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The Distribution of Economic Rents Arising from Subsidized Water When Land Is Leased

Ray G. Huffaker and B. Delworth Gardner

A broad distribution of the benefits of federally "underpriced" water may be best promoted by limiting the size of owned acreage and not the sum of owned and leased acreage as required by the Reclamation Reform Act of 1982. Calculated differences between contractual lease payments and associated tenant-expected economic rents were statistically tested to determine if landowners fully capture the latter. Cash lease markets transferred nearly all economic rents anticipated by tenants to landowners in the study area. Share lease markets do the same if share tenants are assumed to be moderately risk averse.

Key words: distribution, economic rents, farmland, lease, reclamation.

Since the federal government began subsidizing the use of irrigation water in its reclamation projects, the distribution of the subsidy has been of paramount concern. The 160-acre ownership limitation was adopted to spread broadly the wealth gains resulting from pricing water below its value in use. Previous investigations of reclamation policy published in this journal have focused on the magnitude of the water subsidy and its distribution under strict versus lenient enforcement of the 160-acre ownership limitation (Seckler and Young, LeVeen and Goldman).

Until recently, however, a limitation on leased acreage was not considered necessary to spread the net income gains resulting from subsidized water. Apparently landowners were assumed to capture the bulk of these gains, which were distributed among them by the 160-acre ownership limitation. Farmers who found it profitable to operate larger acreages could lease farmland. Any above-normal profits earned by tenants were assumed to be transferred to landowners via competitive bidding for leased farmland. (This is discussed more extensively below.)

Proponents of an acreage restriction on leasing, however, including some officials of the Bureau of Reclamation, apparently are no longer willing to assume that landowners capture the rented profits. They argue that unrestricted leasing has concentrated project net benefits in the hands of a relatively few large tenants in some reclamation areas (Bureau of Reclamation, pp. 3–14). Their call for leasing restrictions was heeded by federal legislators in the Reclamation Reform Act of 1982 (RRA). The acreage limitation was increased to 960 acres for "qualified" recipients, but it included for the first time the sum of leased and owned acreage receiving subsidized water.

This paper asks whether leasing restrictions, in a reclamation area with an active farmland leasing market, would produce a more widespread distribution of project benefits than that existing under ownership restrictions only. The answer pivots on the portion of net project benefits captured by tenants. If tenants are found to secure a "significant" portion, leasing restrictions could limit the acquisition of tenant wealth from subsidized water. If, on the other hand, landowners capture the bulk of the benefits through the lease market, leasing restrictions should be largely innocuous in changing the distribution of those benefits.

Innocuous leasing restrictions could cause efficiency losses without producing the equity
gains which lawmakers anticipated in justifying the new law. A number of existing operations, in reclamation areas containing large farms and active lease markets, may now be in violation of the new restrictions and must therefore adjust accordingly. These adjustments may have adverse impacts on economic efficiency, depending critically on the strength of economies of scale. This paper is an effort to determine the extent of equity gains in a sample reclamation area containing large farms and substantial leasing of land receiving subsidized water. An empirical study is necessary because the distribution of project net benefits in leasing cannot be determined a priori as always being captured by landowners. The next section discusses why landowners may not capture total net benefits in real-world lease markets.

Theoretical Model

Equation (1) depicts the distribution of project net benefits between the landowner and the tenant associated with lease $i$:

$\text{(1)} \quad d_{it} = CP_{io}[T_{io}, L_{io}, MS] - T_{it} \geq 0$

where lease $i$ is observed in year $t$ of its duration (leases are generally observed midcourse rather than during negotiation), and $t = 0$ represents the time period before lease $i$ starts in which prospective tenants bid for the lease and the landowner agrees on a contractual payment (CP). In equation (1) $d_{it}$ is the difference between the contractual payment and the tenant’s expected economic rents revised by price and production information gained while leasing up to year $t$ ($T_{it}$). Contractual payment depends on the economic rents that the tenant and the landowner each anticipated at $t = 0$ ($T_{io}$ and $L_{io}$, respectively) and the structure of the lease market (MS).

What does rational tenant behavior imply about the sign of $d_{it}$? Assume first that during negotiation the tenant perfectly projects economic rents over the term of the lease, i.e., $T_{it} = T_{io}$. The tenant is assumed to be willing to bid the contractual price up to the level of his total expected economic rents since the latter is the maximum bid he can make and still earn the opportunity cost rate of return. Thus, rational tenant behavior indicates that $d_{it} \leq 0$. Values equal to zero indicate that market competition among tenants has forced the successful tenant to bid full expected economic rents. Values less than zero indicate that the tenant captures some of his expected economic rents due to market structure that is less favorable to landowners.

