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Chinatown Revisited: Owens Valley and Los Angeles—Bargaining Costs and Fairness Perceptions of the First Major Water Rights Exchange

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I examine a complicated bargaining problem in the acquisition of private land and water rights by Los Angeles in Owens Valley. This is a pivotal episode in the political economy of contemporary western water. More broadly, Owens Valley provides empirical evidence on how the gains from exchange were divided among the parties and how equity concerns shaped the process and succeeding assessment of market allocation. Negotiations for key properties took place within a bilateral monopoly context, and the bargaining strategies of both parties raised the transaction costs of exchange and formed fairness perceptions about the outcome of the exchange. I analyze the bargaining environment and estimate the determinants of when properties sold and the prices paid for land and water. Farmers who colluded did better by selling the properties than if they had remained in agriculture. Their "cartels," however, were not strong enough to secure more of the surplus from reallocating water from agriculture to urban demand. Most of the gains went to Los Angeles landowners, and this is a source of the notion of water "theft" that continues today.

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"I said, 'What was the fight over?' and Mr. Tripp said 'Same old thing—water.'"

(Tape GX0002, Leahey, E.F. File, notes dated 11/13/no year, LADWP Archives)

"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)

1. Introduction

I examine a complicated bargaining problem, the contentious acquisition of private land and water rights by Los Angeles that was the notorious Owens Valley water transfer to the city. This is an important case where the bargaining strategies of the parties to capture more of the gains from trade increased transaction costs and molded perceptions of fairness of the exchange held by both contemporary and subsequent observers of Owens Valley.

Owens Valley is a pivotal episode in the political economy of western water. Negotiated between 1905 and 1935, with most transitions between 1923 and 1934, this is one of the largest private land and water acquisitions by any local government in American history. About 1167 farms covering 262,102 acres were purchased for $20,768,233 ($219,727,905 in 2003).[1] The associated water rights acquired by the city raised Los Angeles' water supplies by over four times.[2] As late as 1998, Owens Valley and the Mono Basin to the north contributed over 70% of the city's water.[3] This was the first large-scale transfer of water rights in the American West, and it made the growth of Los Angeles possible. Until 1941 and the arrival of Colorado River water, there were no other major sources of supply.

To secure Owens Valley water, the Los Angles Board of Water and Power Commissioners (Los Angeles Department of Water and Power, LADWP, today)

1. Libecap (2007: Table 3.3, 46).

2. By 1920, the Los Angeles Aqueduct with Owens Valley water was supplying 283 c.f.s., when the Los Angeles River was supplying just 68 c.f.s. See Ostrom (1953: 14, 23) and Miller (1977: 158).

3. http://www.ladwp.com/ladwp/cms/ladwp007157.pdf, 2005 Water Management Plan, page 3-3. Because of environmental restrictions, the region now contributes much less.

purchased the valley's small farms and their associated water rights. Ultimately, virtually all were bought. For some farms, sale negotiations were smooth and agreements were reached quickly, whereas for others bargaining was much more acrimonious, taking 5–10 years to complete. To improve their bargaining position, those farmers with the most water attempted to form a single negotiating unit, the Owens Valley Irrigation District. When that effort was thwarted by the city through strategic purchases of land, three smaller sellers' pools were organized to bargain for their members. The pools coordinated their bargaining positions. Pool members engaged in periodic violence, appealed to the state and national press, and called for intervention by politicians to bolster their demands for higher prices. Although the surplus was greatest from the early sale of farms with the most water to the city, farmers who engaged most effectively in collusion delayed sale. The negotiations for these properties were so protracted and contentious, that the national press in the 1920s labeled the clash between Owens Valley farmers and the Board "California's Little Civil War."[4] As noted in the quotes above, Owens Valley has remained famous ever since.

My analysis reveals how the strategies of the antagonists to capture the surplus raised bargaining costs and affected the timing of property sales, the prices paid for land and water, and equity judgments regarding the process. Despite the fact that both groups of parties benefited from the land transactions, the Owens Valley transfer was viewed as one of "theft," and it serves today as a parable, cautioning any agricultural community against water sales to urban areas.

There are two reasons to study these negotiations. One is the historical legacy of Owens Valley.[5] Although difficult to test, there are assertions that Owens Valley has had efficiency consequences by hindering the development of water markets (Ostrom 1971: 449; Haddad 2000, xv; Hanak 2003: 5, 123). The Owens Valley story has become part of the popular media. The 1974 movie *Chinatown*, staring Jack Nicholson and Faye Dunaway, dramatized conspiracies involving Owens Valley water and land speculation in Los Angeles. Accordingly, analysis of the "Ghost of Owens Valley" contributes to the literature on the halting growth of water markets.[6] Examination of bargaining over land and water also provides empirical evidence on the distribution

4. *Literary Digest* December 6, 1924, 13–14. See a summary of critical press articles in the McClure Report (1924, 46–101), Eastern California Museum, Independence, and the *Sacramento Union* articles, March 28 to April 3, 1927, Tape GX0004, Miscellaneous File, LADWP Archives.

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. Century-Old Land Grab Still Contentious*, by John M. Broder and *Mural Comments About Water, and a City Doesn't Like It*, by Randal C. Archibold, where one of the "facts" of Owens Valley was claimed that "L.A. forcibly acquired the water," *New York Times*, November 3, 2005, p. A17. See also Erie (2006: 29–53).

6. Reisner's (1993) book *Cadillac Desert: The American West and Its Disappearing Water* is one of the most influential volumes on western water and it is critical of past and current management practices. Economists also have expressed puzzlement regarding the comparatively limited extent of voluntary exchange of water rights (Young 1986). There are other reasons, including poorly defined water rights and third-party effects of trade that hinder markets. Nevertheless, equity remains an issue in water transactions.

of the gains from trade and how equity perceptions affected negotiations and assessment of the justice of their outcomes. In this way, the analysis contributes to the literature on the economics of bargaining and fairness.[7]

Letters, reports, and memorandums between the Los Angeles Water Board, its land agents, and landowners in the Owens Valley from 1905 through 1935 are deposited in the LADWP Archives, the Water Resources Research Center Archives at University of California (UC), Berkeley, and the Eastern California Museum in Independence, CA. 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 farmland 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, which cover almost all land acquisitions made by the Water Board between 1916 and 1935, are used in the econometric analysis.

2. A Brief Overview of the Owens Valley Water Transfer

Owens Valley, about 120 miles long and up to 6 miles wide, lies on the eastern side of the Sierras in the Great Basin of the United States. In 1920, some 7031 people farmed in it or lived in five small towns. Its agriculture depended upon irrigation from the adjacent Owens River and feeder streams, cooperative mutual ditches, or groundwater pumping. 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).[8] The rest of the valley was semiarid scrubland. All in all, the region had limited agricultural potential. There was limited arable land, growing seasons were short, the soil was alkaline, and there were few outlets to markets. Comparing Inyo County, California (Owens Valley), farms with a baseline of farms in similar Great Basin counties—Lassen in California and Churchill, Douglas, and Lyon in Nevada in 1920—reveals that Inyo farms tended to be much smaller on average (269 acres versus an average of 713 acres for the other four counties) and the annual value of production per farm far lower ($4759 versus $10,069).[9] Examination

7. In laboratory experiments, minimal offers from the first player to the second in ultimatum games are rejected as unfair, even though the latter is better off with any positive amount. See Camerer and Thaler (1995) for discussion of the role of fairness and the breakdown of bargaining. Further discussion is provided by Schmidt and Fehr (2006). See also Alesina and Angeletos (2005: 960–80) who note that there are wide-standing views that "people should get what they deserve and deserve what they get."

