Chinatown: Transaction Costs in Water Rights Exchanges
The Owens Valley Transfer to Los Angeles

by

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ABSTRACT

I re-examine the notorious Owens Valley water transfer to Los Angeles, which is a pivotal episode in the political economy of contemporary western water allocation. Negotiated between 1905 and 1935, it remains one of the largest voluntary water sales in U.S. history. It made the growth of semi-arid Los Angeles possible, increasing the city's water supply by over 4 times. Water rights were bundled with the land so that the Los Angeles Water Board had to purchase nearly 1,000 small farms. The negotiations between property owners and the agency were complicated. There often were lengthy disputes over farm characteristics, amounts of water conveyed, and valuation of both land and water. Bilateral monopoly emerged between sellers' pools and the Board. During bargaining impasses, the aqueduct was periodically dynamited. Today, the outcome of the Owens Valley water exchange is viewed as very one sided--one of "theft" by Los Angeles. As such, it discourages contemporary transfers of water from agricultural to urban areas. Using new qualitative and quantitative evidence, especially for 1924-34, when most water-bearing land was purchased, I examine the sources of bargaining conflicts, the timing of sales, the distribution of the gains from trade, and offer a new assessment of the results of the transfer. Implications for current water rights negotiations are drawn.

"I said, 'What was the fight over?' and Mr. Tripp said 'Same old thing-water.'"[1]

"Do you have any idea what this land would be worth with a steady water supply—About 30 million more than they paid for it." J.J. Gittes (Jack Nicholson) referring to land in the San Fernando Valley, in the movie, *Chinatown*, 1974.

"….farmers remain suspicious of the 'Owens valley syndrome'…The 'theft' of its water…in the early 20th century has become the most notorious water grab by any city anywhere…the whole experience has poisoned subsequent attempts to persuade farmers to trade their water to thirsty cities." *The Economist*, July 19, 2003, 15.

Introduction.

I examine the notorious Owens Valley water transfer to Los Angeles, which is a pivotal episode in the political economy of western water allocation. This exchange was the first large-scale market transfer of water rights in the American West. But it has a very negative reputation, cautioning farmers today against water sales to urban areas. I provide a revisionist, more positive assessment of the transfer.

Under the appropriative water rights doctrine that dominates in the West, water can be claimed, separated from the land, and transferred out of the drainage area. In the case of Owens Valley in the early 20th century, all of the water rights had been claimed by farmers, so that the Los Angeles Board of Water and Power Commissioners had to buy either their rights or their farms. Additionally, some farmers held riparian water rights that were directly tied to the land. Since the farms were so small and the region was so dry, it was not feasible to trade part of a farm's water rights and have it remain viable. Ultimately, Los Angeles required all of the water rights in the valley. Accordingly beginning in 1905, representatives of the Water Board purchased land and appurtenant water rights from over 869 farmers during the next 30 years. By 1934, the agency had acquired 95 percent of the agricultural acreage in the valley.[2]

Since water was bundled with the land, negotiations took place in an agricultural land market. Once the Board purchased a farm, part or all of its irrigation water could be released for export to Los Angeles. Wells also were sunk in some areas to access ground water, especially during dry years. The city retained ownership of the farms (as it does today), consolidating and leasing them for cattle raising and some irrigated farming. Retaining farm ownership secured Board access to surface and ground water and internalized any effects of the temporary draw down of ground water from pumping. Especially between 1924 and 1934 when most properties were acquired, negotiations between farmers and the Board often involved lengthy disputes over farm characteristics, including the amount of water conveyed, as well as farmland and water valuation. I examine the nature of these disputes, the prices paid for land and water, the timing of sale, and the distribution of the gains from trade.

This was an important water transfer. Until the arrival of Colorado River water in 1941, there were no other large sources of water available to Los Angeles. Owens Valley water was transported via the Los Angeles Aqueduct, which became one of the nation's largest public works projects at the time, second only to the Panama Canal (Osborne, *Scientific American*, 364-71, 1913). The new water made the growth of semi-arid Los Angeles possible. By 1920 Owens Valley provided a flow of 283 cubic feet per second of water, whereas the entire Los Angeles basin supplied a flow of just 68 cubic feet per second. Between 1900 and 1930, the population surged from 250,000 to 2,208,492 by 1930. Dramatic increases in land values also followed, particularly in the San Fernando Valley (Nadeau, 1950, 29), and for a time, Los Angeles became the nation's largest agricultural county in terms of value of production. Associated power generation made

the Los Angeles Department of Water and Power the largest municipal electric utility in the country. [3]

Despite all of this, the standard evaluation of the Owens Valley transfer is decidedly negative, asserting theft of farmland and water and destruction of the local economy (Wood, 1973, 8; Reisner, 1986, 60-107; Kahrl, 1982, 38; 438, 443, Kahrl 2000, 255; Ewan, 2000, 42; Wheeler, 2002).[4] Although difficult to test, the Owens Valley legacy appears to have been harmful for development of contemporary water markets. Ostrom (1971, 449) claimed it deterred efforts to re-allocate water from Northern California to urban centers in the south, and Haddad (2000, xv) argued that the "Ghost of Owens Valley" inhibited *all* proposed water transfers from rural areas to cities in the West. Hanak (2003, 5, 123) pointed to the Owens Valley experience in motivating county restrictions on water transfers in California. The 1974 movie, "Chinatown," staring Jack Nicholson and Faye Dunaway, dramatized conspiracies involving Owens Valley water and land speculation in Los Angeles, adding to its negative notoriety.[5]

My analysis of Owens Valley negotiations makes use of detailed records—letters, reports, memorandums from 1905 to 1934 between the Los Angeles Water Board, its land agents, and land owners in the Owens Valley as deposited in the Los Angeles Department of Water and Power Archives, the Water Resources Research Center Archives at U.C. Berkeley, and the Eastern California Museum in Independence, California. These documents describe the bargaining history between the Board and farmers as they negotiated over land and water rights. Bargaining positions, strategies, and key issues of contention are described in the data. Additionally, there is a compilation of 869 farm land purchases, including year of purchase, amount paid,

location of property, name of owner, membership in sellers' pools, as well as other property characteristics. These data are used in the econometric analysis.

The information provides a rich basis for examining the bargaining conflicts that occurred in Owens Valley in a manner that has not been done previously. Insights from the analysis explain why some Owens Valley negotiations were so protracted and acrimonious, and why current transfer efforts often are so difficult.[6]

I find that although farmers secured higher land prices through collusion, their "cartel" was not strong enough to secure water prices close to what Los Angeles might have been willing to pay. Accordingly, the vast majority of the gains of trade went to the city. Even so, Owens Valley farmers did better by selling their land and water than if they had stayed in agriculture. This finding counters a popular misconception regarding the Owens Valley transfer. The imbalance in the distribution of the gains of trade, however, has fueled the notion of water theft, and resistance to contemporary water markets. Given the typically large allocative benefits of water transfers, distributional concerns should be given more attention in order to smooth the development of water markets.

II. A Brief Overview of the Owens Valley Water Transfer.

Between 1880 and 1900 the population of Los Angeles grew five fold to 250,000 people, and prospects for continued growth seemed promising, except for the absence of sufficient water. The city averaged just 14.62 inches of precipitation whereas Chicago, for example, had mean rainfall of 34.12 inches.[7] By the turn of the century there was growing concern among city boosters that water sources beyond the meager Los Angeles river watershed had to be found.[8]Owens Valley on the eastern slopes of the Sierras, some 250 miles to the northeast, offered some 37 million acre feet (a.f.) of water from the

Owens River and ground water, about the same as that held in Lake Mead today (Miller,1977, 49-50). Moreover, the water could flow to Los Angeles by gravity, reducing the need for pumping, which was required later for Colorado River water. The valley, a narrow bowl approximately 120 miles long and up to 6 miles wide, was bisected by the Owens River that dumped into the alkaline Owens Lake. There was no water outlet, and ground water levels were high. In 1920, some 7,031 people farmed or lived in five small towns (1920 U.S. Census).There were 140,000 acres of farmland, of which about 40,000 were improved as pasture or in crops, mostly alfalfa, some grains, and small orchards (apple and pear).[9]

Beginning in 1905 the Water Board purchased land in the southern part of Owens Valley and in the Mojave Desert to acquire right of way for the aqueduct as well as to secure claims to Owens River water that had not been diverted for irrigation in the northern, most agricultural section of the valley. Southern Owens Valley lands were drier and average purchase prices ranged from $1.25 to $23.86 per acre. The mean price for 224 properties (107,369 acres) acquired during this time was $12.29 per acre.[10] By contrast, mean purchase price for lands bought later in the north was $198 per acre.[11] With water rights and right of way secured, the Water Board began construction of the Los Angeles Aqueduct in 1907, and it was completed in 1913.

