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Literature Review on Pricing of Initial Discharge Right of Sewage

Lina Wang[1*], Yongqiang Pan[1], Yitong Wang[2], Linjiao Yang[3]

[1]Economy & Management School, Hainan Normal University, Haikou, China
[2]Radio and Film School, Liaoning University, Shenyang, China
[3]Management School, Liaoning University of Technology, Jinzhou, China
Email: *lina1976113@126.com

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Abstract

Aiming at the research topic of initial pollution emission right pricing, this paper combs the literature at home and abroad, and summarizes the literature research at home and abroad. The following conclusions are drawn: the relevant research can choose the initial discharge right of sewage as the research object, and construct the pricing model of the initial discharge right of the system dynamics sewage, which can not only calculate the price of the future emission right, but also distinguish the key factors that affect the initial emission right price, and provide some reference guidance to the Government and enterprises. It helps to better grasp the price of emission right; on the other hand, it can price the emission right of different parts of the same industry. It is expected to expand the system theory system of the initial discharge right of sewage, and to provide the basis for the relevant decision of the environmental management authorities.

Keywords

Sewage Initial Discharge Right, Pricing, Literature Review

1. Introduction

In recent years, with the intensification of global warming, water pollution, persistent haze, acid rain and other environmental pollution problems are becoming more and more prominent; industrial development has brought material abundance, but also lets mankind face the predicament of high environmental pollution; water pollution has become one of the most serious environmental problems; water pollution mainly has two types of natural pollution and man-made pollution. And man-made pollution is the culprit of the deterioration of water

function. As early as the 20th century, there were two serious accidents in Japan caused by man-made pollution of water environment: Minamata disease and pain, of which 60 people were killed and 283 poisoned in the Minamata disease incident, mainly because the nearby fertilizer plant discharged large quantities of mercury containing sewage into Minamata bay, causing fish poisoning. Mercury poisoning occurs after people eat these poisoned fish; almost at the same time, there was another death from water pollution (pain sickness incident) in Fushan County, Japan, due to the lack of proper treatment of industrial wastewater discharged from nearby electroplating plants, battery manufacturers and welding plants, resulting in cadmium poisoning in the Tongchuan River basin. The lessons of water environmental pollution blood make people realize the importance and urgency of environmental governance and environmental protection under the economic-centered development strategy. The World Health Organization (WHO) survey found that 80% of diseases are directly related to the safety of drinking water; water pollution not only endangers life and health but also hinders economic development, because the water function damage caused by the "water quality water shortage" has become the bottleneck of industrial development. As a developing country with rapid development in China, the extensive economic growth mode with high energy consumption and pollution has made the ink river, Milk River and oil river emerge endlessly, and the increasingly serious water pollution has become more and more prominent since the basic state policy centered on economic construction. By the end of 2013, the country discharged up to 69.544 million tons of sewage; chemical oxygen demands emissions of 23.527 million tons; river basin water quality is declining, as one of the ten systems of the Haihe River pollution is the most serious, the loss of any use of functional and environmental functions of the inferior v water quality section ratio was up to 39.1%. The proportion of water quality section above IV is 60.9%; the water quality of groundwater monitoring point is only 10.4%; the water quality of monitoring point is poor and the extreme difference is 59.6%.

The significance of the research is on the pricing of pollution emission right. Facing the severe situation of global water pollution, how to deal with sewage discharge, and how to effectively control the discharge of pollutants in water bodies and the concentration of pollutants are the vital questions? Based on the current state of environmental degradation, the Kyoto Protocol has developed three pollutant abatement mechanisms: Emissions Trading System, Joint implementation, CDM (Clean Development Mechanism), in which joint implementation, clean development mechanism mainly limits greenhouse gases (including water vapor, carbon dioxide, Nitrogen oxide, methane) emissions. The emission trading mechanism is mainly used for water pollution control in order to alleviate the severe situation of water pollution and gradually improve the water quality. Emission right is a restrictive discharge of sewage in accordance with the law, at present, sewage enterprises to obtain such emission rights are mainly ini-