8. 1925 US Agricultural Census; Walter Packard, "The Future Agricultural Development of Owens Valley," January 22, 1925, Tape GX0004, Special Owens Valley File, LADWP Archives. See also Libecap (2005).

9. 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 is for Inyo and the mean of the averages is for the other four counties. The agricultural potential of Owens Valley generally is exaggerated in the literature. For instance see Kahrl (1982: 38).

of the data set reveals that most farmers had a single, small operation and that ownership of multiple units was rare.[10]

This information is important because it suggests that Los Angeles offer prices based on agricultural productivity (the assumed farmer reservation values) would be low compared to perceived water values in Los Angeles. The benefits attained by reallocation of water from each farm and their distribution are the bases for the bargaining conflicts and distributional concerns analyzed below.

Los Angeles sought water from the Owens River and underlying aquifers in the valley. Under the appropriative water rights doctrine that dominates in the West, water rights 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 appropriated by farmers, so that the Water Board had either to buy their rights or their farms. Since Owens Valley farms typically 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. Accordingly, in order to gain Owens Valley water, Los Angeles had to purchase the farms in the agricultural land market. Additionally, a few farms adjacent to the Owens River held riparian water rights that were directly tied to the land.[11] These rights typically are more difficult to transfer separately, but if Los Angeles acquired those farms, the water could be released to flow down the river to the aqueduct intake.

Beginning in 1905, representatives of the Water Board incrementally purchased land and appurtenant water rights from farmers over the next 30 years. The earliest land acquisitions between 1905 and 1922 were in the southern, driest part of Owens Valley and in the Mojave Desert. These purchases were made to acquire right-of-way for the Los Angeles Aqueduct (constructed between 1907 and 1913) as well as to secure riparian claims to Owens River water that had not been diverted for irrigation in the northern, most agricultural section of the valley (Los Angeles Department of Public Service, 1916). For the most part, these acquisitions were uncontroversial since the farms generally were very marginal and the farmers unorganized. The mean price for 209 properties (92,019 acres) acquired during that time was $15.40 per acre. By contrast, the mean purchase price for the 170,083 acres (958 farms) bought later from 1923 to 1935 in the north was almost 10 times greater at $113.72 per acre.[12]

10. "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, LADWP Archives, hereafter, "Porter file."

11. California is one of the few western states to recognize riparian water rights. See Getches (1997: 4–8) for a discussion of appropriative, riparian, and hybrid systems. Even so, because of the very limited riparian area and the corresponding critical need to divert water through irrigation canals in semiarid Owens Valley as is possible under the appropriative doctrine, riparian water rights were much less important for farmers.

12. Calculated from Libecap (2007: Table 3.3, 46). The number of farms differs from those in the data set used in Figure 1 and in the econometric analysis below because it includes very small properties, 10 acres or less as well as incomplete observations.

There were charges that the Water Board bought properties secretly without revealing its intentions in order to avoid a drive up in prices.[13] This practice could only have been short term in a relatively small community where any farm sale would have been noticed, and the *Los Angeles Times* announced the city's intentions later in 1905.[14] Nevertheless, those few farmers who sold prior to that information would have been unhappy once the identity (and wealth) of the true buyer was revealed. Further, there were charges that Los Angeles was behind the cancellation of a proposed federal project by the Reclamation Service in 1905. Recent research has indicated that the Owens Valley project was dropped in favor of more attractive sites elsewhere.[15] Nevertheless, these events soured the relationship between the Water Board and at least some farmers and certainly helped to support later claims of unscrupulous bargaining tactics by the city.

Through 1922, the water supply from southern Owens Valley and a few scattered acquisitions in the north was thought by the Board to be sufficient to meet anticipated demand in Los Angeles and to justify the construction of the aqueduct. By 1923, however, in the face of new population growth and its objective of maintaining a steady flow of water per capita in the aqueduct to ensure supply, the Board advertised in Owens Valley papers that it sought more water-bearing land in the north.[16] When the Board could not reach agreement with one farmer, it would move on to others until it had acquired enough water-bearing land to meet its immediate objective. Accordingly, the Board kept returning to the valley during the rest of the 1920s to reopen negotiations with those farmers where bargaining had reached an impasse and to buy other properties with less water. By 1934, the agency had acquired 95% of the agricultural acreage in the valley.[17]

Figure 1 details the gradual acquisition of water rights in Owens Valley by showing the cumulative percentage of total water acquired by Los Angeles as of each year. The figure covers the northern part of the valley where most of the farms were located, where most of the agriculture was found, and where the notorious negotiations took place. The data are from 595 observations of all farm sales to Los Angeles between 1916 and 1934 as analyzed econometrically below.[18] Each observation in the data set includes information on the water available annually from a farm. The sum of these amounts represents the total water acquired by Los Angeles by 1934 and serves as the denominator of the

13. Hoffman (1981: 99).

14. Libecap (2007: 39).

15. Hoffman (1981: 68–79, 131–41) and Kahrl (1982: 39–79, 85–140). For a reassessment of the Reclamation Bureau's decision, see Pisani (1984: 302).

16. Urban water is a normal good and as Los Angeles' population and wealth increased, the demand for water likely grew more than anticipated by the agency. The extent of the migration of people to Southern California also was more than expected.

17. Ostrom (1953: 127).

18. The "Porter file" contains 869 properties, and dropping all 10 acres or smaller to include farms leaves 595 farms with 266,429 acre-feet of water calculated by totaling the water provided in each of the farms.

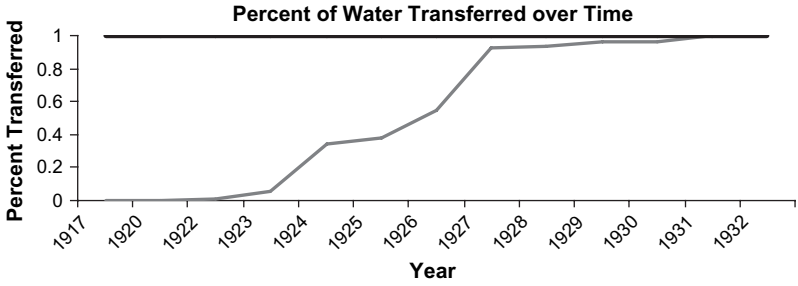

Figure 1. Cumulative Percentage of Owens Valley Farm Water Acquired by Los Angeles as of Each Year, 1916-34.

fraction charted in the figure, whereas the numerator is the cumulative water acquired by the city as of each year.

Had there been no bargaining conflicts to drive up transaction costs and had sales been competitive, the pattern of water acquisitions shown in the figure would have shifted to the left between 1923 and 1934. Accordingly, the added costs of the observed transactions include the additional resources devoted to bargaining by both sides, any losses from delay in the acquisition of farms with the most water per acre and postponed reallocation of their water to the city, as well as the negative legacy of the bargaining conflict on the subsequent development of water markets. With the data available, I do not attempt to measure these costs, but their implications are addressed in the final section of the article.

Figure 2 plots the distribution of the 595 Owens Valley farms by water per acre along with the mean. It is clear from the figure that farms varied considerably in their water holdings. The farms with above-mean water per acre were concentrated on ditches, whereas the below-mean farms were distributed throughout the valley, off major water sources.

Owens Valley farmers were at a disadvantage in negotiating over the terms of sale. There were large numbers of them, and their farms varied sharply in size, water assets, and productive potential. To offset this, in 1922 as soon as it seemed that Los Angeles would be buying much more land in Owens Valley, farmers in the 11 major irrigation ditch companies in the valley began formation of a single negotiating unit, the Owens Valley Irrigation District. The district was to buy the water rights of the member farmers and then bargain directly with the Water Board for their sale. By 1923 the Owens Valley Irrigation District included 323 farms, average size 161 acres, and 54,000 acres in the northern end of the valley.[19] Its members drew 156,000 acre-feet of water on average per year and had claims to a total of 180,000 acre-feet, over three-fourths of all the water devoted to agriculture in the Owens Valley.[20]

19. Details on the formation of the Owens Valley Irrigation District are found in Tape GX0003, McCarthy, W.R. File, Owens Valley Irrigation District Financial Records File, "Petition for the Formation of an Irrigation District," and Financial Records File, LADWP Archives.

