Thematic Week: Water Economics and Financing

Thematic Axis: Water Markets

Title: Water Trades in the Western US: Risk, Speculation, and Property Rights

Authors: Richard Howitt

Department of Agricultural and Resource Economics,University of California, Davis

Abstract:

The increasing scarcity of water in Spain, Australia, and the Western US states will lead to an increase in the use of water markets to reallocate supplies. Depending on the relative importance of water supply uncertainty and impediments to water transfers, markets are forming differently across the western United States. In many locations, trades take the form of short-term leases of water, where the underlying property rights remains unaffected. In other regions, transfers of permanent water rights predominate. Econometric analysis of 3,696 transactions reported in the *Water Strategist* over 1990-2005 supports the conclusion that water property rights have influenced not only whether water trades occur, but also whether trades are permanent transfers of rights or short-term leases. The paper shows that for 14 western states during the years 1999–2002, short-term leases outnumbered permanent-rights sales by an average ratio of eight-to-one. In states with the largest volume of water trades (Oregon, Texas, Idaho, Arizona, and California) the ratio of leases to sales was nearly eleven-to-one.

Some of the emerging trends in western water markets are reviewed and examined for ways to reconcile the quasi-public characteristics of water with the reallocation, risk reduction, and equity roles that influence water markets. Finally the different systems in the US and Australia for defining transferable water rides and minimizing externalities from water trades are compared.

Keywords:

Introduction

Population growth and the increased demand for environmental protection in the U.S. West are placing additional demands on existing water supplies. The increasing environmental and fiscal costs of development limit western states' ability to meet these demands by traditional structural supply augmentation. Excess urban and environmental water demands must therefore largely be met by conserving and reallocating existing supplies. Academics and water agencies alike now widely acknowledge that water trading plays in important role in this process by offering a clear measure of value for conservation and by providing a voluntary, self-compensating mechanism for reallocation.

While several states have had active water-rights markets for many years, until 17 years ago water markets were not marked by large trades whether on an absolute basis or in proportion to state water consumption. For small trades, the costs of defining permanent water rights remained sufficiently low to enable trades to occur. In the early 1990s, droughts, environmental constraints on water development, and the cost of new water supplies pressured large water-using states—such as Oregon, Texas, Idaho, Arizona, and California—to consider alternative water-market structures. These states initially proposed market structures based on those in Montana, New Mexico, Utah, and Wyoming (states with long histories of water sales), which predominantly based their water markets on the sale of permanent water rights between private parties. Water masters in these states, who often had the role of approving the transferable quality of the water rights, registered the sales.

This simple pure-market system has not dominated the development of water markets in the West in recent years. Table 1 shows that for 14 western states during the years 1999–2002, short-term leases outnumbered permanent-rights sales by an average ratio of eight-to-one. In states with the largest volume of water trades (Oregon, Texas, Idaho, Arizona, and California) the ratio of leases to sales was nearly eleven-to-one. Several factors contribute to this domination of the water market by leases. The two most important factors are (1) the prevalence of usufructory (appropriative) rights and (2) the concern for third-party effects on water exports in exporting regions. This combination of private and public rights makes the simple, permanent sale of water rights more complex than initially envisaged.

Because states usually retain residual water rights, and state or federal agencies hold contracts for a substantial quantity of the developed surface water, many water users may claim only usufructory rights to water. Such rights do not automatically guarantee rights holders the same volume as transferable rights. Transferable rights need to be defined as a function of usufructory rights. Transferable water rights are proscribed by a wide array of ancillary property rights, instituted to protect third parties and the public interest. Thus, we can describe water as a quasi-public good. Clearly these restrictions on water trades discourage fluid markets, while short-term leases limit the ability of markets to reduce supply-side risk to water buyers. This paper reviews some of the emerging trends in western water markets and examines ways to reconcile the quasi-public characteristics of water with the reallocation, risk reduction, and equity roles that western water markets are expected to play.

A Quantitative Measure of Western Water Markets

The economic literature on western water markets invariably focuses on actions in a single state. Comparable data across western states is hard to find. Hansen, Howitt and Williams[1] compiled 2,804 transactions from a monthly trade journal called the *Water Strategist* from 1990 to 2005. This section of the paper is taken directly from Hansen et al.

