Controlling chemical industrial pollution with regulatory tools: the case of Yichang, Hubei, China

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Abstract. Chemical industries may pollute the air, water, and soil as well as jeopardize the ecological system and human health. China has established a relatively comprehensive regulatory regime to control industrial pollution, including pollution from chemical industries. This paper evaluates various regulatory tools to find their efficacy and appropriateness, and uses Yichang, a city rich in phosphate ore and phosphate industries, as an example. This paper integrates qualitative research methods and quantitative research methods. The analysis indicates that regulatory tools can be effective in controlling environmental pollution and restoring the jeopardized ecology. It also indicates that the Chinese government can enforce the environmental law effectively. However, these regulatory tools are also costly, insufficiently clear, and may not be effective for each place.

1. Introduction
Chemical industries may pollute the air, water, and soil as well as jeopardize the ecological system and human health [1-3]. Environmental pollution shall be a compulsory requirement on the development of chemical industries. However, for various reasons, chemical industries may have developed without sufficient environmental consideration and pollution control measures [4]. This leads to the needs to remediate the existing pollution and prevent further pollution. The public image of chemical industries also deteriorated in recent years, which makes it even more urgent for the government to take measure against pollution originating from chemical industries [5,6]. Regulatory tools may play a vital role to achieve pollution control goals. This paper evaluates various regulatory tools to find their efficacy and appropriateness, and uses Yichang, a city rich in phosphate ore and phosphate industries, as an example. This study mainly evaluates the effectiveness of various regulatory tool and also touches on the effect of the competition among local governments on environmental governance [7].

2. Method and data sources
This paper integrates qualitative research methods and quantitative research methods [8]. This paper uses qualitative method to find and assort regulatory tools and evaluate the general situation of the case to be studied. As to the effectiveness of regulatory tools for the case, this paper also uses quantitative research methods. The data used in this paper are publicly available. A field study of the case was conducted to verify the publicly available data to the largest extent of feasibility.

3. Regulatory tools available for chemical industrial pollution
Albeit command-and-control rules are the major part of Chinese environmental law, China has long sought other regulatory tools and looks for more cooperative and flexible mechanisms to coordinate the economic development and environmental protection [9, 10]. China has established a relatively comprehensive regulatory regime to control industrial pollution, including pollution from chemical
industries [11-13]. The pivotal legislation is the Environmental Protection Law of the People’s Republic of China, which was recently revised in 2014 (the 2014 revised Environmental Protection Law) [14, 15]. The Environmental Protection Law was adopted and revised by the Standing Committee of the Chinese National People’s Congress (NPC Standing Committee). The same legislative body also adopted and revised other environmental protection laws such the Law on the Prevention and Control of Water Pollution (the Water Pollution Control Law) [16, 17], the Land on the Prevention and Control of Soil Pollution (the Soil Pollution Control Law). Below laws in the hierarchy of the rules are administrative regulations and local regulations. Administrative regulations are adopted by the State Council, i.e., the Central Government of China. Local regulations are adopted by local congresses at or above districted cities. The Ministry of Ecology and Environment (MEE), previously the Ministry of Environmental Protection (MEP), has the authorities to adopted rules and technical standards [16]. Besides the MEE, other governmental departments also have authorities over environmental protection and industrial development, particularly the National Development and Reform Commission [14].

The environmental protection requirements impose obligation on the industries as well as grant law enforcement authorities on governmental agencies. The obligations on the industries in one sense are regulatory tools for governmental agencies to regulate the economy for the public interests. Key regulatory tools can be summed up as follows:

3.1. Pollutant discharge standards

The pollutant discharge standards are the basic requirements on industrial enterprises. These standards are specific for each category of industry, some are even specific for each category of technology used for production. For example, there are separate pollutant discharge standards for pharmaceutical industries: formation products category (GB 21903-2008), chemical synthesis products category (GB 21904-2008), extraction products category (GB 21905-2008), bio-pharmaceutical category (GB 21907-2008), mixing/compounding and formulation category (GB 21908-2008), and Chinese traditional medicine category (GB 21906-2008). The title of a pollutant discharge standard generally contains words indicating whether it is for water pollutants, air pollutants, or other pollutants. However, some standards may contain provisions on both water pollutants and air pollutants but their titles just indicate that they are for water pollutants. Therefore, people should be cautious to avoid neglecting any applicable standards.