20. About 180,000 acre-feet of a total of 234,000 acre-feet of agricultural diversion. An acre-foot is 326,000 gallons. See Hoffman (1981: 176–9) and Kahrl (1982: 277).

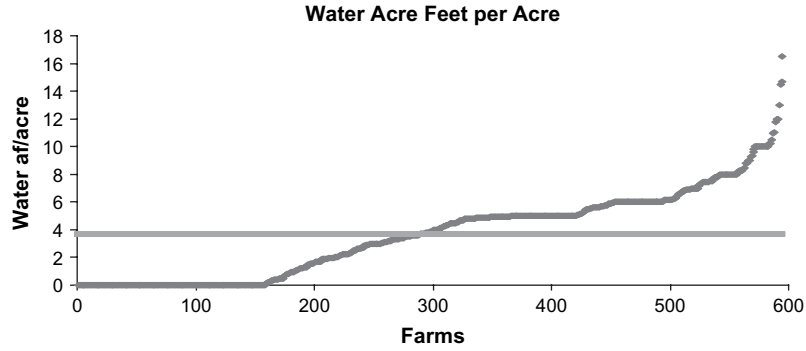

Figure 2. Water Distribution across Owens Valley Farms, 1916-34.

Had it been successful, the irrigation district might have fundamentally changed bargaining outcomes in the valley and the history of the region, but it was not. Recognizing the threat the district posed, in 1923 and 1924 the Water Board raised its offer prices for properties on two key ditches, McNally and Big Pine, and purchased them as quickly as it could. As shown in the statistical analysis below, these defecting farmers earned substantial premiums for their lands. This action broke the geographic continuity and membership cohesiveness of the irrigation district, and by the end of March 1925, it was effectively sidelined.[21] After that farmers either negotiated competitively with the Board or collaboratively through three sellers' pools. Negotiations between the Board and members of these pools took the longest, some lasting through 1934 before final agreement was reached. They were the center of the bargaining disputes that plagued Owens Valley. These are the negotiations that made Owens Valley famous and are examined in more detail below.[22]

3. The Bargaining Environment

Exchange requires locating the relevant parties, measuring the attributes of the asset to be traded, negotiating a sale price, 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;

21. 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. See also Kahrl (1982: 279).

22. The historical literature stresses the secrecy of the early purchases as the basis for the legacy of Owens Valley. But this is over emphasized. As stated earlier, the "secret" purchases were limited and occurred in 1905. Most properties were purchased after 1922, when the identity of the buyer was very well known. See, for example, Ostrom (1953: 116–18).

Demsetz 1964, 1968; Dahlman 1979; Williamson 1979, 1981; Barzel 1982).[23] The bargaining environment also affects the costs of negotiation.[24]

In the case at hand, the bargaining context for the most important farms was one of bilateral monopoly between the Water Board and the sellers' pools. Bilateral monopolies have indeterminate pricing outcomes because they depend upon relative bargaining strength. Each party has incentive to misrepresent its position in order to extract a greater share of the gains of trade, and there is little competitive pressure to force more accurate information revelation. Accordingly, bilateral monopoly negotiations often break down and take a long time to complete (Williamson 1975: 238–47; Blair et al. 1989). The issues to be addressed are the extent of market power achieved on each side and how these conditions affected the distribution of returns, the timing of exchange, and its costs.

3.1 The Water Board

On the one side was the Water Board, which essentially was the only buyer of farmland in Owens Valley. Its aqueduct was a large, fixed immobile investment whose value depended upon the flow of Owens Valley water. The Board was made up of five members, appointed by the Mayor to staggered terms and confirmed by the City Council. As such, the agency was subject to citizen demands on the Mayor and City Council for a relatively constant, reliable flow of water per capita in the aqueduct and under ratepayer oversight in the management of its funds.[25] The Board's actions also were under scrutiny of other civic organizations, such as the Chamber of Commerce and Municipal League that were attempting to attract new residents and businesses to Los Angeles. Any negative publicity resulting from its dealings with farmers harmed the city's reputation. For instance, concerns about violence, threats to the water supply, and negative publicity for Los Angeles led the Governor's office, the Municipal League, and the Los Angeles Chamber of Commerce to offer mediation in 1927.[26] The Chamber of Commerce sent in an investigating committee and the Los Angeles Clearing House Association offered to arbitrate the dispute over land and water values between Owens Valley property owners and the Water Board.[27] Sensitivity of the Board to negative publicity was a tool used by the farmers in their negotiations with it.

23. Useful summaries of transaction cost issues and concepts are in Eggertsson (1990) and Allen (2000).

24. Haddock and McChesney (1991) examine bargaining in a different setting, but they summarize some of the issues that raise bargaining costs when discovery of the terms of trade is not quick or easy and there is strategic noncooperation. See also Kennan and Wilson (1993) for a general summary of bargaining issues. Bargaining under incomplete information that results in delay in agreement is discussed theoretically by Osborne and Rubenstein (1990: 91–112).

25. Ostrom (1953: 59–62).

26. Ostrom (1953: 124–5).

27. Municipal League Bulletin, Volume 4, No. 11, July 30, 1927, "Why Not Settle the Owens Valley Trouble?" Other press attacked the city's actions, see a series in the *Sacramento Union*, March 28 to April 2, 1927, all in Tape GX0004, Miscellaneous File; Telegram from the Owens Valley Protective Association to the Mayor, May 13, 1927, Tape GX0004, Reparations File.

For these reasons, the Board sought to acquire water-bearing lands quickly to ensure water supplies, smoothly to minimize transaction costs, and cheaply to stay within its water bond limits.[28] In bargaining with farmers, the Water Board sought to buy farmlands and the water rights associated with them based on their agricultural values in Owens Valley, rather than Los Angeles water values which were much higher. If the Board could obtain the farms at these prices, the total surplus from reallocation of water would go to the city's landowners, capitalized into the value of the land, and burdens on the city's ratepayers would be minimized.

Accordingly, the Board had incentive to maintain a competitive environment among sellers, blocking the formation of any collusive sellers' organization. If successful, the Board then could price discriminate in its purchases of farms based on the assessed value of agricultural productivity in Owens Valley. Because farms were small and no single one was essential for the city's water supply, a threat position of the Board was to leave a uncooperating farmer isolated, surrounded by properties that were sold to the city. Indeed, some farmers complained that the Board engaged in a checker boarding strategy, buying properties around holdouts who did not sell.[29] At a time of agricultural depression in the 1920s and declining agricultural land values, the Board's option to leave a farm isolated and unpurchased was no doubt a credible threat. Unfortunately, because of an absence of property maps in the data set, it is not possible to determine how important checker boarding might have been.

Because agricultural productivity endowments were known best by the farmers and less well by agency personnel, the Board established an appraisal committee to collect data on each farm's characteristics.[30] These data were then compared to similar farms to arrive at an appraised productivity value: "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. . . ."[31] Offer prices were formed by multiplying appraised values times a fixed adjustment factor of 4.1.[32] If adhered to, such a pricing rule potentially allowed

28. 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. Early bond elections were contentious because of political allegations of land speculation as described in the movie *Chinatown*.

29. Hoffman (1981: 179–81).

30. 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 landowners, C. P. Crowell and S. F. Zombro, LADWP Archives.

