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Transaction costs associated with agricultural water trading in the Heihe River Basin, Northwest China

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ABSTRACT

Trading in water via a market has become an effective way to deal with water resource scarcity. Transactions costs (TCs) are known to prevent markets from operating efficiently or from forming altogether. Therefore, evaluation of the level of transactions costs is an important precursor to establish an efficient water market. We analyze one water transaction scenario in the context of government regulation in Zhangye City in the middle reach of the Heihe River Basin (HRB) in China: water rights-trading between irrigation areas in agricultural use, which is one of the most urgent scenarios and maximizes the likelihood of a transaction in future. The results show that without calculating the transfer costs and the third-party effect costs, TCs per unit water range between 0.004 and 0.247 yuan/m^3 based on the set of transaction scales and cost limits in the middle reach of the HRB. Under the most realistic transaction case i.e., only one purchaser in the Luotuocheng irrigation district in Gaotai County and several sellers located in Ganzhou County, the lowest TCs per water are associated with trading between the Daman and Luotuocheng irrigation districts at a maximum trading scale of the water amount and with minimum costs. The highest TCs result from obtaining water from the Xidong intake in the Xijun irrigation district. In addition, given the highest permitted trading price of the local government-set standards (three times the agricultural water price, approximately 0.3 yuan/m^3), the transaction costs would range from 1% to 93% of the water trade price, and acceptable lower transaction costs can be obtained through appropriate operations and trading scales.

1. Introduction

According to the United Nations, roughly 0.46 billion people live in highly stressed water-use areas or countries; 1/4 of the global population faces water shortages and this proportion is expected to reach 2/3 by 2025 (UNWATER, 2007). The water crisis has seriously impacted the sustainable development of human beings; at the same time, human activities influence the stability and development of the water resource system, even the whole ecosystem (Bekchanov et al., 2015).

Water resources are in severe short supply in China, especially in inland river basins in the northwest region. The water resource per person in China is 2200 m^3, equal to 1/4 that of the rest of the world, and the water resource per person in the Heihe River Basin (HRB) is 1250 m^3 (An and Hao, 2007). The total net irrigation water quota is 15.05×10^8 m^3 in Zhangye City located in the middle reach of the HRB in 2011. There are only 6435 m^3 of irrigation water per hectare in Zhangye City (Zhangye City Water Management Bureau, 2012).

The whole world, including China, is coping with water scarcity. Because of the difficulties associated with developing a new water supply through engineering/technological means, water demand management measures have often become the key solution to deal with water availability issues (Harou et al., 2009; Randall, 1981); developing water markets for trading is an important option (Rosegrant and Binswanger, 1994). Water transactions have become a primary means to reconfigure the water source using a voluntary basis rather than laws and regulations (Weinthal, 2002). In early 2002, Zhangye City begun building a water-saving society and a tradable water market, the first project of its type in China.

Water rights trading can improve water use efficiency, promote water conservation (Rosegrant and Binswanger, 1994; Thobani, 1997), and increase the output per unit water use (Easter et al.,

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1998; Howe et al., 1986; Ringler, 2001). Moreover, if the trading price is high enough, it can promote the development and use of water-saving technology (Dinar et al., 1997; Wang, 2012). Nowadays, water markets in the USA (Colby, 1990), Australia (Crase et al., 2013), Mexico and Chile (Rosegrant and Binswanger, 1994) have expanded. Moreover, other governments like the South African (Thiam et al., 2015) and Chinese (Zhang et al., 2009) are currently calling for water markets. However, after more than 10 years of building water markets, water quotas and water rights trading is low and does not occur at a large scale in Zhangye City.

Due to the existence of various barriers and transaction costs (TCs), there are few countries like Australia or the USA that use the water market mechanism successfully (Bauer, 1997; Zhang, 2007). TCs usually affect the decision on whether a transaction will occur, the frequency of water transactions, their pricing and the net benefit (Colby, 1990; Hellegers and Perry, 2006; McCann and Easter, 2004; McCann et al., 2005). Therefore, it is a very important task to evaluate TCs for building the system and water market.

TCs were first discussed in the economics literature by Coase (1937). Cheung (1969), Williamson (1973, 1975, 1981), and North (1990) studied and developed the theory of TCs. According to Coase (1937), TCs are the costs of using a price mechanism. Williamson (1975) divided TCs into ex ante and ex post according to the time at which the contract was signed.

