Thematic Week: Water Economics and Financing

Thematic Axis: Water Markets

Title: Water use rights markets and water allocation: the chilean case

Authors: Guillermo Donoso

Profesor Titular
Departamento de Economía Agraria
Pontificia Universidad Católica de Chile

Abstract:

Economic efficiency is maximized by allocating limited water among alternative uses so that marginal social benefits are equated across the different uses. Numerous authors have presented arguments that water, being a natural resource with varying value for different agents and uses, within clearly defined market constraints will be allocated to its highest valued use through the exchange of some type of property right, either for a limited time period (lease) or in perpetuity (sale). Since the establishment of the water allocation mechanism based on a market of water use rights in Chile, a series of empirical and theoretical studies have been carried out to determine: the existence of a water use rights market and the number transactions; water use rights market efficiency; bargaining, cooperation, and strategic behaviors of market participants; and the marginal gains from trade. These studies indicate that the allocation framework based on a market allocation system established by the Water Code in 1981 has been efficient from an investment point of view, mainly due to the water use rights security granted by the legislation. This is evidenced by significant investments that have been undertaken by several economic sectors to improve water use efficiency and to increase the availability of groundwater through exploration. Likewise, the free transaction of water use rights, even though in many areas water use rights markets have not been very active, constitutes an efficient reallocation mechanism which has facilitated the reallocation of granted rights.

Keywords: Water use rights markets, Water reallocation through markets, Water market performance

1. INTRODUCTION

Water resources are an important factor for production worldwide. Bonnis and Steenblik [1997] point out that many countries face water availability problems, both seasonal and non-seasonal, in addition to droughts and groundwater depletion. Independent of the view about the nature of the water scarcity problem, it is clear that water availability represents one of the most important environmental restrictions for development and recently as a limiting factor for population growth and food production [World Bank, 1992]. The growing demand driven by population growth and economic development generates strong competition and water use conflicts between the different sectors. Meeting the demands of such sectors requires a thorough revision of current water sector planning and management practices, as well as of its policies and institutional framework. Saleth and Dinar [1999, 2004] indicate that institutional changes are needed to improve water allocation since previous institutions were developed during a water surplus era.

There are a variety of institutions which may implement optimum water allocation. Following Rosegrant and Gazmuri [1994], alternative water allocation systems may be classified as follows: (a) allocation by an authority, whether through administrative or negotiation processes; (b) allocation based on opportunity costs; and (c) allocation based on a market of tradable water use rights. Each one of these systems presents significant differences and is based on different principles.

Under an administrative allocation system, water authority determines the maximum amount of water that each sector or each agent should receive, and delivers it free of charge. In other words, the administration decides on the optimum allocation for each person.

Under the system of allocation that imposes a fee based on the opportunity costs of the resource, the water authority must estimate the opportunity cost or shadow price of the resource. The administration allocates resources to all applicants willing to pay the fee, and this fee is expressed in units of water, with applicants paying a fee corresponding to the units of water acquired.

In a water market, the water is reallocated through the exchange of some type of property right, either for a limited time period (lease) or in perpetuity (sale). The water market consists of the interactions between buyers and sellers of water use rights.

In systems where water is allocated by the authority, it has been seen that the increasing difficulty to meet the population's water demands has determined the need to reformulate the role of governments in the provision of water services. Centralized water allocation systems, where government is the owner of water supply industries and whose management approach is focused on water supply, have been the benchmark to define public policies, generating problems related to water supply scarcity and poor water quality. Consequently, administrative allocation systems have not been able to create effective incentives to optimize global water production and distribution, assigning a value to water services that represent their true opportunity costs. It has not created incentives to promote efficient use of water nor adopted management and technological innovations. On the other hand, water supply and distribution systems in State hands has kept the water industry isolated from the rest of the markets, which has not generated economic incentives for greater water allocation efficiency through price differentiation and quality [Spulber and Sabbaghi, 1998].

In the agricultural sector, the government's role has tended to transfer the responsibility of water management to farmers [Van Koppen, 2003], which in some areas has resulted in an absolute lack of support to irrigation projects. In many developing countries, irrigation initiatives are carried out by the same producers as a response to market opportunities. In this scenario, the role of the state

must comprise not only building irrigation works, but also providing information, facilitating investment, improving access of producers to the markets, and improving marketing and input supply channels.

Water use rights markets have been implemented in the case of Chile, USA and Australia. These cases have indicated that market mechanisms represent a good means to allocate water for two main reasons. First it secures transfer of water from low value to higher value activities. Second, it puts the burden of information collection on water users and avoids problems of asymmetric information common in centrally planned situations. However, to operate properly, water markets require well developed water conveyance facilities and the appropriate institutions to define water rights and water endowments contingent on water availability. It is also necessary to have a complete set of rules for trading in water endowments and in water use rights. Finally, institutions are needed to oversee trading activities and resolve conflicts when they arise.

