Advances in Economics, Business and Management Research, volume 212
7th International Conference on Economy, Management, Law and Education (EMLE 2021)

Research Progress and Review of Water Rights Trading in China

Dan Wu[1,*] Xiaoqian Xiang[1]

[1] School of Economics and Management, North China University of Technology, Beijing 100144, China
[*]Corresponding author. Email: wu_daniel@163.com

ABSTRACT
With the deepening of research on water rights trading in China, the system of water rights market system has gradually been mature and improved continuously. With reference to the existing literature, this paper systematically sorted out the research progress of water rights trading patterns and models in China, and reviewed the literature on water rights trading. According to the research results, through more than 20 years of practical exploration of water rights trading, China has formed four main models of water rights trading: water entity trading model, water ticket system trading model, water-in-taking permit trading model and water bank trading model. Studies on water rights trading models mainly focused on two aspects: the price mechanism of water rights trading and cooperative game model research. How to consider both water quantity scarcity and water quality scarcity, explore China's water rights trading model according to local conditions, and build a practical water rights trading model that includes complex hydrological conditions and water resources utilization characteristics, etc., still needs to be further studied.

Keywords: *Water rights trading, Market, Pattern, Model, Mechanism.*

1. INTRODUCTION

As an important means of regulating the uneven distribution of water resources in time and space and achieving optimal allocation of water resources, water rights trading is a market-based means of redistributing water rights in administrative areas, thereby effectively improving the efficiency of water resources utilization in administrative areas and their sectors. Since 2000, China has continued to conduct in-depth research on a water rights market system that is adapted to China's national and water conditions. In 2005, the State Council made the construction of a national water rights system a key element in deepening the reform of the economic system. The Eleventh Five-Year Plan for national development proposed "the establishment of a national system for the initial allocation of water rights and a system for the transfer of water rights". In 2011, the Document No. 1 "Decision of the CPC Central Committee and State Council on Accelerating Water Resources Reform" issued by the Communist Party of China (CPC) Central Committee proposed to implement the strictest water resources management system and establish "three red lines" and "four systems" for water resources management, so as to promote the water rights system. During the Twelfth and Thirteenth Five-Year Plans, the State Council issued a series of policy documents, such as the "Opinions of the State Council on Implementing the Strictest Water Resources Management System", the "Assessment Measures for Implementing the Strictest Water Resources Management System", the "Action Plan for Water Pollution Prevention and Control", the "Overall Plan for Reforming the Ecological Civilization System", and the "General Plan for Reforming the Ecological Civilization System", "Notice on Launching Pilot Work on Water Rights", "Interim Measures for Managing Water Rights Trading", and "Action Plan for Double Control of Total Water Consumption and Intensity in the 13th Five-Year Plan" to strengthen the management of water rights

*Funds: Youth Fund Project of Humanities and Social Sciences, Ministry of Education (21YJCZH176); Beijing Natural Science Foundation (9202005); Project of Beijing Urban Governance Research Base of North China University of Technology (21CSZL24); Yuyou Talent Project of North China University of Technology (XN020035).
CLCN: TV213.4

and improve water rights market system. In this regard, the research progress and review of China's water rights trading patterns and models are conducted based on the practical exploration and theoretical research results of water rights trading in China, in order to provide reference for deepening China's water rights trading research.

