

# A framework for estimating the transaction costs of alternative mechanisms for water exchange and allocation

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[1] Alternative mechanisms for water transfers will differ in the types of transaction costs incurred as well as their magnitudes and incidence. This article presents a framework for including transaction costs as well as transfer costs in the evaluation of alternative mechanisms. The work on measurement of transaction costs associated with water markets has underestimated these costs by only focusing on the costs incurred once a market exists. The framework presented here also includes the costs associated with the development of a market mechanism. Once the appropriate framework has been developed, there are a number of measurement issues involved with incorporating transaction costs in the overall assessment of the efficiency of water allocation mechanisms. While the costs involved with the final transaction are relatively easy to measure, those involved with the initial information gathering, policy enactment, and design and implementation of a formal market mechanism are rarely documented. Similarly, it is much easier to measure transaction costs after the policy is implemented; however, it is necessary to predict costs to inform decision-making and improve policy design. *INDEX TERMS:* 6319 Policy Sciences: Institutions; 6324 Policy Sciences: Legislation and regulations; 6329 Policy Sciences: Project evaluation; *KEYWORDS:* institutions, transaction costs, water markets

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## 1. Introduction

[2] There has been intense interest in improving the efficiency of water use because of increasing scarcity and water quality issues. *Saleth and Dinar* [1999, 2004] indicate that institutional changes are needed to improve water allocation, make irrigation systems financially sound, and provide incentives for adoption of water-saving technologies since previous institutions were developed during a water surplus era. Water markets are usually suggested as one of the possible means to accomplish these objectives. The increased demand for water from the household and industrial sectors can be seen as driving the demand for institutional change.

[3] *Saleth and Dinar* [2004] indicate that there are economic, ecological, and political constraints to institutional change and that water markets need to be considered in the broader context of the design and implementation of alternative institutional arrangements. Institutional change is path-dependent [North, 1990], so costs will be affected by the current water institutions. In addition, the costs of implementing these new arrangements will be affected by a country's broader institutional environment, including the legal system. This article focuses on the transaction costs of moving to a new water allocation mechanism, taking this broader institutional environment as given.

[4] Transaction costs are real resource costs and must be quantified in order to be included in economic analysis. There have been a number of studies evaluating both the magnitudes and determinants of transaction costs involved with water transfers. The existing studies of the measurement of transaction costs associated with water markets have underestimated these costs by only focusing on the transaction costs incurred once a market exists. The costs of establishing a new allocation mechanism, such as a market, have not been estimated, but *Saleth and Dinar* [1999] indicate these costs may be considerable given political realities. Therefore, in assessing the efficiency gains from institutional change, the transaction costs of moving to the new allocation mechanism, including assignment of water rights, and the transaction costs associated with market sales versus administrative allocation need to be included in the analysis. Transaction cost measurement will also facilitate analysis of the determinants of transaction costs, which can be used to improve the design of water allocation mechanisms.

[5] This article provides a framework for estimating these transaction costs in order to facilitate comparison of alternative surface water allocation mechanisms and to enhance their design. There are four potential allocation mechanisms: (1) administrative allocation, (2) opportunity cost pricing, (3) informal tradable water rights, and (4) formal tradable water rights [Rosegrant and Binswanger, 1994; Easter et al., 1998], all of which will incur transaction costs. Our emphasis will be on moving from an administrative

allocation to formal tradable water rights, given the existing physical infrastructure.

## 2. Framework for Transaction Cost Measurement

[6] There are several definitions of transaction costs, including the costs of running the economic system [Arrow, 1969] and the expenses of organizing and participating in a market or implementing a government policy [Gordon, 1994]. Both of these definitions go beyond the costs involved with a particular market exchange. This is contrary to previous transaction cost measurement studies, but in line with the framework developed in this article. Stiglitz [1986] treats transaction costs and administrative costs as essentially interchangeable concepts, and this will be the convention used in this article since (1) water allocation can be affected through either administrative or market means and (2) the definition of rights which enables a market will involve government intervention. It is essential that any framework be general enough to include both market and nonmarket mechanisms since both alternatives may be under consideration.

[7] Separating out transaction costs into categories is important for valid measurement and policy design [McCann *et al.*, 2004]. A typology can be used to compare studies, ensure that all relevant types of costs have been accounted for, facilitate the collection of data, and improve policy design by highlighting relationships between types of costs. Also, different types of allocation mechanisms may have a different mix of costs or a difference in their relative importance which may help in explaining the fundamental determinants of transaction costs. Examples of types of transaction costs are discussed by a number of authors [Dahlman, 1979; Stavins, 1995; Foster and Hahn, 1993; Griffin, 1991; Conlisk, 1996].