The *Water Strategist* reports rights transfers and leases (including price, quantity, buyer and seller identification, buyer and seller use, and some additional contract terms) in sixteen western states on a monthly basis. Several other studies have used the *Water Strategist* data.[2] The most recent of these is Brewer et al. (2007)[3], who use the data to survey how western water markets have developed in response to the large disparity in value between urban and agricultural water uses. Brewer et al. find that the number of agriculture-to-urban transfers is increasing over time and that water is increasingly transferred under longer-term leases and sales rather than one-year leases. They also find that urban users pay more to buy and lease water relative to agricultural users, though variance of price across states is much greater than variance across sectors within a state.

Using data compiled from the *Water Strategist*, Brown (2006)[4] estimates the effect of time, precipitation, population, buyer use, groundwater, and transaction size on sale and lease price. Consistent with our observations from the *Water Strategist*, he finds that sale price is increasing over time but is unaffected by drought periods. Lease price is higher during drought periods than during wet periods and for transfers to municipal and environmental uses than to agriculture.

Brookshire et al. (2004)[5] also use the *Water Strategist* database (over the years 1990-2001) to estimate a demand function for water rights for three of the most active markets in the western United States, in Arizona, New Mexico, and Colorado. They find that municipal and agricultural buyers pay significantly more for water rights than governmental buyers, who are primarily purchasing for environmental uses mandated by state or federal law. They also emphasize that much of the variation in price and quantity across the three markets is due to institutional differences. For example, rights in the Colorado-Big Thompson Project in Colorado are homogeneous and transaction costs are low, whereas in New Mexico, there is a backlog of groundwater rights to be adjudicated by the Office of the State Engineer before transfer can occur.

Table 1 indicates the quantities of water transferred by lease and sale from 1990-2005. The four states that transfer the most water in absolute terms are Arizona, California, Texas and Idaho. These states also report the highest volume transferred through leases. Most leases are short-term; only 13% of leases (representing 8% of transaction-year volume) were for durations of longer than one year. Long-term leases are in some respects more similar to rights transfers than to short-term

[1] Hansen K, R.E. Howitt, and J. Williams. "Short-Term Leases or Long-Term Transfers? An Econometric Test of Water Market Structure in the Western United States" Working paper Dept Agricultural & Resource Economics. UC Davis, September 2007

[2] We know of no other dataset as comprehensive as this one. The *Water Strategist* appears to be the best available data source at the moment for a comprehensive review of western U.S. water markets.

[3] Brewer, J., R. Glennon, A. Ker, and G. D. Libecap. 2007. "Water Markets in the West: Prices, Trading, and Contractual Forms." Working Paper 13002, NBER Working Paper Series. Cambridge, MA.

[4] Brown, T. C. 2006. "Trends in Water Market Activity and Price in the Western United States." *Water Resources Research* 42 W09402.

[5] Brookshire, D. S., B. Colby, M. Ewers, and P. T. Ganderton. 2004. "Market Prices for Water in the Semiarid West of the United States. *Water Resources Research* 40 W09S04.

leases. They allow water agencies to avoid repeated negotiation costs associated with multiple transactions and exposure to future price uncertainty, often without the more burdensome regulatory restrictions imposed on rights transfers. The buyer and seller in a number of transactions reported in the *Water Strategist* explicitly identified their short-term leases as a means of acquiring information before entering into longer-term contractual arrangements.

The most striking feature within this table is the variation in state lease-to-sale ratios reported in the second-to-last column of Table 1. For example, for every 31 acre-feet of water transferred under lease in California during the study period, only 1 was transferred under sale. For every 4 acre-feet transferred under lease in Colorado, 1 is transferred under sale. This stark difference is undoubtedly due to the institutional conditions that prevail in the Central Valley Project (CVP) in California and the Colorado-Big Thompson Project (CBT) in Colorado.[6] The CBT operates as a single water district, encompassing both agricultural and urban areas, which lowers trading costs significantly compared to the more jurisdictionally fragmented CVP. Second, proportional water rights in the CBT make rights transfers easy compared to the CVP, where the priority rationing system requires that water be quantified and potentially adjudicated before it is traded away. (Carey and Sunding 2001)[7].