2. RESEARCH PROGRESS OF CHINA'S WATER RIGHTS TRADING MODEL

Wang Shucheng, the former Minister of Water Resources, proposed [1] that basin water resources management should establish an operational mechanism of governmental macroeconomic regulation and control, democratic consultation, quasi-market operation and water users' participation in management, providing an effective operational path for the improvement of water rights management system. Numerous scholars in academia have conducted hotspot studies and in-depth discussions on the principles of initial water rights allocation and allocation models. Water rights trading refers to the act of transferring the right to use water resources between localities and sectors (industries) for a fee based on differences in water-use efficiency and water saving costs [2]. Among them, rights to use water resources are sold from water-rich areas to water-poor areas due to differences in natural endowment of water resources, initial water rights allocation, water development and use, and water consumption. Due to the difference of input-output efficiency of water resources among departments (industries), the industrial departments invest in the agricultural department for water-saving transformation through the way of water rights replacement, so as to use the saved water for industrial production, which has been widely used in Inner Mongolia and Ningxia. In 2000, China launched the first case of "Dongyang-Yiwu" water rights trading in Zhejiang Province, marking the beginning of water rights trading in China. In 2012, Document No. 3 "Opinions of the State Council on Implementing the Strictest Water Resources Management System" issued by the State Council proposed to "establish a sound water rights system, actively foster a water market, encourage water rights trading, and use market mechanisms to allocate water resources rationally". The "National Agricultural Water Conservation Programme (2012-2020)" proposed that "regions with the conditions should gradually establish a trading mechanism for water conservation, build a trading platform and protect the legitimate rights and interests of farmers in the transfer of water rights". Since 2014, the Ministry of Water Resources has selected seven provinces (autonomous regions), such as Ningxia, Jiangxi, Hubei, Inner Mongolia, Henan, Gansu and Guangdong, to carry out pilot work on the registration of rights to use water resources and water rights trading, marking the rapid development of China's water rights trading into a substantive operation. In September 2015, the Central Committee of the Communist Party of China and the State Council issued the "General Programme for the Reform of the Ecological Civilization System", proposed that "the construction of water rights trading platform should be carried out, and the Ministry of Water Resources should take the lead in implementing the water rights trading system". In 2016, the Ministry of Water Resources issued the "Interim Measures for the Administration of Water Rights Trading", dividing water rights trading into three types, namely, regional water rights trading, water-drawing right trading and irrigation water users' water rights trading according to the type of authentic rights, the subject and scope of the trading. In addition, this document made specific provisions on the subject and duration of the trading, the price formation mechanism of the trading and the operation rules of the trading platform, marking the development of water rights trading into a mature stage in China.

Through more than 20 years of practical exploration of water rights trading, China has formed four main water rights trading models: the water entity trading model, the water ticket system trading model, the water-intaking permit trading model, and the water bank trading model [3] [4]. Specifically, firstly, the water entity trading model is represented by the Zhoushan water rights trading and the "Dongyang-Yiwu" water rights trading, where the trading object is a certain amount of water resources or water ownership, and is also known as the commodity water trading model. Secondly, the water ticket system trading model is represented by water rights trading between agricultural water users in Zhangye City. With the use of the water ticket system, farmers pay a water ticket for water before using water, and if they use water excessively, they need to buy water from users who have saved on their water tickets through market transactions, and the water tickets saved by farmers are transferable. Thirdly, the Yellow River Conservancy Commission has proposed a "water-drawing rights permit" trading model and developed the "Implementation Measures for the

Transfer of Water Rights in the Yellow River" to improve the utilization efficiency of water resources in the Yellow River and to regulate the water rights trading market. "The water-drawing rights permit" is a water rights trading practice that is applicable to the allocation of water resources in the basin. Fourth, the water bank is an enterprise operation organization similar to the bank established under the macro-control of the national water administrative department, which takes water resources as the service object [5]. The role of the water bank is similar to that of the financial bank. Through the "water bank", those with surplus water rights store the remaining water rights and benefit from them, while those in need of water pay funds and borrow water rights to meet their water needs [6]. For example, in Beijing's Daxing district, water banks are set up by village and town water associations to act as intermediaries in water rights transactions. In addition, scholars have explored diversified water rights trading models based on China's national water situation. For example, Jia Dan et al [7] explored water rights trading models of desalinated seawater, i.e. desalinated seawater directly entering the municipal pipeline network, desalinated seawater being sold to users directly, desalinated seawater being sold after self-use, and desalinated seawater exchanging for water rights to support key industries. Combining contractual water saving management with water rights trading, Wang Yin et al [8] proposed two trading models: "water saving before trading" and "pre-selling before saving", as well as two types of trading: storage and direct sales and commissioned sales. Zhang Jianbin et al [9] proposed a water trading model of "quality for quantity", whereby industrial enterprises invest in water pollution control projects in exchange for water to alleviate water quality hydropenia. Considering China's actual situation and starting from the rationality of bivariate water rights transaction, Guo Fei et al [10] put forward three transaction models: bivariate comprehensive transaction, pricing by quality, fixed value by quantity and trading by quality and quantity.

