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Option Contracts in Practice: Contractual and Institutional Design for California Water Transfers

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Executive Summary

In 2003, the Metropolitan Water District of Southern California (MWD) introduced option contracting in the California water market, signing 11 contracts with Sacramento Valley agricultural water districts for access to a total of 146,230 acre-feet (af) of water. The option contracts gave MWD the right, but not the obligation, to purchase water several months in the future. Contracting was repeated with three of the larger agricultural districts in 2005, for a supply of just over 100,000 af. In March of 2008, the San Diego County Water Authority entered the option market. Option contracting could prove an important aspect of water market development, facilitating temporary transfers of water at a time when the state's supply is under increasing pressure and demand continues to grow.

A look at past contracting suggests that gains associated with individual trades have been significant, leading to an increase in joint payoffs to the seller and buyer of 70-85%. Expected losses from urban water shortages in the MWD service area were estimated at $49M in 2003 and decreased to $18M under contracting. The magnitude of the total gains from trade in 2003 and 2005 is estimated at between $29M and $34M.[1] Future contract design should address the following points: (1) inefficiencies in the current price structure, (2) flexibility with regard to renegotiation, and (3) policies for community mitigation. Past contract prices have been structured as two volumetric charges: a base price, or reservation fee, and an exercise price to be paid if delivery is taken at a future date. Levying a volumetric reservation fee can lead the buyer to purchase an inefficiently small number of options. A change in the price structure, introducing a non-volumetric contracting fee can remedy this. Renegotiation clauses can aid efficiency by allowing one party to effectively buy out the other if its valuations for water rise significantly. Finally, the administration and effective use of community mitigation funds, which have become a standard element of contracts, requires review.

Institutions designed to support option trading in the water market need to address two existing barriers to trade: (1) *matching* (where potential buyers and sellers pair up), and (2) *access to infrastructure*. The matching phase is currently complicated by the lack of a centralized system for signaling willingness to trade. An online marketplace to connect buyers and sellers could help address the matching barrier. Online platforms have been successfully instituted in a number of markets, including timber, electricity, and e-commerce. Infrastructure access is another barrier. Under the current system, the Department of Water Resources controls the critical north-south infrastructure and grants priority access to State Water Project contractors based on their size. Infrastructure rights cannot be freely bought or traded. For smaller parties or non-contractors there is a considerable risk that infrastructure will be unavailable for delivery at a given date. A system of tradable infrastructure rights would help address this issue. Preapproved block permits for infrastructure rights, issued by region and auctioned off sequentially to qualified districts within the region, would establish such a system. Block permits have the advantages of repeatability (they can be reissued) and adjustability in the face of changing ambient conditions. o

Policy Insights

1. Standardized option agreements are an important step in the transition from nonmarket relational contracting, in which select parties draft custom contracts, to an active market for standardized contracts. The drafting of standardized contracts should consider a new price structure, implementing a fixed contracting fee in place of the current volumetric (per acre-foot) reservation charge, and clauses both to allow renegotiation and to address the appropriate use of mitigation funds.

An option contract specifies two prices – an option price and a strike price – and an exercise date, on which the buyer decides whether or not to take delivery of the contracted water (sometimes referred to as *calling* or *exercising* the option). The strike price is that which the buyer will pay per acre-foot (af) of water if he elects to exercise the option, e.g., the price per af of water taken on delivery. There is also an upfront charge (or reservation fee) paid by the buyer in order to secure the right to exercise the contract at a future date. The terms of option agreements signed to date in the water market have varied, typically involving detailed operational provisions and differing prices. The contracts signed by MWD in 2003 have served as a template of sorts. Contracting remains, nonetheless, essentially a nonmarket transaction characterized by time spent in the matching, valuation, and negotiation phases. To the extent that standard agreements can be drafted and implemented, water transfers will come to resemble *market transactions* rather than nonmarket transactions. The drafting of standard agreements raises a number of issues, including that of price structure.

