The Distribution of Economic Rents When Irrigated Farmland Is Leased

Selected Paper for AAEA Summer Meetings
Purdue University, 1983

R. G. Huffaker, Graduate Student
B. Delworth Gardner, Professor
Department of Agricultural Economics
University of California
Davis, California 95616

This research was funded by a grant from the U.S. Bureau of Reclamation.

I. Introduction

Irrigation water supplied by federal reclamation projects has often been priced below its supply cost (Bureau of Reclamation, 1980, p. F-4). Pricing water below cost has been deliberate policy to stimulate irrigation development in the west. One effect of this underpricing is to add to the economic rents captured by federal water users.

Since water is applied to land by irrigation, and since control of the land usually gives entitlement to the subsidized water (which is contracted to landowners for a definite period at specified user charges), the above economic rents tend to become capitalized in land values. The Reclamation Act of 1902 attempted to promote a widespread distribution of total rents by imposing acreage restrictions on the ownership of reclamation land.

When land with subsidized water is leased, economic rents tend to become capitalized to some extent in lease values. Commentators on reclamation policy, including some officials in the Department of the Interior, express concern that ownership restrictions have not proven sufficient in dispersing total rents in reclamation areas where land leases are an integral part of farming operations. They argue that, in these areas, unrestricted leasing is concentrating economic rents in the hands of a relatively few large tenants (Bureau of Reclamation, 1980, p. 3-14). They therefore call for acreage restrictions on the leasing of farmland in reclamation areas. President Reagan signed the Reclamation Act of 1982 into law on October 12, 1982. Consequently, the Act limits the amount of owned and leased land in noncorporate operations in reclamation areas to 960 acres if water is to be obtainable at subsidized prices.

The distribution of economic rents in farm leases is the key issue in determining the effectiveness of acreage restrictions in redistributing rents from tenants back to landowners. If landowners already receive the great bulk of rents in leases, leasing restrictions can not be effective in transferring much income and wealth. In fact, leasing restrictions could possibly make landowners

worse off by discouraging the creation of economic rents, as the most efficient users of farm resources could be prohibited from the use of these resources, i.e., the restrictions could result in less farm wealth being generated by the same amount of farm resources. If, on the other hand, tenants secure a significant portion of the rents, leasing restrictions can discourage both creation of rents and their transfer to tenants.

This report proposes a method of testing whether unrestricted leasing of farmland in federal water projects concentrates the distribution of economic rents. The Imperial Valley (California) was the reclamation area chosen for the study because the necessary data were much more accessible there than in the other areas still subject to federal acreage restrictions. There are two major reasons that the Imperial Valley's current exclusion from the acreage restrictions does not preclude it from being a representative reclamation area. First, the Imperial Valley was under the restrictions from Dr. Yellin's successful court challenge to the Valley's previous exempt status in 1976, to the Supreme Court's unanimous decision to restore the Valley's exemption in 1980. The Valley had only been exempt for 1.5 years before the 1982 survey. Also, many of the leases studied were formed during the non-exempt period. Second, the acreage restrictions under previous reclamation law did not include restrictions on the amount of land an operator could lease and irrigate with federal water. Thus, the non-exempt status of a reclamation area was not a factor obstructing the lease market there.

A survey was taken from twenty-five tenants participating in 156 cash leases and 45 share leases. The economic rents each tenant could likely expect were calculated from the survey data, amortized, and compared to the annual rental rates actually paid to landowners (in the case of cash leases), or to the annual expected share rents each tenant was calculated to anticipate paying landowners (in the case of share leases). The comparisons were used to draw inferences on such matters as the degree to which tenants in the sample participate in the economic rents generated by producing with the low-cost federal water,

and the probable effectiveness of acreage restrictions on leasing in shifting the distribution of rents.

II. Theory

A. The Nature of Farmland Leases

Farmland leases are contracts by which a landlord gives to a tenant--for a specified time and for fixed payments--the use and possession of lands, buildings, and other property.