3. RESEARCH PROGRESS OF WATER RIGHTS TRADING MODEL IN CHINA

According to the "Dongyang-Yiwu" water trading practice in 2000, scholars have deepened their researches on the theoretical model of water trading, and the model of water trading based on game theory has become a research hotspot. For example, Kong Ke et al [11], [12] established a two-stage dynamic game model based on the behavioural characteristics of water users in the water market, maximizing total benefits. Chen Hongzhuan et al [13], [14], [15] established a game pricing model for the quasi-market and water market phases of water rights trading based on game principles and methods, and analyzed the decision-making mechanisms for pricing water rights trading in the quasi-market and water market phases respectively. Li Changjie et al [16], [17], [18] established an incomplete information Bayesian game model and mechanism for the auction between buyers and sellers in the water rights trading market. Wu Li et al [19] built a cooperative game model for water rights trading that is compatible with the characteristics of the market under macro-regulation in China by analyzing the trading information of both sides of water rights trading in China, getting a Nash Bargaining solution to obtain the trading price of water rights. In addition, Wang Huimin et al [20] applied the theory of complex adaptive systems to establish a CAS model for water rights trading and validated the effectiveness of the water rights market mechanism by simulating it through the SWARM platform.

In 2016, the Ministry of Water Resources issued the "Interim Measures for the Administration of Water Rights Trading", which specified the scopes and types of tradable water rights, trading subjects and duration, and trading prices. In the same year, the China Water Rights Exchange was officially launched. Since then, scholars have begun to conduct research on the price mechanism of water rights trading based on empirical data in China, and studies on water rights trading have been further deepened and water rights trading models have been enriched. Zheng Hang et al [21][22][23] analyzed and proposed a mathematical model of market-based water rights trading based on the basic rules of market-based water rights trading, and studied the quoting behaviour and risk-averse strategies of traders under the market-based trading model. Zhang Jianling et al. [24] took the water receiving area of Henan Province as the research object, drew lessons from the existing water rights trading theory, and constructed a water rights trading model based on the water-saving and efficiency, so as to increase the goal of cities in the water receiving area and solve the imbalance between supply and demand of water resources in the areas along the line. Based on AHP-CRITIC method and fuzzy identification model, Zhang Wenge et al. [25] analyzed the main factors

affecting the reasonable earnings response coefficient, and proposed a method to determine the reasonable return coefficient of water right transaction price in water shortage areas. Wu Fengping et al [26] constructed an adaptive water rights trading system based on the theory of complex adaptive systems, analyzed the actors of water rights trading under market orientation, and constructed a theoretical framework of the price formation mechanism of water rights trading based on market orientation.

4. CONCLUSION

The study of water rights trading is a hot research topic in the field of water resources management in China, and the existing water rights trading patterns and models in China have served as a good guide for the practice of water rights trading. Theoretical in-depth analysis of water rights trading is as follows.

The development of China's water rights trading model is not perfect. Firstly, the time span of the water entity trading model is too long to solve the water supply difficulties in arid areas in a timely manner, which is only applicable to smaller water rights transactions. Large-scale water rights trading requires the construction of diversion projects, which increases transaction costs, and the water entity trading model is unable to meet large-scale water rights trading. Secondly, the water ticket trading model can only be limited to a certain area and is confined to small-scale water rights trading between individual water users, with the government playing an important role in the trading process. The water ticket trading model puts farmers in a passive position, restricting the freedom of water rights trading subjects and affecting their motivation. The water-intaking permit trading model requires an allocation of water for the entire river, which is currently only met by the Yellow River basin and cannot be replicated on other rivers. Research on China's water banking trading model is mainly confined to the establishment of water banks, their modes of operation and related systems or the feasibility of water banking. Comparing the international experience of water banking applications, further research is needed on how to achieve the full application of water banking in China. Therefore, although the existing water trading model in China has to some extent alleviated the problem of water scarcity between different regions or sectors (industries), it is not suitable for nationwide replication. Further research is needed on how to explore China's water rights trading model in the light of local conditions.