Through 1924, this water supply was thought sufficient to meet anticipated demand in Los Angeles and to justify the construction of the aqueduct. When the aqueduct began flowing it supplied 4 to 5 times domestic urban demand, but under the appropriative water rights doctrine, the water had to be in beneficial use and not stored for the future in order for Los Angeles to retain ownership.[12] Accordingly, water was

made available for farming in the San Fernando Valley, but as urban water demand grew, agricultural use declined. By 1920 urban water demand accounted for 54 percent of aqueduct flow, and by 1935, 72 percent.[13]

In 1924, drought and increased water demand due to rapid population growth caused the Water Board to begin negotiations to purchase additional farm properties in the northern Owens Valley. These negotiations, however, were much more difficult than were the earlier purchases, taking some 10 years to complete for the most valuable properties. Ultimately, the Board secured an additional 145,867 acres of farmland in Owens Valley.[14]

The farms of primary interest to the Board were those that carried the most water, and generally they were part of formal irrigation ditch companies that diverted water from the Owens River to non-riparian farmland. The construction of ditches required cooperative investments so that farmers joined to incorporate mutual ditch companies and to place joint appropriative water claims. The amount of water held by each farmer was directly linked to the number of shares owned in the ditch company. Once the Water Board completed purchase of a farm located on a ditch, its water allocation, as well as any water held via riparian rights, could be released to flow down river to the aqueduct intake at the bottom of the valley. Other farms on the ditches continued to receive their water. As we will see, however, these ditch companies provided a ready organizational device for farmers in bargaining with the city.

III. Transaction Costs: Valuation and Bi-lateral Monopoly.

Owens Valley is famous today because of its almost 30 years of conflict between the Los Angeles Water Board and some valley farmers over the conditions of sale of

water-bearing lands to the city. The episode was referred to in the press at the time as "California's Little Civil War." The question is what was behind this controversial and lengthy process of negotiations? What raised the transaction costs of exchange?

Broadly speaking, exchange requires locating the relevant parties; communicating information about the asset to be traded and terms of trade (offer and ask prices); inspection, verification, and measurement of the asset; negotiation to reach a sale price over mutually-accepted asset attributes and property rights; and finally, contract drafting and enforcement. The transaction costs literature emphasizes that each of these activities can be complex, affecting the timing, extent, and nature of trade (Coase, 1937, 1960; Barzel, 1982; Dahlman 1979; Demsetz; 1964, 1968; and Williamson 1979, 1981).[15] The bargaining setting also can raise the transaction costs of negotiation.

If the transactions had taken place in a perfectly competitive market with multiple buyers and sellers, then competition among parties on both sides would have generated information about property characteristics and competition would have resulted in a market-clearing price. Although there would have been many transactions, measurement, negotiation, and compliance costs would have been minimal. Similarly if there had been either a monopsony (the Water Board) or a monopoly (a single land owner) and the other side had been competitive (many land and water buyers, many land sellers), then the transaction costs of exchange also would have been minimal. With a monopsony buyer and competitive sellers, the transaction costs would have been primarily ones of locating the relevant parties from which to buy. Sales parameters would have been dictated by the monopsonist, reducing bargaining costs. Competition among sellers would have generated information for the monopsonist in determining an offer price, and the

competing sellers would have accepted it. If the sellers had been heterogeneous, however, the monopsonist would have had some additional measurement costs in assembling enough individual farm characteristics to effectively determine its offer prices. With that information it could have set different prices for each seller and engaged in price discrimination in order to extract the gains from trade. Alternatively, with a monopoly seller and competitive buyers, the transaction costs would have involved locating the buyers and competition among them would have led to acceptance of the monopolist's offer price. And if the buyers were heterogeneous, there would have been information costs in determining the differential characteristics of the buyers for individual price determination and price discrimination.

If any of these three bargaining settings had described Owens Valley, it is likely that we would hear little of it today. The negotiations over water-bearing land would have proceeded smoothly with little dispute, but with different distributional outcomes. But Owens Valley was characterized by bi-lateral monopoly conditions, and these raised the transaction costs of exchange. With reduction in competition among sellers (monopoly) there was less information generated about the characteristics and value of the land to be exchanged. This situation increased the search and measurement costs for the buyer. Similarly, with less competition among buyers (monopsony), there was less information generated as to what price they were willing to pay, raising search and measurement costs for sellers. And with a monopoly seller and monopsony buyer, both sides attempted to price in a manner that extracted the gains from trade, increasing negotiation costs. Each party had an incentive to misrepresent its position, and there was little competitive pressure to force more accurate information revelation. Indeed, the literature on bi-lateral

monopoly negotiations points out that they have indeterminate outcomes pricing outcomes that depend on the bargaining strengths of the two parties, they often break down, and they take a long time to complete (Williamson, 1975, 238-47; Blair, Kaserman, and Romano, 1989). The data set used below will allow for the testing of the relative bargaining strengths of the Water Board and the sellers' pools of farmers and how their actions might have raised the costs of exchange.

Valuation.

There were two sources of valuation disputes between farmers and the Water Board in negotiations. One was the determination of the value of any particular property when farms were heterogeneous with respect to agricultural potential (soil fertility, elevation, and level terrain) and access to water (surface water rights and groundwater). Cultivation required irrigation, and water was directed through ditches from the Owens River to the best farm lands. Such lands were scarce and not uniformly distributed across farms. This condition raised conflicts regarding the valuation of individual properties because there were few clear benchmarks for comparison.

Further, a critical problem was how to value the "excess water" that also varied across farms. A great deal of water was concentrated in certain parts of Owens Valley while other parts were comparatively dry. With limited arable land throughout the valley not all of the water in well-endowed areas could be translated into additional cultivated acreage and significant agricultural production. As a result, water-intensive flood irrigation was common on the limited land available, and early observers commented on the profligate use of water by Owens Valley farmers leaving some lands water logged.[16]

A regression of total cultivated acreage per farm on water acre feet illustrates the situation. The estimated coefficients indicate that an additional water acre foot available to a farmer allowed for an increase in cultivated land of only .035 acres in Owens Valley.[17] This is less than in contemporary agriculture elsewhere in California where an additional acre foot of water adds from .17 to .33 acres of cultivation.[18] As further illustrated below, the marginal agricultural value of extra water in Owens Valley was low. This situation brought negotiating conflicts as farmers sought to price their water-bearing lands according to perceived Los Angeles water values, whereas the Water Board clung to much lower agricultural water values. Disputes over the valuation of water were particularly contentious for farms with the most water because on those properties marginal values were closer to zero than on comparatively drier farms.

In negotiations, each farm owner had the most complete information about the agricultural potential of his property and the amount of water held, but at the same time, had an incentive to exaggerate their values. Accordingly, to assemble offer prices, the Board relied upon a committee of expert appraisers to assimilate local farm information. To reduce disputes with the land owners, the Water Board selected a committee that would be viewed as credible and acceptable to both parties.[19]

During the valuation process, Board land agents collected information about each farm—location, water rights, amount of irrigated land in cultivation, pasture, "brush" land, orchards, improvements, and submitted the information to the appraisal committee. The committee, in turn, would compare this information with that for similar farms that had already been purchased to arrive at an "appraised value." The Water Board generally used a fixed multiple, usually 4.1 times appraisal value, to determine its offer or bid

price.[20] The Board instructed its land agents to offer prices that were comparable to what had been paid for similar farms in that region: "It is also to be understood that these properties are to be appraised in the same manner and on the same basis that you have appraised other properties of substantially the same character and in accordance with previous values…."[21] The Board repeatedly resisted adjusting prices beyond what it had offered for other lands in an area. This action is consistent with the effort of a monopsonist to move up the supply curve of land, and the Board's success in doing so is examined below.

Organized groups of land owners challenged the committee's appraised values, and called instead for binding arbitration in price disputes, using outside arbitrators. Challenges were based on disputes both regarding the relevant comparison properties, as well as assessment of individual farm characteristics. For example, one owner, who had been offered $3,100 for her property, complained that a neighbour had been offered $10,500, even though he had 1.25 acres less than her, with only 2 inches of water from the ditch, while she had 3 inches.[22] Another wanted her land appraised against a different group of properties, selecting five farms whose owners had received more than she had been offered.[23]

The disparities between the bid and ask prices due to measurement disputes could sometimes be very large. Owners of the 160-acre Parker ranch asked for $30,000 for the property and improvements. Land agents for the Water Board offered $11,496. At least part of the gap was based on the absence of comparison purchases in the area. Although the owners lowered their ask price to approximately $23,000, negotiations languished for at least four years.[24] In another case, J.T. Otey rejected a bid of $11,200 for his 50-acre

farm, claiming it was undervalued by the Board. Using prices paid for neighboring properties he countered with an ask price of $18,338.56, and held out for two years, selling the farm to the city for $19,000.[25]

Bi-lateral Monopoly Disputes.