31. 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.

32. Tape GX0004, Special Owens Valley Committee File, Resolution, July 20, 1925, Board of Water and Power Commissioners, LADWP Archives.

for price discrimination by the Board as it moved along the supply curve of farmland.

To meet its objectives of securing a reliable water supply in the face of a rapidly growing urban population and to minimize the transactions costs of negotiation, the Board likely was most interested in buying larger farms with more water than in negotiating with many smaller farmers, who had less. When the Board successfully reached agreement with a farmer, it acquired the right to the water associated with the land, either a riparian claim (less important) or appropriative claims to ditch water and/or groundwater beneath the surface property. It could then release the farm's water from the ditch and/or pump groundwater for flow down the Owens River to the aqueduct intake.

In the early 1920s (Figure 1), when there were many farms available and considerable water remaining in the valley, the Board could pick and choose properties to buy if the farmers were competitive in their sales efforts. If bargaining impasses ensued with some farmers, the Board could move to other properties. The Board, however, faced more difficult bargaining problems with farmers who were collusively organized and as it faced a water supply constraint in Owens Valley.

3.2 Farmers

On the other side were the farmers. Almost all farms were small, with each holding only a limited portion of the total water in Owens Valley. Hence, no one farmer had market power or was vital for meeting Los Angeles' water needs. Hence, to improve their bargaining power, farmers had incentive to negotiate collectively, and as we have seen above, they attempted to do so through formation of the Owens Valley Irrigation District. If it had been successful, the farmers would have had a credible threat of withholding sale of their lands and water until the Board agreed to a more favorable price.

Rational farmers would seek at least the present value of the agricultural productivity of their farms as their reservation prices, plus as much of the surplus value from trade as they could get. Farmers were well aware of how valuable Owens Valley water was in Los Angeles where land values were rising rapidly with the arrival of new water. Contemporary newspapers reported fabulous jumps in land values in the San Fernando Valley, where properties rose from a few dollars an acre to $500 and more per acre as early as 1913 with completion of the aqueduct.[33] To illustrate the effect of the arrival of Owens Valley water, taking $300 as the average increase in land value in the nonurban areas of Los Angeles County alone, the gain was over $37,000,000 for new agricultural lands added between 1910 and 1920 and possibly an additional

33. Besides the movie *Chinatown*, there is extensive discussion of the land boom in the San Fernando Valley with Owens Valley water. See Nadeau (1950: 29–32, 41, 62–8), Ostrom (1953: 149–63; 1971: 448–9), Hoffman (1981: 154–73), and Kahrl (1982: 195).

$227,395,500 for increases in value of agricultural lands existing in 1910 due to a more certain water source and greater urban land expansion.[34]

Owens Valley farmers wanted their share of this bonanza. For example, before the Water Board, one landowner 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. . . ."[35] Whether or not a farmer could extract more of the surplus depended on being in an effective bargaining group that could give them some market power. Competitive farmers would reveal their reservation prices and be under pressure to accept offers that met them.

3.2.1 The Sellers' Pools. As described above, the Water Board successfully blocked formation of a single bargaining unit for the farmers. After that three smaller sellers' pools were formed by owners of small clusters of adjacent, relatively homogeneous farms on two important ditches in 1923 and 1924. These farmers controlled about 17% of the valley's water.[36] The organizations 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 also on Bishop Creek Ditch. The pools were organized and led by the largest landowner in each cluster, who acted as the bargaining agent for all pool members.[37] By reducing competition among sellers, these farmers had more bargaining power.

Pool members could threaten to hold out for higher prices until later when either Los Angeles became more desperate for the water and/or there were fewer remaining farms in the valley and opportunities to purchase additional supplies. For example, in 1926 Keough pool members refused a Board offer of $1,025,000 for all of their properties, demanding instead $2,100,000. The Board countered with $1,250,000, followed by $1,600,000 from the pool,

34. These figures are only to illustrate the possible magnitude of the large gains in Los Angeles County. The $227,395,500 is calculated from the 757,985 acres of agricultural land in 1910 as estimated in the census times a possible increase in land value of $300. The $37,000,000 is a $300 increase in value per acre for the 124,348 acres of farmland added in Los Angeles County between 1910 and 1920 as water became more certain.

35. 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.

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 acre-feet. with the pools providing 43,480 acre-feet. Because of the absence of maps, it is not possible to isolate spatial factors that might have affected the formation of the pools, but it is known that all members of each pool were on the same irrigation ditch, and there were multiple ditches in Owens Valley. This suggests that the members were in close proximity to one another.

37. Tape GX0002, Memo, July 26, 1928, E. F. Leahey, Department of Water and Power Land Agent, to W. B. Mathews, DWP, E. F. Leahey File, LADWP Archives.

which also was refused.[38] Negotiations were not resolved with the last pool members until 1931. In holding out, however, members had to compare the expected returns from accepting the offer of the Board with the option value of delay. Members suspected that Los Angeles would need more water, but there was uncertainty as to the amount required. Until late in the 1920s it was unclear to all parties just how much land and water Los Angeles would have to buy, given unexpected population growth and reoccurring droughts in the region. As early as 1911, the *Annual Report of the Los Angeles Board of Public Service Commissioners* stated, "What the ultimate needs of the City will be is impossible to foresee."[39] As a result, there was risk to holdouts of missing a sale if the Board determined that it had sufficient supplies and no longer needed to acquire additional properties in Owens Valley. This was an important problem that threatened to undermine the unity of each pool since some members might conclude that they would be better off by selling now rather than delaying.

The credibility of each pool's threat position depended on its size and cohesiveness. For the pools to be effective, they had to retain their members and avoid defection. If only a few small farmers left a pool, it could retain its effectiveness for those that remained. But the defection of a large farmer, especially the pool leader, was a serious blow. Among the three, the Keough was the most concentrated and tightly organized with a Herfindahl index (HHI, based on the size of farms in the pool) of 1583. The Watterson pool had a HHI of 1163, and the Cashbaugh, 410.[40] Within the Keough pool, there was some defection with 17 of the 23 members selling in 1926 and 1927, but these were very small farmers (14 of them had 10 acres each). The core of the pool, led by the largest landowner, Karl Keough with 4482 acres (60%) of the 7862 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, whereas the city countered with $254 per acre. In 1931 (when farmland values everywhere else were falling due to the Great Depression), he finally sold for $466 per acre.[41]

The other two pools suffered from early sales by their largest landowners. Within the Watterson pool, the leaders and biggest landowners, Wilfred and Mark Watterson, with 1216 acres across three separate plots agreed to sell to

38. Memo, July 21, 1926, by Board of Water and Power 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. *Tenth Annual Report of the Board of Public Service Commissioners for the Year Ending June 30, 1911* (1911: 43).

40. HHIs based on water acre-feet give similar relative values. For similar use of a HHI to measure bargaining strength, see Libecap and Wiggins (1984).