China's water market is based on a complex ecological-hydrological-economic-social coupled system of water rights trading, which is influenced by many factors such as hydrological characteristics, such as water resources management systems, water use efficiency and social culture. Existing models of water rights trading do not take into account the complexity of the water resources system, the balance between water resources supply and demand, the characteristics of the water rights system and the responsibilities and powers of the government, and are not sufficiently comprehensive to be operable in practice. Further research is needed on how to construct a practical water rights trading model that incorporates complex hydrological conditions and water resource use characteristics.

With the development of nationwide water rights trading pilots, research cases have developed from arid regions such as Gansu, Inner Mongolia and Ningxia to water-rich regions such as Hubei, Jiangxi and Guangdong, and have begun to explore the construction of water markets in key areas such as the upper reaches of the Yellow River and Yangtze River, the Xiongan New Area and along the South-North Water Diversion Route. Through the continuous exploration of national and provincial water rights pilot work, the water rights and water market has made greater progress overall, but there are still shortcomings. Current examples of water rights trading practice largely consider only water quantity and ignore water quality. Further research is needed on how to consider both water quantity-based and water quality-based water shortages and to conduct research on water rights trading to address water shortages comprehensively and effectively. Therefore, innovative design of new water rights trading patterns and models that are adapted to the characteristics of China's regional water situation has become a major direction for future water rights trading research.

AUTHORS' CONTRIBUTIONS

Dan Wu is responsible for experimental design and writing the manuscript and Xiaoqian Xiang responsible for research collection and writing the manuscript.

REFERENCES

[1] Wang Shucheng. Water rights and markets — economic instruments for optimal water allocation [J]. China Water Resources, 2000(11):6-9. (in Chinese)

[2] Shen Manhong. Water Right Transaction and Governmental Creation [J]. Management World, 2005(06):45-56. (in Chinese)

[3] Chen Guanghua, Rui Zhiwen. Legal Analysis of Transaction Model of Water Rights from the Perspective of Constructing Water Bank System [J]. Journal of Henhai University (Philosophy and Social Science Edition), 2010,12(04):48-52+91. (in Chinese)

[4] Zeng Yushan, Lu Sugen. Analysis of Water Right Transaction Mode in China [J]. Journal of Xuzhou Institute of Technology (Social Sciences Edition), 2015, 30(04): 66-71. (in Chinese)

[5] Wang Jia, Luo Jianzhao. Study on the Regional Water Bank System [J]. Journal of Anhui Agricultural Science, 2006(13): 3239-3240. (in Chinese)

[6] Zheng Shuli. Research of Zhejiang "Water Bank "operation mode and guarantee mechanism [J]. Territory and Natural Resources Research, 2009(04):86-87. (in Chinese)

[7] Jia Dan, Liu Shujing, Wang Jing, Xing Shuying, Xu Xian. Research on the participation of desalination in water rights trading model in China [J]. Journal of Economics of Water Resources, 2017,35(04):34-37+76. (in Chinese)

[8] Wang Yin, Zhou Weiwei, Fan Jingming, Zhang Bin. A study on the model of water rights trading involving water savings from public pipe network contracts [J]. Journal of Economics of Water Resources, 2019, 37(06):76-79+88. (in Chinese)

[9] Zhang Jianbin, Li Mengying, Zhu Xuemin. "Quantity by Quality":New Dimension of Water Rights Transactions Reform — Logic Origin, Requirements Explanation, Possibility of Implementation and Policy Guarantee [J]. Journal of Chongqing Technology and Business University (West Forum), 2019, 29(05):93-100. (in Chinese)