In Owens Valley, there was a single buyer, the Los Angeles Water Board, and the farmers attempted to organize as a single negotiating unit, the Owens Valley Irrigation District. Although this effort failed, three sellers' pools were formed to collusive bargain with the Board. Because Los Angeles had to buy farms in order to get the water rights, a land market was used to secure water. The Water Board sought to buy farmland based on its value in Owens Valley agriculture, and the farms were heterogeneous with respect to their agricultural productivity and their water supplies. Farmers wanted to sell their farms based on the value of their water in Los Angeles, but they did not have complete information as to what the value of water was in Los Angeles and what the Water Board was willing to pay for it. In land and water negotiations, each side attempted to force the other to their respective position.

The Water Board's purchases were financed through water bond issues.[26]The Board had incentive to maximize the amount of water-bearing land obtained within the constraint of its bond revenues. There were political pressures on the Board to do so. It was made up of five members, appointed by the Mayor to staggered terms and confirmed by the City Council. The agency was responsible for providing a reliable water supply to the city. Once the Los Angeles aqueduct was constructed for over $23 million, the Board had a large fixed, immobile investment that depended upon Owens Valley water.[27]Demands on aqueduct water grew with population growth in Los Angeles and

with periodic drought that reduced other sources of supply. The total water provided by all farms in the valley was 266,429 acre feet, which was about the total required for the aqueduct in the peak demand year 1927.[28] After that year, the Board began to move north into the Mono Basin in search of more land and water, and it secured right of way through federal lands to extend the aqueduct into that region in 1931.

The agency was under ratepayer scrutiny in the management of its funds.[29] Each new bond issue required voter approval, and multiple bond issues were floated between 1905 and 1930 for Owens Valley purchases and water infrastructure. Not all bond elections were successful, however. At least two proposed bond issues in 1917 and 1929 were defeated by Los Angeles voters, and as the situation in Owens Valley became more controversial, funding of city purchases may have become more problematic politically Ostrom (1953, 50, 63).

Although much of the Owens Valley bargaining record involves conflicts over price between the city and land owners, with the latter claiming that they were underpaid, there is evidence of concern that the city was paying too much for land. For example, a land buyer John Merrill asserted in 1927 that while the city had paid an average of $200 per acre for Owens Valley lands thus far, the lands could have been secured for $50 to $75 per acre for a total expenditure of $5 million rather than $12 million.[30] The *Hollywood Daily Citizen* ran an editorial objecting to any payment for town properties beyond appraised values.[31]

As noted above, in its negotiations with farmers, the Water Board used Owens Valley agricultural water values in determining the prices it offered land owners, whereas the latter tried to use Los Angeles water values in determining the prices they demanded

for their properties. For example, before the Board, one land owner claimed that she priced according to "the comparative value of what that water is worth to you….because we know you want water and not the land…that is what you want and all you want…."[32]

To increase their bargaining power, Owens Valley farmers attempted in 1922 to form one bargaining organization, the Owens Valley Irrigation District. The farms included in the proposed district accounted for 78 percent of all of the water in the valley.[33] This effort at cartelization, however, was undermined by three factors.

One was the heterogeneity of the farms, as described earlier that limited the ability of farmers to form a cohesive unit. Second was the general marginality of Owens Valley agriculture that lowered reservation prices and made many farmers anxious to sell. The valley's elevation (from 3,600 to 4,300 feet), short growing season (150 days), alkaline soil, narrow cultivatable area, and limited access to markets constrained its agricultural potential. Its production was characteristic of Great Basin agriculture rather than of elsewhere in California. Comparing Inyo County (Owens Valley) farms with a baseline of farms in similar Great Basin counties—Lassen, California and Churchill, Douglas, Lyon, Nevada for 1920, however, reveals that Inyo farms tended to be smaller on average (269 acres versus an average of 713 acres for the other four counties) and the annual value of production per farm lower ($4,759 versus $10,069).[34]

Third was the aggressive action of the Water Board to purchase enough strategically-located farms to block formation of the encompassing irrigation district. In 1923 and 1924 the Board bought all of the farms on two large ditches, the McNally and Big Pine Ditches, as well as farms on other important ditches.[35] The premium prices paid

for these farms are demonstrated below. Importantly, there is no record of disputes over these sales negotiations.

In the absence of a single bargaining unit, three smaller sellers' pools formed on separate ditches, controlling about 17 percent of the water.[36] They included the Keough pool on the Owens River Canal with 23 members, the Watterson pool of 20 members on Bishop Creek Ditch, and the Cashbaugh pool of 43 members on Bishop Creek Ditch. The pool leaders were the largest land owners, and they were recognized as bargaining agents for all pool members by the Water Board.[37] Negotiations between the Board and these pools took the longest and were the center of almost all of the bargaining disputes in Owens Valley. These are the negotiations that made Owens Valley famous.

In 1926, the Keough pool demanded $2,100,000 for its properties, and the Board first offered $1,025,000 and then increased its bid to $1,250,000. The pool countered with a price of $1,600,000, which was rejected by the Board.[38] Negotiations were not resolved with the last pool members until 1931.[39] Members of all three pools resorted to violence to pressure the Board to meet their price demands when negotiations broke down, threatening the security of the city's water supply. Between 1924 and 1931 the aqueduct and city wells were periodically dynamited whenever negotiations with the city stalled, although the aqueduct was never seriously damaged (Wood, 1973, 30-37; Ostrom, 1953, 121-27). These episodes of violence attracted state and national attention, and pressured the Board to reach agreement on price with recalcitrant property owners.[40] The Board correctly viewed the dynamiting as a negotiating tactic, but at the same time, it was extremely worried about disruption of the aqueduct flow.[41] In November 1924, the Alabama Gates spillway was seized and opened, dumping the water into the desert and

leaving the aqueduct dry. The Board responded by increasing its efforts to secure additional Owens Valley lands (Ostrom, 1953, 84-93; Hoffman, 1981, 185-8).

In contrast to negotiations with pool members, sales agreements with competitive, non-ditch, non-pool farm owners appear to have gone much more smoothly. Indeed, the Water Board reported that "the prices paid, with few exceptions, have been entirely satisfactory to the seller."[42] Many of the 869 farm properties purchased between 1916 and 1934 were not on ditches or in pools. In the data set used below of 595 farms, 228 were not on ditches. These farms were purchased for their ground water and any riparian claims. Non-ditch properties tended to be the least productive in the region, and they received the lowest prices per acre of land as indicated in Table 1, but they received the highest prices for their limited water.[43]

In the following section an analytical framework is provided to guide statistical analysis of the purchase of farm properties and accompanying water rights. The objective is to explain the timing of sale, the purchase price of farm land, and the relative bargaining power of the Water Board and the sellers' pools.

IV. Analytical Framework.

In the case at hand, the transaction costs of exchange will be increased wherever bi-lateral monopoly conditions prevail. Although direct measures of transaction costs are not available, it is possible to determine the timing of sales and the bargaining strengths of the relevant parties. All things equal, members of sellers' pools should sell later as they negotiate with the city and earn higher prices for the land. The delay in sale for pool members will be due to disputes with the Board over the accurate valuation of their properties and to their efforts to capture a greater share of the gains of exchange.

The data set allows for estimation of the timing of sale and the price paid per acre of land. In general, the sales price of an acre of water-bearing farm land in Owens Valley will be determined by its agricultural productivity, the value of water in Los Angeles, time of sale, the role of sellers' pools, and other farm characteristics:

(1) P_l = f (farm size, farm size^2, cultivated acreage, cultivated acreage^2, water/acre, water/acre^2, riparian water rights, year of sale, pool membership, non-pool ditch farms).

The farm size, cultivated acreage, and water variables (including a riparian dummy for those properties that also had riparian water claims) directly affect agricultural productivity by capturing economy-of-scale effects, inherent fertility and topography as represented by cultivated acreage, and access to water, which was critical in this semi-arid region. All of these variables should have positive effects on price. The squared terms address potential non-linearity, and are likely to be negative. This effect is especially important for the water term, given the problem of "excess" water in the valley. The value of water in Los Angeles is not directly observed in available data, but it is proxied in the year of sale variable. Los Angeles' population grew dramatically over the period, increasing demand for Owens Valley land and water. The mid-to-later 1920s were also periods of drought in Los Angeles that raised demand for Owens Valley land and water. A significant, positive effect of time on price would be consistent with greater Los Angeles' water values. The pool member variables capture the relative bargaining strength of the three pools, and the non-pool ditch farms captures the effects of those farms that were preemptively purchased by the Board to block formation of an encompassing negotiating organization, the Owens Valley Irrigation District. Other tests of relative bargaining strength are possible from the data as described below.

Although the observed market trades were for land, it is possible to calculate an implicit price of water and estimate the determinants of water prices using the same series of variables as outlined in (1) above. This estimation will illustrate whether bargaining power in the land market translated into correspondingly higher prices for water.