41. "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.

the Board in 1926 at a slight premium over the Board's offer.[42] They were quickly followed by all but three of the 20 pool members. The others sold in 1927. The Cashbaugh pool also had 20 of the 43 members selling in 1926 and the leader, William Cashbaugh with 596 acres, selling in 1927.[43]

Pool leaders coordinated through joint organizations such as the Owens Valley Protective Association in efforts to pressure the Board to meet their price demands by appealing to state politicians and the press. In response, throughout the 1920s, the press was invariably critical of Los Angeles, portraying Owens Valley negotiations as ones of small farmers battling a large, wealthy city against uneven odds.[44] For example, in March 1927, the Protective Association ran a succession of provocative advertisements directed to the California Governor and State Legislature in the *Sacramento Union* that included "A Message from Owens Valley—The Valley of Broken Hearts" and "We, the Farming Communities of Owens Valley, Being About to Die, Salute You." The paper also ran a series of sensational articles with titles like "Owens Valley Plight Pitiful" and "Water Sharks Wreck Valley."[45] These articles stressed the unfairness of Los Angeles' offers as it allegedly took the farmers' water and their livelihoods in order to fuel urban growth to the south. The allegations were repeated in other press coverage and subsequent evaluations of the Owens Valley transfer.[46] Further, between 1924 and 1931 whenever negotiations stalled, the aqueduct and city wells were periodically dynamited, although the aqueduct was never seriously damaged.[47]

3.2.2 Unorganized, Competitive Nonditch Farms. Nonpool farmers, who were not on key ditches, competed to sell their properties to the Board, often writing to it with their offers. In 1925, Board Counsel W. B. Mathews commented on the "insistent demand" by some property owners for the city to buy their lands.[48] Because these farms had smaller amounts of water the Board was less interested in them and often bought them later. There is no evidence that these farmers were involved in any of the bargaining conflicts in Owens Valley. Indeed, in these negotiations, the Water Board reported that "the prices paid, with few exceptions, have been entirely satisfactory to the seller."[49] With

42. The Watterson brothers continued to lead resistance in Owens Valley because they owned other properties in the area, including town lots and ran the largest local bank.

43. Tape GX0001, Fish Slough File "Cashbaugh Pool," LADWP Archives.

44. *Literary Digest* December 6, 1924, 13–14, Tape GX00086, LADWP Archives.

45. *Sacramento Union*, March 29 to April 3, 1927, Tape GX0004, Miscellaneous File, LADWP Archives.

46. For summary, see Hoffman (1981: 193–6, 208–51).

47. Ostrom (1953: 121–7) and Wood (1973: 30–7).

48. Tape EJ00086, Mathews, W.B. File, 1925 letter outlining dispute over Longyear properties, LADWP Archives.

49. Tape GX0004, Sale of Lands File, Letter from LADWP to two landowners, C. P. Crowell and S. F. Zombro, reporting on the status of land purchases in Owens Valley. "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, LADWP Archives.

no market power, these farmers had to accept offer prices from the Board once their reservation values were met or lose the sale. They would get little of the surplus from the transfer.

4. Empirical Analysis of Owens Valley Bargaining

The discussion has focused on how the bargaining environment in Owens Valley likely increased negotiation costs and established long-term views of the equity of the outcome. It is not possible to directly test those claims. The data set, however, does allow for examination of the role of the sellers' pools in determining the timing of sale and price received by the farmers, relative to the unorganized baseline. The actions of the sellers' pools were an integral part of the bargaining conflicts with the Water Board that characterize the history of Owens Valley. The data set also allows for analysis of the other determinants of the time of sale and price paid for land and water.

4.1 Mean Values for Owens Valley Farms, by Category

The data on farm properties purchased between 1916 and 1934 by the Water Board include 869 observations, which as noted earlier include almost all properties acquired by the Board during that time. Excluding properties of 10 acres or less as not being farms, but town lots, as well as dropping incomplete entries leaves 595 observations.[50] Of those, 367 farms were on irrigation ditches and 228 were not on ditches, but spread throughout Owens Valley. Table 1 provides mean values for farm property owners in Owens Valley by various classifications.

As indicated by the mean values in the table, members of the most cohesive pool, Keough, on average sold 2 years later than the overall sample and commanded the highest price per acre of land. Members of the Cashbaugh and Watterson pools also did better on average in terms of price per acre and total purchase price than did competitive nonditch properties. In general, 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 nonpool farmers who were on ditches and purchased preemptively to block the formation of the Owens Valley Irrigation District earned more in total and per acre of land than did the nonditch farmers and slightly more on average than did members of two of the weaker sellers' pools. All pool farms had sales prices considerably above the 1925 mean census farm values for the four Great Basin counties. Their per-acre land prices were at least three times those of competitive farms not on ditches. These results are consistent with the notion that pool membership would increase bargaining power for farmers relative to the Water Board.

50. There is no bias from dropping the observations of nonfarm properties.

Table 1. Owens Valley Farm Property Characteristics, Mean Values

Property type	Price per acre ($)	Total purchase price	Year of purchase	Size (acres)	Price of water per acre-feet	Total water acre-feet
All properties[a]	198	$23,425	1926	154	$178	448
Farms not on ditch	82	19,890	1927	207	473	261
Keough pool	443	27,647	1928	79	77	366
Cashbaugh pool	242	32,156	1927	126	69	544
Watterson pool	237	33,983	1926	147	75	584
Nonpool on ditches	263	23,861	1926	122	112	581

	Water acre-feet per acre	Total cultivated acreage	% Cultivated land	Water acre-feet per cultivated acre	Riparian rights %	#
All properties[a]	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
Nonpool on ditches	5	14	22	30	36	281

[a]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.

It is possible to calculate the implied price received for water. The price paid for water is obtained by dividing the sale price of the farm by the water acre-feet conveyed in its purchase. As shown in Table 1, although nonditch 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. Although nonditch farms had less water, the Board still had to pay at least their agricultural reservation values in order to secure sale. Because of limited arable land in Owens Valley, not all water on a farm translated directly into greater farm production. This was especially the case for those farms with the most water, where parts of farms were swampland.[51] This condition also underscores the unfairness assessment of the results of bargaining over land in Owens Valley. When farm prices were based on agricultural productivity, as was desired by the Water Board, farmers with less water would receive more per-unit of water than would their counterparts, who had greater water endowments but with lower marginal agricultural values.

This issue is examined in the econometric analysis below, but the mean values in Table 1 suggest that additional water increased farm values at a declining rate. For nonditch, competitive farms the average sale price was $19,890 or $473 per acre-foot of water. This total farm sale price is somewhat less than the mean 1925 census farm value for four comparable Great Basin counties

51. This suggests that additional water increased agricultural productivity at a declining rate, which motivates the nonlinearity controls included in the econometric analysis below.

(Lassen, California; Churchill, Douglas, and Lyon, Nevada) of $21,167, but these nonditch farms were the least productive units in Owens Valley. This result is consistent with the notion that competitive farmers would receive their reservation values, the net present value of agricultural production. Even so, 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.[52] It is no wonder that these small competitive farmers sold whenever the Board offered to buy their farms.

4.2 Estimation Framework

Regression analysis allows for more precise examination of the factors that determined the year of sale and the prices paid per acre of land and per acre-foot of water. Based on discussion of the bargaining environment, the following relationships will be estimated, first for year of sale:

$$\text{Year of sale} = g(\text{farm size, cultivated acreage, water per acre, riparian water rights, pool membership, nonpool ditch farms, aqueduct flow per capita, and lagged changes in Los Angeles population}). \quad (1)$$

The data set includes only the year in which each property was sold to the Water Board. Unfortunately, there is no systematic information on offers and counteroffers for properties. The year of sale will reflect both demand factors reflecting the interests of the Board and supply conditions reflecting the interests and efforts of farmers, especially those of pool members. As noted above, the agency was charged with providing water to the city. Declines in the current flow of aqueduct water per capita and past growth in population would encourage the Board to return to Owens Valley to negotiate for more properties to maintain water supplies. Farms with more water per acre and riparian water rights likely would be sought earlier to meet this demand. Further, all else equal, larger farms might have more water, and those with more cultivated acreage might have signaled access to water not captured in the other water variables, suggesting that these two variables would lead to earlier years of sale. Pool membership in general would make delay of sale more feasible whenever farmers believed that initial offer prices were too low. Collectively holding more water, pools were in a better position to reject Board offers and to demand higher prices at lower risk that they would be left isolated with unsold properties. The more cohesive the pool, the better it would be able to resist defection and hold out for higher prices. The nonpool ditch farmers who were early defectors from the Irrigation District described above should also have