2. WATER USE RIGHTS MARKETS AND WATER ALLOCATION

The interest in water markets and water prices stems from the growing recognition that water is scarce worldwide. This scarcity is driven by increasing world populations, cyclical drought, climate change, and rigid institutional allocation structures. This increased scarcity has driven an intense interest in improving the efficiency of water use. 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. Thus, policy –makers have broadened the scope of water policy objectives to include economic efficiency.

Economic efficiency is maximized by allocating limited water among alternative uses so that marginal social benefits are equated across the different uses. Numerous authors [see *e.g.* Alchian and Demsetz, 1973; Barzel, 1989; Michelsen, 1994; Hadjigeorjalis and Riquelme, 2002; Freebairn, 2003; and Brookshire *et al.* 2004] have presented arguments that water, being a natural resource with varying value for different agents and uses, within clearly defined market constraints will be allocated to its highest valued use. Nieuwoudt and Armitage [2004], for example, using discriminate analysis find that water rights under allocation mechanisms based on markets move to the highest economic return in the Orange River region in South Africa.

In principle, in a competitive water use rights market, supply and demand are equated and the different resource valuations of different agents participating in the market converge to an equilibrium price. This would be the case if water use rights were homogeneous goods. However, several researchers have found that water use rights are heterogeneous and its price varies according to its attributes [Crouter, 1987; Colby *et al.,* 1993; Bjornlund and McKay, 1998; and Ganderton 2002].

In spite of the role and information of water use rights prices, there is limited research on the determinants of water use prices, their dispersion, and the operation of the market through prices. Hook and Alexander [1999] estimate demands for surface irrigation water directly from disaggregated profit functions for fields in the San Joaquin Valley of California. The authors find substantial ranges of inelastic demand for delivered water, and thresholds across which demand becomes elastic. Burke et al. [2004] integrates hydrologic and economic aspects, focuses on irrigators, and estimates an underlying supply curve for water. They find supply to be relatively price elastic. Brookshire et al. [2004] analyze the development of water rights prices in three markets (Arizona's Central Arizona Project, Colorado's Big Thompson, and New Mexico's Middle Rio Grande Conservancy District) in the semiarid southwest of the United States. Using a structural

model of supply and demand for water in these markets, controlling for market-specific characteristics, the authors attempt to characterize the operation of the market through prices. While there is evidence that demand forces drive the market price, data limitations prevented the identification of the supply curve. A significant proportion of the market price remains influenced by individual basin factors such as institutional arrangements. These authors find that price dispersion is partly explained by the type of agent that intervenes in the transaction. Wheeler *et al.* [2008] estimate price elasticities of demand and supply of water allocations in the Goulburn-Murray Irrigation District. Demand is inelastic to water prices and influenced by previous month's demand, drought and season.

In Chile, this type of research is absent, in spite of the great interest in studying Chile's free market approach to water economics [see *e.g.* Gazmuri and Rosegrant, 1996; Hearne and Easter, 1995, 1997; Ríos and Quiroz, 1995; Donoso *et al.* 2001; Bauer, 2004 and 2005]. Most studies have centered on the analysis of the performance of water markets. An exception is a recent study conducted by Jordan [2007] who studied market prices for water in the first section of the Maipo River Basin for the time period between July 1998 and June 2003, analyzing the behavior of different economic agents and price variability. This analysis is based on the econometric estimation of a supply and demand system for water use rights, and a reduced model for their prices based on supply and demand determinants, as well as characteristics of the participating agents. Results indicate that price dispersion is determined by agent type and experience in the water use rights market, as well as the economic performance of the sector to which agents belong, the expected value of the water rights and the geographical location where the transaction takes place. This confirms the hypothesis that price variation that characterizes this market is partly due to the shallowness of the market and the fact that transactions are the result of bilateral negotiations between market agents.

3. CHILE'S WATER USE RIGHTS MARKETS

As Hearne and Donoso [2005] point out, Chile has had a long tradition of irrigation, private canal users' associations, and water-use rights that dates back to colonial times. The first Chilean text to regulate the use of water is an 1819 Executive Decree which defined the dimensions of an irrigating system, form of sale, and responsibility for water intakes. The 1855 Civil Code declared that "*rivers and all waters that run through natural channels are national goods of public use",* and establishes that access to water is obtained by means of water-use rights "*granted by the competent authority".*

The concept of "Water Right" was introduced in the 1930 Water Code bill, and this concept was further developed in the Water Code of 1951, where it is established that water use rights allow holders to use, posses, and dispose of them, without this representing a transfer of water ownership. In this Code, the law defines water uses, making a list of the preferential areas on which there is a political interest to develop. In the event of competition in the same area, the relevant authority chose the most important and useful company. This was left to the criterion of the relevant Administrative Authority.