V. Empirical Analysis of the Time of Purchase, Prices Paid, and Distribution of Gains in the Land and Water Markets.

The data set of farm properties purchased between 1916 and 1934 by the Water Board includes 869 observations. Excluding properties of ten acres or less as not being farms, but town lots, as well as dropping incomplete entries leaves 595 observations. Of those, 367 farms were on irrigation ditches and 228 were not on ditches, but scattered throughout Owens Valley. Table 1 provides mean values for farm property owners in Owens Valley by various classifications.

Table 1

As indicated by the mean values in the table, farms on ditches sold for higher prices per acre and greater total prices than did those that were not on a ditch. The former had higher percentages of cultivated land; had more water per acre of land; and their owners were more likely to be in a sellers' pool. Those farmers who were in the Keough pool commanded the highest price per acre of land, and members of the Cashbaugh and Watterson pools also did better on average in terms of price per acre and total purchase price than did non-ditch properties. Even non-pool farmers who were on ditches earned more in total and per acre of land than did the non-ditch farmers. These farmers benefited from the early actions of the Water Board to purchase their farms before joining a pool.

Although non-ditch farms sold for less in total and per acre of land, their owners earned more per water acre foot than did farmers more favorably located on ditches. This outcome reflects the purchase of a bundled asset in the land market. The price paid for water is obtained by dividing the sale price of the farm by the water acre feet conveyed in its purchase. While non-ditch farms had less water, the Board still had to pay at least their agricultural or reservation values in order to secure sale. If not all water on a farm translated directly into greater farm production, as was the case for farms with "excess water," then farmers with less water would receive more per unit of water than would their counterparts, who had larger water endowments with lower marginal agricultural values.

This issue is examined in the econometric analysis below, but the mean values in Table 1 suggest that added water increased farm values at a declining rate. For non-ditch farms the average sale price was $19,890 or $473/a.f. water. This total farm sale price is somewhat less than the mean 1925 census farm value for the four comparable Great Basin counties (Lassen, California; Churchill, Douglas, and Lyon, Nevada) of $21,167, but these non-ditch farms were the least productive units in Owens Valley. A sale value of nearly $20,000 corresponded to 6 years of gross farm receipts for Inyo County farms during a time of agricultural depression.[44] It is no wonder that these farms sold with little fan fair whenever the Board offered to buy them. The Board was less interested in these farms because they supplied comparatively little water. The LADWP archives contain letters from such farmers, frustrated by the Board's lack of response to their offers of sale.[45]

The mean sales values for pool farms were higher than for non-pool farms, and all ditch farmers (pool and non-pool) received more in total than did their non-ditch colleagues. Pool farms had sales prices considerably above the 1925 mean census farm value for the four Great Basin counties identified earlier. Their per acre land prices were at least three times those of farms not on ditches. Ditch farmers who had the most water, however, did less well per unit of water in their negotiations with the Board.

Table 2 provides descriptive statistics for econometric analysis of the bargaining over Owens Valley lands. The estimated equations in a 2SLS system are

$$(2)\quad y_{2i} = \gamma_0 + \gamma_1 x_{1i} + \gamma_2 x_{1i}^{\,2} + \gamma_3 x_{2i} + \gamma_4 x_{2i}^{\,2} + \gamma_5 x_{3i} + \gamma_6 x_{3i}^{\,2} + \gamma_7 D_r + \gamma_8 D_k + \gamma_9 D_c + \gamma_{10} D_w + \gamma_{11} D_o + \gamma_{12} z_{1i} + \gamma_{13} z_{2i} + \eta_i$$

$$(3)\quad y_{1i} = \beta_0 + \beta_1 y_{2i} + \beta_2 x_{1i} + \beta_3 x_{1i}^{\,2} + \beta_4 x_{2i} + \beta_5 x_{2i}^{\,2} + \beta_6 x_{3i} + \beta_7 x_{3i}^{\,2} + \beta_8 D_r + \beta_9 D_k + \beta_{10} D_c + \beta_{11} D_w + \beta_{12} D_o + \varepsilon_i$$

where y_{2i} is year of purchase; y_{1i} is per acre sales price; x_{1i} is cultivated acreage per farm; x_{2i} is total farm acreage; x_{3i} is water acre feet/acre; and D_r, D_k, D_c, D_w, D_o are dummy variables for having riparian water rights, membership in the Keough, Cashbaugh, and Watterson pools respectively, or owning a farm on a ditch but not in a pool; and z_{1i} and z_{2i} are instruments, lagged precipitation deviation from the mean in Los Angeles to capture drought effects, and lagged population change in Los Angeles. The 2SLS structure is used because of potential endogeneity in the estimation of the year of purchase and sales price per acre.[46]

Table 2

Table 3

As shown in panel 3a, among the sellers' pools, members of the Keough pool on average held out a year longer than the baseline farmers not on ditches. For members of the Watterson and Cashbaugh pools, however, sale time is not statistically distinguishable from the baseline group. But farmers who were on ditches but not in pools and who had their properties preemptively purchased by the Board to discourage pool membership sold about half a year earlier than the baseline on average. Farms with more water were purchased earlier, reflecting the Board's desire to secure properties that brought the most water. An additional acre foot of water/acre of land speeded sale by .26 year or about 3 months. Further, previous year's drought and population growth in Los Angeles brought earlier sales. A 10-inch deviation in rainfall from normal and an additional 100,000 people both prompted earlier sales by a year.[47]

Panel 3b reports regression estimates of the determinants of the price per acre of land. As shown in the table, the per acre price increased by $32 per year, reflecting the greater value of Owens Valley water-bearing land to Los Angeles over time. Among the agricultural productivity variables, water endowments mattered the most, with an additional acre foot of water/acre adding over $42/acre to the sales price. This contribution, however, grew at a declining rate. The fall off in the value of the marginal product of additional water/acre varied across the sample, with the farms at the center of the most contested negotiations having the largest negative effects. Using the estimated coefficients on the water/acre and water/acre squared terms, it is possible to estimate when the value of the marginal product of water/acre would be zero for a farmer. For the total sample, this occurs at 17 a.f./acre. The farm with the most water/acre had 16.5 a.f./acre.

Seller's pools exhibited market power in the land market, with members of the Keough pool earning about $187 more per acre than did the 228 non ditch property owners and $108 more per acre than those farmers who were on ditches but not in pools. Members of the Watterson and Cashbaugh pools earned approximately $80 and $57 more per acre respectively than the baseline farmers. To keep farmers out of pools, Los Angeles paid an additional $79/acre for the non-pool ditch farms, an amount equal to or better than their owners would have earned in the Watterson and Cashbaugh pools.

In sum, the econometric estimates of per acre land prices reveal that farm size, water endowments, pool membership, preemptive land purchases, and growing Los Angeles demand over time all increased sales values. Among pool farmers, who were at the center of bargaining conflicts, Keough members held out the longest and earned the most per acre. The Keough group was the most concentrated and tightly organized with a Herfindahl index (based on farm size) of 1,583. The Watterson pool had a Herfindahl index of 1,163, the Cashbaugh, 410, and non-pool, ditch farmers, 216.[48] Although 17 of the 23 Keough members sold out in 1926 and 1927, these were very small farmers (14 of them had 10 acres each). The core of the pool, led by the largest land owner, Karl Keough with 4,482 acres (60 percent) of the 7,862 acres on the Owens River Canal and by far the most water of any other pool member, and five other farmers held out until 1931 for higher prices. Member George L. Wallace, for instance, offered his lands to the Board in 1926 for $417 per acre, while the city countered with $254 per acre. In 1931, however, he finally sold at $466 per acre.[49]

By contrast, the Cashbaugh and Watterson appear to have sold too early, earning less per acre. Within the Watterson pool, the leaders and largest land owners, Wilfred and

Mark Watterson, agreed to sell to the Board in 1926 at a slight premium, as did all but three of the 20 pool members. The others sold in 1927. Although the Cashbaugh group began to face erosion of its bargaining stand in 1926, when 20 of the 43 members sold, most of the remaining farmers, including the leader, William Cashbaugh with 596 acres and more than twice as much water as any other pool farmer, sold in 1927.[50]

Although there is evidence of collusive market power among pool members in the land market, it is of interest to see how this may have affected the water market. Table 4 reports a 2SLS estimation of the year of sale and the implicit price per acre foot of water using the same explanatory variables as in the land market estimation.

In terms of time of sale, drought and population growth in Los Angeles, as well as farm size and cultivated acreage speeded sale of water. Non-pool ditch farms had their water purchased earlier. Pool membership, however, had no impact on the time of sale. In terms of the sale price of water, there is no statistically significant effect of the time of sale or pool membership on water prices. Los Angeles' growing demand for land over time did not translate into higher water prices in Owens Valley. The water/acre variable has a significant and negative coefficient of -360.20. The more water a farm conveyed with its purchase, the lower the per acre foot water price. The dramatic fall off in price as indicated by the coefficient's size is consistent with the mean values shown in Table 1. The evidence, then, is that the Water Board was able to use its market power to price water more according to its agricultural value and not its value in Los Angeles. Although pool members earned more per acre of land, this collusive ability was not enough to translate into higher water prices.