52. 1925 Agricultural Census, value of farm production per farm, Inyo County, was $3412.

earlier years of sale, relative to the baseline of nonpool, competitive nonditch farms.

$$P = f(\text{farm size, square of farm size, cultivated acreage, square of cultivated acreage, water per acre, water per square acre, riparian water rights, pool membership, nonpool ditch farms, cumulative percent of total water purchased}). \quad (2)$$

The recorded per-acre price paid for farmland in Owens Valley will also reflect both demand and supply factors. Those variables that measure agricultural productivity—farm size (economies of scale), cultivated acreage (other water, inherent fertility, topography), measured water per acre, and riparian rights would raise prices by increasing the reservation values of farmers. It is likely that the Board would be willing to pay more for farms with more water and that were larger to reduce overall transaction costs. The squared terms, however, are apt to be negative. The pool member variables capture the relative bargaining strengths of the three pools, also predictably raising price, and the nonpool ditch farms variable captures the effect of Board purchases to encourage defection from the Irrigation District, relative to the competitive fringe, nonpool, nonditch farms. The cumulative percent of total water purchased as of each sale also should raise farm prices if it reflects a tighter supply constraint faced by the Board in its negotiations.

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 variables outlined in equation (2). This estimation will illustrate whether bargaining power in the land market translated into higher prices for water. The predicted effects of each variable in the estimations are described above.

In estimating the determinants of the year of sale, a proportional hazard duration model is used. The model assumes a Weibull distribution for the survival function and was chosen based on analysis of the empirical survival function where the majority of farms in Owens Valley sold later in the data set.[53] Under this parameterization, the survival function takes the form:

$$S(t_i) = \exp(\lambda_i t_i^p), \quad (3)$$

where $\lambda_i = \exp(x_i\beta)$, p is an ancillary shape parameter to be estimated,[54] t_i is the year of sale $-$ 1916 because the first sale did not occur until 1917, and x_i

53. A Weibull distribution is a common parametric form for duration models. See Greene (1997: 790–4). To ensure the results were not driven by the parametric assumption, I also fitted a Cox proportional hazards model, which does not specify a parametric form, and results were qualitatively the same.

54. Note, if $p = 1$, the Weibull parametrization simplifies to the exponential.

represents a vector of control variables described in equation (1), including 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. Generally, in a duration model the hazard function, $h(t_i)$, is of primary interest. It is the hazard or probability that a farm will be sold in any given year, conditional on not being sold by that time. It is given by

$$h(t_i) = p\lambda_i t_i^{(p-1)}, \tag{4}$$

where λ is as described above. The results of the maximum likelihood estimation of the hazard function are presented in Table 3.

The second estimating equation for price of land using ordinary least square (OLS) is

$$y_{1i} = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{1i}^2 + \beta_3 x_{2i} + \beta_4 x_{2i}^2 + \beta_5 x_{3i} + \beta_6 x_{3i}^2 + \beta_7 x_{6i} + \beta_8 D_r + \beta_9 D_k + \beta_{10} D_c + \beta_{11} D_w + \beta_{12} D_o + \varepsilon_i, \tag{5}$$

where y_{1i} is per-acre sales price; x_{1i}, x_{2i}, and x_{3i} are as above; x_{6i} is the cumulative percent of total water purchased as of each property's sale; and D_r, D_k, D_c, D_w, and D_o are the dummy variables defined above.

4.3 Empirical Results

Table 2 provides descriptive statistics for the two estimations.

Table 3 contains the hazard ratios obtained using maximum likelihood estimation for the variables in equation (4).[55]

Examining the important collusion variables, members of the Keough pool have a hazard ratio of 0.40, indicating that the likelihood of sale in a year, conditional on not having sold previously, was only 40% of the hazard rate for the baseline population. The marginal effects calculation suggests that the most cohesive Keough pool members delayed sale by almost a year and a half longer than the competitive farmers not on ditches. For members of the less cohesive Watterson and Cashbaugh pools, however, membership in these pools is associated with 149% and 92% higher hazard rates relative to those farms in the baseline group. Based on the marginal effects estimates, Cashbaugh and Watterson pool members on average sold between 11 and 15 months earlier than did nonditch farmers. This result reflects the relatively early defection of members of those two pools, compared to the Keough pool as discussed above. These farms had water and were comparatively more attractive to the Water Board than were the drier nonditch farms. When the members defected, they sold. Those farmers who were on ditches but not in pools

55. Annual Los Angeles population and population change are estimated through 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. Aqueduct flow information is available from Libecap (2007: Table 3.2, 42).

Table 2. Descriptive Statistics

Variable (595 observations)	Mean	Standard deviation	Minimum	Maximum
Land price per acre ($)	198	163	3.00	955
Year of purchase	1926	1.87	1917	1932
Farm size (acres)	154	267	10	3502
Cultivated acreage	17	40	0	422
Water acre-feet per 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 (nonpool) (Y/N)	0.47	0.50	0	1
Los Angeles population change (000)	123	75	23	283
Annual aqueduct flow/Los Angeles population	0.00016	0.00003	0.00012	0.00032

and who had their properties purchased by the agency to halt the formation of the irrigation district have a hazard ratio of 1.52, suggesting that they had a 52% greater likelihood of sale in a year than the baseline. On average, they sold about 7 months earlier than the baseline farmers. Some of these farmers held out longer than did a number of those in the weaker pools.

Farms with more water, all else equal, were purchased earlier, reflecting the agency's desire to secure properties that brought more water to the aqueduct. The hazard ratio is 1.08, signifying that an additional acre-foot of water would

Table 3. Hazard Model Estimation—The Land Market: Determinants of Year of Purchase

Variable	Hazard ratio	SE	dy/dx at mean values
Total farm (acres)$_t$	1.000467***	1.57×10^{-4}	−0.001
Total cultivated acreage$_t$	0.9931538***	1.30×10^{-3}	0.010
Water acre-feet per acre$_t$	1.08459***	1.89×10^{-2}	−0.12
Riparian rights$_t$	1.114411	1.07×10^{-1}	−0.16
Member of Keough pool$_t$	0.3987926***	9.62×10^{-2}	1.46
Member of Cashbaugh pool$_t$	1.922613***	3.56×10^{-1}	−0.94
Member of Watterson pool$_t$	2.488455***	6.04×10^{-1}	−1.28
Farms on ditches but not in pool$_t$	1.515241***	1.86×10^{-1}	−0.62
Aqueduct flow/Los Angeles population$_t$	0.9526597***	1.65×10^{-2}	0.07
Los Angeles population change$_{t-1}$	1.009573***	9.00×10^{-4}	−0.01
/ln_p	1.945629***	2.98×10^{-2}	
595 observed, log likelihood = 252.33, χ^2 (10) = 217.45.			

Note: The year of sale used in the hazard model regression is year$_t$ − 1916.

***Significant at the 1% level or better.

**Significant at the 5% level.

*Significant at the 10% level.