The pollutant discharge standards constitute a regulatory tool because it is more for regulation than for nature science, more of norms than of facts. Article 16(1) of the 2014 revised Environmental Protection Law provides that the agency of the State Council in charge of environmental protection (currently the MEE, previously the MEP) shall adopt national pollutant discharge standards according to the national environmental quality standards as well as economic and technological conditions. The second paragraph of the same Article 16 provides that the governments of provinces, autonomous regions, and municipalities directly under the State Council have authorities to adopt more stringent local pollutant discharge standards applicable to the respective regions. Although Article 16(2) does not explicitly require these local governments to adopt pollutant discharge standards in light to economic and technological conditions, it shall be understood that economic and technological conditions shall be considered when adopting local pollutant discharge standards. Therefore, the stringency of pollutant discharge standards is a policy choice. If the government wants to discourage an industry, push the industry to introduce or develop better technology, it may adopt more stringent standards, even more stringent than the currently and domestically available technology. Like the environmental quality standards [18], the pollutant discharge standards incentivize local governments to harden environmental law enforcement. However, this regulatory tool has rigidity: it can only be tightened and cannot be loosen as the time goes by.

3.2. Industrial policies

The Chinese government regularly adopts and updates industrial policies to differentiate the treatment of different industries. Some industries are regarded as promising and are prioritized while some other industries are regarded as outdated or environmentally unfriendly and are discouraged. The industry
policies may take different forms. The most fundamental one is the national five-year plan, a plan adopted by the plenary meeting of the National People’s Congress. The current national five-year plan is the thirteenth five-year plan for the period from 2016 to 2020. At the national level, different ministries and commissions also adopt their respective sectoral five-year plans based on the master five-year plan adopted by the NPC. Local congresses and governments also adopt their local master five-year plans and sectoral five-year plans. These five-year plans indicate the governmental attitude towards different industries and thus influences investors, financial market, and other stakeholders. This of course indicates that industrial policies are a form a regulatory tool. The thirteenth national five-year plan calls require the reduction of greenhouse gas reduction from some major industries including the chemical industry. The same plan also calls for the promotion of international cooperation of chemical industry. This indicates that the government attaches much important on the development of chemical industry but also calls for the upgrading of chemical industry for the industry’s own sake as well as for environmental protection purposes.

3.3. Supply of industrial land

Land is subject to tight control of the government. Land is either owned by the State or collectively owned by individual villages. The rural land is collectively owned by individual villages on behalf of villagers, other land is owned by the State. With the exception of village enterprises, all other enterprises can only use state-owned land for industrial purposes. The use of land for industrial purposes is not only subject to payment, but also subject to government approval. The approval of industrial land is quite complicated. It suffices to say here that lower government such as county government and city government not necessarily have the authorities to approve the land use even though they have strong desire to develop local economy through industrial development. The higher government, particularly the Development and Reform Commission at the provincial level, plays a key role in the land use for industrial purposes. Other governmental agencies, such as the zoning authorities, also have much authorities on the land use. When deciding whether to approval a piece of land for a particular major enterprise or for an industrial park, the approving agencies need to consider the environmental background, the economic potential of a particular enterprise or industry, and many other factors, including the above-mentioned industrial policies. In essence, the approval of industrial land is part of economic regulation. In this sense, the supply of industrial land is a regulatory tool.

3.4. Other regulatory tools

The environmental law also provides other regulatory tools for environmental protection. Article 4(2) of the 2014 revised Environmental Protection Law requires the State to take economic and technological policies and measures that are beneficial to the saving and recycling of resources, to the protection and improvement of the environment, and to the promotion of harmony between the human being and the nature. Article 7 of the same law provides that the State supports the research, development, and utilization of science and technology for environmental protection, encourages the development of environmental industries, promotes the digitalization of environmental protection, and enhances the level of science and technology for environmental protection. Based on these two legal provisions and provisions of other relevant laws and regulations, quite a few regulatory tools have been developed. For instance, the program on environmental insurance restarted recently [19].

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**Figure 1. Regulatory tools**
4. Case study of Yichang

4.1. General information of Yichang

Yichang is a city in the western part of Hubei province, in the central part of China. This city is along the Yangtze River and is the dividing point of the upper and middle stream of Yangtze River. The Yangtze River suffered from pollution in the past decades and the Yangtze River pollution is regarded as an urgent issue for the whole country [20-22]. Notably, the thirteenth national five-year plan requires the protection of the ecological system of the Yangtze River Catchment.