Past contract prices have been structured as volumetric charges. There is an initial per-af reservation charge for the water under contract and an exercise price to be paid per af of water taken on delivery at a future date (the exercise date). Given that the buyer may not exercise all, or even any, of the options that he holds, the reservation charge induces him to hold a conservative number of options. This is inefficient from an economic standpoint.[2] Rather, the buyer should be able to hold as many options as he would conceivably need at the exercise date. Maximum flexibility is economically efficient, as long as the seller's opportunity cost of providing this flexibility vanishes. The latter holds true, at least approximately, in the California water market. A fixed contracting fee would remove the incentive to under-contract while still allowing the seller to levy an upfront payment. As the seller can still extract a profit through the upfront fee, he faces no disincentive to switch pricing schemes. Charges for a number of services are structured this way, including billing for water, telephone, and electricity service. There is an upfront fee (sometimes referred to as a connection fee) to establish service. The volumetric charge is based on actual usage. This prevents under-usage.

2. Observed trends in the contract market include rising contract prices, additional buyer activity, and one-year durations. The latter will no longer be possible under more stringent environmental review guidelines, necessitating a shift in the market.

In five years, water option prices have risen from $10/af base and $90/af strike (in 2003) to $50/af base and $200/af strike (in 2008). One interpretation of the price hike is an increase in seller bargaining power possibly due to (1) a heightened

awareness (among sellers) of the high cost of urban water shortage and (2) the presence of more stringent buyer competition. One result of the higher prices is a more even distribution of gains from trade between sellers and buyers. A look at past contracts suggests that prices may have been highly favorable to buyers. The increase in buyer activity suggests the viability of one-year water transfer contracts as an approach to covering short-term water shortages. These transfers currently enjoy an expedited environmental review. A full review under the California Environmental Quality Assurance (CEQA), which generally takes in excess of six months, is required for long-term water transfers. If required for short-term transfers, it would render such contracting infeasible: the time required for review would exceed the time horizon of the water transfer. A lawsuit filed this past year in the Butte County Superior Court by Butte Environmental Counsel against Richvale Irrigation District seeks to eliminate expedited environmental review for short-term transfers. In the event of a decision in favor of Butte, a shift from one-year to multi-year option contracting would be required to keep the contract market alive. This may prompt new contract structures, e.g., flexible multi-year agreements.

The development of a flexible contract structure, under which two parties interested in trade can secure environmental review and approval for a multi-year period *without being locked into the terms of trade for each year*, would offer several advantages. First, it would encourage buyers and sellers to preemptively establish channels for trade. This increases the overall likelihood of a successful future transfer by ensuring completion of the matching phase in advance. Second, it would reduce the transaction cost associated with contract ratification. In effect, the two parties would be free to engage in repeated contracting upon receipt of an initial favorable environmental review. There is one example to date of a multi-year (35-year) option contract, signed between MWD and the Palo Verde Irrigation District (PVID) in 2003, granting MWD the right to call up to 100,000 af a year.

3. Preallocated block permits for infrastructure access would facilitate option trading by creating a system of tradable, or auctionable, conveyance rights. A central clearinghouse for matching buyers and sellers would further support market development.

Preallocated block permits have been used to establish markets for emissions trading of nitrogen oxide and sulfur dioxide in the United States, and carbon dioxide in Europe. A well-defined emissions right specifies a quantity, location, and time horizon. The block permit standardizes these features. Sulfur dioxide emissions permits, for example, are defined as a ton of SO_2 per annum anywhere in the U.S. Permits are issued by a government body to all stakeholders based on set criteria, such as size of operations or number of constituents. In the case of sulfur dioxide permits, grants were made to electricity utilities by the U.S. Environmental Protection Agency (EPA) and based on historical emissions.

In the California water market, block permits for infrastructure would need to specify a volume of water (total af) transferrable within a specific time window, possibly ranging from several days to months. Under such a system, permits are tradable, or auctionable. Preallocation of permits would allow parties arranging future transfers, e.g., under option contracts, to secure infrastructure access in advance. Under

the current priority-based system, parties with low-priority access wishing to trade are unlikely to be able to do so. Transfer permits issued at the regional level could be auctioned off sequentially to qualifying water districts, e.g., those within the region. Once allocated, permits could then be traded through a central clearinghouse (online marketplace).

Prices and Terms from the 2003, 2005, and 2008 Contracts

Option contracts have been signed in the California water market in 2003, 2005, and 2008. The contracts are typically signed in the early spring before hydrologic conditions for the year are known. MWD actively pursued contracts in 2003 following a two-year dry spell, during which storage levels had been drawn down. MWD did not actively pursue contracts in 2004. The agency did sign contracts in 2005, with dry conditions having persisted in 2004. The 2005 options were not called, as spring rains alleviated dry conditions. The dry conditions in 2007 and 2008 made option contracts appealing to MWD, but negotiations in 2008 fell through. SDCWA signed two contracts in 2008.