tial distribution, transfer, auction and other ways. The emission trading of water pollutants (pollution rights trading) is based on the control of the total amount of water environment capacity, the adoption of restrictive sewage measures. The emission trading mechanism, under the premise of considering the carrying capacity of environmental resources and synthesizing the current environmental and economic situation, follows a quantitative environmental management measure of the principle of "polluter, who pays", because of its low cost of pollution control, good practice effect and flexibility, which has gradually become a kind of policy tool to control pollution widely used in various countries. Emission rights flexibility now, one is that when the cost of pollution control of enterprises is higher than the cost of purchasing emission rights, enterprises choose to buy emission rights, when the cost of purchasing emission rights is greater than the cost of pollution control, enterprises choose their own governance, and second, when the emission rights purchased by enterprises can be transferred to the required sewage enterprises, so that the rational use. Third, the participating subjects of emissions trading can carry out the banking and borrowing of emission rights according to their own needs and expectations of future emissions trading prospects.

International emissions trading is becoming increasingly marketable, with the EU auctioning quotas of up to 5% in the first phase (2005-2007) to the second stage (2008-2012) allowing 10% percent of emissions to be auctioned, and the third phase (2012-2020), which provides for the full auction of quotas for the electricity industry, with carbon emissions trading the most active, according to the World Bank statistics in 2010, global carbon emissions have achieved 141.9 billion of dollars, the 2020 global emissions trading volume is expected to reach 3.5 trillion U.S. dollars will surpass the oil market to become the largest market, China as of the end of the first quarter of 2015, carbon emissions accumulated 20 million tons, turnover accumulated 1.3 billion. Emissions trading has gradually entered the Chinese market since the 80, and since 2007 years China has carried out 11 pilot emission trading and paid use pilots, including Jiangsu, Zhejiang, Hunan, Hubei, Henan, Hebei, Shanxi, Shaanxi, Inner Mongolia Autonomous Region, Tianjin, Chongqing, Chemical demand emission trading has been traded in almost every pilot area, and chemical oxygen demand indicators are generally used to reflect the degree of contamination of water bodies, and chemical oxygen demand (COD) is the use of such methods as spectrophotometry, high potassium acid. By means of chemical methods such as dichromate method to determine the amount of redox substances in contaminated water, the 1987 Shanghai Fujian region to carry out water pollution emission rights trading, by 2008 a total of 37 transactions, the amount of 13.91 million, is the earliest chemical oxygen demand emissions trading pilot. By the end of 2013, the amount of emissions trading amounted to nearly 1.05 billion yuan, the amount of paid use of nearly 2 billion yuan. Although the emission trading pilot has made some achievements, but because there is no unified and reasonable emission right pric-

ing method, there are significant differences in the initial distribution price and transaction price of emission rights in various regions, such as the price of cod emission right in Shanxi province reached 29,000 yuan/ton, while the price of cod emission right in Inner Mongolia Autonomous Region is only 1000 yuan/ton. The difference between the two is 29 times, some regions refer to the initial distribution of emission rights in other regions, do not take into account the differences in the region, resulting in the price of emission rights too high or too low, unreasonable prices can not only effectively control pollution may also cause emissions trading market chaos but hinder the promotion of emission rights trading work. Initial emission right pricing is the key problem in the process of emission right trading, and reasonable pricing can effectively motivate enterprises to participate in pollution control and promote emissions trading.

The severe situation of water pollution on the one hand threatens human health and life at the same time also hinders economic development, protects the source of life, effective control of water pollution is a major issue for all mankind, the highly developed market economy and a good financial environment make emissions trading possible, and severe water pollution makes emissions trading imperative. The key problem of initial emission trading is the pricing of initial emission right, according to Microeconomics, price should reflect the real value of commodity, and the price of emission right should reflect the real value of emission right. The low price of emission right can not effectively motivate enterprises to reduce pollutant emissions, while exorbitant prices will inhibit the economic development of enterprises, reasonable pricing can achieve the effect of controlling and managing pollution, from the practical effect of the pilot of emission rights trading in China, the price difference of emission right for paid use in various regions is significant. The price of emission of chemical requirements ranges from 1000 yuan/ton to 29,000 yuan/ton, because there is no unified and reasonable pricing method, so that the price of cod emission right has deviated from the real value, not only is not conducive to the smooth running of sewage discharge rights, but also affects the realization of emission reduction targets, especially in the initial stage of emissions trading. Therefore, it is of great significance to study the pricing of initial discharge right of sewage, so that reasonable fair trade of sewage discharge right will finally reach the goal of controlling sewage protection water resources. On the one hand, it can provide a reference theoretical method for the pricing of initial discharge right of sewage, on the other hand, it has certain reference significance for promoting the pilot of emission right trading at home and abroad, and also provides reference for other initial emission right pricing (such as sulfur dioxide emission trading, carbon dioxide emission right transaction) in other regions.