[8] For the specific case of water transfers, Rosegrant and Binswanger [1994] list identifying opportunities, negotiating transfers, monitoring third-party effects, conveyance, mitigation of third-party effects, and resolving conflicts. They neglect the costs associated with institutional change necessary for moving to a market mechanism for the allocation of water, thus underestimating transaction costs. This issue of embeddedness is illustrated in Figure 1. Market transactions depend on the development of market institutions, which in turn, depend on the existing legal system. A useful transaction cost typology will incorporate both market transactions as well as institutional change.

[9] Thompson [1999] develops an institutional transaction cost framework, which incorporates enactment costs (and thus costs of institutional change) as well as implementation and monitoring/enforcement costs. The focus on enactment costs reflects the emphasis on the transaction, where property rights are implicitly or explicitly defined or redefined as the unit of analysis. Creating a market for tradable water rights requires decisions regarding the initial allocation, and therefore subsequent trades involve second-order transaction costs.

[10] McCann *et al.* [2004] have extended Thompson's model to include initial research and information costs, which are important for the full life cycle of an institutional change, and contracting costs, to highlight the issue of second order transaction costs. A typology for transaction

costs associated with a change to a market mechanism should thus include (1) research, information gathering, and analysis, (2) enactment of enabling legislation, including its design, (3) design and implementation of the policy instrument, (4) support and administration of the ongoing program, (5) contracting costs, which are relevant for the case where a market has been set up, (6) monitoring/detection, and (7) prosecution/inducement/conflict resolution. Most studies have only focused on some subset of these costs.

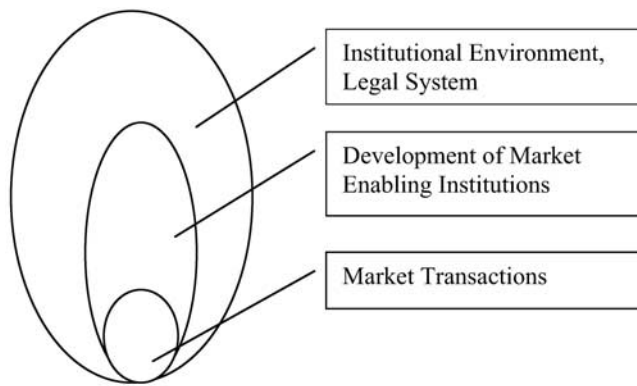
[11] There are a number of boundary issues concerning the measurement of transaction costs in addition to whether costs of research and institutional change are included. Costs involved in a water trade include the cost of the water itself, the conveyance costs, and other transaction costs, including transfer costs. In some cases it may be difficult to distinguish conveyance costs from other transaction costs. For example, is the design of a new water metering system a conveyance cost or a standard transaction cost? Rosegrant and Binswanger [1994] include conveyance costs as well as third-party mitigation costs in their use of the term transaction costs. It is important to determine whether conveyance costs are grouped with transaction costs when comparing studies, thus illustrating the importance of a typology.

[12] Transaction costs consist of both ex ante costs, such as information acquisition, which occur before the actual transaction, and ex post costs, such as contract enforcement, which occur afterward. Defining the transaction is not straightforward. Ramstad [1996] points out that J. R. Commons said that a transaction is a transfer of property rights, while O. Williamson said that a transaction is a transfer of a good or service across a technologically separable interface. One can relate the former to water rights and the latter to water. On one level the transaction could be thought of as occurring during the enactment of legislation or resolution of the issue through the courts, which would be in line with Commons' definition. At this point, changes may occur both in the definition of the privileges and duties associated with water rights as well as the assignment of rights. However, market transactions are subsequent to the initial assignment of rights, so these transactions would fit both Commons' and Williamson's definition. The two definitions thus correspond to the embeddedness illustrated in Figure 1.

[13] Once an appropriate framework or typology has been developed, measurement of transaction costs is facilitated. A discussion of methods that have been used to examine the magnitude of transaction costs and recommendations for future work are presented in section 3.