Yichang is an administrative region at the level of districted city. The term “districted city” means that this administrative region is lower than province or autonomous region but higher than county or district. The term “districted city” also means that its urbanized area is consisted of more than two districts. However, this does not mean a districted city does not have rural areas or mostly rural areas. The rural areas can be divided into counties while more urbanized areas can be county-level cities. This is true for the case of this paper. Yichang has five districts, 3 county-level cities, and 5 counties. Altogether, Yichang has about 4.13 million residents.

Yichang is rich in phosphate ores and shale gas. The phosphate ores are mostly deposited in Yiling District, Xingshan County, and Yuan'an County, including 16 mineral beds. The explored deposit is of more than 200 million tons, which accounts for more than 54% of the total deposit of Hubei province. This deposit also makes Yichang the third large deposit of the whole country. However, the quality of phosphate ores is not very good. The deposit of shale gas currently found is mostly located in Dianjun District.

The industries of Yichang heavily rely on phosphate ores. First, the exaction of phosphate ores is a big industry in terms of revenue, taxation, and employment. Second, the phosphate chemical industry is an even bigger industry. Besides phosphate chemical industry, Yichang also has coal chemical industry and salt chemical industry. In terms of GDP, the chemical industries altogether account for about one third of the total GDP of Yichang.

4.2. Environmental problems of Yichang

The chemical industry also has the potential to cause environmental problems. This is because of the following reasons. First, the industry is scattered. Although Yihua and Xingfa are two major companies, other companies are small and scattered. There are 12 areas that can be regarded as industrial areas/parks for chemical industries. There are 134 companies of chemical industries, 48 of them locate in areas close to Yangtze River. Second, the technology is not state-of-the-art. Some of the companies such as Yihua and Xingfa invest much money in research and development and equipment acquisition, but many other companies do not spend much money on research and development and are insufficiently equipped. Third, the products are low in price and profit. The leading products are chemical fertilizers such as urea chemical fertilizers and ammonium phosphate chemical fertilizers. These products do not bring about much profit but consume much natural resources and energy and lead to much pollution. Fourth, they cause high risks of environmental pollution and worksite safety. Pollutants from chemical industries accounts for about 70% of all industrial pollutants. The phosphate pollution of Yichang caught the national attention. The thirteenth national five-year plan calls for the control of phosphate pollution of the whole Yangtze River Catchment. The most difficult part of this task is Yichang.

4.3. Regulatory tools taken by Yichang

In recent years, Yichang mainly used the following regulatory tools to reduce and control chemical pollution:

4.3.1. Governmental plans. The city government mobilized the impetus of governments and adopted several governmental plans, notably the Opinions on the Specialized Renovation and Upgrading of Chemical Industries, Three-Year Action Plan for the Renovation and Upgrading of Chemical Industries, the Plan of Yichang City for the Green Development of Chemical Industries (2017-2025), the Master Plan of Yichang City for the Development of Phosphate Industries (2017-2025), the Master
Plan of Yaojiagang Industrial Park (2017-2025), the Master Plan of Yidu Chemical Industrial Park (2017-2030), and other plans.

4.3.2. Differentiated treatment of industrial parks. The current 12 chemical industrial parks will be classified into three categories. Two chemical industrial parks are classified into prioritized industrial parks, i.e., the Zhijiang chemical industrial park and the Yidu chemical industrial park. They are to be upgraded and further developed. They will be equipped with advanced pollution control facilities. They will set strict requirements on companies that plan to enter these industrial parks. Water pollutant will be first treated by each individual company then further treated by the industrial park. The industrial parks will achieve a high degree of circular economy and clean production by facilitating the recycling of materials and energy within the industrial parks [23]. Five chemical industrial parks are classified as controlled development areas. They should improve the allocation of production capacity, control pollutant discharge, and upgrade technology and processes. The rest five industrial parks will be closed.

4.3.3. Differentiated treatment of companies engaged in chemical industries. The 134 companies currently engaged in chemical industries fall into four categories. Those who do not meet zoning requirements and industrial plans and cannot meet requirements on environmental protection and worksite safety shall be closed and leave the chemical industries. The number of companies fallen into this category is 34. These companies that already exist in acceptable chemical industrial parks and can meet all requirements on environmental protection and worksite safety after upgrading will continue their business and undergo an overall upgrading. The number of companies that fall into this category is 57. These companies that are currently located outside of acceptable chemical industrial parks but are low in risks of environmental pollution and worksite safety will be moved to accepted chemical industrial parks if they are willing to upgrade their facilities and undergo an examination process. The number of companies that fall into this category is 36. The fourth category include 7 companies that voluntarily abandon their business in chemical industries.