Because of its more centralized political context, the Water Code of 1967, reinforces the concept of water as public property and changes the judicial nature of water use rights, giving it the character of an actual administrative right, where the State grants the use of the national good of public use subject to public right regulations. The State grants the use of the waters, but not their ownership. Water Rights are an administrative right that may expire, and the process of water reallocation subjects it to planning so that it can be executed by means of the "rational use and beneficial rate." Thus, the 1967 Water Code greatly strengthened the state in its control of water. However, it is

important to point out that during this period, the 1967 Water Code was not fully implemented due to lack of institutional capacity and resources during the Allende government (1970–1973).

Based on the political changes that occurred in Chile in 1973, the economic paradigm changed from one in which the State must protect and oversee optimal allocation of resources to one in which the market is responsible for allocating resources in an efficient manner

The different instruments and ordinances outlined above, including the codes in existence prior to 1981, were limited in their ability to allow for the formation of an efficient water market consistent with the new economic system. These limitations were related primarily to the definition of water use rights, the amount of information available to users, transaction costs, potential harm to third parties, conflict resolution mechanisms, and institutions, legal and regulatory frameworks needed in order for the market to function properly. In synthesis, the underlying philosophy of the Water Code of 1981 was to establish permanent and tradable water use rights so as to reach efficient water allocations.

Since the establishment of the water allocation mechanism based on a market of water use rights in Chile, a series of empirical and theoretical studies have been carried out to determine: the existence of a water use rights market and the number transactions; water use rights market efficiency; bargaining, cooperation, and strategic behaviors of market participants; and the marginal gains from trade.

Several authors, [Gazmuri and Rosegrant, 1996; Rios and Quiroz, 1995; Hearne and Easter, 1995, 1997; Gómez-Lobo and Paredes, 2001; Cristi and Trapp, 2003] find evidence of active trading for water-use rights, specifying that the markets are more active in those areas where the water resource is a scarce resource with a high economic value. These studies indicate that the market mechanism has, in general, represented an efficient water allocation system, given the evidence of active trading for water-use rights. This is the case of the Limarí Valley, where water is scarce with a high economic value, especially for the emerging agricultural sector [Hearne and Easter, 1997; Donoso, *et al.,* 2001; Hadjigeorgalis, 2004; Zegarra, 2002]. Inter-sectoral trading has transferred water to growing urban areas in the Elqui Valley [Hearne and Easter, 1997] and the upper Mapocho watershed, where water companies and real estate developers are continuously buying water and account for 76% of the rights traded during the 1993-1999 period [Donoso *et al.,* 2001].

Jordan [2007], in a more recent study using transaction data between July 1998 and June 2003 in the first section of the Maipo River Basin, documents 1063 transactions of water use rights. The average unit price of traded water use rights is of US$91,422 and throughout the period water use prices have increased. Additionally, market prices present a high degree of variation, as evidenced by its standard deviation of US$378,190/water use right; this high price variability is indicative of shallow markets. Results show that for the period in study the estimated market depth is on average 2.41%, with variations between 0.5% (2003) and 3.7% (2001). For the same market, Donoso *et al.* [2001] estimated that market depth for the period between July 1993 and June 1999 was on average 1.26%. Thus the shallowness of the market for water use rights has decreased in the past 5 years, associated with economic development of the area and increasing market activity due to growing water scarcity.

On the other hand, other authors such as Bauer [1998, 2004] and Hadjigeorgalis and Riquelme [2002] state that the efficiency of water markets has been poor due to the existence of thin water markets. Thus, from these studies one can conclude that the performance of the water use rights market in Chile has been variable.

A key conclusion of these studies is that water markets are more prevalent in areas of water scarcity. They are driven by demand from relatively high valued water uses and facilitated by low transactions costs. In the absence of these conditions trading has been rare and water markets have not become institutionalized in most valleys. And although market transactions are still rare they are becoming more frequent in areas subject to economic growth [Hearne and Donoso, 2005].

Additionally, Donoso [2006] concludes that the variability in performance of the market can be explained by problems both related to and independent of the allocation system. Problems independent of the allocation system affect the efficient allocation of the resource but are not considered to be related to the free transferability of water rights. In other words, the existence of a rights market neither creates nor aggravates the problem. Furthermore, the problems represent a reallocation impediment under any allocation system. At the same time, problems related to the allocation system affect the efficiency in allocating water resources and are related to the water market system.

The most important problems independent of the water allocation mechanism are those arising as a result of unavoidable transaction costs, externalities due to inadequate definition of water use rights in the Water Code, and uncertainty regarding the availability of water.

Likewise, certain problems related to the allocation system have been identified – problems such as the lack of adequate and timely information; the difference between nominal and in rem rights; conflicts arising between users due to the sale of traditional rights; avoidable transaction costs; and the hoarding of non-consumptive rights.