Table 1 indicates that although water markets are growing, total volume traded remains small compared to overall consumption. In most states, less than 1% of water consumed is transferred through sales or leases each year. When water is transferred under long-term lease or a sale, only the quantity transferred in the first year of the contract is reported in Table 1. As these numbers include only transaction-year volume, they under-report the significance of sales and long-term leases relative to short-term leases.[8] When volume is calculated cumulatively (so that the volume transferred under a long-term lease in 2001 is counted in 2001 and each subsequent year of the study period), transferred water is still less than 3% of consumptive use in most states.

Table 1 also indicates the number of transactions within each state for each contract type. Markets are clearly thin. In approximately half of the 192 state-year cells within this dataset, there are no transactions reported in the *Water Strategist*. When and where transactions do occur, there are few buyers and sellers.

Table 2 compares average volume-weighted lease and sale prices for transactions over the study period. "Lease price" is the cost in dollars per acre-foot of acquiring a pre-specified volume of water in each year of the contract. "Sale price" is the total cost of obtaining a right to one acre-foot of water each year, in perpetuity. Sale and lease price distributions are both skewed, with small, high-value transactions driving average results. The highest prices observed in the data set are small mining transactions in remote regions. Further, sale transactions on the Front Range of the Rocky Mountains in Colorado are generally small and frequent, due to low transaction costs associated with transferring water within the CBT. To compensate for the skewness of the price data, the prices we present are volume-weighted.

Across states and years there is large variation in lease and sale prices. The final column of Table 2 reports the implicit capitalization rate, which is the ratio of annual lease price to total sale price. States' individual implicit capitalization rates vary greatly. The ratios for Oregon and

[6] See J.M Carey and D.L. Sunding "Emerging Markets in Water: A Comparative Institutional Analysis of the Central Valley and Colorado-Big Thompson Projects" Natural Resources Journal, Vol. 41, No. 2, Spring 2001 for a thorough summary of how differences in institutional structure between the CBT and the Central Valley Project in California have led to different market environments.

[7] Ibid

[8] Cumulative calculations of volume transferred within each state are available from the authors upon request.

Washington are relatively large, in part because it was common over the study period for irrigators to lease out water at very low prices in wet years to avoid losing rights due to non-use. A variety of state and non-profit institutions have developed in those states to facilitate such transfers. The average implicit capitalization rate for the entire dataset is 4.56% (5.33% excluding CBT sale transactions), below the market cost of borrowing money of 8%.[9] The low implicit capitalization rates is likely due to the fact that many transfers occur at administratively set prices that do not reflect water value. Most notably, irrigators often pay subsidized rates for leased water. Further, municipal users are willing to pay a premium to acquire water rights. Interestingly, the average capitalization rate for the final four years of the study period is 5.33% (6.36% excluding CBT sale transactions), which is closer to expectations about the cost of borrowing money. This observation suggests that water pricing may be becoming more efficient over time.

However, the implicit capitalization rates reported here remain below the market cost of borrowing capital. In the absence of transaction costs, risk and uncertainty, those wanting water would be indifferent between purchasing a right, which yields a flow of water each year in perpetuity, and acquiring water each year from the market in the form of a short-term lease, each year for all time. Several characteristics might prevent parity between the two alternatives. First, buyers may be willing to pay more than the annualized sale cost for an annual lease, because the decision to postpone an investment, such as the purchase of a water right that is very expensive to reverse due to high transaction costs, has value (Dixit and Pindyck 1994)[10]. Alternatively, sellers may require a premium to sell their water rights, which in theory should equal the uncertainty cost to the buyer of repeated exposure to spot prices in the lease market. Buyers may be willing to pay such a premium to purchase a right for the same reason (Howitt 1998)[11].

Trends in the new uses of water are striking. Tables 3 groups transactions within the dataset by buyer use, for lease and sale transactions respectively. There is much greater annual variability in quantity and number of lease transactions than sale transactions within all three new use categories. This is to be expected, as leases are often in response to short-term fluctuations in hydrological and economic conditions.