Leases can be divided into two major groups: cash and share agreements. Cash leases call for a predetermined annual payment which is unaffected by observed crop prices or yields over the course of the agreement. Share leases call for a predetermined percentage of yearly gross revenues. In the latter the annual payment a landowner receives is tied to observed yield and price levels. The agreement forces the landowner to share the burden of uncertain yields and prices with the tenant. The landowner's willingness to share this burden of uncertainty depends on the degree to which he is averse to taking risks. Suppose that tenants and landowners can be categorized as to their degree of risk averseness. The more disinclined tenants are to risk, the more willing they will be to trade off a portion of their expected rents for the extra security of sharing the burden of uncertain crop yields and prices with landowners in a share lease (ceteris paribus). Less risk averse tenants will be more interested in higher expected returns and will gravitate toward cash leases. The more risk averse landowners will desire cash leases while the less averse will be content with share leases if they don't sacrifice income. One therefore expects the less risk averse tenants to match up with the more risk averse landowners in cash leases, with the reverse true in share leases.

B. The Distribution of ex ante Economic Rents in Cash Leases

The lease price is the mechanism by which economic rents, anticipated by the tenant from producing on the landowner's farmland, are distributed between landowner and tenant in cash leases. The conditions of the lease are, presumably,

agreed to ex ante, before production occurs and before the rents are actually earned. It is ex ante rents that are reflected in the observed cash lease price. The level of these rents depends on, among other things, the price and yield expectations of the tenant.

Suppose, for example, that landowner X expects to capture annual economic rents of $100/acre if he farms the land himself. Assume that two producers, A and B, can earn expected rents of $110 and $120, respectively, if either rents the farm from X. Since A or B can employ the farm resources more efficiently than can X, it is expected that the farm will be rented out to the highest bidder. It is also expected that B will offer X at least $110 if active competition exists between A and B. If X knows, however, that B's anticipated yearly rents are $120/acre, he will bargain with B for more than $110. Rather than sacrifice his potential of $120, B will pay up to $120, but only if he has to. It is evident that the rate which B actually pays will vary between $110 and $120, depending on the information possessed by X and B and the bargaining power each has.

In determining the distribution of the tenant's expected rents in cash leases, it is useful analytically to work with the ratio of the observed rental price, P_L ($/year/acre) to the associated amortized rate of expected rents, π^{ε}_{CS} ($/year/acre), i.e., $P_L/\pi^{\varepsilon}_{CS}$. The ratio is interpreted as the fraction of the tenant's expected economic rents that he pays to lease the farmland.

Whenever there is a uniquely determined lease price associated with the tenant's expected rents for a given tract of land, a priori the ratio $P_L/\pi^{\varepsilon}_{CS}$ will fall in the range between 0 and 1, i.e., $0 < P_L/\pi^{\varepsilon}_{CS} < 1$. A value of $P_L/\pi^{\varepsilon}_{CS} = 1$ indicates that, for whatever reasons, the landowner captures the entire amount of the tenant's expected rents. A value less than 1 implies that the observed lease price was not bid up to the level necessary to include the total amount of expected rents. The tenant captures a portion of the rent he anticipates. A value $P_L/\pi^{\varepsilon}_{CS} > 1$ indicates irrational behavior on the part of the tenant. It is not expected that a tenant would tolerate paying a landowner more than his expected

rents when he could earn a larger return by employing his resources in their next best alternative.

C. The Distribution of ex ante Economic Rents in Share Leases

The predetermined percentage of yearly gross revenue is the mechanism which distributes a tenant's anticipated rents between the landowner and him in a share lease. There is no predetermined lease price, as in cash agreements, so there is uncertainty as to how much the landowner will be paid each year. Share leases can be put on an expected cash-equivalent basis by determining the tenant's expected gross revenue and calculating the landowner's share. Let the resulting amount be denoted as SH^{ε} (SH^{ε} is analogous to P_L in cash leases).

Let the tenant's expected rents in share leases be denoted as π^{ε}_{SH}. π^{ε}_{SH} differs from π^{ε}_{CS} due to the different degrees of tenant risk aversion inherent in each.