Past option contracts have specified, in addition to prices, a number of trade-related conditions. There are fees for conveying water on state-owned infrastructure, which the contracts signed to date specify will be paid by the buyer. There are also losses associated with using natural channels for conveyance (referred to as "carriage losses"), which the contracts again stipulate are to be borne by the buyer. These losses can represent up to 20% of the total volume transferred. In addition, San Diego County Water Authority assesses a 50% probability that infrastructure will be unavailable for conveyance: with limited pumping capacity at the south-Delta outtakes for conveyance of water north-south, transfers may be delayed or blocked. The contracts designate that the risk of non-conveyance is to be assumed by the buyer. Both parties agree, however, to work together to achieve a storage solution (with the U.S. Bureau of Reclamation (USBR)) such that water can be transferred at a later date. Environmental review costs incurred under CEQA are to be shared. The manner in which water is to be made available for transfer *and* the community-wide impacts of the transfer are dealt with explicitly in the contract. Crop acreage is to be fallowed upon call of an option. The buyer agrees to pay a mitigation fee in excess of the strike price per acre-foot (af) of water called, with the total fees paid comprising a mitigation fund to be disbursed at the seller's discretion.[3]

The first option contracts were initiated by MWD and signed in 2003, with 11 irrigation districts in the Sacramento Valley. MWD again entered into option agreements in 2005. MWD held options for 146,230 af and 112,495 af of water, respectively, in the two years – an amount totaling approximately 5% of MWD's average annual deliveries (of 2.4 maf). The contracts were structured similarly, with the largest contract signed between MWD and the Glenn-Colusa Irrigation District (GCID), the biggest irrigation district in Glenn and Colusa counties, and one of the bigger statewide districts. The base price was $10/af and the strike price was $90/af, for up to 60,000 af of water. MWD paid a non-refundable $600,000 upfront. The option was indexed to the hydrologic conditions, a proxy for the value of water at the future date: if 2003 was designated a "critical" water year in accordance with an established index (the 40-30-30 Sacramento Valley Index), the strike price was to be incremented by

$25/af to $115/af. The contract specified that if the water was not made available by GCID at the time of exercise, MWD would receive a full refund plus interest. The option was set to expire on February 15, on which date MWD called all of the options. A $5/af mitigation payment was issued (and, in fact, requested) by MWD to "be deposited by GCID into a restricted interest bearing account to be administered and utilized by GCID for the purpose of monitoring and mitigating any and all adverse impacts, environmental and other associated with the GCID water transfers." The contract also asserted the following: "… GCID contends that there are no third party economic impacts…associated with its transfer of pre-1914 water rights water." A relatively small quantity of the total acreage in GCID was fallowed to supply the water. This policy of restricted fallowing is encouraged by the state's water code. Under the Water Code, fallowing of acreage in excess of 20% of a district's total landholdings requires public review.

There were several amendments to the MWD-GCID 2005 contract. Most notably the call date was pushed back from February 15 to April 1 and an extension clause was added, whereby the option could be extended from April 1 to May 2 for an additional option payment of $20/af. The clause also specified that the extension be for no less than 40,000 af, where the total number of options held amounted to 80,000 af of water. The hydrologic indexing was removed from the contract, and the new strike price of $115/af reflected an increase of $25/af. The initial fee remained at $10/af. The payout structure associated with the extendable option was slightly more complex: the total payment (option fee plus strike) was set at $125/af with an additional payment of $10/af (total $135/af) if the option had been extended after April 1 but called before April 16, and an additional payment of $20/af (total $145/af) if the option had been extended after April 1 and was called between April 16 and May 2. Hence, for an option called before April 1, the strike price would be $115/af – the $125/af minus the upfront fee of $10/af, with no extension fee.

