they did not meet the requirements for environmental protection. China plans to shut down another 8 to 10 million tons of backward paper capacity during the 13th Five-Year Plan period (2016–2020). Administrative measures have played a historic role in eliminating backward paper capacity. However, since 2016, the government's environmental governance of paper enterprises has tended to move away from mandatory administrative means toward market-based means. The Ministry of Ecology and Environment has shifted its attention from environmental assessment to actual emissions and from focusing on key polluting enterprises to issuing emission permits for paper enterprises. These changes reflect the government's tendency to adopt economic measures. Therefore, the transition of the environmental governance of paper enterprises from mandatory administrative measures to market-based means is a general trend (He 2014).

   In addition, supply-side reform and "One belt, one road" policy also afford an opportunity to eliminate backward paper capacity and promote industrial optimization and upgrading. For example, supply-side reform encourages improvements in quality and efficiency and gradually realizes the substitution of domestic paper products for some imported products. The "One belt, one road" policy encourages the "superiority" capacity of paper enterprises to export to countries along the Belt and Road, which is beneficial for eliminating backward capacity (Liu and Gao 2016).

5. Design a suitable kraft pulping process and continuously increase the pulping capacity and decrease the level of pollution.

   There are many methods of pulping. Kraft pulping is a chemical process that uses sulfite cooking liquors with different pH values to treat raw plant fiber materials and make pulp. However, kraft pulp remains the main raw pulp in the 21st century owing to its product quality, production efficiency, and economic advantages. In the 21st century, kraft pulping has almost replaced sulfite pulping and accounts for most pulp production, whereas other pulping processes are in the initial development stage (Lin 2009).

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