2. Overview of Research of Domestics and Abroad

2.1. Overview of Domestic Studies

Because of the negative externality of sewage discharge, in order to reduce and

eliminate external non-economic, to ensure the sustainable development of water environment resources, the implementation of environmental property rights transactions is necessary. Attack Bright (2012) from the point of view of water environmental capacity scarcity, it is necessary to propose the implementation of water pollutant emission rights trading, analyze the existing software (such as existing emissions trading experience and accounting methods) and online monitoring system and other hardware conditions, pointing out that water pollutant emission rights trading is feasible [1]. Shanna (2011) According to the theory of externality of traditional economics and Coase theorem and the present situation of water environment, this paper points out the necessity of the transaction of sewage discharge right, and obtains the implementation condition of sewage discharge right trading in Panyang Lake Economic Ecological Zone from the aspects of technology, policy and society [2]. Because of the urgent problem of environmental pollution, the emission trading mechanism, as an effective tool to control pollution, has attracted more and more scholars' attention, at present, the domestic research on emission rights mainly focuses on carbon emissions, in addition to studying the price of emission rights also studies the distribution of emission rights [3], emission rights optimization allocation [4] [5] [6]. Emission rights laws and regulations, emission rights trading system and other aspects, many scholars on the domestic and foreign emissions trading practice analysis and evaluation [7] [8] [9].

For the research on the price of emission right, domestic scholars mainly study the pricing of emission right, the price of emission right in different industries and the influencing factors of emission right price.

1) Research on initial emission right pricing

The pricing models and methods of emission rights mainly have futures pricing method, resource shadow price pricing method, recovery cost method, general equilibrium model, dynamic game model and so on. Feng Lu (2014) based on the characteristics of carbon emission rights, futures pricing under three different conditions is constructed on the basis of futures pricing model: Holding cost pricing model, non-arbitrage pricing model, futures pricing model under incomplete market conditions [10]. He Mengxu (2011) in the perspective of financial engineering, this paper studies the pricing and initial distribution of carbon emission rights in China, and holds that options can be introduced into the pricing of carbon emission rights [11]. Some scholars believe that shadow prices determine the price of emission rights, the shadow price of resources reflects marginal benefits, so the shadow price of pollutants can reflect its marginal cost, according to the shadow price of pollutants can calculate the emission price of pollutants, Guan Lijuan (2012) and other people through the construction of resource shadow price pricing model, calculate the initial emission right of carbon dioxide from Shanghai to 509 yuan/ton and the initial distribution of emission rights in 9 districts of Shanghai of which the Pudong new area has a carbon emission quota of up to 79.5332 million tons and a Jingan quota of only 169,400