In 2008, the San Diego County Water Authority (SDCWA) signed option contracts with two northern irrigation districts, the Butte Water District and Sutter Extension Water District. These contracts specified the same base fee of $10/af, with an extension clause for $40/af. The exercise price increased significantly to $200/af.[4] San Diego paid the $50/af reservation fee per option (the $10/af base plus the $40/af extension fee) and ultimately exercised all of the options. The general terms of the contract closely match those of the MWD contracts, specifying that the buyer bear both the cost and losses associated with conveyance, as well as the risk of non-conveyance (with cooperation to secure north-of-Delta storage as an alternative to immediate conveyance). In two departures from the MWD contracts, the SDCWA contracts designate that the buyer pay all environmental permitting costs and forego the community mitigation fee. Significant detail regarding the actual crop fallowing or crop-shifting practices (to make water available for transfer) was omitted and payment details were simplified. The SDCWA contracts are a streamlined version of the MWD contracts.

Magnitude and Distribution of Welfare Gains from Contracting

Both parties have stood to gain from entering into option agreements. Both the magnitude and the distribution of the gains to each side are an important consideration from a societal perspective

and may impact parties' willingness to trade in the future.

Generally, the economic gains from contracting depend on two key uncertain factors: (1) the seller's *opportunity cost* of water and (2) the buyer's *potential shortage cost* of water. If the seller elects not to transfer water, the alternative use of the water is application to a crop such as rice. The opportunity cost of transferred water is the profit expected from the sale of the rice. The buyer's potential shortage cost of water depends on the potential magnitude of the shortage, e.g., how many acre-feet of residential demand an urban water agency must fulfill, as well the cost of either meeting this demand or declaring a shortage. For an urban water agency in Southern California, for instance, projected shortages could range from zero to 100,000 af in a given year at a cost of $1,347 af, where the latter is the penalty rate for additional supply (from MWD).

Under current assessments of the shortage cost for water in Southern California ($1,347/af) and historical commodity prices for rice, buyers have appropriated a disproportionately large share of the gains from trade. Over 90% of the total gains from trade accrued to the buyers in 2003 and 2005. Contract prices rose in 2008, resulting in a more even distribution of the gains from trade, with the seller's share increasing to 30%. If the upward trend continues, it will likely result in a more even distribution of gains from trade.

Table 1 reports estimates of the seller's and buyer's valuations without contracting, where the buyer's payoff is negative, reflecting the anticipated shortage cost of water. These are reported as the seller's and buyer's reserve values. The payoffs under contracting are also estimated. The magnitudes of anticipated losses from water shortage without contracting are estimated at $49M and $43M in 2003 and 2005, respectively. Contracting reduces the anticipated losses to approximately $18M in 2003 and $17M in 2005. The social welfare gains from contracting are $34M and $29M. The smaller welfare gains in 2008 owe to the reduced size of the contracts that year: approximately one-fifth the quantity of water was transferred.

The estimates in Table 1 are sensitive to a number of assumptions, notably those regarding the shortage cost of water, the commodity prices for the seller's crop, and the seller's and buyer's actual valuations.[5] The terms of the past contracts reveal neither expectations regarding the shortage cost of water nor expectations regarding commodity prices in the years that they were signed. The proxy for the shortage cost of water

	2003	2005	2008
Seller's Reserve ($M)	6	9	4
Buyer's Reserve ($M)	(49)	(43)	(8)
Seller Payoff ($M)	9	12	5
Buyer Payoff ($M)	(18)	(17)	(5)
Welfare Gain ($M)	34	29	5

Table 1. Estimated Welfare Gain Under Contracting

assumed here is the aforementioned penalty rate charged by MWD (to SDCWA, for instance) for supply in excess of the base contracted amount. If the shortage cost of water were in reality lower than that estimate, then the reduction in the buyer's averted shortage cost would yield a more even distribution of the gains. The shortage cost of water may be lower than the MWD penalty rate if, for example, lower-cost supplemental water sources or rationing are viable alternatives. Lower-cost supplemental groundwater may be made available via groundwater pumping, desalination or reuse technologies, or through other water transfer arrangements.

Key Contract Parameters

Option contracts are a form of coinsurance, where the value from contracting is derived from the ability of the buyer and the seller to share risk. The buyer faces a potential costly supply shortage, the magnitude of which depends on the future level of demand as well as the assessed cost of not meeting that demand. The future level of demand depends on a number of parameters, including climatic conditions, and remains uncertain. The seller, a farmer, faces an uncertain price on the commodity market for a crop under cultivation. The future price of the crop determines his opportunity cost of transferring water. These two key uncertainties – future commodity prices and potential urban water shortages – are critical to contract valuation and pricing. Both vary interannually.