Over the study period, sales and leases to environmental use both increased as percentages of total leases and sale volume transferred. Environmental transfers have been facilitated by institutions such as the Environmental Water Account (EWA) in California, under which state and federal fishery managers purchase water in real-time to augment in-stream flows at critical periods (Hanak 2003).[12] Loomis et al. (2003)[13] suggest that public agencies and non-profit organizations

[9] Brown (2006) compensates for the skewness of the data by presenting median rather than volume-weighted prices. Using median prices, he calculates an implicit capitalization rate of 1.94%. Using his time period (1990-2003) and his methods for categorizing data, we generate similar implicit capitalization rates by new use. Brewer, et al. (2007) also make the same calculations for purposes of comparison.

[10] Dixit, A., and R. Pindyck.1994. *Investment Under Uncertainty*. Princeton: Princeton University Press.

[11] Howitt, R. E. 1998. "Spot Prices, Option Prices and Water Markets." In *Markets for Water: Potential and Performance*, eds. K. W. Easter, M. W. Rosegrant, and A. Dinar. Boston: Kluwer Academic Publishers.

[12] The EWA is a fund established by the CALFED Bay-Delta Program that allows states and federal fishery managers in the San Francisco Bay/Sacramento-San Joaquin Delta to purchase water to increase fresh-water inflows and provide better fish protection with a minimum of disruption to water purchasers south of the Delta. Environmental purchases accounted directly for one-third of traded volume in California in 2001, the first year of EWA operations Hanak, E. 2003. *Who Should Be Allowed to Sell Water in California? Third-Party Issues and the Water Market*. San Francisco: Public Policy Institute of California.

[13] Loomis, J. B. K. Quattlebaum, T. C. Brown, and S. J. Alexander. 2003. "Expanding Institutional Arrangements for Acquiring Water for Environmental Purposes: Transactions Evidence for the Western United States." *Water Resources Development* 19 (1):21-28.

are able to purchase water through voluntary transactions for environmental in-stream flows because the environmental value of water now exceeds the value of water used in irrigation in some parts of the West. Environmental buyers tended to acquire water under short-term lease rather than long-term lease or rights transfers. There were only 67 sale transactions to environmental use. Of the 275 leases to environmental use, only 22 were longer than one year.

Agricultural and municipal/industrial use as a percentage of water transferred annually both decreased over the study period. Water for agricultural use also tended to be purchased under short-term lease rather than long-term lease or rights transfer. Of the 454 transfers to agricultural buyers, 288 were leases. Of these leases, only 20 were transfers of longer than one year.

Municipal agencies acquire water rights with far greater frequency and volume than either agricultural or environmental entities. They are first and foremost concerned with reliability. Table 3 shows that municipal buyers consistently paid higher prices for rights than environmental and agricultural users over time and throughout the West. Municipal purchases decreased in absolute and percentage terms. Within the CBT, it is not uncommon for municipal water agencies to purchase a water right and lease the water back to the agricultural seller until the water is needed for municipal use. Table 3 indicates that municipal agencies also acquire significant quantities of water under lease. When municipal agencies do acquire leases, they tend to be long-term; of the 372 municipal leases reported in Table 3, 100 are for periods longer than one year. The time trends for the aggregate water market in the 16 western states are shown for annual leases and sales of water rights in figures 1 and 2 respectively. Both the number of transactions and the volume of water are plotted. All four time trends are significantly positive. Note that the annual water volume leased is shown as a regression line as the actual volume is also a function of the precipitation for a given year. The message from these figures is simple, both the lease and sale market for water in the western US has grown steadily over the past 16 years.

In Praise of Speculation

Water supply is inherently uncertain, but the demand for water is relatively inelastic and in some cases counter cyclical. Thus it is reasonable that reliability and supply risk are foremost for many water managers. I also want to emphasize the difference between speculation and market manipulation. A pure speculator provides a valuable social service by buying risk from producers who want to sell it and concentrate on production. Market manipulation, in contrast, attempts to distort the market for risk or any other product.