Table 4. OLS Estimation: The Land Market: Price Per Acre (Dependent Variable Total Farm Purchase Price per Acres)

Variable	Coefficient	SE
Constant	−49.33***	15.88
Cumulative water$_t$	144.55***	15.89
Total farm (acres)$_t$	−0.15***	0.04
Total farm (square acres)	3.7×10^{-5}**	1.5×10^{-5}
Total cultivated acreage$_t$	0.69***	0.25
Total cultivated square acreage	-1.7×10^{-3}**	8.7×10^{-4}
Water acre-feet per acre$_t$	37.52***	4.13
Water acre-feet per square acre$_t$	−1.12***	0.37
Riparian rights$_t$	−1.45	9.56
Member of Keough pool$_t$	213.22***	24.69
Member of Cashbaugh pool$_t$	52.34***	18.66
Member of Watterson pool$_t$	81.13***	24.92
Farms on ditches, not in pool$_t$	68.64***	12.60
595 observed, $R^2 = 0.62$, $F(12, 582) = 78.48$		

***Significant at the 1% level or better.

**Significant at the 5% level.

*Significant at the 10% level.

increase the likelihood of sale in a year by 8%, and an additional acre-foot of water per acre of land speeded sale by 0.12 year or by over 1 month, all else equal. Past growth in Los Angeles' population has a hazard ratio of 1.01, raising the likelihood of sale, and current aqueduct flow per capita has a hazard ratio of 0.95, indicating higher water supplies reduced the likelihood of sale.[56]

Table 4 shows OLS estimates of the price paid per acre of land. As shown in the table, the estimated coefficient for the supply constraint variable facing the Water Board, the cumulative percent of total water purchased is approximately

56. I reestimated the year of sale equation with OLS, and the estimated coefficients were reasonably close to the marginal effects measured at the mean of the duration model. Estimates from OLS were slightly less significant than from the duration model, but most coefficients were still statistically significant at reasonable levels of significance. I also estimated the OLS model with robust standard errors (SEs) to correct for any arbitrary heteroskedasticity that might have led to the model's precision. The SEs and p values were quite similar with this methodology to the SEs and p values using traditional OLS variance-covariance matrix restrictions. Additionally, I created a new variable which lagged the average price of all transactions in each year and included this in the model with traditional and robust SEs. This new variable was strongly correlated with aqueduct flow per capita because both vary only by year and are increasing over time. Inclusion of the average price variable did not change the magnitudes of my estimates or their SEs. Further, if I arbitrarily dropped variables from the model, the SEs for the remaining variables remained similarly precise, suggesting that strong correlation among the regressors was not driving the precision of the estimates. Indeed, the regressors are not strongly correlated with each other (except the aqueduct flow per capita variable and the average price variable which was not included in the model in the article.)

145. This suggests that a 1% increase in the fraction of water purchased relative to the total amount available raised the price of land by $1.45 per acre. Among the agricultural productivity variables, water endowments mattered the most, with an additional acre-foot of water per acre adding over $37 per 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 per acre varied across the sample, with the farms at the center of the most contested negotiations having the largest negative effects. The size of the estimated coefficients on the water per acre and water per square acre terms implies that the value of the marginal product of water per acre was zero at 16.8 acre-feet per acre.[57] In the data set analyzed here, 1 farm with the largest water holdings had 16.5 acre-feet per acre, 3 had 13 acre-feet per acre or more, and 30 farmers had at least 9 acre-feet per acre. Hence, those farmers with the most water had the greatest reason to resist efforts by the Board to purchase their water-bearing properties according to their agricultural productivity values. These generally were the farmers who colluded to secure higher per-acre prices. As we will see, the fact that they were not able to secure more for their water through the land market contributed to the notion of "water theft."

Even though there was differential cohesion and ability of the sellers' pools to hold out, they exhibited market power in the land market. Members of the Keough pool earned about $213 more per acre than did the 228 nonditch property owners and $145 more per acre than those farmers who were on ditches but defected from collusive efforts. Members of the Watterson and Cashbaugh pools earned approximately $81 and $52 more per acre, respectively, than the competitive baseline farmers.[58] To keep farmers out of the irrigation district, Los Angeles paid an additional $68 per acre for the nonpool ditch farms, an amount better than their owners would have earned in the Cashbaugh pool, but less than that in the Watterson pool.[59]

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 implicit water market. Table 5 reports OLS estimates of the implicit price per

57. These figures represent estimated water holdings per acre or extraction potential for the aqueduct.

58. As indicated above, the Watterson pool members on average sold earlier than did those in the Cashbaugh pool. By itself, this would imply that the Watterson pool farmers should have received less per acre. But the pool variable may be picking up another factor, that the Watterson brothers, who were leaders of the pool, were community resistance leaders and, hence, the Board may have been willing to pay more to get them to defect.

59. Substituting the pool dummies with the relevant HHIs in the estimation provides similar rankings for the pool results reported here. Even when estimating the model with robust SEs to correct for arbitrary heteroskedasticity the SEs remain small and the coefficients precisely estimated. Including year dummies does not change the magnitudes of the coefficients nor their statistical significance. Moreover, the regressors are not highly correlated with each other. To check for possible endogeneity introduced by the fraction of total water purchased variable, I instrumented the variable with lagged percent of total water purchased. The two-stage least square (TSLS) results, however, are quite similar to the OLS results reported in the article. A Hausman specification test fails to reject the null hypothesis that the variable is exogenous.

Table 5. OLS Estimation: The Water Market: Price Per Acre-Foot (Dependent Variable Total Purchase Price per Total Acre-Feet of Water on the Farm)

Variable	Coefficient	SE
Constant	−1457.73***	288.65
Cumulative water$_t$	−67.16	178.50
Total farm (acres)$_t$	−1.05**	0.41
Total farm (square acres)	3.1×10^{-4}*	1.7×10^{-4}
Total cultivated acreage$_t$	2.97	2.65
Total cultivated square acreage	-8.4×10^{-3}	8.9×10^{-3}
Water acre-feet per acre$_t$	−358.53***	55.37
Water acre-feet per square acre$_t$	22.69***	4.36
Riparian rights$_t$	26.33	107.58
Member of Keough pool$_t$	−14.65	265.67
Member of Cashbaugh pool$_t$	−194.29	192.91
Member of Watterson pool$_t$	−287.34	248.72
Farms on ditches, not in pool$_t$	−108.84	138.27
443 observed, $R^2 = 0.09$, $F(12, 430) = 4.86$		

***Significant at the 1% level or better.

**Significant at the 5% level.

*Significant at the 10% level.

acre-foot of water using the same explanatory variables as in the price per-acre of land estimation. The price of an acre-foot of water is obtained by dividing the total sales price for a farm by the amount of water associated with it. Because not all farms had water endowments, the sample sizes in the land and water market analyses are not the same.

Over all, the model performs poorly in explaining the implicit price of water, suggesting that there was only a weak relationship between the variables that affected land prices and the prices received per acre-foot of water. Negotiations between the Water Board and farmers took place within the land market in order to gain water, suggesting that the relationship would be imperfect. Even so, the results help explain the lingering sense of unfairness of the negotiation results in Owens Valley. There is no statistically significant effect of pool membership on water prices. Although pool members earned more per acre of land, their collusive ability was not enough to translate into higher water prices. Importantly, the water-per-acre variable has a significant and negative coefficient of −358.53. The more water a farm conveyed with its purchase, the lower the per-acre-foot water price. Although this negative effect was mitigated as the amount of water on a farm increased, the size of the estimated coefficients on the water per acre and water per square acre terms indicates that the effect did not become zero (and then turn positive) until water endowments reached 7.9 acre-feet. Only 55 of the 443 farms with water in Owens Valley had water of this amount or more. For most farmers, then, the more water they had, the lower the water price they received.