There exist reasonably accurate data on historical commodity prices.[6] The validity of historical data is, however, called into question by sudden and sharp price movements, as observed in 2007-2008 on the commodity exchange, with soybean, rice, and wheat prices hitting historical highs. For the purposes of contract-design, there are quotes openly available throughout the year for futures on all major commodities. In contrast, there are very limited data on the actual cost of urban water shortage for users in Southern California. The cost of a secondary supply serves as a proxy for the cost of shortage when the utility intends to cover any unmet demand. A 1993 survey by CIC, Inc., an economic consulting firm hired by SDCWA to assess water outage costs under earthquake scenarios, suggested shortage costs run as high as $5,000/af.[8]

Price per cwt	**13.5-19**	**($/cwt)**
Subsidy per cwt	**2**	**($/cwt)**
Yield per acre	**71.5**	**(cwt)**
Revenue per acre	**858-1,753**	**($)**
Average cost per acre	**832.77**	**($/acre)**
Profit per acre	**133.25-525.73**	**($/acre)**
Water use per acre	**3.3**	**(af/acre)**
Profit per af of applied water	**40-159**	**($/af)**

Table 2. Rice Production Data (Per hundred-weight, or cwt) [7]

Table 2 reports production data for rice used to calculate the farmer's opportunity cost of transferred water. The consumptive use of water per cultivated acre of rice, for example, is 3.3 af of water. Only water consumptively used is eligible for transfer, where *consumptive use* is defined as the quantity absorbed by the plant or evaporated from the plant or soil surface.

Assessing the buyer's potential shortage cost of water requires an estimate of the potential magnitude of the shortage, and then the associated cost of shortage. A distribution of potential future shortages can be estimated based on historical deliveries, firm supply, and projected demand scenarios. The supply is comprised of both available storage water and annual flows into the system.

Design of Standardized Contracts

The issuance of standardized contracts reduces both the uncertainty and the overhead associated with contract negotiation. Drafting such contracts raises a number of questions. *What price structure should be adopted? Also, what contractual clauses are desirable?* And, *how should contracting costs, including, environmental review cost and conveyance, be allocated?*

An efficient two-part price structure implements (1) a fixed fee for contracting and (2) a strike price equal to the seller's opportunity cost plus the marginal cost of conveyance. As discussed, past contracts have implemented a volumetric price structure, charging a per-option (per-af) reservation fee and exercise fee, or strike price. In general, this price structure results in the buyer holding too few options from a social welfare perspective. By charging a fixed fee for contracting in place of the volumetric reservation charge, the seller still collects an upfront payment but does not bias the buyer's decision.

Contracting incurs both fixed costs and marginal costs. The cost of undergoing environmental review is a fixed cost and can be allocated to the buyer through the fixed contracting fee. The conveyance charge for moving water on state-owned infrastructure is a marginal cost and should be rolled into the strike price.

A second issue is the design of standardized option clauses to address renegotiation and community mitigation funds. Renegotiation clauses have not been standard to date but would help ensure that delivery on contracts is avoided when uneconomical. If the buyer must take physical delivery of the water to which he has a contractual right, as opposed to reselling it or keeping it, there is a potential efficiency loss. Delivery of goods under contract is rare in financial markets, where the contracted good is (re)sold to the party with the highest value at the exercise date, often through an external spot market, and money changes hands. There is no spot market for water as yet in California. In its absence, the renegotiation clause encourages the buyer and seller to fully consider the alternative to delivery, e.g., that of resale to the seller. It may also encourage sellers to look for outside buyers in the intervening period.

An alternative to the renegotiation clause is a strike price indexed to the seller's market conditions. Specifically, the price is indexed to the seller's profit from crop cultivation as a function of the prevailing commodity prices. This ensures that the buyer only exercises options up to the point where the value of water in an urban setting exceeds that for agricultural applications. Historical prices for crops such as rice have remained significantly below estimates of the urban shortage cost of water. However, the record high prices

for commodities this past year, in the face of global crop failures and rising demand, call this assumption into question and make indexing even more appropriate.