tons [12]. Ye Bin (2012) constructs the shadow price model, uses the linear plan to price the carbon emission right of the Shenzhen power industry, and analyzes the influence of different power generation modes on the price of carbon emission right [13]. The initial price should be formulated in combination with the time limit of emission right and the social average pollution control cost of different pollutants under the discount rate and the factors such as regional economic development, industry level and enterprise equity, Shiniping (2011) used the replacement cost method to take the urban emission right as the research object. By investigating the social average processing costs of 1720 sewage companies in a given city, the initial distribution price of chemical oxygen demand and sulfur dioxide emission rights in the city is 28,900 yuan/ton, 13,400 yuan/ton [14]. Luo Zhixia (2014) believes that in the general equilibrium model, the price of carbon emissions is equal to the marginal cost of emission reduction [15]. Li Shuying (2012) through the establishment of the initial discharge right of sewage Bayesian Nash equilibrium and sequential game equilibrium model [16], it is concluded that three northeastern provinces Liaoning, Jilin, Heilongjiang Sewage initial discharge rights price of 2027 yuan/ton, 1211.85 yuan/ton, 1377.52 yuan/ton. Ai Jianghong (2011) used dynamic game theory to analyze the initial price of carbon emissions in the power generation industry, it is concluded that the price of carbon emission rights is formed through the game between the government and power generation enterprises and power generation Enterprises [17]. Han Guowen (2014) The internalization of the environmental cost of carbon emissions is regarded as the production cost of the enterprise into the production function of the enterprise, combined with the Var model, it is concluded that the price of carbon emission right is equal to the carbon value in the fully competitive market, in which the carbon value is the value produced by a unit of CO_2. Data on carbon emissions trading in the European Union for the period 2011 verified that the price of carbon emissions was determined by the carbon value [18]. Shen Jianfei (2015) considers the cost associated with emission rights as the intrinsic value of the enterprise, constructs the carbon emission right pricing model through the quantitative benefit analysis method, and obtains that the price range of carbon emission right is 127.2 yuan/ton - 188.8 yuan/ton [19]. Zhu Help (2011) combined with least squares support vector machine, data grouping processing method, particle swarm algorithm three methods to construct the international carbon emission right market price forecast model, and through the EU Emissions Trading Mechanism (ETS) carbon transaction price for an empirical analysis [20]. Gao Yang (2014) the least squares support vector machine and particle swarm algorithm are also used to construct the international carbon emission right price forecast model combined with the empirical modal decomposition method, and the European ice Carbon Emission Futures exchange (Intercontinental Exchange) is selected. The closing price of carbon emission right futures trading in the period 2008-2013 was simulated and verified [21].

2) Study on the price of emission rights in different industries

Due to the large differences in the cost of pollution control in different industries, so the price of emissions in the same industry is also different [22], Jiangsu Province. According to the industry differences in the implementation of the initial emission rights price is also different, including steel, electroplating, paper industry and other heavy pollution industry sewage initial discharge right price of 4500 yuan/ton. And the general industry's initial discharge of sewage right price is 2600 yuan/ton, Jiaxing, Zhejiang province will be the sewage enterprises into heavy pollution industry, restricted industries and incentive industries, and the implementation of the initial emission rights price is higher than 80,000 yuan/ton, 60,000 yuan/ton, 50,000 yuan/ton, the use of the term is 20 [23]. And Wenzhou paper, chemical, electroplating, tannery and other heavy pollution enterprises, chemical requirements emission rights initial distribution price of 29,300 yuan/ton, the general industry for 24,600 yuan/ton [24].

3) Study on the influencing factors of emission right price

The price of emission right is affected not only by industry difference but also by policy and system. Chen Xiaohong (2012) analyzes the price of carbon emission right from three factors of supply, demand and market, and finds that quota supply affected by policy and system is the most important influencing factor of transaction price. However, with the improvement of the policy and trading system, the degree of influence gradually becomes smaller [25], in the analysis of the Chicago Climate Exchange carbon Financial transaction price found: carbon emission rights market prices are mainly affected by energy prices and quota supply and demand [26]. Wang Yulu (2012) believes that the price of carbon emission rights mainly includes supply demand, oil, natural gas and coal energy prices, more carbon emissions of industry production and attitude towards energy conservation, in which the distribution of emission rights through the impact of the supply of emission rights, thus affecting the price of emission rights, especially in the early stages of the implementation of emissions trading. The introduction of looser emission rights quotas in general, as a result of reduced market resistance, often results in excessive free distribution, resulting in lower emission rights prices [27].