The theoretical conditions under which the landowner could be expected to capture total net benefits from lease $i$ ($d_{it} = 0$) are (a) tenants who are all equally productive (thus supramarginal economic rents are not available to be captured by any tenant), (b) a high degree of competition among tenants (thus total net benefits are fully incorporated into the agreed contractual rate as prospective tenants bid against each other for the lease), and (c) a lack of competition among landowners to find efficient tenants (thus landowners do not compete against each other by accepting bids that do not include total net benefits).

The strong possibility that the above conditions may not hold in many farmland lease markets illustrates the need for an empirical study. (In fact, it must be widely believed that they do not hold since recent changes in reclamation law have restricted leased acreage in an effort to prevent tenants from capturing “too much” of the available economic rents.) The spatial dimensions of agricultural production and the resulting high costs of cultivating widely scattered parcels certainly would violate the condition that all tenants are capable of producing at equal cost and may dampen competition among prospective tenants. At the same time, landowners may vigorously compete for efficient tenants who are favorably located relative to available leased land. In either case, the result is that lease prices may not be bid up to the level of total expected rents of the most efficient tenants. Thus, a recent crop-sharing study, after recognizing that competitive formulations ignore the above problems, analyzed leasing as a bargaining problem by employing a Nash solution to derive an equilibrium crop share (Bell and Zusman).

Assume now that the tenant imperfectly projects economic rents associated with lease $i$. Thus, there is a discrepancy between the tenant’s expected economic rents at negotiation and his expectation $t$ years into the lease ($T_{it} \neq T_{io}$). His revised expectation may fall on either side of the initial expectation depending on the information he gains in operating the lease up to year $t$ of its term. Two implications of the foregoing are: (a) equation (1) cannot be used to differentiate empirically between ten-
The null hypothesis to be tested is that observed contractual lease rates are equal, on average, to tenant expectations of economic rents computed from survey information. Thus, the two-tailed test is:

\[ H_0: \bar{d}_{it} = 0 \]
\[ H_A: \bar{d}_{it} \neq 0. \]

It is assumed that the \( d_{it} \)'s are normally distributed so that a \( t \)-statistic may be used to calculate acceptance intervals around \( d_{it} \). The sample, to be described more fully below (156 cash and 46 share leases), is large enough so that the sampling distribution of \( d_{it} \) should tend toward a normal distribution by the central limit theorem. The large samples of cash and share leases also permit the approximation of the \( t \)-distribution with the standard normal. Assuming the necessary independence of the \( d_{it} \)'s seems reasonable since each was associated with separate fields. Assuming that the \( d_{it} \)'s were drawn from identical distributions also appears reasonable. The data were taken from a single region and were therefore similarly affected by weather, pests, and other exogenous events. Also, no discernible pattern was found between economies of scale and the level of tenant-expected economic rents (discussed below). Varying farm sizes should therefore not lead to dissimilar distributions.

The acceptance region for the mean difference is

\[ ( -z_{\alpha/2} s/\sqrt{n} < \bar{d}_{it} < z_{\alpha/2} s/\sqrt{n} ) \]

where \( z = d_{it}(s/\sqrt{n}) \) is a standard normal deviate, \( s \) is the sample standard deviation, and \( n \) is the number of observations in the sample. The data can also be interpreted in view of the percentage of tenant-expected rents captured by landowners. The acceptance region around the mean percentage of landowner-captured expected economic rents, \( PCT_{it} \), is

\[ ( PCT_{it} = CP/T_{it} * 100 ) \]

where \( PCT_{it} = CP/T_{it} * 100 \), by equation (1). The critical values of \( PCT_{it} \) in equation (3) are obtained by substituting the critical values for \( d_{it} \) from equation (2) into the above \( PCT_{it} \) function. The results are analyzed in terms of both acceptance intervals (2) and (3).

Acceptance of the null hypothesis implies that landowners would capture, on average, full net project benefits if distribution were to occur when observed at time \( t \). The upper tail alternative represents average landowner capture of more than 100% of tenant-expected economic rents, most likely due to unrealized tenant profit expectations. The lower tail alternative represents average tenant capture of a portion of their expected economic rents from leasing.