There are other indications of the relative market power of the two parties in the negotiations over water-bearing land. It is possible to compare the implicit prices paid per water acre foot with the price that the Water Board might have been willing to pay. In 1931, voters in the Metropolitan Water District, which included Los Angeles, approved bonding for $220 million for construction of the Colorado River Aqueduct to bring 1.1 million acre feet to the city annually. This translates approximately to $220/acre foot for water from the Colorado River or $9.50/acre foot for an annual flow.[51] Converting all implicit water prices for each Owens Valley farm into prices for an annual flow of water and plotting them in Figure 1 illustrates the position of the farmers relative to this baseline. As shown, farmers generally received well below the maximum amount the Board might have been willing to pay, regardless of whether or not a farmer was part of a sellers' pool.

Figure 1

The total expenditures for Owens Valley farms between 1916 and 1934 by the Water Board were $13,937,934. 266,428 acre feet of water were secured, and the average price per acre foot was $52.31.[52]If the Water Board had paid $220 per acre foot for Owens Valley water as it did for Colorado River water, the total sales expenditures would have been $58,614,375, over 4 times the actual outlay. Clearly, the Board paid less for Owens Valley water than it had to pay for Colorado River water.

As another indication of the market power of the Water Board, consider the following exercise in the land market. As indicated in Table 3b, Los Angeles gradually paid more per acre of land over time as its population grew and as drought raised demand for Owens Valley farms and their water holdings. If the last farms purchased in 1932 are

viewed as the properties where marginal values for Los Angeles and Owens Valley farmers were more similar and the Board had paid their per acre price ($286.58) for all previously-purchased farms, total expenditures would have been $26,258,557, rather than $13,937,934. This exercise compares Board farmland expenditures if it had moved up the supply curve for land as a monopsonist with the hypothetical alternative of paying the equilibrium, "competitive" price for all properties. As indicated, the hypothetical value is about double the actual expenditure.

All in all, while farmers exhibited some collusive market power in the land market through their pool membership, this power was limited and did not translate into higher prices for water. In contrast, the Los Angeles Water Board had more market power in both markets, securing Owens Valley water for less than it paid for water elsewhere.

VI. Impact of the Water Transfer: An Assessment.

Most of the benefits of the sale of water went to Los Angeles, and this is the origin of the notion of water "theft" that exists today. Even so, Owens Valley farmers were still better off by selling their land and water rights than if they had remained in agriculture. One indication is that the mean price paid between 1916 and 1934 by the Board per acre of land in Owens Valley was $198 (Table 1), whereas the mean 1930 census per acre value of land and buildings in the four comparable Great Basin counties in 1930 was $36.40. By this measure, Owens Valley farmers on average had their property values increased by over 5 times that of their peers elsewhere in the Great Basin. Further between 1900 and 1930, census land values in Owens Valley rose by around a factor of 11, increasing from an average of $13 per acre to $143 (Barnard and Jones,1987,10-12). By contrast, land values in the baseline Lassen County, California

rose by a modest 2 times over the same 30-year period, from $10 per acre to $21. These data suggest that most of the rise in land values in Inyo County (Owens Valley) was due to land purchases by Los Angeles and not due to changes in agricultural commodity and livestock prices.

During the same period, the value of agricultural land and buildings in Los Angeles County rose by $406, 451,090 from $70,891,930 to $477,343,026, an increase of 673 percent, mostly due to the increased migration and development opportunities made possible by arrival of Owens Valley water. At the same time, the value of agricultural land and buildings in Inyo County rose by $11,757,724, from $1,801,810 to $13,559,534, an increase of 653 percent. By contrast, farm property values in Lassen County increased by $6,306,099, from $3,657,520 to $9,963,619 or 172 percent from 1900.[53] Again, the baseline Great Basin county does not do as well. Property values reported by the California State Board of Equalization provide a similar picture.[54]

An alternative way of assessing the impact of Owens Valley land sales is to consider the counterfactual of no Los Angeles purchase or export of Owens Valley water, the expansion of farm acreage in Inyo County at the same rate as occurred in Lassen County, and the same increase in land prices in Inyo as occurred in Lassen. Under this plausible counterfactual, farm land values would have been $4,547,738 in 1930 in Owens Valley.[55] But this value is over $9,000,000 *less* than what actually occurred.

Figure 2 illustrates the impact of Water Board purchases on land values in Inyo County relative to five other Great Basin counties, Lassen, California and Churchill, Douglas, and Lyon, Nevada between 1910 and 1954. The run up in land prices in Inyo County during the 1920s is very apparent. It is also apparent the experience in Inyo

County after 1930 was not much different from that in the other counties. Clearly, the county was not turned "in to a desert" as is alleged in the literature. Other measures provide the same result.[56] This assessment is in contrast to the usual argument that Owens Valley was being turned into a waste land by Los Angeles.[57]

VII. Concluding Remarks: Lessons of Owens Valley for Understanding Contemporary Water Transfers.

The analysis presented here suggests why Owens Valley land negotiations took so long and were often so acrimonious. The farm lands were heterogeneous, and there were intense disputes over property valuation and the sharing of the gains from re-allocating water to Los Angeles.[58] The bargaining for water was complicated because it took place in a land market and the most contentious, lengthy negotiations took place within a bi-lateral monopoly setting. Indeed, the bargaining disputes with the members of the three sellers' pools are what have made Owens Valley infamous today.

Despite evidence that indicates both parties to the exchange benefited from the land sales, the perceived assessment is one of theft. The sense of theft comes from the inability of the pool farmers to capture more of the value of their water holdings as they negotiated in an agricultural land market. The competitive, non-pool, non-ditch farmers who had the least productive farms and water expected to unambiguously benefit from outside purchases by Los Angeles. They concluded transactions quickly and smoothly based on the agricultural value of their lands whenever the Water Board showed an interest in purchasing them. On the other hand, those farmers with the most productive farms and most water did least well in their water sales, even when they collusively organized.

Additionally, there was a huge imbalance in the distribution of the total gains from trade in the land market. The census data presented above indicate that the overall gains to Los Angeles were 40 times or more than those of Owens Valley from the redistribution of water through the sale of water.[59] The perception of unfairness over the terms of trade also was driven by the nature of supply and demand for water. Urban users had relatively inelastic demand, whereas farmers competing for sale had comparatively elastic export supply. Hence, Los Angeles residents gained considerable consumer surplus from the transaction.[60] The effort of farmers to gain more of the gains of trade in negotiation explains the formation and relative greater success of the sellers' pools. Even so, a disproportionate share of the returns went to Los Angeles.

The evidence presented in this paper demonstrates that the Owens Valley transfer was not a disaster as asserted in the contemporary literature. Indeed, it does not deserve to be cited as the leading example of the dangers of water exchanges from agriculture to urban and environmental uses. Its outcome was favorable for the parties involved and should be presented as such. The conflict or "theft" was over the distribution of the gains from trade in which both parties participated.[61]

In 1958 John McGee challenged prevailing attitudes about predatory price cutting with a re-examination of the actions of Standard Oil of New Jersey to expand market share.[62] He found little evidence to support the systematic use of predatory price cutting by Standard Oil despite historical accounts to the contrary. His paper helped to revise or at least better focus antitrust policy. The aim here is similar, although more modest, to emphasize the importance of resolving distributional conflicts in water transfers. These disputes play an important role in current water transfer efforts, especially as they apply

to alleged third-party effects.[63] The long and tortuous record of negotiations in Owens Valley, despite large *ex post* aggregate gains from trade highlights the importance of addressing these disagreements in order to smooth water transfers. Given the likely surpluses generated from the re-allocation of water, the basis for addressing such concerns seems to be at hand. The allocative benefits will swamp distributional concerns.[64]

Table 1
Owens Valley Farm Property Characteristics, Mean Values

Property Type	Price /Acre	Total Purchase Price	Year of Purchase	Size (acres)	Price/ Water A.F.	Total Water A. F.
All Properties*	$198	$23,425	1926	154	$178	448
Farms Not on Ditch	82	19,890	1927	207	473	261
Keough Pool[1]	443	27,647	1928	79	77	366
Cashbaugh Pool[1]	242	32,156	1927	126	69	544
Watterson Pool	237	33,983	1926	147	75	584
Non Pool on Ditches	263	23,861	1926	122	112	581
	Water A.F./Acre	**Total Cultivated Acreage**	**% Cultivated Land**	**Water A.F/ Cultivated Acre**	**Riparian Rights %**	**#**
All Properties*	4	17	17	28	35	595
Farms Not on Ditch	1	19	9	14	31	228
Keough Pool	6	16	20	69	96	23
Cashbaugh Pool	4	15	14	33	19	43
Watterson Pool	4	27	21	18	25	20
Non Pool on Ditches	5	14	22	30	36	281

*Properties 10 acres or larger purchased by Los Angeles between 1916 and 1934. Smaller properties were not farms, but town lots and addressed separately: "Porter files," LADWP Archives.