The main reason permanent sales of water are preferred to leases is that they automatically solve the problem of supply uncertainty for the purchaser. Paradoxically, however, permanent sales transfer the risk to the seller, who, given the uncertainty about water sales prices, is bound to wonder if he sold too cheaply. Lach (2005) shows that supply-risk reduction in the form of water reliability is foremost in the preference function of the majority of water utility managers surveyed.[14] The practices of Colorado's Big Thompson Project exemplify urban agencies' use of water-rights purchases to reduce risk. Howe reports that while irrigating farmers only owned 64% of the Project's allotments in 1982, they used 71% of the available water.[15] This resulted from unused urban water rights being leased back to the farmers.[16]

14. Denise Lach et al., *Maintaining the Status Quo: How Institutional Norms and Practices Create Conservative Water Organizations*, 83 TEXAS L. REV 5–6 (2005).

15. C.W. Howe et al., *Innovations in Water Management: Lessons from the Colorado-Big Thompson Project and Northern Colorado Water Conservancy District, in* SCARCE WATER AND INSTITUTIONAL CHANGE 171, 187 (Kenneth D. Frederick ed., 1986).

16. *Id.* at 187–88.

Despite their strong advantages in reducing third-party impacts, short-term leases shift the supply and price risk to the purchaser. Given the relatively inelastic nature of urban water demands and their high use values, the reluctance of urban managers to rely on the undefined potential of annual spot markets seems very rational, despite several successful examples of spot markets. Of the two types of risks in lease markets, it seems that managers are more concerned about supply risk than spot-market price risk.

Option contracts that explicitly separate the cost of risk from the cost of water supply can reduce the cost of both supply risk and price risk. Using option contracts, water purchasers can sell the supply risk to those water rights holders who can absorb the risk at a lower cost. For example, an urban agency with relatively inflexible demands can take an option contract with a farmer who grows annual crops. Clearly, the cost of adjusting crop production to water variability is much lower than an urban rationing or pricing scheme. Like other aspects of water policy, water option markets are more complex than simpler commodities (such as pork bellies). In the first place, a water-options purchaser is only interested in receiving the physical quantity of water when he chooses to exercise the option. In most other option markets, the majority of options are not exercised by the physical delivery of the good in question; options are instead resolved through financial settlements. Uncertainty about when the option will be exercised adds further complication to water market options. Since the holder of the option will only want to exercise it under critical or drought conditions, the option contract must rely on an outside measure of supply—such as a water-supply index—that independently assesses the probability of necessary conditions. Finally, since droughts often occur during a series of years, an option contract with a single exercise option has limited value.

Effectively managing drought risk requires an option contract with several characteristics. First, the contract should run for a period equal to its short-run planning horizon—often seven years or more. Second, the potential to exercise the contract should be available for at least any two years during that period. The contract should also specify the triggering conditions for exercising the option and the strike price. Despite these requirements, urban and agricultural interests have implemented several bilateral option contracts over the past 12 years. Agreements between the Metropolitan Water District of Southern California and several Sacramento Valley irrigation districts are ongoing. Table 4 shows the fundamental characteristics of these contracts.

In 1994–1995, the California Department of Water Resources briefly implemented a type of option with a much shorter term.[17] The Department had successfully run three emergency drought spot markets in 1991, 1992, and 1994. However, the California hydrologic cycle allows very little time—six weeks—to declare a drought and implement the purchases and contracts needed to run an emergency spot market. Both water sellers and purchasers requested a system that would allow more time to adjust to a drought market. When the water year started with poor rainfall in 1994, the department instituted a one-year option market, which opened in December of that year.[18] The market was aimed at inducing a more responsive supply of water to the water bank, and at creating a price structure that could vary between December and April, as the extent of water supplies became better known. The market took the form of water purchasing options in case the drought year continued. The fixed option price was $3.50 per acre-foot, and the call price of the option was fixed at $36.50 per acre-foot.[19]

17. Scott A. Jercich, *California's 1995 Water Bank Program: Purchasing Water Supply Options*, 123 J. WATER RESOURCES PLAN. & MGMT 59, 63 (1997).

18. *Id.*

19. *Id.* at 62.