[10] Guo Fei, Chen Xiangdong, Liu Rui, et al. Study on Trading Models of Water Rights Trading with Water Quality and Water Quantity Variables [J]. Yellow River, 2021, 43(2):79-83. (in Chinese)

[11] Kong Ke, Xie Jiancang, Yue Xinli, et al. Game analysis of water resources market [J]. Journal of Hydraulic Engineering, 2005(04):491-495. (in Chinese)

[12] Li Hhaihong, Wang Guangqian. The mechanism of the water right trade [J]. Journal of Hydraulic Engineering, 2005(04):104-109. (in Chinese)

[13] Chen Hongzhuan, Yang Zhen, Yang Xianghui. Price decision mechanics of Chinese water right trade in terms of game playing [J]. Journal of Hydraulic Engineering, 2006(11):1407-1410. (in Chinese)

[14] Feng Wenqi, Ji Changming. Study of market transaction game model in water resources optimal allocation [J]. Journal of Huazhong University of Science and Technology (Natural Science Edition), 2006(11):83-85. (in Chinese)

[15] Luo Hui, Li Liangxu, Wang Meihua, et al. Quasi-market design and its market equilibrium of tradable water rights [J]. Journal of Hydraulic Engineering, 2006(04):492-498. (in Chinese)

[16] Li Changjie, Wang Xianjia, Fan Wentao. Design of Mechanism and Bayesian Model of Water Rights Market [J]. Systems Engineering — Theory and Practice, 2007(05):90-94+100. (in Chinese)

[17] Zhang Xiaojun, Hou Hanpo. Optimal Allocation of Beijing's Water Resources Based on Cross-sector Water Rights Trading [J]. Journal of Capital University of Economics and Business, 2010, 12(3):68-73. (in Chinese)

[18] Dai Tiansheng, Gu Boyan, Zhao Wenhui. Analysis of Nash Equilibrium Model for Water Rights Market [J]. Journal of Harbin University of Science and Technology, 2011(01):132-134. (in Chinese)

[19] Wu Li, Zhou Huicheng. Study of the cooperative game model for water rights trade [J]. Journal of Hydroelectric Engineering, 2012, 31(03):53-58. (in Chinese)

[20] Wang Huimin, Tong Jinping, Lin Chen, et al. CAS-based Modeling and Simulation of Water Rights Trading [J]. Systems Engineering — Theory and Practice, 2007(11):164-170+176. (in Chinese)

[21] Zheng Hang, Chen Ben, Lin Mu. Bidding behavior in an optimal water trading model [J]. Journal of Tsinghua University (Natural Science Edition), 2017, 57(04):351-356. (in Chinese)

[22] Liu Gang, Yang Liu, Shi Yubo,et al. Empirical study on double layer dynamic game price decision mechanics ofwater rights transaction under Quasi-Market [J]. China Population Resources and Environment, 2017,27(04):151-159. (in Chinese)

[23] Tian Guiliang, Jia Meng. Empirical study on water right price influencing factors based on national platform data [J]. Resources and Industries, 2019,21(01):88-94. (in Chinese)

[24] Zhang Jianling, Dou Ming, Zhao Peipei, et al. Water Right Trade Model for Henan Intake Area of Water Transfer Project from South to North (Middle Route) Based on Water-saving and Benefit-increasing Target [J]. China Rural Water and Hydropower, 2017(10):158-162+168. (in Chinese)

[25] Zhang Wenge. Tan Li., Li Haobing. Study on Profit Coefficient of the Price of Water Rights Trading Based on Fuzzy Recognition [J]. Yellow River, 2019, 41(6). (in Chinese)

[26] Wu Fengping, Yu Qianwen, Shen Junyuan,et al. Theoretical framework of market-oriented pricing mechanism for water rights transaction [J]. China Population Resources and Environment, 2018, 028(007):17-25. (in Chinese)