The ratio $SH^{\varepsilon}/\pi^{\varepsilon}_{SH}$ measures the fraction of rents anticipated by the tenant which he expects to pay to the landowner. It is expected to fall in the same range as $P_L/\pi^{\varepsilon}_{CS}$, for the same reasons.

III. Empirical Analysis

A. Data

The data used in this study were obtained from a 1982 survey--conducted under the direction of USDA and the University of California--taken from forty farm operators in the Imperial Valley. The sole source of irrigation water for the Valley is the All-American Canal, a federal reclamation project approved in 1928. The sample was stratified by farm size with the range of individual farm sizes being from 231 to 7,119 acres. Farm operators taking part in the study were randomly selected from among growers of cotton and other field and vegetable crops. Twenty-five of the operators surveyed lease some land. The most popular crops grown in both types of leases were cotton, alfalfa, wheat and sugarbeets. The major difference between the crops grown in cash leases and those grown in share leases is that only 2 of the 45 share leases studied included any specialty crops (i.e., lettuce, broccoli, etc.), while 30% of the cash leases

included such crops. This reflects the strong possibility that landowners are averse to sharing in the risk associated with vegetable crops because of the large income fluctuations. Another possibility is that tenants are risk loving to the extent that they are unwilling to trade off their higher expected returns (from growing specialty crops) for the added security of sharing the burden of risk with the landowner.

B. Calculating a Tenant's Anticipated Economic Rents Under Constant Risk Aversion

Crop price and yield probability distributions were elicited in the survey from each tenant and used to construct two further distributions representing the probability of various levels of per acre rents which each tenant anticipates. Assuming that prospective tenants maximize the expected utility of rents in the form of a constant risk aversion function, such as the negative exponential or quadratic utility functions, and that rents have a bell-shaped or normal distribution, implies that a tenant's expected utility maximizing level of risky economic rents (hereafter referred to as EUM rents) in any year t for cash leases (CS) and share leases (SH) are:

$$\pi^{CS}_{UM_t} = \mu_{\pi_t} - \frac{\phi^{CS}}{2} V_{\pi_t}, \qquad (1) \qquad\qquad \pi^{SH}_{UM_t} = \mu_{\pi_t} - \frac{\phi^{SH}}{2} V_{\pi_t}, \qquad (2)$$

where μ_π ($/acre/year) and V_π ($/acre/year)^2 are the mean and variance respectively of the tenant's rent distribution. (Crop production costs were budgeted using survey information and the Budget Generator of the University of California Cooperative Extension.) Note that π_{UM} increases as mean rent increases, but decreases with the dispersion of rent possibilities around the average. The decrease is weighted by ϕ, which is called the constant risk aversion coefficient and is assumed constant over all levels of rents. Higher levels of ϕ imply more risk averse behavior since the variance associated with risky rents is given greater weight in determining the EUM level of rents. Note also that ϕ^{SH} probably does not equal ϕ^{CS} since each reflects the different aversions to risk which cause tenants to either gravitate toward share leases or cash leases.

A basic weakness of this approach, pointed out by Freund (1956), is that the estimation of ϕ is largely a subjective task, and any chosen value is exceedingly difficult to defend. Previous research (Just, 1974; Lin et al., 1974; Adams, 1975) indicates that farmers, at least in California, are risk averters. These studies do not, however, contain estimates of ϕ for California farmers. Freund, who pioneered this work, considered values for ϕ of 0.0002 to 0.0004 to be reasonable. Since no one value of ϕ could be justified for use in this study, the analysis was conducted for six values ranging from 0 to 0.0075. The analysis was not repeated for values greater than 0.0075, because at that level the variance of expected rents was given such great weight that many of the EUM rents, in both cash and share leases, were negative.