Early in the water season (December, 1994), the projected total demand for the options reached 310 thousand acre-feet[20]. As the rainfall situation improved, demand for options fell; the Department sold only 29 thousand acre-feet of options (in five separate contracts) during January and February of 1995.[21] Furthermore, the latter part of the season saw substantial precipitation and snow pack, which greatly improved the water situation and reduced the demand for options to zero by mid-April.

While the option market had only a small impact in 1995, its operation illustrates that such markets do reduce the risk to buyers and can be operated by public agencies. Given the thinness of such markets and the long periods in which there is no demand for them, it seems very unlikely that they are a viable commercial proposition. However, since they provide a public service through risk reduction, it is appropriate that public water agencies run such markets on a non-profit basis.

Establishing Property Rights for Water Trading

From an economic perspective the Beneficial Use doctrine that dominates western water rights is an effective property right for the equitable allocation of a resource that is focused on a single use and in excess supply. These are the conditions that prevailed in the gold mining communities that originated the concept. The modern situation for water users of shifting demands and technologies and ever-present scarcity requires that the voluntary and socially efficient reallocation of water be allowed. A simple redefinition that characterizes socially beneficial water trades as a beneficial use would enable the voluntary reallocation of water to more valuable uses.

Australia and Chile have taken the logical step of decoupling water rights from land. This requires the difficult and expensive legal step of defining water rights on a consumptive basis and also associating priorities with these rights(Young & McColl 2002)[22]. This separation of water rights from land rights is more complicated under systems with usufructory rights and the varying time-dependent priorities found in the prior appropriation system prevalent in the western US.

A fragmented and decentralized market requires that the monitoring, enforcement, and information costs are low. It follows that those water rights that are permitted to trade have to be correspondingly simple. California has adopted an unofficial criterion for credible traded water that meets the requirements of simplicity and equity. Essentially the criterion distinguishes between what is colloquially called Wet Water versus Paper Water. Paper water refers to the wide range of rights, some of which are either underutilized, or include return flows, or imprecisely defined. Wet water is defined strictly on the basis of historic consumptive use. While there is a great range of water efficiencies, a simple property right based on average consumptive use provides a low-cost measure that is worth the minor physical inefficiencies. In short, a successful and equitable reallocation must be based on property rights that are a subset of the broader water property rights, but which avoid high transaction costs and third-party impacts.

The state of Colorado has a highly developed code of augmentation requirements that ensure only the net consumptive use is sold out of a given basin. The absence of these provisions in Australian definitions of transferable rights is likely to lead to externalities as water trading develops. In addition, the definition of water rights in Australia seems to give equal priority to nominal water rights that are not in effective use. Giving equal standing in the market to these "sleeper" rights is in sharp contrast to the California practice of ignoring sleeper rights and assigning tradable rights on the basis of historic consumptive use.

[20] One acre foot equals 1,233 M^2

21. *Id.* at 61.

[22] Young. M,D. and J.C.McColl, 2002. Robust Separation. CSIRO, Australia

In addition to trading water, in many places the only capacity to move water is through a public infrastructure that has de facto rights held by the original contractors. The ability to trade water conveyance capacity is also an important development for efficient water reallocation in the West.

Conclusions

Trading of water in the western US is shown in figures 1 and 2 to be active, growing, and consistent with economic principles. Water trades are dominated by short-term leases rather than out right sales of property rights, this is particularly prevalent in states that have stringent environmental regulations, and concerns over third-party impacts. In addition, as water is sold to lower valued uses, leases are more frequently used. An informal case study of examples of corporate attempts to profit from water trading shows that every major corporate foray into this field has met with failure. One can only conclude that the property rights and regulatory restrictions on Western water trades generate high costs for the centralized corporate model. However the data[23] shows that de-centralized small-scale water trades are flourishing. Thus the fear and requirements for anti-speculation legislation seem to be greatly overblown.

In contrast, since supply reliability is of critical importance to many water purveyors, the ability to offset risk by selling options or contingent contracts to willing buyers is a way of increasing the social value of scarce water resources. This will require a legal definition of those water rights that can be traded or held in reserve, to reduce risk.

A comparison of water trading and the definition of tradable war to rights between the western US and Australia shows significant differences in how rights are defined and third-party impacts minimized. Given the similarities of Australia, Spain, and the western US, in the distribution of water use, the pressures for changed water use, and the climate, emerging water markets in all three countries can benefit by examination of the good and bad characteristics of the existing water trading systems.