2.2. Overview of Foreign Studies

Emissions trading was first proposed by J.h.dales in "pollution, wealth and Price" published in 1968, and Tietenberg made a comprehensive and systematic exposition of the idea of emissions trading in his book Emissions trading-pollution control policy reform. The United States first applied the concept of emissions trading to river pollution and atmospheric pollution source control, other developed countries such as Australia, Germany and the United Kingdom also began to implement emissions trading, the United States began to adopt a "benchmark-credit" model of the emissions trading system, and gradually established the "Bubble", "Offset", "Bank" and "Netting" as the core of the emissions

trading system, by 1990 to implement the "Acid Rain Plan" based on "Total Control", and the establishment of a legal regime for emission rights. As a tool of effective pollution control based on market, emission trading has been concerned by scholars, and foreign scholars' research on emission rights mainly involves emission right price, emission right distribution [28], emission right trading market and market power [29], emission trading cost [30], EU emission trading mechanism (ETS) management [31] [32] [33] and many other fields.

The study of emission right price by foreign scholars is also divided into three categories: the study of emission right pricing, the analysis of emission right price fluctuation and the study of the influencing factors of emission right price.

1) Research on emission right pricing

The emission right pricing models adopted by foreign scholars mainly have general equilibrium model, Garch model, option pricing model and so on. The general equilibrium model holds that the price of the emission right is equal to the marginal emission reduction cost, while the equilibrium model assumes that the market is a fully competitive market, and when the product market is monopolized, the marginal emission reduction cost is no longer equal to the equilibrium price, because the search cost, the information cost, the bargaining cost and the transaction cost of the settled settlement cost and the trading cost of the emission right make the marginal emission reduction cost deviate from the market price [33]. Chevalier J. (2010) constructed AR (1)-GARCH (1,1) carbon price forecasting model [34], Suk Joon Byu (2013) compared GARCH model, K near neighbor algorithm and implied volatility three methods to the ability to predict carbon emission rights futures prices [35]. The study found that the forecast price of carbon emission right derived from the Garch model was better than that of the other two models. Wang Y D (2012) found that the multi-variable model GARCH family model is better than the single-variable model GARCH family model for the price prediction in the energy market [36]. Eric Paul (2010) studied European carbon option pricing [37].

2) Analysis of emission right price fluctuation

Moderate emission licensing prices have a significant impact on consumer and investor decision-making in the global energy market [38] [39], license price fluctuations may lead to delays in investment in emission reduction technologies and increases in emission reduction costs, and setting the upper and lower limits of license prices is a direct way to limit price fluctuations. Some scholars have shown, through simulation studies, that the upper and lower limits of the set license price can be cost-effective (Burtraw *et al.*, 2010; Fell and Morgenstern, 2010) [40] [41]. License storage allows companies to hedge against the risk of license price fluctuations arising from uncertainty about governance costs and emissions. Kijima *et al.* (2010) also considers that allowing emissions storage to reduce emission price fluctuations [42], Alberola and Chevallier (2009). It was found that the lower spot price of EU emissions trading in Phase I (2005-2007) was mainly due to the non-restriction of emissions storage [43], but the mere

introduction of licensing storage without other policies (such as price controls) could put the price of emission permits high at an early stage, Introduction of licensed storage simultaneous price control on the one hand, to prevent the initial license price is high, on the other hand, can reduce the price fluctuation to promote the stability of the license price [44]. Li Xu (2014) believes that the introduction of financial options in emissions trading can reduce licensing price fluctuations, options can hedge the uncertainty of future spot prices. At the same time, stimulating investment in emission reduction technologies to achieve emission reduction targets, Masaaki Kijima (2010) and Fatemeh Nazifi (2010) point out that if a system allows proper licensing of lending and storage can weaken the surge in forward and spot prices [45] [46].