![Figure 2. Chemical industrial parks and companies engaged in chemical industries before and after the implementation of regulatory measures](image)

4.3.4. Control of land use and mineral rights. The control of land use has fundamental effect on the development chemical industries. The local zoning was changed so that it is no longer allowed to maintain or establish chemical industry facilities within one kilometer of the river banks. The existing chemical industrial facilities are to be relocated to other places. In contrast, the two prioritized industrial parks for chemical industries are out of the one-kilometer limit and get more land to get expanded. The mining rights of phosphate ores is also subject to control. Some operators may not be able to get their mineral rights renewed once their mineral rights expire. Whether they can get their rights renewed depends on factors closely related to environmental protection, such as the location of their phosphate mineral beds, their environmental protection facilities, their parent company (whether they are owned by an advanced chemical industrial company).
4.3.5. **Impetus on lower governments.** The city government adopts some measure to enhance the accountability of lower government for environmental protection and the streamlining of the chemical industries. The city government set goals for each county or district. If a county or district fails to meet its goal, the head of the county government or district government may be disciplined or at least loses credit for promotion. If a county or district government meets the goal, its head may be rewarded with promotion or other rewards. The city government also encourages the cooperation among districts and counties. For example, Xinfa’s move to Xiaoting is the result of the cooperation between Xingshan County and Xiaoting District. Although Xinfa is a county-level state-owned company, it is allowed to move to Xiaoting District. This is different from the general practice that a county-level state-owned company generally stays in the county, at least its headquarters shall be at the county, so that this county may get the taxation benefit.

4.4. **Environmental improvements of Yichang**

Yichang has achieved much progress in environmental protection with these regulatory tools. The pressure on the environment has been eased and there are some actual improvements of the environment. The main achievements are as follows:

4.4.1. **Closure and relocation of polluters.** So far 30 of the 34 companies on the closure list have been closed. The companies on the relocation list are preparing for relocation.

4.4.2. **Upgrading of production facilities and environmental protection facilities.** Most of the companies allowed to continue their business have started to upgrade their production facilities.

4.4.3. **Development of chemical industrial parks.** The two prioritized chemical industrial parks have started to expand. A high standard is taken for the expanded part. A thick layer of concrete floor is constructed for anti-leakage purposes. A centralized waste water treatment facility is planned for each industrial park which will further treat the waste water of companies engaged in chemical industries. However, each company still needs to preliminarily treat their wastewater in their own facilities. the preliminarily treated waste water will be discharged into the centralized treatment facility of the industrial park.

4.4.4. **Cleanup and remediation of land previously used for chemical industry.** The land previously used for chemical industry may have been contaminated and may jeopardize the ecology and human health. The government requires the former user to clean up the land before returning the land to the State or transferring the land use right to the next user. For the companies on the closure list, their production sites have been tested for possible soil pollution and cleanup plans have been drafted and to be implemented after their closure. The government also has a plan to provide financial support to clean up the sites of companies who are financially unable to clean up their sites. Currently, production facilities within one kilometer of the river banks have been relocated or closed. The land has been used for public road or have been vegetated or forested for ecological restoration.

4.4.5. **Improved environmental quality.** During the year of 2017, the energy consumption per unit of GDP reduced by 7.14% from the previous year, the water consumption per unit of GDP reduced by 13.7% from the previous year. During the period of January to August of 2018, the number of days meeting the first and second grades of the National Ambient Air Quality Standards is 3.9% more than the days of the same period of 2017.

5. **Concluding remarks**

The above analysis indicates that regulatory tools can be effective in controlling environmental pollution and restoring the jeopardized ecology. It also indicates that the Chinese government can enforce the environmental law effectively and the environmental law is not just a “paper tiger” in China [24, 25]. However, people should still be cautious that these regulatory tools are also costly and may not be effective for each place [26]. Furthermore, legal rules on these regulatory rules are not
sufficiently clear. It is true that these regulatory rules have legal basis because they are provided in the 2014 revised Environmental Protection and other laws and regulations. However, these legal rules are not sufficiently clear and hard to implement. Nevertheless, the experience of Yichang provides insight on how these regulatory tools operate and how to make clearer legal rules.