## 3. Methods for Transaction Cost Measurement

[14] There have been a number of transaction cost measurement studies related to water markets. S. C. Nunn (Department of Economics, University of New Mexico, Distinguishing technical from political transactions costs in water exchanges: The case of New Mexico, unpublished working paper, 1988) directly surveyed water users in New Mexico who had recently been involved in a water transaction to determine their transaction costs. Colby [1990] compared actual transaction costs among various western states and found that transaction costs averaged 6% of the price paid by the applicant to transfer water, although this varied by state, with a high of 12% in Colorado. Policy-



**Figure 1.** Boundary issues regarding transaction costs.

induced transaction costs to applicants ranged from \$54 per acre-foot (1 acre-foot = 1234 m<sup>3</sup>) in New Mexico to \$187 in Colorado. *Brown et al.* [1992], using a survey to examine transaction costs of transfers in New Mexico, found considerable variation among surface water basins, from \$2 to \$1384 per consumptive acre-foot. They also found economies of scale in transaction costs with an average of \$474 for transfers of 0–5 acre-feet and \$4 for transfers over 150 acre-feet. Transaction costs were ~13% of the price paid in their study. Overhead costs incurred by the State Department of Water Resources for the California Water Bank were ~8% of the water purchase cost [*Howitt*, 1994]. On the basis of a farmer survey, *Hearne and Easter* [1995] found that the transaction costs involved with water transfers in Chile represented 7–23% of the transaction price. It should be noted that none of these studies looks at the cost of developing market institutions. Also, in cases where transaction costs were expected to exceed net benefits a transaction would not be observed, so these measures have potentially underestimated transaction costs.

[15] Some indication of transaction costs associated with institutional change can be found in the Texas experience. *Griffin* [1998] reports that Texas water law, because of its history, has aspects of both prior appropriation and riparian rights, which created conflict. Adjudication of water rights in the Rio Grande Valley began in 1956, lasted 15 years, and cost \$10 million (nominal) in attorney's fees and court costs. The creation of a properly designed system of water rights has enabled active water markets there.

[16] There have also been transaction cost measurement studies in the area of agrienvironmental policy. Some researchers looking at environmental and natural resource policies have used either surveys or interviews to estimate transaction costs, which is time consuming and thus costly [*McCann and Easter*, 1999; *Kuperan et al.*, 1998]. However, it allows them to obtain information on the full range of relevant costs and on implicit as well as explicit costs. Government expenditure reports have been used by a number of researchers [*Falconer et al.*, 2001; *Falconer and Whitby*, 1999; *McCann and Easter*, 2000], which has the advantages of representing actual expenditures and not requiring surveys or interviews. There are a number of disadvantages, however, including (1) incomplete coverage of costs desired by researchers, (2) data poorly organized for research purposes in that it may be difficult to separate out costs for different policies or to clearly separate transaction costs from abatement or transfer costs, (3) often, the need

for cooperative agency contacts willing to pull together information, (4) the potential for confidentiality issues, and (5) the data can only be used for studies conducted after the fact. Access to people and data is a major problem faced by researchers examining transaction costs. Agency staff are concerned that this information may cast them or their program in an unfavorable light, but this information is necessary to make programs more efficient.

[17] Another problematic issue is implicit versus explicit costs. If the farmer pays a consultant or middleman to locate a willing buyer or seller, this is an explicit cost, but if they do this themselves, it is an implicit cost. In the public sector, reallocation of agency staff time is an implicit cost, while allocation of additional staff and monies is an explicit cost. Estimating the hours spent and then attaching an appropriate value to that time is a standard technique to deal with farm family labor, and a similar technique has been employed in estimating the implicit cost associated with agency staff time [*Egdell*, 1998; *Kuperan et al.*, 1998; *McCann and Easter*, 1999].

[18] One also needs to distinguish whether the transaction cost measurement is conducted before or after the policy decision or policy implementation. If several options are being evaluated prior to making a decision, it is necessary to try to predict transaction costs, but this may require surveys, which may suffer from hypothetical bias. Measurement after the fact is feasible only for the alternative that was actually chosen, but data such as financial records or government documents may be available.

[19] Systematically collecting information while the institutional change is being debated, planned, and implemented would be ideal, and governments should be encouraged to collect this type of information. A pilot environmental project in Australia includes measuring transaction costs as part of the evaluation (L. Strappazon, personal communication, 2001). *Dinar* [2000] suggests that data about ongoing water pricing reforms should be systematically collected using a common format. *Colby and D'Estrée* [2004] have developed a format for collecting data on conflict resolution which includes information relating to transaction costs.

[20] A framework for transaction cost measurement and improvements in methodology will facilitate work on the determinants of transaction costs. Knowledge of types of costs, when they are incurred, and their magnitudes can help researchers and policy makers isolate critical determinants of transaction costs and design more efficient institutions and procedures.