Table 2
Descriptive Statistics

Variable (595 observations)	Mean	Standard Deviation	Minimum	Maximum
Land Price/acre	$198	$163	$3.00	$955
Year of Purchase	1926	1.87	1917	1932
Farm Size (acres)	154	267	10	3,502
Cultivated Acreage	17	40	0	422
Water Acre Feet/Acre	3.7	3	0	16.5
Riparian Rights (Y/N)	0.35	0.48	0	1
Keough Pool (Y/N)	0.04	0.19	0	1
Cashbaugh Pool (Y/N)	0.07	0.26	0	1
Watterson Pool (Y/N)	0.03	0.18	0	1
Other Ditch (non-pool) (Y/N)	0.47	0.50	0	1
LA Annual Population Change (000) 1916-1934	123	75	23	283
LA Annual Precipitation Deviation from Mean in inches (1910-40)	0.11	4.98	-8.51	4.25

Table 3
The Land Market
Determinants of Year of Purchase and Price Received Per Acre

a.) First Stage Results
DV = Year of Purchase

Variable	Coefficient	SE
Constant	1928.67***	0.22
Total Farm Acres$_t$	-1.9E^{-03}***	5.3E^{-04}
Total Farm Acres^2	5.1E^{-07}**	2.3E^{-07}
Total Cultivated Acreage$_t$	0.02***	0.004
Total Cultivated Acreage^2	-2.2 E^{-05}*	1.3E^{-05}
Water Acre Feet/Acre$_t$	-0.26***	0.06
(Water Acre Feet/Acre)^2	0.02***	0.01
Riparian Rights$_t$	0.07	0.14
Member of Keough Pool$_t$	1.06***	0.37
Member of Cashbaugh Pool$_t$	-0.25	0.28
Member of Watterson Pool$_t$	-0.44	0.37
Farms on Ditches but not in Pool$_t$	-0.52***	0.19
Precipitation Deviation$_{t-1}$	0.10***	0.01
LA Annual Population Growth$_{t-1}$	-0.01***	0.002

581obs. , R^2 = .33, F(13,581) = 23.40)

***significant at the 1% level or better.
**significant at the 5% level
*significant at the 10% level

b.) Second Stage Results
DV = price per acre

Variable	Coefficient	SE
Constant	-62,365.90***	10,721.73
Estimated Year of Purchase$_t$	32.39***	5.56
Total Farm Acres$_t$	-0.13***	0.04
Total Farm Acres^2	3.1E^{-05}**	1.6E^{-05}
Total Cultivated Acreage$_t$	0.40	0.27
Total Cultivated Acreage^2	-1.3E^{-03}	8.9E^{-04}
Water Acre Feet/Acre$_t$	42.40***	4.36
(Water Acre Feet/Acre)^2	-1.42E^{-06} ***	0.38
Riparian Rights$_t$	1.58	9.68
Member of Keough Pool$_t$	187.15***	25.52
Member of Cashbaugh Pool$_t$	57.22***	18.87
Member of Watterson Pool$_t$	80.71***	25.36
Farms on Ditches but not in Pool$_t$	79.10***	13.35

581 obs.

***significant at the 1% level or better.
**significant at the 5% level.
*significant at the 10% level.

Table 4
The Water Market
Determinants of Year of Purchase and Price Received Per Acre Foot

a.) First Stage Results

DV = Year of Purchase

Variable	Coefficient	SE
Constant	1927.81***	0.31
Total Farm Acres$_t$	-2.1E^{-03}***	5.6E^{-04}
Total Farm Acres^2	5.60E^{-07}***	2.2E^{-07}
Total Cultivated Acreage$_t$	0.01***	0.004
Total Cultivated Acreage^2	-7.2 E^{-06}	1.2E^{-05}
Water Acre Feet/Acre$_t$	-0.08	0.08
(Water Acre Feet/Acre)^2	2.3 E^{-03}	6.0E^{-03}
Riparian Rights$_t$	0.27**	0.15
Member of Keough Pool$_t$	0.51	0.37
Member of Cashbaugh Pool$_t$	-0.08	0.27
Member of Watterson Pool$_t$	-0.17	0.35
Farms on Ditches but not in Pool$_t$	-0.48***	0.19
Precipitation Deviation$_{t-1}$	0.12***	0.01
LA Annual Population Growth$_{t-1}$	-0.01***	0.002
	433obs. , R^2 = .35, F(13,429) = 19.22)	

***significant at the 1% level or better.
**significant at the 5% level
*significant at the 10% level

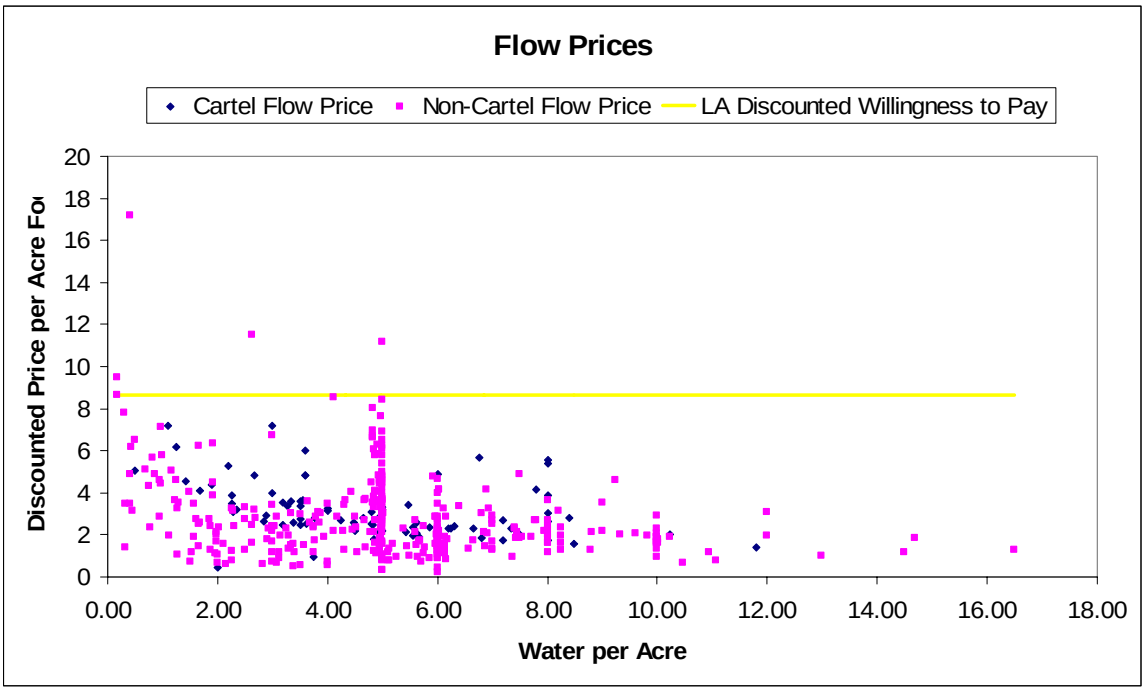
b.) Second Stage Results

DV = price per acre foot of water

Variable	Coefficient	SE
Constant	50,633.06	117,569.10
Estimated Year of Purchase$_t$	-25.55	61.02
Total Farm Acres$_t$	-1.09***	0.44
Total Farm Acres^2	3.2E^{-04}**	1.7E^{-04}
Total Cultivated Acreage$_t$	3.20	2.77
Total Cultivated Acreage^2	-8.54E^{-03}	8.9E^{-03}
Water Acre Feet/Acre$_t$	-360.20***	55.68
(Water Acre Feet/Acre)^2	22.73 ***	4.36
Riparian Rights$_t$	31.45	110.02
Member of Keough Pool$_t$	-3.89	267.21
Member of Cashbaugh Pool$_t$	-194.63	192.96
Member of Watterson Pool$_t$	-291.33	249.68
Farms on Ditches but not in a Pool$_t$	-120.86	143.92