PV^{CS} and PV^{SH} in equations 3 and 4 (below) are the income totals available for distribution between landowner and tenant over the entire term of the lease. In order to compare the stocks of EUM rents to the flow of annual payments, the stocks were converted into flows via amortization. PV is amortized by solving for the yearly payment, π^{ε}, which transforms PV into the present value of an n-year annuity of $\$\pi^{\varepsilon}$/year, discounted at r%:

$$PV^{CS} = \sum_{t=1}^{n} \pi_{UM_t}^{CS} (1/1+r)^t \Longrightarrow \pi_{CS}^{\varepsilon} = \frac{PV^{CS}}{\sum_{t=1}^{n} (1/1+r)^t} \qquad (3)$$

$$PV^{SH} = \sum_{t=1}^{n} \pi_{UM_t}^{SH} (1/1+r)^t \Longrightarrow \pi_{SH}^{\varepsilon} = \frac{PV^{SH}}{\sum_{t=1}^{n} (1/1+r)^t} . \qquad (4)$$

where $\pi_{UM_t}^{CS}$ and $\pi_{UM_t}^{SH}$ are as defined in equations 1 and 2, and r is the rate of return of the next best investment. This was assumed to be the rate of return on newly issued Aaa long-term corporate bonds. The yearly payments π_{CS}^{ε} and π_{SH}^{ε}, it will be remembered, make up the denominators of the ratios determining the percentage of anticipated rents a tenant pays to the landowner via the agreed-upon lease price in cash leases and via a percentage of expected gross revenues in share leases.

Calculation of Landowner's Share of a Tenant's EUM Gross Revenues

Share leases, as stated above, call for a predetermined percentage of annual

gross revenues. However, unlike cash lease tenants, share lease tenants do not know, at the start, how much they will actually pay the landowner over the course of the lease. Share tenants can, however, anticipate the amount. Share leases were put on an expected cash equivalent basis by determining a tenant's expected utility maximizing (EUM) gross revenue and calculating the landowner's share.

Equations 5-7 calculate the landowner's share of a tenant's EUM gross revenues.

$$\mu_{GR_t} = a[\mu_{P_j}\mu_{Y_j} + Cov(P_j, Y_j)]; \quad a = \% \text{ share} \tag{5}$$

$$V_{GR_t} = (V_{\pi_t})a^2 \tag{6}$$

$$SH_{UM_t} = \mu_{SH_t} - \frac{\phi}{2} V_{SH_t} \tag{7}$$

where $j = 1, \ldots, m$ crops; $t = 1, \ldots, n$ years of lease; and GR = gross revenue. The analysis depicted in the above equations is entirely analogous to the calculation of a tenant's EUM net revenues, π^{ε}_{SH}. Note that $V_{SH_t} = (V_{\pi_t})a^2$ since costs are assumed to be known by the tenant with certainty (and therefore do not enter into V_{π_t}) and $Var(aX) = a^2 Var\ X$, where a is a constant and X is a random variable.

The amortized value of the landowner's share of a tenant's EUM gross revenues was calculated as:

$$SH = \frac{\sum_{t=1}^{n} SH_{UM_t}(1/1+r)^t}{\sum_{t=1}^{n} (1/1+r)^t} \tag{8}$$

where $t = 1, \ldots, n$ years of lease.

IV. Discussion of Results

The results reported below are interpreted in light of criticisms that: (1) unrestricted leasing concentrates the distribution of project benefits in favor of large tenants; and (2) farm operators frustrate the intent of reclamation law by dispersing ownership to family members and employees, and then through "sweetheart deals", lease the land back at very favorable rates. A regression model, attempting to explain the variation in the percentages of full EUM rents paid by tenants, was estimated for selected levels of risk aversion to aid in interpretation.

The variables in the regression were aggregated at the landowner level--in other words, all leases held by a tenant with the same landowner were grouped together (no cases occurred where a tenant held both share and cash agreements with the same landowner). The rationale for this level of aggregation was the lack of independence of individual lease prices due to the tendency of landowners and tenants to agree on a standard lease price for multiple tracts of land.

The attributes of leases thought to affect the percentage of full EUM rents paid by tenants to landowners are: (1) whether the lease is a cash or share agreement; (2) the term of the lease; and (3) whether the lease is a family arrangement. The attributes of tenants are: (1) the number of landowners a tenant leases from; and (2) the total acreage operated (owned and leased).