A very low probability, \( \alpha = 0.005 \), of incorrectly rejecting \( H_0 \) is desired. Such a mistake would support the innocuous imposition of restrictions on leased acreage, with its possible negative effect on agricultural efficiency.

Calculating Tenants' Expected Economic Rents

Recall that \( d_{it} \) is the difference between the contractual payment and the tenant's expected economic rents, \( T_{it} \). Actual contractual payments were observed for each lease as revealed by surveyed tenants in the Imperial Valley of California. The following addresses how the \( T_{it} \)'s were estimated from survey information taken from 25 tenants participating in 156 cash and 45 share leases.

Literature exists which shows that farmers may not be indifferent to the variability of annual returns produced by various crop options (Just; Lin, Dean, and Moore; Adams). For this reason, the estimation of tenant-expected economic rents associated with lease \( i \) was framed in an expected utility-maximization model where expected utility is an increasing function of expected wealth, \( \mu_{wi} \), and a decreasing function of the variance of wealth, \( V_{wi} \).
Mean wealth, \( \mu_{w_{it}} \), was calculated as the present value of the flow of annual expected economic rents:

\[
\mu_{w_{it}} = \sum_{t=1}^{n} \pi_{it}[1/(1 + r)]
\]

where \( \pi_{it} \) over the life of lease \( i \) (\( t = 1, \ldots , n \) years); \( \phi \) is the constant risk aversion coefficient associated with the tenant; and \( r \) is the opportunity rate of return. The proxy used in the study for \( r \) is the rate of newly issued AAA long-term corporate bonds. This rate is assumed to be a good average of the productivity of low-risk investments in the capital markets.

A elicitation procedure was utilized to calculate the tenant’s expectations of crop prices and yields over the course of the lease. Producers were asked to allocate probabilities, summing to one, over a range of possible yields for a given crop. The same process was repeated for the associated ranges of crop prices. The first two moments were calculated from each distribution and used to estimate the expected rents and variances in equations (4) and (5), respectively.

Costs, specific to each crop grown by a tenant, were estimated using the format of Imperial County budgets prepared with the Budget Generator developed by the University of California Cooperative Extension. Land was treated as the residual claimant to all economic rents. Slight economies of scale were built into the budgets. Opportunity costs of management were arbitrarily fixed at 5% of gross revenues. Total labor hours were priced at the going wage rate. Figures entering the budgets came from survey information on machinery, crop production practices, office staffs and field labor, variable input usage (i.e., fertilizer or water applied during each application specified in a tenant’s production practices), machinery value, and costs of variable inputs (i.e., fertilizer or water cost per unit). These production data were combined with information collected from secondary sources to make crop production costs as specific as possible to the farm on which the crop was grown. Estimated costs were then shown to each operator for confirmation. Final cost figures resulted from operators’ corrections.

Alfalfa was the only crop for which a covariance between price and yield was estimated and used to compute expected rents. This is in response to alfalfa producers’ ability to exert greater control of crop yield over the course of the growing season than do producers of most other crops.

The variance of wealth, \( V_{w_{it}} \), was calculated as the discounted sum of the variances of annual expected economic rents, \( V_{\pi_{it}} \):

\[
V_{wi} = \sum_{t=1}^{n} V_{\pi_{it}}[1/(1 + r)]
\]

This computation assumes that \( \text{Cov}(\pi_{it}, \pi_{i\tau - \tau}) = 0 \), for all tenants, i.e., rents in different years are uncorrelated. Survey data do not exist to calculate covariances between years, nor are there a priori reasons for expecting a given magnitude. \( V_{\pi_{it}} \) were calculated as the variance of the product of two random variables: \( P_{it}, Y_{it} \) (Mood, Graybill, and Boes, p. 180).

A basic weakness of the expected utility approach, pointed out by Freund, is that the constant risk aversion coefficient (\( \phi \)) is a subjective variable and is therefore very difficult to estimate. Chosen values are hard to defend. Coefficients unique to each operator in this study were not estimable from survey information. No studies were located which estimated risk aversion coefficients for operators in the Imperial Valley.

Our approach was first to study the polar case of tenant risk neutrality. Risk neutrality serves as a useful benchmark because maximum bids are calculated at their highest level. If the differences between contractual payments and maximum bids are insignificantly
different from zero under risk neutrality, they will only become more so as risk aversion is allowed to increase. Risk neutrality may not be an unrealistic assumption. In commenting on an earlier study calculating maximum bid prices for farmland (Harris and Nehring), Whitmore showed that there was little difference between expected and risk-adjusted bid prices.