***significant at the 1% level or better.
**significant at the 5% level.
*significant at the 10% level.

Figure 1


Flow Prices
Cartel Flow Price
Non-Cartel Flow Price
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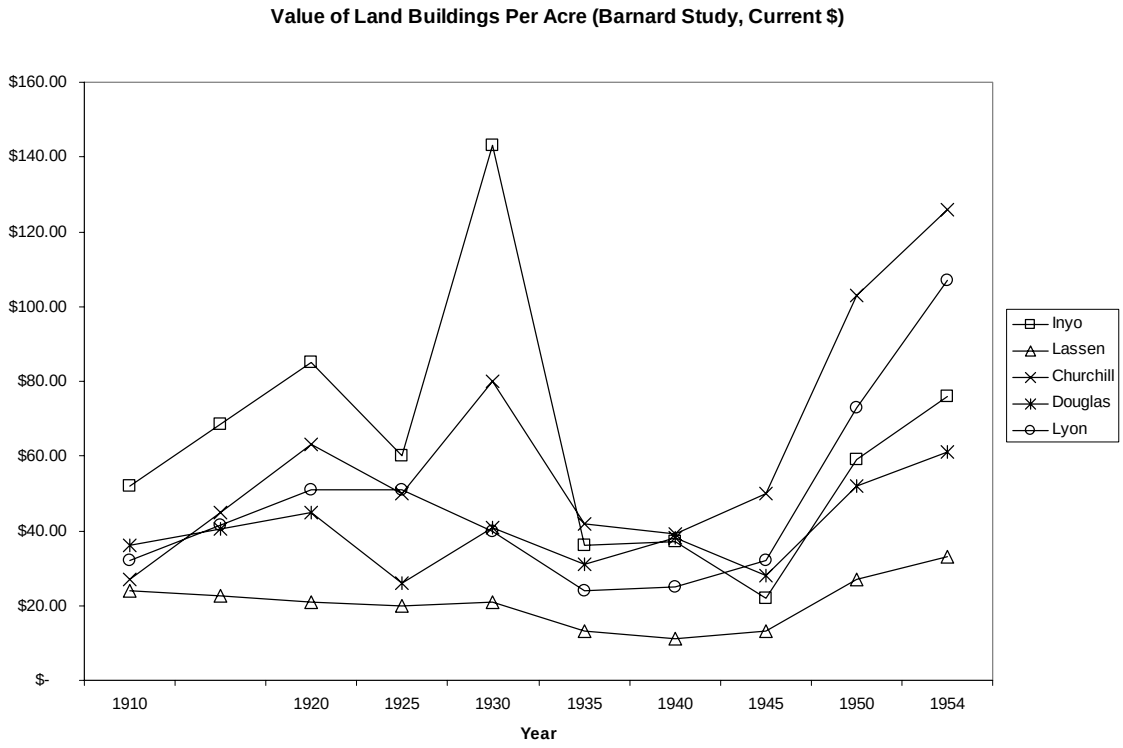
Water per Acre

Figure 2
Land Values Per Acre, Inyo County (Owens Valley) and Comparison Counties



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[1] Tape GX0002 Leahey E.F. file, notes dated 11/13/no year, LADWP Archives.
[2] Ostrom (1953, 127).
[3] Ostrom (1953, 23). LA hosted the Xth Olympic Games in 1932. See also Kahrl (1982, 227-230).
[4] A search of the Westlaw "ALLNEWS" data base of Owens Valley, for example, provides large and negative press accounts. More balanced views are in Nadeau (1950, 126-28), Hoffman (1981, xviii-xiv), Vorster (1992), Walton (1992, 192-97), and Sauder (1994, 124-34, 151-64).
[5] The perception of land theft and community destruction continues in the press. For example, see New York Times, August 8, 2004, p. 14, "Los Angeles Mayor Seeks to Freeze Valley Growth. Centry-Old Land Grab Still Contentious," by John M. Broder.
[6] As described below, recent negotiations between the Metropolitan Water District of Southern California and the Imperial Irrigation District and Palo Verde Irrigation District have encountered similar issues.
[7] Mean precipitation for Los Angeles, 1921-2002 from www.nwsla.noaa.gov/climate/data/cqt_monthprecip_cy.txt and mean for Chicago, 1871-2003 from home.att.net/~chicago_climo/CHIPRCP.gif .
[8] Ostrom (1953, 23) provides data on the various sources of water for Los Angeles, 1920-1950.
[9] 1925 U.S. Agricultural Census; Walter Packard, "The Future Agricultural Development of Owens Valley," January 22, 1925, Tape GX0004, Special Owens Valley File, LADWP Archives.
[10] Charles H. Lee, "Statement of Lands in Inyo and Mono Counties Owned by Department of Public Service of the City of Los Angeles Prior to January 1923," January 1924, Water Resources Research Center Archives, UC Berkeley, Lee Folders MS 7611 98L4a.
Total land and expenditure 1905-1923 107,369 acres, $1,319,526 for $12.29/acre; 224 properties; most purchased 1905-10.
[11] Tape GX0007, Owens Valley Lands file, Report to Ralph Criswell of Owen Valley Lands, August 6, 1927 from John T. Martin, Right of Way and Land Agent and "Tabulation Showing Status of Ranch Land Purchases Made by the City of Los Angeles in the Owens River Drainage Area from 1916 to April 1934," Prepared in Right of Way and Land Division by Clarence S. Hill, Right of Way and Land Agency, Compiled by E.H. Porter, April 16, 1934, Tape GX0004, LADWP Archives, hereafter referred to as "Porter file."
[12] Sauder (1994, 122), Ostrom (1953, 148). The beneficial use requirement meant that water had to be used and not stored (hoarded) for future use.
[13] Calculated from table in Ostrom (1953, p. 24).
[14] "Porter file." Memo by land agent, AJ Ford for the Investigation file, March 11, 1931, Tape GX0002, Investigating Committee File, LADWP Archives. Also 1,300 town properties were purchased.
[15] Useful summaries of transaction cost issues and concepts are in Allen (2000) and Eggertsson (1990). Empirical studies of transaction costs in exchange include Joskow (1987, 1988), Stavins (1995), Archibald and Renwick (1998), Howe, Boggs, and Butler (1990), and Wallis and North (1986).
[16] Water Resources Research Center Archives, UC Berkeley, Ms/1 98.17 Lee Folder, "Use of Water for Irrigation in Owens Valley in Connection with the Supply of the Los Angeles Aqueduct." Charles H. Lee and S.B. Robinson, February 1910, p. 5.
[17] $y_i = \gamma_0 + \gamma_1 x_i + \gamma_2 x_i^2$ with y_i cultivated acreage for each of 525 farms and x_i water acre feet per farm. The coefficient estimates for the water variables are .035 (.003) and -1.39e^{-06} (.1.46e^{-07}), standard errors in parenthesis.
[18] Ellen Hanak reported that irrigation use in California typically ranges from 3 to 6 acre feet/acre, giving the .33 and .17 figures reported in the text.
[19] In 1925, the Water Board assembled a special Appraisal Committee of "three of the leading citizens of Owens Valley:" George W. Naylor, Chair of the Board of Supervisors of Inyo County (Owens Valley), V.L. Jones, Inyo Assessor, and U.G. Clark, former county Assessor, Tape GX0004, Sale of Lands File, Letter from Board of Public Service Commission to land owners, C.P. Crowell and S.F. Zombro, LADWP Archives.
[20] Tape GX0004 Special Owens Valley Committee File, Resolution, July 20, 1925, Board of Water and Power Commissioners. LADWP Archives.