6. References

[1] He G, Zhang L, Mol A P J, Wang T and Lu Y 2014 Why small and medium chemical companies continue to pose severe environmental risks in rural China Environmental Pollution 185 158-167

[2] Tang D, Li T Y, Chow J C, Kulkarni S U, Watson J G, Ho S S H, Quan Z Y, Qu L R and Perera F 2014 Air pollution effects on fetal and child development: A cohort comparison in China Environmental Pollution 185 90-96

[3] Ministry of Environmental Protection of the People’s Republic China (MEP), National Bureau of Statistics of the People's Republic of China (NBS) and Ministry of Agriculture of the People’s Republic of China (MOA) 2010 Report of the First National General Survey of Pollution Sources (Beijing).

[4] He G, Lu Y, Mol A P J and Beckers T 2012 Changes and challenges: China’s environmental management in transition Environmental Development 3 25-38

[5] Qiu J 2008 China bows to public over chemical plant Nature 451 117

[6] Chen W Y and Hua J 2015 Citizens’ distrust of government and their protest responses in a contingent valuation study of urban heritage trees in Guangzhou, China Journal of Environmental Management 155 40-48

[7] Yang H, Chen S and Zhou Y 2008 Local government competition and environmental policy South Economy 2008 30

[8] Mutshewa A 2010 The use of information by environmental planners: A qualitative study using grounded theory methodology Information Processing & Management 46 212-232

[9] Wang A L 2013 The search for sustainable legitimacy: Environmental law and bureaucracy in China Harvard Environmental Law Review 37 365-440

[10] You M 2008 Moratorium on EIA approvals: China’s new environmental enforcement tool Natural Resources Journal 48 163-187

[11] Johnson T R 2016 Regulatory dynamism of environmental mobilization in urban China Regulation & Governance 10 14-28

[12] Mol A P J 2009 Urban environmental governance innovations in China Current Opinion in Environmental Sustainability 1 96-100

[13] Wang L 2010 The changes of China’s environmental policies in the latest 30 years Procedia Environmental Sciences 2 1206-12

[14] You M 2015 Changes and challenges of the 2014 revised Environmental Protection Law in the context of China’s five fundamental transitions Hong Kong Law Journal 45 621-649

[15] Falk R L and Wee J 2015 China’s new Environmental Protection Law Environmental Law Reporter 45 10023-26

[16] You M 2018 Annual review of Chinese environmental law developments: 2017 Environmental Law Reporter 48 10389-93

[17] You M 2009 Annual review of Chinese environmental law developments: 2008 Environmental Law Reporter 39 10510-15

[18] You M 2014 Addition of PM 2.5 into the national ambient air quality standards of China and the contribution to air pollution control: the case study of Wuhan, China The Scientific World Journal 2014 768405

[19] Feng Y, Mol A P J, Lu Y, He G and van Koppen C S A 2014 Environmental pollution liability insurance in China: compulsory or voluntary? Journal of Cleaner Production 70 211-219

[20] Yi Y, Wang Z, Zhang K, Yu G and Duan X 2008 Sediment pollution and its effect on fish through food chain in the Yangtze River International Journal of Sediment Research 23 338-347
[21] Yi Y, Yang Z and Zhang S 2011 Ecological risk assessment of heavy metals in sediment and human health risk assessment of heavy metals in fishes in the middle and lower reaches of the Yangtze River basin *Environmental Pollution* **159** 2575-85

[22] Han G and Xu J 2013 Land Surface Phenology and Land Surface Temperature Changes Along an Urban–Rural Gradient in Yangtze River Delta, China *Environmental Management* **52** 234-249

[23] Guohui S and Yunfeng L 2012 The Effect of Reinforcing the Concept of Circular Economy in West China Environmental Protection and Economic Development *Procedia Environmental Sciences* **12**, Part B 785-792

[24] Ryan E 2013 The Elaborate Paper Tiger: Environmental Enforcement and the Rule of Law in China *Duke Environmental Law and Policy Forum* **24** 183-239

[25] Yang H, Huang X, Thompson J R and Flower R J 2015 Enforcement key to China’s environment *Science* **347** 834-835

[26] Ma C 2010 Who bears the environmental burden in China—An analysis of the distribution of industrial pollution sources? *Ecological Economics* **69** 1869-76

**Acknowledgments**

This article is one of the outputs of the author’s research project sponsored by the National Social Science Fund of China (Project No. 15BFX181). It is the result of independent academic research and does not necessarily reflect the views of the authors’ funders or affiliations.