#### 4. Determinants of Transaction Costs Associated With Water Markets

[21] Transaction costs depend on history [*North*, 1990]. In this article we are assuming that a particular physical infrastructure is in place and that the current water allocation mechanism is some sort of administrative system. In cases where a new water system is implemented, design of infrastructure and definition and assignment of water rights should be done with a view to minimizing rent seeking and transaction costs and maximizing efficiency of water use. In other words, the system should be designed to facilitate water markets. Considerable thought needs to be given to the issues of what property rights are implicitly and explicitly being

conferred and what the ramifications are. *Challen* [2000] has shown that the property rights regime affects the transaction costs involved with water markets. *Gasmuri and Rosegrant* [1994] indicate that in Chile, new publicly funded irrigation projects require participation and commitment by potential water users. The design of irrigation systems and the infrastructure and administrative structure that was established when the irrigation system was built affect transaction costs associated with movement to a market-based water allocation mechanism. The physical features of water, return flows in particular, create interdependence and conflict.

[22] Factors which may have an impact on the magnitude of transaction costs associated with establishment of water markets can be grouped into three broad categories, physical attributes, institutions relating to water, and the broader institutional environment, although interactions between the three are important. In addition, these costs will depend on the design and sequencing of the institutional change [*Saleth and Dinar*, 2004]. These factors will also determine what types of transaction costs are incurred in a particular case. Many of these factors will also influence the size of the transaction costs of other allocation mechanisms, not just water markets.

#### 4.1. Physical Attributes

[23] Transaction costs will be affected by the physical infrastructure and technology that is in place, water scarcity, uncertainty of water supply, whether the transfer is local, which also relates to whether it is transferred out of agriculture, size of the transfer, effects of transfers on third parties, effects on other water users, the duration of the transfer of the water right, and water attributes (quantity, quality, time, and place) that are incorporated in water contracts and the precision of those contracts. Ideally, water contracts and water rights would include quantity and quality as well as place and time for delivery of the water. This would reduce uncertainty and allow water users to better plan future investments. In the past, contracts and water rights have primarily specified the place and quantity, with quantity often only specified as a share of the canal or stream flow, or were based on set times and places for using all or part of the flow available in the canal. In contrast, few contracts and water rights, especially for agricultural use, include any provisions specifying water quality. As water quality becomes even more important, for example because of increasing salinity, future water rights and/or contracts are likely to include it. Adding water quality to contracts will require increased monitoring, thus increasing transaction costs.

[24] As scarcity increases, moving from contracts or water rights that are quantified in volumetric terms rather than just shares of water flow will become more common. The existing technology and infrastructure will have an effect on the cost of moving to a volumetric system. Changes may be required in technology, such as the use of water meters versus timing of flow, or even in the conveyance systems. These changes will necessarily be associated with changes in institutions such as the water rights system and the system of enforcement and conflict resolution [*Saleth and Dinar*, 2004].

#### 4.2. Water-Related Institutions

[25] The particular institutional arrangements, both formal and informal, that existed before the change will affect

the costs of moving to a new allocation mechanism. Many restrictions on transfers, while they increase transaction costs, allow incorporation of third-party effects into the decision-making process to limit negative indirect economic and social impacts [*Colby*, 1988; *Gould*, 1989]. It should be noted that transfers of water relate to changes in place or purpose of use. There can be water transfers with or without a change in ownership of the underlying water right as well as a change in ownership without a change in use [*Gould*, 1989].

[26] Water-related institutions that will affect the transaction costs of moving to a formal water market in an irrigation system include institutions that affect the incidence of costs, including transaction costs, of moving to the new system [*Rosegrant and Binswanger*, 1994]; the power of affected parties, both gainers and losers, and their tendency toward rent-seeking behavior; the current administrative structure; whether or not water user associations or mechanisms for conflict resolution are in place and effective [*Saleth and Dinar*, 2004]; the existence of contract enforcement mechanisms, both formal or informal [*Greif*, 1997]; institutions that facilitate or block informal water trades; whether property rights to water are already recognized; and whether a water rights registry exists. Monitoring and enforcement costs are reduced if there is little dispute over the initial distribution of water rights. The establishment of water user associations, streamlined procedures, and efficient and credible conflict resolution mechanisms will also help to limit these costs.

[27] Characteristics of the existing water rights regime, e.g., whether the water rights are based on strict public ownership or some form of riparian or prior appropriation system, will affect transaction costs. For example, water marketing requires transferability. The prior appropriation doctrine, common in the western United States, treats water as a separate interest; thus this type of water right is transferable without fundamental institutional changes. Water law in the west consists of statutes, case law, and administrative procedures and is very complex [*Colby*, 1988]. A fundamental understanding of water rights in a particular case is necessary, as demonstrated by several studies on their impact on water markets in the west [*Colby*, 1988; *Curie*, 1985; *Gould*, 1989; *Griffin*, 1998].