3) Analysis of influencing factors of emission right price

Emission trading markets are often incomplete competitive markets, dominant companies can exercise market power, increase pollution control costs for other companies, reduce their own emission control costs, and the misuse of market power can lead to price distortions, inefficient output, redistributive economic rent-seeking and other issues. Since the emissions trading market is not fully competitive market, oligarchs use market power to manipulate license prices, Makoto Tanaka (2012) believes that the appropriate initial allocation of emission rights licensing is an effective tool to weaken the abuse of such market power, through model analysis to draw two conclusions. One is that the transfer of licenses from oligarchs to other enterprises in the initial distribution can usually weaken market power, lower license prices, raise social surpluses, and when other enterprises emit less, transferring permits from heavily polluted oligarchs to less polluting oligarchs can also reduce market power and emission license prices [47] [48] [49]. Timothy N Cason (2003) found, through experimental studies, that monopolistic emissions trading prices and sellers' profits were higher but less efficient than double-headed monopolies, and that monopolistic emissions trading prices, profits and trading volumes were usually closer to competitive equilibrium than to monopolistic equilibrium [50] [51]. GDP, climate, emission reduction technologies, energy prices, and political risks may also affect the price of carbon emissions [52] [53]. Anger N. (2008) the distribution of emission rights is found to affect the price of emission permits, noting that if the licensing is strictly allocated, the supply of emission permits will be reduced and the demand may rise, thereby increasing the license price. CONVERY (2007) points out that both real energy prices and expected energy prices affect the price of carbon emissions.

3. Review of Research Domestics and Abroad

From the research situation domestics and abroad, we can see that the research object of domestic and foreign scholars is mainly carbon emissions, at the same time, scholars at home and abroad have analyzed the EU emissions trading mechanism, and there are many consistent topics in the research of scholars at home

and abroad, but the research angle is different, because the foreign developed countries emission trading mechanism is implemented earlier. In practice and theory has a certain advanced nature, domestic emission rights trading started late is still in the pilot stage, so that scholars at home and abroad in the study of a great difference, domestic scholars on the price of emission rights related research mainly focused on the basic level. This paper mainly discusses the calculation of the initial emission right price, while foreign scholars mainly study the market price forecast of the emission license, and study the pricing of emission right financial derivatives such as carbon financial price, the fluctuation behavior of the emission license price in the market and the research on how to limit the price fluctuation, the research is mainly based on the experimental simulation.

Many domestic and foreign scholars are devoted to the study of emission right pricing, and have achieved certain results, which provides theoretical reference and practical guidance for the pricing of emission rights, but there are still many questions about whether these pricing models should be applied to the current emissions trading in China.

Some of these initial emission rights pricing methods are more complex, practical operation is difficult to apply in practice, for example, in the process of dynamic game, multiple games after the formation of the emission right price process there is a high information cost, resulting in low willingness to participate so that it is difficult to form a reasonable emission right price.

Some models need to meet strict assumptions and these assumptions are often not established in practice as shadow pricing method is in the optimal allocation of emission rights, shadow price is equal to the price of emission rights, and because of transaction costs, information asymmetry, market monopoly and other existing emission rights are difficult to achieve optimal allocation. The futures pricing model needs to meet the assumption that the market is frictionless and there is no transaction cost, but the transaction cost such as search cost, information cost, bargaining cost, pricing settlement cost and so on inevitably arises in the process of emission right trading.

The emission right pricing model established by some scholars is limited to one pollutant in a particular industry, while there is no analysis of the applicability of emission rights pricing for other pollutants in other industries, such as the pricing of carbon emissions rights in the power industry.

Due to the imperfect domestic emission trading market, many emissions trading data have not yet been generated, in the use of pricing models (such as futures pricing model) budget emission rights prices mainly draw on more mature foreign emission rights related data, not applicable to China's current emissions trading model.

4. Conclusion

According to the relevant literatures domestics and abroad, there are many literatures to study the pricing of carbon emission rights, and there are relatively

few literatures to study the pricing of initial discharge rights of sewage, and the future research can select the initial discharge right of sewage as the research object, and construct the pricing model of the initial emission right of system dynamics wastewater. On the one hand, the system dynamics pricing model can not only calculate the price of future emission right, but also distinguish the key factors that affect the price of initial emission right, provide some reference guidance to the governments and enterprises, and help to grasp the price of emission right better. On the other hand, because the system dynamics pricing model does not require strict assumptions, its application scope is wide, and not only applicable to different regions of the initial emission right pricing and also applicable to different pollutant emission rights pricing, according to the industry coefficient and regional difference coefficient. You can price the emission right in different parts of the same industry, and the actual operation is simple; reasonable and effective results can still be simulated in the absence of parameters. It can provide decision-making basis for government macro-and micro-environmental governance and pollution control.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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