TCs are usually difficult to identify and measure because of incomplete information and uncertainty in any real economic society. Separating TCs into categories is important for effective measurement and policy design (McCann et al., 2005). There are several controversies with respect to the categories and meanings of transaction costs in water markets. For example, should we measure the cost of institutional change, the price paid for the water rights and the costs of implementing a transfer?

In practice, it depends on the boundaries, the stages of evaluation and the real situations of trading for which costs should be measured, see Table 1. Before a new policy is proposed or implemented, the changes in the institutional environment are required. In addition, total costs should include all the key components, which we refer to as the maximum boundary. Thompson (1999) developed an institutional framework that included enactment costs and implementation and monitoring/enforcement costs. At the stage of development of the tradable water rights system market, i.e., before the water market was implemented and after the legal system was completed, the government is involved in the reallocation of property rights that enable private trade. Given this background, McCann and Easter (1999) added initial research cost, information costs and contract costs based on Thompson's model. Zhang et al. (2009) identified and analyzed the TCs involved in the implementation of a tradable water rights system in the HRB in northwest China. This author separated TCs into the TCs associated with the water use rights (WUR) system implementation and the TCs associated with WUR trading. In his study, the TCs associated with the WUR system implementation were evaluated using the results of the water fee minus the production costs (such as maintaining canals, installing water meters, etc.) because of the analysis background and difficulty in obtaining data, which deviated from the original intention. The TCs associated with the water rights trading are in the minimum boundary when simply analyzing the costs involved with market transactions. In the market transaction, whether the transfer costs and third-party effect costs should be included depends on the situation of the specific water transactions (Table 1).

Researchers may have different measurement results related to water TCs if they measured different cost components, different institutional stages, or different backgrounds of different areas. Colby (1990) found that the policy-induced TCs (PITCs) averaged a small fraction (6%) of the price paid for water rights trading and the proportion of each American state may not be the same. The overhead costs incurred by the State Department of Water Resources were approximately 8% of the water purchase cost for the California Water Bank, which was operational (Howitt, 1994). In Chile, the water TCs ranged from 7% to 23% of the trading price based on farmers' investigation (Hearne and Easter, 1995). Brown et al. (1992) measured New Mexico TCs of water transfer, and found that the costs ranged from 2 to 1384 dollars per acre-foot; this wide range varied across different surface river basins. Moreover, this author found the average TC was 13% of the water price paid and the cost was 474 dollars for a 0–5 acre-feet transfer quantity, but only 4 dollars when the transfer exceeded 150 acre-feet.

Based on Zhang (2007)'s study, there are no geographical barriers, technical barriers, or cultural barriers to water markets in Zhangye City. Why is water rights trading so low more than ten years after the implementation of the tradable water markets? Were the TCs high enough to impede water rights trading?

In this paper, we assess the TCs in designed large-scale water rights trading between irrigation districts in Zhangye City in the HRB under the governmental water management institutions,

Table 1
Boundary and stage issues related to the components of transaction costs.

Boundary	Key components	Studies including these	Studies excluding these	Stage or situation of transaction cost measurement
Institutional environmental, legal system (the maximum boundary)	Enactment costs	Thompson (1999)	Rosegrant and Binswanger (1994)	Before a new policy is proposed or implemented
Development of market of the tradable water rights system (the medium boundary)	Costs of a Tradable water rights System Implementation	Thompson (1999); McCann and Easter (2004); Zhang et al. (2009)	Rosegrant and Binswanger (1994)	Before the water market is implemented or early implementation; some costs must be incurred during the whole period
Market transactions (the minimum boundary)	Information costs Negotiation and Contract Costs Enforcement Costs Monitoring Costs	McCann and Easter (2004); Zhang et al. (2009); Rosegrant and Binswanger (1994)		Almost always
	Conveyance Costs (transfer costs)	Rosegrant and Binswanger (1994)	Colby (1990), Zhang et al. (2009)	Long distance water transaction
	Third-party effect costs	Rosegrant and Binswanger (1994), Colby (1990), Qureshi et al. (2010)	Zhang et al. (2009)	Transaction across sectors or inter-basins

(1) Usually, the components of the TC in the maximum boundary include the latter two; the components of the TC in the medium boundary include the minimum boundary.
(2) Whether the transfer costs and third-party effect costs should be included depends on the situation of the specific water transactions.