[21] Tape GX0003 Owens River and Big Pine Canal File, letter to the Owens Valley Appraisal Committee from E.F. Leahey, September 10, 1926, LADWP Archives.
[22] Tape GX0003 Owens River and Big Pine Canal File, Transcript of Proceedings, August 13, 1926 Ladies Committee to Board of Water and Power Commissioners, testimony by Mrs. R. C. Clapp. LADWP Archives.
[23] Tape GX0003 Owens River and Big Pine Canal File, Transcript of Proceedings, August 13, 1926 Ladies Committee to Board of Water and Power Commissioners, testimony by Mrs. Wallace. LADWP Archives.
[24] Tape GX0006, George W. Parker File, LADWP Archives. Search of the "Porter file" shows no entry for the Parker ranch.
[25] Tape GX0004, Sale of Lands file, Letter to E.F. Leahey, Water Board land agent from J.T. Otey, February 4, 1927 and "Porter file," LADWP Archives.
[26] Early bond elections were contentious because of political allegations of land speculation as described in the movie Chinatown. See also, Hoffman (1981, 141-54), Kahrl (1982, 90-103, 195), Ostrom (1953, 58, 149-54), and Nadeau (1950, 29-41). Contemporary water financing issues are discussed in Smith (2001).
[27] Joskow (1987) discusses the hazards of relationship-specific investments and how parties to long-term coal contracts contracted around them to promote trade.
[28] The "Porter file" contains 869 properties, and dropping all 10 acres or smaller to include farms leaves 595 farms with 266,429 acres feet of water calculated by totaling the water provided in each of the farms. Daily flows in the aqueduct are from Ostrom (1953, 22) from 1920-1935 which are in cubic feet per second. These are converted to acre feet per year by multiplying by 1.98 the conversion factor from cubic feet per second to acre feet and then by 365 to express as an annual amount. 1927 aqueduct flow was 265,231af. In 1931 the Board secured right of way through federal lands to extend the aqueduct into the Mono Basin to the north in search of more land and water. An additional 142,000 acre feet annually was available there (Kahrl, 1982, 331, 345).
[29] Ostrom (1953, 59-62). In 1925, under a new City Charter, the Water Board was required to cover all interest and principal charges on outstanding bond debt from its revenues, not from taxpayers. "Water Bonds" advertisement, Tape DS0010, Power and Water Bond Election File, August 31, 1926, LADWP Archives.
[30] Tape EJ00086, Correspondence June to September 1927, letter John A Merrill to Board of Public Service Commissioners, August 15, 1927, LADWP Archives.
[31] Tape GX0001, Clippings File, Hollywood Daily Citizen editorial, n.d. probably late 1929. LADWP Archives.
[32] Tape GX0003 Owens River and Big Pine Canal File, Transcript of Proceedings, August 13, 1926 Ladies Committee to Board of Water and Power Commissioners, testimony by Mrs. Wallace. LADWP Archives.
[33] Calculated from the Porter File.
[34] Miller (1977, 53-55). US Census and Barnard and Jones (1987). The data are average farm size in Inyo County and the means of the average farm sizes for Churchill, Lyon, Douglas, and Lassen Counties. Similarly, the average value of farm production per farm for Inyo and the mean of the averages for the other four counties. The agricultural potential of Owens Valley generally is exaggerated in the literature. For instance see Kahrl (1982, 38).
[35] The role of the purchase of the McNally and Big Pine Ditches in thwarting the effective organization of the Owens Valley Irrigation District that would have united all of the sellers' pools is described in a letter, September 22, 1924 to the Grand Jury of Inyo County from W.W. Yandell and Ione Seymoure of the Farmers Ditch Company regarding Los Angeles purchase of McNally Ditch. Tape GX0007, Town Properties File. Tape GX0001, Ditches File, "Percentage of Water Stock Owned by City of Los Angeles in Private Ownership in the Following Ditch Companies," LADWP Archives. See also, Kahrl (1982, 279), Nadeau (1950, 95), Sauder (1994, 140-43).
[36]Data in the Porter File includes water acre feet per property along with designed pool membership. With this information it is possible to calculate the total water acre feet available from the valley and accounted for by pool group. The total was 266,429 a.f. with the pools providing 43,480 a.f.
[37] Tape GX0002, Memo, July 26, 1928, E.F. Lahey, DWP Land Agent, to W.B. Mathews, DWP, E.F. Leahey File, LADWP Archives.
[38] Memo, July 21, 1926 by Board of Water and Public Service Commissioners, Tape GX0004, Special Owens Valley Committee File, "Owens River Canal Properties," Tape GX0004, Sale of Lands File, and

Letter, July 21, 1925 to the Board of Water and Power Commissioners from the Purchasing Committee, Tape GX0003, Owens River and Big Pine Canal File, LADWP Archives.

[39] Allegations of third-party effects on town lot values also complicated negotiations between the Board and pool members. It was asserted that the purchase of water-bearing lands reduced farming and commercial activity in the valley's five small towns. Libecap (2005) finds little support for this claim.

[40] *Literary Digest* December 6, 1924, 13-4. Tape GX00086, Letter May 9, 1924 from land agent John Martin to William Mulholland claiming that the dynamiting was an effort to force the city to buy at "exorbitant prices."

[41] Tape GX0001, Miscellaneous File, "The Dynamite Holdup," Statement by the Board of Water and Power Commissioners, LADWP Archives.

[42] Tape GX0004, Sale of Lands File, Letter from LADWP to two land owners, C.P. Crowell and S.F. Zombro reporting on the status of land purchases in Owens Valley and "Porter file" LADWP Archives.

[43]Part of the reason for smooth agreement for purchase of non ditch properties was the Board's fear of adverse court rulings under *Santa Barbara v. Riverside*, 186 California, 7, 15 (1921). Under that ruling any land owner who could demonstrate damage due to the drawdown of the water table from pumping and export of water by another party could secure an injunction halting *all* ground water pumping in the region. To maintain the flow of groundwater to the aqueduct the Board quickly purchased properties whenever pumping injunctions were threatened by land owners. Miller (1977, 161). *Katz v. Walkinshaw* 141 Calif 116, 140 (1903) also protected correlative rights by limiting draw down through pumping.

[44] 1925 Agricultural Census, value of farm production per farm, Inyo County, was $3,412.

[45] Letter, October 8, 1926 from attorney, John Neylan to W.B. Mathews of the LADWP Legal Department complaining that although his client had not attempted to gauge the city and had stayed away from pool, she had not heard about her offer to sell for three years. Tape GX0003, Line Pine File, LADWP Archives.

[46] A Hausman test suggests endogeneity with a Chi-square test statistic of 6.54, 1 df, and a p value of .0105. The instruments are relevant and an OIR test indicates that the instruments are valid. Annual precipitation data from 1910 to 1940 are for Long Beach from http://climvis.ncdc.noaa.gov/cgi-bin/ghcn/precp.chcncgi. Long Beach data are virtually the same as those for Los Angeles for which the data were more limited. Annual Los Angeles population is estimated and provided at http://www.laep.org/target/science/population/table.html. The estimations are based on decennial census data and estimates provided by the California Taxpayers Association, the Los Angeles Chamber of Commerce, and those compiled by the Los Angeles County Regional Planning Commission.

[47] During the drought of 1924, for example, precipitation was almost 9 inches below normal in Los Angeles.

[48] Herfindahl indices based on water acre feet give similar relative values.

[49] "Owens River Canal Properties" and "Letter," February 24, 1926 from various individuals to F. Del Valle, President, Los Angeles Water Board, Tape GX0004, Sale of Lands File and "Porter file."LADWP Archives.

[50] Tape GX0001, Fish Slough File "Cashbaugh Pool," LADWP Archives.

[51] Los Angeles' share of Colorado River aqueduct water and costs are from Hundley (2001, 229) and Erie (2000, 155, fn 26). Los Angeles sought 1.1 million acre feet, although subsequent court rulings reduced this to 550,000 acre feet. The conversion is based on the present value of an annuity at 3% for 40 years. 3% is the mean high grade municipal bond rate between 1920 and 1960 and the conversion factor for presenting the stock price as an annual flow is 23.11477.

[52] Calculated from the land sales data in the "Porter file," LADWP Archives.

[53] Census data are from http://fisher.lib.virginia.edu/cgi-local/censusbin/census/cen.pl. These figures are only representative of the actual gains from trade. The data for Los Angeles do not include increases in urban land values and the amount of agricultural land in Los Angeles declined by 369,000 acres between 1900 and 1930. Similarly, the amount of farm land in Inyo County declined by 46,000 acres, whereas in Lassen County, farm land grew by 92,000 acres. Nevertheless, the data are indicative of the values involved.

[54] Reports of the California State Board of Equalization, Sacramento: State Printing Office, 1900-1935.

[55] These values are calculated as follows: Using census data for 1900 and 1930, Inyo County had 141,059 acres in farms in 1900 and Lassen 381,103 acres. In 1930, Lassen had 473,268 acres, an increase of 24%. Had Inyo farm acreage grown in the same way, then in 1930 there would have been 174,913 farm acres. Lassen farm acreage values doubled over the 30 years, and 1900 Inyo per acre values were $13. Using the

Lassen increase, gives a 1930 per acre value in 1930 of $26 and multiplying this times the 1930 estimated acreage gives a value of farm acreage of $4,547,738. Actual census value of farm land and buildings in 1930 is $13,559,534 for a difference of $9,011,796.

[56] Census data on the value of agricultural production per farm and population for example show Inyo County to move very similarly with its Great Basin neighbors.

[57] Most recently, see New York Times, August 8, 2004, p. 14 where the Owens Valley transfer is labeled a "Century-Old Land Grab."

[58] This is similar to efforts to define unitization shares in oil fields. See Wiggins and Libecap (1985).

[59] This figure is based on the difference in the rise in value of agricultural land and buildings in Los Angeles County and Inyo County between 1900 and 1930--$407,051,000 as compared to $11,568,000 (U.S. Census data).

[60] Ellen Hanak reminded me of the nature of supply and demand forces in generating this result.

[61] When the gains from trade are very large, distributional outcomes move to the forefront as they did in Owens Valley negotiations. Generally, it may be the case that trades are smoother when the benefits are shared reasonably equally, but encounter more difficulties in completion when the distribution is very skewed toward one party. P.J. Hill suggested this point to me.

[62] I thank Sam Peltzman for reminding me of McGee's findings.

[63] There are other efficiency concerns if the export of water involves extraction of subsurface, common-pool ground water basins. For discussion, see Hanak (2003, 2004) and Knapp, et al (2003). Third-party effects are discussed by Colby (1995), Howitt (1994), Carter, Vaux, and Scheuring (1994), Howe (1997), and others. Major, on-going negotiations in the U.S. West involve the Imperial and Palo Verde Irrigation Districts in California. Third-party effects are discussed by Northwest Economic Associates (2004).

[64] Dellapenna (2000, 356-7) also points to the importance of distributional concerns in water markets.