The issuance and use of a community mitigation fund is a third issue in contract design. Mitigation funds have become a standard element of contractual water transfers. The funds have been established in recognition of negative community-wide impacts due to fallowing programs associated with water transfers, including reduced farm employment and farming-related equipment sales. Size and designation of mitigation funds have varied considerably; a generally-accepted fair and successful precedent has yet to be established. Funds that are structured to disburse individual compensation, such as that established under the Imperial Irrigation District (IID) transfer with the San Diego County Water Authority (SDCWA), generate concerns akin to those facing the welfare systems – namely that dependencies will be encouraged and a precedent for high levels of compensation will be established. At the same time, such programs may be necessary to provide assistance during a transitional period. Funds that are either tied to community development and aimed at diversifying the local economy or, alternatively, set aside for active water management programs, may prove more sustainable.[9]

The viability of temporary water transfers as a mechanism for covering supply shortages hinges on their continued acceptance by farming communities. Water rights sales, or permanent transfers, have met with considerable institutional resistance by farming communities in the past. Although water transfers at the district level typically require approval only by the irrigation or water district board, community sentiment is likely to be fully taken into account. For instance, the GCID board of directors, elected by proportional vote based on landholdings in the irrigation district, ultimately made the contracting decisions in the MWD-GCID transfer. However, the board would have been aware of both the possibility of organized community resistance to prevent future water sales and its accountability to its constituents. The careful design of mitigation funds can help win this approval and also ensure that temporary transfers don't threaten the sustainability of agricultural practices in the future.

An alternative to the establishment of mitigation fees would be the introduction of contractual clauses specifying retainers, or side payments, for community farming enterprises and laborers. The advantage of retainers is a guarantee that the infrastructure, e.g., operation of the mills and marketers, vital to farming activity remains solvent. Closure of these enterprises due to low volume over a period of successive years would be disruptive to future farming practices. In years when transfers are not desirable, e.g., when crop prices are high or water supply is plentiful, farms must remain operable. Given that transfers under fallowing are currently restricted to a less than 20% of a districts total cultivated acreage, the fluctuation in crop volume due to transfers may not be great enough to threaten local business. There is a natural fluctuation in annual volumes due to favorable/unfavorable growing conditions, for which the system is already attuned. As with individual payments from a central mitigation fund, the question arises as to whom exactly qualifies for a retainer fee. Also at issue is the appropriate fee level.

Design of Institutions to Support Contractual Water Transfers

High search costs and limited infrastructure access pose serious barriers to the formation of a more active contracting market. A centralized clearinghouse to match buyers and sellers would reduce search costs. The Drought Water Purchase Program operated by the DWR in dry years is a model of this concept. DWR purchases water from willing sellers, typically agricultural districts, and then makes the water available to interested buyers, typically urban water districts. The limited operation of the market – in select dry years – curtails the ability of buyers to tailor their water management programs. Such management might, for instance, require transfers during non-drought years to replenish storage. There are hundreds of water districts in California, each potentially with an incentive to become involved with water transfers. Under the current system, these districts have limited ability to initiate trade. An online marketplace could effectively match willing buyers and sellers. Online platforms have been vetted in a number of sectors, including popular commerce (eBay), timber (eTimber), and electricity (APX). Timber auctions match logging companies and mills. Auctions can be initiated by either side at any point – buyers initiate reverse auctions or sellers initiate forward auctions.[10] Similarly, in online electricity markets, wholesale and commercial electricity buyers and sellers are matched anonymously based on bids and offers, with each party specifying a reserve price which it will not go above (or below).

DWR's existing role as market-maker is a natural one in light of its control of the major north-south water artery, the State Water Project. Water sold through the Drought Water Purchase Program can be conveyed on state infrastructure under DWR's first-priority rights. Opening the market, as proposed under the adoption of an online trading platform, first requires that infrastructure rights be accessible. Otherwise market participation will be restricted to several large players with high-priority rights. Under a system of tradable, or auctionable, conveyance permits, parties wishing to arrange water transfers could simultaneously set transfer contracts and bid on conveyance rights. Preallocated block permits would accomplish this and have the advantages of repeatability and adjustability, where permits can simply be reissued or adjusted by a proportionality factor, to account for changes in ambient conditions and new claims.