A tenant’s expected rents were amortized to make them comparable to the annual payments made in cash and share leases. The series of uneven annual expected rents can be converted into an n-year annuity in the following way:

\[ T_n = R(\mu_w - \phi/2V_w) \]

where \( R = \frac{1}{\left\{ \sum_{t=1}^{n} \left[ 1/(1 + r) \right]^t \right\}}. \)

**Contractual Payments in Cash and Share Leases**

The contractual payment in cash leases is the lease price, \( P_L \) ($/acre/year). Differences in cash leases are thus computed as \( d_{it} = P_{Li} - T_{it} \). In share leases the contractual payment depends on the predetermined percentage of yearly gross revenue, \( a \). Because there is no predetermined lease price, there is uncertainty as to how much the landowner will be paid each year of the lease. Payments made in share leases are put on an expected cash-equivalent basis with payments made in cash leases by redefining mean wealth in equation (3) to be the present value of the flow of annual expected gross revenues and calculating the landowner’s amortized share, \( LSH_{it} \). Differences in share leases are therefore calculated as \( d_{it} = LSH_{it} - T_{it} \).

**Data**

Most of the data used in this study were obtained from a 1982 survey—conducted under the direction of the U.S. Department of Agriculture and the University of California—taken from forty farm operators in the Imperial Valley, California. The sole source of irrigation water for the valley is the All-American Canal, a federal reclamation project approved in 1928.

Historically, the valley has been excluded from the acreage restriction policy, except for most of the period 1976–80. Since 1980, it has been again excluded and likely will continue to be in the future. An area subject to the limitation would have been preferred. However, farm operators in reclamation areas under current acreage limitations are understandably reluctant to divulge information on leasing practices and prices which might later be used to tighten up the restrictions even more. Attempts were made to secure data in such areas with large farms and substantial leasing, without success. The Imperial Valley was selected because it is in no danger of being affected by any new reclamation legislation, it has an active lease market, and it receives federally subsidized water. Farms there are also very large by almost any standard.

Approximately 460,000 acres are irrigated with subsidized water. Vegetable crops are farmed on approximately 90,000 acres with most of the remainder in field crops. The valley produced a gross income of $764,862,000 in 1981. Vegetable crops accounted for 20% of the income, with lettuce and melons as the leading crops. Field crops made up 44%, with cotton, alfalfa, wheat, and sugar beets as the leading income producers. The livestock and dairy industries provided most of the remaining income.

Sampled farm size ranged from 291 to 7,119 acres. Twenty-five operators surveyed leased some amount of land. The smaller acreage operations tended to be family farms, while the larger ones were mainly family corporate farms.

Operators were asked to describe all of their leases in terms of rental rate, time horizon, landowner, crops grown, and capital investment on the rented land. Leases were selected with terms of five years or less since reliable information on leases was available only for the last five years. The identities of the crops grown on each leased field in 1982 and 1983 were available in the survey. Crops grown back in 1978 were identified via pesticide application permits on file at the Agricultural Commissioner’s Office in Imperial County. No records exist to identify the crops produced on the leased fields prior to 1978. None of the leases studied lasts beyond 1983.

Operators farming more than 1,500 acres were more diversified than those farming less. The larger farms produced lettuce, broccoli, cantaloupes, onions, sudan grass, and tomatoes, in addition to alfalfa, wheat, cotton, and sugar beets. The cropping patterns on owned land in the survey are much like those
on farmland under cash leases. The major difference between the crops grown in cash leases and those grown in share leases is that only one of the forty-five share leases studied included any crops from the second group mentioned (vegetables, melons, etc.), while 28% of the cash leases included such crops. This reflects the strong possibility that landowners in the sample are averse to sharing in the risk associated with vegetable crops because of large income fluctuations from one year to another.

Discussion of Results

Acceptance intervals were first estimated for cash and share leases assuming risk-neutral tenants. The average difference between pairs of cash lease prices and tenant expected economic rents was estimated to be $-18.33/acre (results are reported in table 1). The $18.33/acre captured by tenants falls squarely within the interval denoting acceptance of the null hypothesis [$± 29.79/acre]. Likewise, the 92% of total rents captured by cash landowners was not significantly different from 100% since the acceptance interval was estimated to be 83%, 117%.