[23] Hansen et al 2007. ibid

Table 1

Transacted Volume For Reported Water Transactions, 1990-2005

	Lease		Sale		Total			
State	No. of Obsvns	Quantity (taf)*	No. of Obsvns	Quantity (taf)*	No. of Obsvns	Quantity (taf)*	Lease /Sale Ratio	Transactions as % of Total Use
AZ	60	7,707	77	136	137	7,844	56.52	6.52
CA	522	7,755	52	251	574	8,006	30.86	1.20
CO	81	333	1,175	92	1,256	425	3.63	0.18
ID	81	3,619	16	89	97	3,708	40.64	1.11
MT	18	16	1	0	19	16	94.24	0.01
NM	73	390	44	29	117	418	13.47	0.70
NV	3	30	182	92	185	122	0.33	0.24
OR	57	844	6	10	63	854	88.17	0.64
TX	180	1,334	49	197	229	1,531	6.76	0.36
UT	18	122	39	56	57	177	2.19	0.22
WA	37	134	6	83	43	218	1.61	0.19
WY	38	213	1	0	39	213	3,810.18	0.20
Total	1,168	22,496	1,648	1,035	2,816	23,532	21.73	0.95

Source: Transaction data from the *Water Strategist*; total water use from U.S. Geological Survey.

Note: "No. of Obsvns" indicates the number of transactions reported by the *Water Strategist* within each state for each contract type. Note that each transaction entry in the *Water Strategist* often represents more than one buyer-seller pair. The entries have been separated into multiple transactions when there is enough information on buyer and seller identity and /or new uses to do so. Otherwise, the number of transactions reported above and in subsequent tables may represent multiple buyer-seller pairs.

Note 2. * 1 taf = Thousand acre foot = 1,233,000 M^2 = 1.233 gigalitres

Table 2
Volume-Weighted Prices (2005$) For Reported Water Transactions, 1990-2005

State	Lease Price ($/af)	Sale Price ($/af)	Implicit Capitalization Rate (%)
AZ	62	1,157	5.39
CA	109	1,157	9.44
CO	50	3,791	1.31
ID	10	273	3.60
MT	12	172	6.96
NM	65	1,868	3.50
NV	6	3,849	0.16
OR	197	973	20.23
TX	51	956	5.34
UT	92	1,599	5.73
WA	66	227	28.98
WY	26	2,857	0.92
Total	74	1,390	5.33

Source: Data from the *Water Strategist*.

Note: CBT sales of 39,511 af are omitted from the price calculation. If included, Colorado sale price increases to $5,374/af, total sale price increases to $1,622/af, and the overall implicit capitalization rate is 4.56%.

Table 3
Lease Volume And Volume-Weighted Prices (2005$) By New Use

	Agricultural			Environmental			Municipal		
Year	No. of Obsvns	Quantity (taf)	Price ($/af)	No. of Obsvns	Quantity (taf)	Price ($/af)	No. of Obsvns	Quantity (taf)	Price ($/af)
1990	21	447	58	5	117	21	8	281	51
1991	12	236	94	1	28	71	31	612	171
1992	30	249	108	12	83	77	18	323	108
1993	10	534	71	4	19	47	19	451	110
1994	22	549	25	6	366	14	17	280	76
1995	13	651	41	5	155	44	14	153	119
1996	14	696	37	6	378	26	10	172	113
1997	19	145	30	23	576	38	22	119	77
1998	10	82	23	11	140	13	15	136	75
1999	34	424	26	25	309	45	36	548	59
2000	12	688	42	15	173	103	20	756	90
2001	19	309	64	12	190	103	32	773	250
2002	26	248	20	29	676	71	53	149	107
2003	11	114	106	30	421	114	46	294	123
2004	18	64	30	30	929	58	15	38	104
2005	17	224	62	61	610	87	16	30	90
1990-92 Avge	21	311	81	6	76	47	19	405	127
2003-05 Avge	15	134	69	40	653	79	26	121	119
Total	288	5,658	49	275	5,169	60	372	5,115	124

Source: Data from the *Water Strategist*.