#### 4.3. Institutional Environment

[28] *Easter et al.* [1998] and *Saleth and Dinar* [2004] stress the importance of the institutional environment, including the legal system, and familiarity with market institutions in facilitating development of water markets. In addition, social norms and social capital will affect the transaction costs of informal markets and the implementation of formal markets. How well the government functions in general, its capacity and willingness to implement programs, and its transparency will also affect transaction costs. A weak government would be expected to result in higher transaction costs for institutional change.

[29] Physical attributes, water-related institutions, and the institutional environment will all affect transaction costs associated with a change to a market-based allocation mechanism for surface water. Improvements in transaction cost measurement will improve efficiency by including the full costs of changes and also by allowing more detailed examination of the determinants of transaction costs, which

**Table 1.** Typology of Transaction Costs and Effect of Determinants

Type of Transaction Cost	Major Determinants of Increased Transaction Costs
Research and information	hydrological and climatic uncertainty, lack of system storage, water transferred out of agriculture and/or out of the basin, significant third-party effects including environmental effects, dependence on return flows, lack of clear water rights
Enactment or litigation (initial transaction)	significant third-party effects, dependence on return flows, duration of the transfer, riparian water rights, lack of clear water rights, complexity of water law, incidence of costs is concentrated, lack of water users associations, lack of familiarity with markets, lack of social capital, weak government
Design and implementation	water transferred out of agriculture and/or out of the basin, infrastructure not suited to transfers of water, significant third-party effects, existing institutional and administrative structure not designed for water marketing, riparian water rights, lack of clear water rights, complexity of water law, lack of water users associations, lack of familiarity with markets, lack of government will
Support and administration	larger areas, increasing number of people involved, increased precision of contracts required with respect to quantity, quality, time, and place, lack of effective water users associations, lack of familiarity with markets
Contracting (second-order transactions)	lack of rule of law, lack of social capital, increased precision of contracts required, lack of water users associations, lack of familiarity with markets, lack of system storage, lack of water rights registry
Monitoring/detection	lack of social capital, poor monitoring technology, increased precision of contracts required, lack of water users associations, disagreement about initial distribution of water rights, high transportation and communication costs
Prosecution/enforcement	Hydrological uncertainty, lack of water users associations, lack of conflict resolution and contract enforcement mechanisms, weak government, high potential for violence

will improve institutional design. Table 1 combines the typology developed earlier with determinants of transaction costs that would be likely be associated with the various types of costs. A lack of effective water user associations, disputes over water rights, and large third-party effects would increase many types of transaction costs, while other determinants, such as precision of contracts required, would primarily affect costs associated with market transactions.

## 5. Recommendations

[30] A study of the full transaction costs associated with the change to an alternative water allocation mechanism has not been attempted to our knowledge. Such measurement work could be conducted after the implementation of the alternative mechanism, before design and implementation of the mechanism, or during this process. While predictions would be desirable as far as evaluating the net benefits of moving to the alternative allocation mechanism, it is the most difficult option for the reasons mentioned above. We therefore suggest a combination of evaluation after the fact and documentation of the process as it happens.

[31] The first step would involve evaluating previous instances of this type of change in similar physical and institutional environments in order to predict the types of transaction costs that will be incurred. Interviews should be conducted with a range of individuals involved with that process to ensure that all types of costs are included. Costs may be incurred by the legal system, legislative bodies, and administrative agencies as well as by stakeholders. In addition, these interviews may suggest ways in which the process could be improved in order to minimize conflict and reduce transaction costs as well as highlighting potential determinants of transaction costs. Design details are important for the magnitude and incidence of transaction costs.

[32] After the development of a framework indicating the specific types of costs that are likely to be incurred and by whom, the data collection methodology can be designed and

transaction costs can be measured. A problem with collecting data during the process of institutional change is that it may take several years; therefore some types of costs may already have been incurred.

[33] Measuring the transaction costs of moving to a more efficient water allocation mechanism is a complex process involving definition of the boundaries of the study, determining the types of costs that will be incurred and by whom, and use of existing data as well as survey methodologies to estimate these costs. Nevertheless, this type of research can improve decision making by estimating the full costs and benefits of institutional changes required to improve water allocation. In addition, this information can be used to improve the design of water allocation mechanisms.

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