The share lease sample does not strongly support either the null or alternative hypothesis. Share lease tenants were estimated to capture an average of $22.77 per acre, or 16% of total expected rents. The amount of tenant captured rents falls on the borderline of the acceptance interval estimated around $23.87. The 84% captured by share landowners on average also falls on the borderline of the PCT acceptance interval, 84%, 116%.

Risk Aversion in Share Leases

Acceptance intervals were reestimated for share leases, assuming a risk premium of $50 per acre, to see if the difference between share rates and expected economic rents would become decidedly insignificant. The risk premium is the amount of wealth a tenant would be willing to give up in order to “buy his way out” of crop price and production risk. The average risk premium over all tenants is $\bar{\rho} = \phi/2 \bar{V}(W)$ (Newbery and Stiglitz, pp. 72–73), where $\bar{V}(W) = 56,263$ is the average discounted variance of wealth over all tenants. The assumed average risk premium of $50 per acre, being less than 10% of the average expected wealth over all share tenants ($522.28/acre), does not appear unrealistic.

The null hypothesis of no significant difference between cash-equivalent share rates and tenant expected economic rents is accepted (results reported in table 2). Share tenants capture an average of $9.62 per acre (8% of total rents), which falls within the associated acceptance interval [$± 23.87]. The 92% of total rents captured on average by share landowners is not significantly different from 100% given the acceptance interval (82%, 118%).

Other Findings

It does not appear that a significantly larger fraction of economic rents is being captured by the larger tenants than by smaller ones. There was no discernible pattern in the percentage of total expected rents paid to tenants and scales of operation. This indicates that if size generates greater economic rents, both landowners and tenants realize it; and the competition among large tenants is severe enough to transfer the same fraction of these rents to the landowners, as is the case with smaller scales of operation.

Table 1. Acceptance Intervals: Cash and Share Leases, Tenant Risk Neutrality

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<th>$d_n = 0$</th>
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<tbody>
<tr>
<td></td>
<td>Lower</td>
<td>Upper</td>
<td>Lower</td>
</tr>
<tr>
<td>Cash</td>
<td>$-29.79$</td>
<td>$-18.33$</td>
<td>$29.79$</td>
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<tr>
<td>Share</td>
<td>$-22.83$</td>
<td>$-22.77$</td>
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Table 2. Acceptance Intervals: Share Leases, Tenant Risk Aversion

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<th>$PCT_n = 100%$</th>
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<tr>
<td></td>
<td>Lower</td>
<td>Upper</td>
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<tr>
<td>$H_0$:</td>
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<td>$23.87$</td>
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<tr>
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<td>$84$</td>
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Reclamation policy has been criticized for allowing operators to frustrate the intent of the acreage restrictions by selling their land to relatives or employees and then leasing it back at very favorable rates in what are known as "sweetheart" deals. The Imperial Valley has been exempt from acreage restrictions for much of its history, and no evidence is available that farmers expect that the policy will be changed. Therefore, valley operators probably would not have the same incentives to form "sweetheart" deals in the attempt to overcome acreage restrictions as may those living under restrictions. This study, therefore, does not provide a test of this issue.

Finally, see Huffaker and Gardner for discussion on how our results shed light on the controversy surrounding current attempts to repeal the RRA's controversial "hammer" clause [43 USCS sec. 390cc(b)].

Conclusions

Based on our empirical findings from the study area, the major policy conclusion is that a broad distribution of the benefits of "underpriced" water is best promoted by limiting the size of owned acreage and not the size of the sum of owned and leased acreage as required by the Reclamation Reform Act of 1982. Our results show that cash lease markets would transfer nearly all economic rents anticipated by tenants to the landowners in the study area. The same results would hold in share lease markets if the share tenants were assumed to be moderately risk averse.

The Imperial Valley is not an ideal study area in all respects, however, since it has not been continuously subject to the acreage restrictions of reclamation law. Thus, from our data we can infer little about the circumvention of the intent of the law by "sweetheart" arrangements between operators and family members and employees. We believe we have shown, however, that this area with underpriced water, extensive leasing, and a broad size distribution of tenants, has developed competitive lease markets capable of transferring the bulk of project net benefits to landowners; and this result might well be applicable to other reclamation areas. A possible caveat is that landowners in the Imperial Valley are under no pressure to dispose of excess land, but the effects of this on the lease market are far from obvious.

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