Note: The sum of water transferred under lease to municipal/industrial, environmental, and agricultural uses does not equal total lease volume transferred in Table 1 because transactions that list multiple new uses or do not specify a new use are not included in this table.

Table 4.
Option Contracts between Sacramento Valley Districts and MWD, 2002–03

	Option Price	Call Price	Critical year Charge	Third Party Cost	Quantity
Average Contract	$10	$90	$25	$5	Options 167 KAF
2003 Actual	$10	$90		$5	Calls 120 KAF

Figure 1. Leases of Water

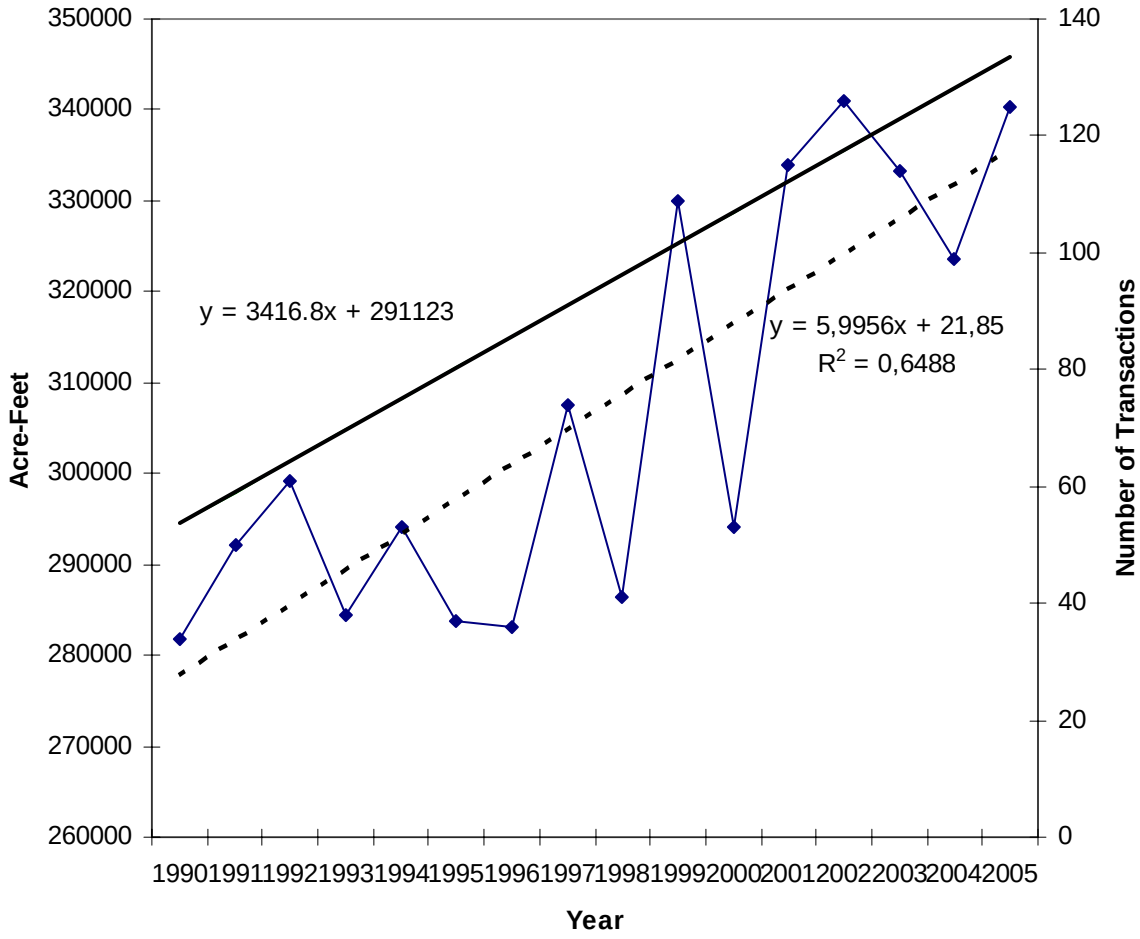

Figure 2. Water Rights Sales