The initial allocation of block permits – with each block consisting of a standardized volume, location (access and delivery point), and time window – for infrastructure access could be granted at a regional level. Block size would be on the order of 10,000 af. The location would be tied to a capacity-constrained point, e.g., a pumping facility. The time window for the permit may range from a few days to a few months. Adjustments to block size could then be tied to ambient conditions, such as minimum flow levels. The final distribution of rights between individual districts wishing to engage in trade could then be decided through sequential auctions of the allotted regional blocks, with all districts within the initial region as qualifying auction participants. A double auction would be conducted through the central (online) clearinghouse, in which the holders of block permits (essentially infrastructure rights) and buyers wishing to transfer water submit electronic bids. If the permits are adjustable, e.g., can be uniformly decremented or even nullified due to legal

restrictions on conveyance, possibly under environmental statute, then the infrastructure risk remains. This notwithstanding, the issuance of defined permits reduces the uncertainty and creates the *possibility* of trade and hence active contacting.

A remaining issue for legislative review, is that of subsidies. The current structuring of subsidies under the Farm Bill is such that farmers are paid a subsidy per cwt for a given crop. In years that land is not cultivated, the subsidy is foregone. The subsidy distorts the value of water by assigning additional value to it when used to grow crops as opposed to used for urban use or transfers. This subsidy deserves review, keeping in mind that a simple transfer of the subsidy from crop cultivation to general water use (including transfers) may have the undesirable impact of increasing wasteful use.

Temporary water transfers could come to play an important role in managing the state's water supply uncertainty. These short-term transfers have the advantages of flexibility, allowing parties to adjust to changing yearly conditions, and low transaction cost. Further reliance on option agreements as a water supply management tool, however, requires institutions to support trade. A centralized clearinghouse and standardized contracts to further reduce transaction cost – in particular matching and negotiation costs – as well as the introduction of tradable infrastructure permits, would support an active market-based system for water transfers. The design of these institutions in California will be of interest to the worldwide community, which also faces water supply pressure in the form of population growth, economic expansion, global climate change, and concern about environmental degradation. o

Notes

1. Tomkins, C.D., Weber, T.A. (2008) "Option Contracting in the California Water Market," Technical Report #2008-10-09, Department of Management Science and Engineering, Stanford University, Stanford, CA.

2. Ibid, p. 14.

3. Metropolitan Water District (2003) "Option and Short-term Water Purchase and Sale Agreement Between Glenn-Colusa Irrigation District and the Metropolitan Water District of Southern California," MWD, Sacramento, CA. Also, MWD (2005) "Option and Short-term Water Purchase and Sale Agreement Between Glenn-Colusa Irrigation District, Dudley Ridge Water District, Kern County Water Agency, and Metropolitan Water District of Southern California and Palmdale Water District," MWD, Sacramento, CA.

4. San Diego County Water Authority (SDCWA) (2008), "Memorandum of Understanding between Butte Water District and San Diego County Water Authority for Transfer of Water," SDCWA, San Diego, CA. Also, San Diego County Water Authority (SDCWA) (2008), "Memorandum of Understanding between Sutter Extension Water District and San Diego County Water Authority for Transfer of Water," SDCWA, San Diego, CA.

5. The technical assumption is that the seller maximizes expected value.

6. See for instance the Food and Agricultural Organization of the United Nations (FAO). [http://faostat.fao.org/]

7. Rice prices as quoted by the Farm Service Agency (FAS). *Interview with Don Perez of FSA, Glenn Colusa County, December 27, 2007.* Data on the cost of rice production from USDA, Research Team, *Rice Briefing*; data on the yield per acre of cultivated rice from *Feed Grains Database*:[http://www.ers.usda.gov]. Consumptive use of water for rice is approximately 3.3 af per acre according to the California Department of Water Resources (2007). Application is actually 5.89 af.

8. CIC Research, Inc., (1993) "The Economic Impact on San Diego County of Three Levels of Water Delivery: 80, 60, or 40 Percent Occurring for Two Months or Six Months, Phase II," CIC Research Inc., San Diego, CA.

9. Hanak, E. (2003) "Who Should be Allowed to Sell Water in California? Third-Party Issues and the Water Market," Public Policy Institute of California, San Francisco, CA.

10. Hanak, ibid., p. 95.

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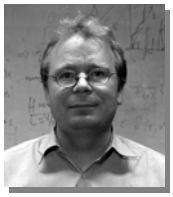

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