Based on the studies that have studied the performance of the 1981 Water Code, Donoso [2006] concludes that the allocation framework based on a market allocation system established by the Water Code in 1981 has been efficient from an investment point of view, mainly due to the water use rights security granted by the legislation. This is evidenced by significant investments that have been undertaken by several economic sectors to improve water use efficiency and to increase the availability of groundwater through exploration. Likewise, the free transaction of water use rights, even though in many areas water use rights markets have not been very active, constitutes an efficient reallocation mechanism which has facilitated the reallocation of granted rights.

Given the evidences of market imperfections and the hoarding of non-consumptive rights, the Water Code was modified in 2005. The new Water Code establishes a non-use fee applied to surface water use rights. These non-use fees will be levied only in those cases where water uptake infrastructure does not exist. Thus its expected impact on consumptive water use rights is low, since the majority of these rights present water uptake investments. This is not the case for non-consumptive rights where it is expected that the impact of the non-use fees will reduce water use rights hoarding. Additionally, the water code reform improves the auction system employed to allocate water use rights when there are multiple demands over the same rights. It also strengthens the state's regulatory authority over future grants of water rights by establishing additional requirements for the petition of new water use rights. The reform also addresses minimum ecological flow issues. It is necessary to develop future reliable empirical data in order to correctly evaluate the future performance of the Chilean water use rights markets under this modified regulatory framework.

4. FINAL COMMENTS

In general, one can conclude that the allocation framework based on a market allocation system established by the Water Code in 1981 has been efficient from an investment point of view, mainly due to the water use rights security granted by the legislation. This is evidenced by significant investments that have been undertaken by several economic sectors to improve water use efficiency and to increase the availability of groundwater through exploration. The irrigation sector has invested in irrigation technology and expanded the production of permanent fruit crops.

Likewise, the free transaction of water use rights, even though in many areas water use rights markets have not been very active, constitutes an efficient reallocation mechanism which has facilitated the reallocation of granted rights. Water use rights markets are driven by demand from relatively high-valued water uses and facilitated by low transactions costs in those valleys where Water User's Associations and infrastructure present assist the transfer of water. These markets have permitted the development of mining activities in areas characterized by water scarcity through the acquisition of water-use rights from agriculture, for example.

The allocation of secure property rights has, in general, been beneficial to most sectors of the economy. The favorable business climate for water supply and sanitation companies has led to high levels of service coverage and increased investment in wastewater treatment. Chile has a high level of drinking water and sewerage systems, comparable to those in developed countries. In 2000, 99.1 percent of the urban population and 72.3 percent of the rural population had access to drinking water. In addition, from 1990 to 2000 sewerage coverage in urban areas expanded from 86.9 percent to 93.4 percent and from 19.1 percent to 31.7 percent in rural areas (Salazar 2004).

However, water pollution is a significant problem and has major social costs. Consequently, designing and implementing a more efficient water pollution control policy is absolutely urgent and vital. Therefore, Chile, like many other countries, has decided to reform its water quality management. Water pollution in most of Chile is due mainly to a lack of a proper domestic and industrial wastewater treatment. Water supply and sanitation companies are responsible for wastewater collection and treatment. From 1989 to 2002 wastewater treatment coverage expanded from 8 percent to approximately 42 percent of the population (Salazar 2004). Chile has set an ambitious programme to expand wastewater treatment so that 80 percent of raw domestic wastewaters will be treated by the year 2006 and 95 percent by 2010. The aims also include an expansion of industrial wastewater treatment so that 50 percent of these discharges will be treated by the year 2006. Thus, projected increases in wastewater treatment investment should significantly improve surface water quality.

Hearne and Donoso [2005] point out that the successes of Chile's 1981 Water Code are: i) the property rights and incentives given to irrigators to stimulate the agriculture sector; ii) the presence of water markets in a few valleys; iii) the performance of many Water Users Associations in distributing irrigation water,; iv) the well-regulated, and mostly privatized, water supply and sanitation sector; and vi) the ambitious investment program in wastewater treatment. Future water policy challenges include aspects such as i) an improved coordination between consumptive and nonconsumptive rights users in reservoir management, iii) increased capacity to resolve conflicts between users, and v) improved environmental protection, including appropriate standards for minimum river flows and ambient water quality. Future research is necessary to determine whether the policy reform enacted in 2005 will be able to ensure that unused nonconsumptive use rights do not inhibit investment and growth.

Therefore, the Water Code of 1981 shows that the allocation system based on the water rights market has significant economic benefits because it considers water as an economic good,

internalizing its scarcity value. However, the adequate application of this system requires strengthening the institutional framework to achieve the integrated management and sustainable use of water. Evidence shows that unregulated markets will not operate without third party effects and will not achieve expected economic benefits.

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