There is another indication of the relative market power of the two parties in the negotiations over water-bearing land. It is possible to compare the implicit

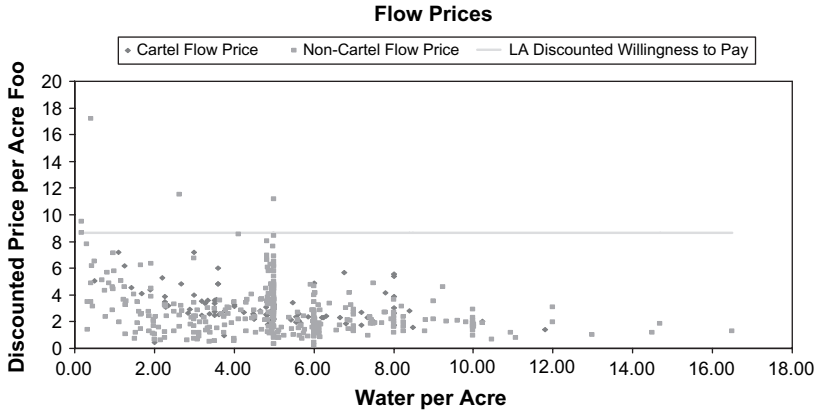

Figure 3. Water Flow Prices Paid to Owens Valley Farmers Relative to What Los Angels Paid for Colorado River Water.

prices paid per-water acre-foot with the price that the Board might have been willing to pay. In 1931 after most Owens Valley properties had been purchased, 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 per acre-foot for water from the Colorado River or $9.50 per acre-foot for an annual flow.[60] Converting all implicit water prices for each Owens Valley farm into prices for an annual flow of water and plotting them in Figure 3 illustrates the position of the farmers relative to this baseline. This exercise does not include the added costs of pumping Colorado River water nor of treating it, since Colorado River water was more mineralized than was Owens Valley water. 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. Moreover, those farmers with more water endowments per acre of land received among the lowest prices per acre-foot for their water. This illustrates the weakness of the sellers' pools, whose members generally had the most water per acre, to secure higher prices for their water, despite all of their maneuvering in the land market.

Moreover, consider the total expenditures made by the Board relative to what it might have been willing to pay. The total outlay for Owens Valley farms by the Board between 1916 and 1934 in the data set used here was $13,937,934 to secure 266,428 acre-feet of water for an average price per

60. Los Angeles' share of Colorado River aqueduct water and costs are from Erie (2000: 155, fn 26) and Hundley (2001: 229). 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.

acre-foot of $52.31.[61] Part of the $24,600,000 capital cost of the Los Angeles Aqueduct should be added to this figure because it was necessary to move the water. The Board purchased farms and their water after 1916 in order to expand the aqueduct flow close to its capacity, from 290 to 460 cubic feet per second (c.f.s.).[62] This increase was 170 c.f.s. or 37% of aqueduct capacity. Adding 37% of the capital cost or $9,102,000 to the land expenditure figure results in a total outlay of $23,076,934 for water and relevant capital costs.

If the Board had paid $220 per acre-foot for Owens Valley water, as it did for Colorado River water and related infrastructure, the total sales expenditures would have been $58,614,375, or about two and a half times the actual outlay. For even the farms that the agency bought preemptively in 1923 and 1924 to block the Owens Valley Irrigation District, the price paid per acre-foot was $68.50.[63] It seems clear then that the Water Board paid less for Owens Valley water than it had to pay for Colorado River water and, hence, what it might have been prepared to pay. This is only a suggestive exercise, but the outcome reflects the relative bargaining power of the agency, and it underlines the legacy of water theft in the transactions.[64]

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

This article explores how the Owens Valley controversy, with its rhetoric of unfair treatment and theft, affected economic outcomes. The analysis suggests why some Owens Valley land negotiations took so long and often were so acrimonious. It shows how efficiency-enhancing trade was tied up by distributional conflicts. There were intense disputes over property valuation and the sharing of the gains from reallocating water to Los Angeles.[65] The bargaining for water was complicated because it took place in a land market and the most contentious, lengthy negotiations took place between the Water Board and farmers who were part of collusive organizations. The efforts of the latter to delay sale in order to capture more of the gains of exchange slowed the valuable reallocation of water from marginal agriculture to higher valued urban uses in Los Angeles. Additional resources were expended by both parties in maneuvering to improve their positions.

Farmer appeals to the press about the inequities of the process created lasting perceptions of injustice in the transfer of water from Owens Valley to

61. Calculated from the land sales data in the "Porter file," LADWP Archives.

62. "Statement to Mayor's Advisory Committee Prepared by the Special Owens Valley Committee of the Board of Public Service Commissioners," December 16, 1924, Tape GX0004, Special Owens Valley Committee File, LADWP Archives.

63. "Recent Purchases of Water in Owens Valley by City of Los Angeles," November 1923 Cope Rand Means Co. Engineers, San Francisco, Water Resources Research Center Archives, UC Berkeley, Lee Folder, MS 7611 98246.

64. See also Libecap (2007: 89–90).

65. This is similar to efforts to define unitization shares in oil fields where there are conflicts over lease valuation and the sharing of the surplus gained from halting common pool extraction. See Wiggins and Libecap (1985).

Los Angeles, where it generated dramatic increases in land values. Indeed, the ensuing bargaining disputes have lingered on as part of the historical legacy of Owens Valley, which is important for understanding the politics of water reallocation and the difficulties faced by water markets today.[66]

Although I do not measure the increases in transaction costs arising from the bargaining strategies of the parties, it is possible to measure the outcomes. In general, Owens Valley farmers did better through the sales of land to Los Angeles than if they had remained in agriculture. As shown in the regression analysis, colluding farmers earned more per acre of land than did their unorganized colleagues. Further, between 1910 and 1930, when Los Angeles was buying properties, farmland values in Inyo County (Owens Valley) as reported in the US Census rose by 175% to $143 per acre, whereas in the four similar baseline Great Basin counties they rose by 52% to an average of $45.50 per acre.[67] Nevertheless, Owens Valley farmers did not do as well in the water market. Their sellers' pools were unable to capture more of the value of water in Los Angeles. Most of the surplus went to Los Angeles' property owners.

Comparing US Census data on the rise in value of agricultural land and buildings in Los Angeles County and Inyo County (Owens Valley) between 1900 and 1930 reveals a gain of $11,568,000 in Inyo versus $407,051,000 Los Angeles. The Los Angeles values are about 40 times those of Inyo, and in part, they reflect access to a steady supply of Owens Valley water. Alternative sources from the Colorado River did not arrive until 1941. Even this is an understatement of Los Angeles' gain because the growth of urban land values is not reported in the census. If one uses property value data from the California State Board of Equalization a similar picture emerges. Each year the Board of Equalization reported the "Grand Total Value of All Property" by county and municipality. The data include the value of real estate (farm and nonfarm), improvements, personal property, money and solvent credits, and railroad assessments.[68] Between 1900 and 1930, the total value of all property in Inyo County rose by 917%, but in Los Angeles County the increase was 4408%. It is no wonder that Owens Valley farmers wanted more of the benefits of the exchange.

The sense of inequity 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.[69]

66. As noted above, see Young's (1986) questioning about why water markets have been so slow to develop.

67. Calculated from farmland and buildings data in Barnard and Jones (1987: 10–12).

68. Schedules E and F, *Annual Reports of the California State Board of Equalization*, Sacramento: State Printing Office, 1900–35.

69. 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.

Besides providing empirical evidence to the literature on the economics of bargaining and fairness, the experience of Owens Valley emphasizes the importance of resolving distributional conflicts in water transfers where the amounts of money at stake can be very large. Today, so much water is devoted to low-valued uses at the margin in agriculture, $15–$25 per acre-foot, whereas marginal urban and environmental values are so much higher, $500 per acre-foot or more, that transfers can generate considerable benefits. Addressing distributional claims, however, are not straightforward as Owens Valley demonstrates, and they delay otherwise beneficial transactions.[70]

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70. The long-standing battle between the Imperial Irrigation District (the largest user of Colorado River water in California), San Diego, and the Metropolitan Water District of Southern California illustrates the problem. See Haddad (2000: 71–7) and Hanak (2003: 72–81).

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