The variable representing share leases in the regression is defined as: $SH = \begin{cases} 1 \text{ for share leases} \\ 0 \text{ for cash leases} \end{cases}$. Tenants gravitating toward share leases tend, on the average, to be more risk averse than tenants gravitating toward cash leases, i.e., $\phi^{CS} < \phi^{SH}$, where ϕ^{CS} and ϕ^{SH} are average risk aversion coefficients for cash and share tenants respectively. The regression model was estimated for six selected values of risk aversion with the same value of ϕ used to calculate the percentages of full payment in both cash and share leases. This was done for analytical convenience since it is not known a priori the amount by which $\phi^{SH} > \phi^{CS}$ on the average. Using the same value of ϕ to estimate tenants' EUM rents in both cash and share leases results in overestimating the rents generated in the latter. One thus expects to see a lesser percentage of expected share rents paid by tenants on average at each level of ϕ, if the theory presented here is correct. The anticipated value of the coefficient in the regression is therefore negative.

The terms of all leases held by tenants with the same landowner are averaged and included in the regression as AVTRM. The effect of AVTRM on the above probabilities can be justified a priori to be either positive or negative. The reason is that a longer lease can benefit both landowner and tenant. A landowner may, for example, prefer the current tenant because he is reliable and always pays on

time. A longer lease allows the landowner to keep his preferred tenant under contract for a longer period. The landowner may induce his preferred tenant to stay by allowing him to capture a portion of his expected rents. It follows that a longer term would lower the probabilities of the tenant paying 100% of his expected rents in cash and share leases.

Conversely, a tenant may be willing to pay a greater portion of his expected rents for the security of a longer lease. A longer lease makes it more possible for him to profit from taking good care of the land. He also would not have to undergo the search or transaction costs of finding or negotiating another lease. In this case a longer term would increase the probabilities.

The variable representing family leases: $FL = \begin{cases} 1 \text{ if family lease} \\ 0 \text{ if not} \end{cases}$, was included to gauge the extent of the previously mentioned "sweetheart deals". A positive estimated coefficient implies that tenants holding family leases do pay a lower percentage of their expected rents on the average.

The number of landowners (LL) a tenant leases from was included in the analysis as an attempt to incorporate some measure of competition into the model. A negative coefficient implies that the percentage of expected rents paid to the landowner decreases with the number of landowners he leases from. Such a finding would be consistent with (though not a proof of) the hypothesis that tenants renting from multiple landowners have monopsony power in the lease market.

Finally, the total land operated by tenants (TLO) was included to determine whether larger scale operators pay lower average percentages of their expected rents. A negative estimated coefficient would be consistent with finding that they do pay lower average percentages. The rents elicited from tenants, however, do not appear to be consistent with the existence of economies of scale (Huffaker, 1983). This leads one to expect that the coefficients of TLO will be insignificantly different than zero.

The regression model was most successful in explaining the variation in percentage rents paid for moderate levels of risk aversion (ϕ = 0.00 to 0.0025).

The largest fraction of variation explained was 0.31 for the model estimated with $\phi = 0.0025$. This is not an altogether unsuccessful fit for a model estimated with cross sectional data. The hypothesis that all coefficients are simultaneously insignificantly different than zero can be rejected at the 1% level of significance in all but one regression. The results were consistent regardless of the level of risk aversion, and are summarized as follows: (1) The constant was estimated to be positive and significantly different than zero; (2) the percentage of expected rents paid by tenants to landowners was found to vary inversely with the five abovementioned variables; and (3) the share lease dummy variable and the average term of leases were the only statistically significant variables. These results are now used to fortify the conclusions reached by reporting the calculated percentages of expected rents paid by the tenants to landowners.

The percentages of expected rents paid by tenants to landowners--calculated from the cash and share leases studied--do not support the hypothesis that unrestricted leasing in the sample reclamation area is concentrating economic rents in the hands of: (1) a few large tenants; and (2) tenants holding family leases. First, over 92% of the total cash rents anticipated by tenants, and 84% of the total share rents, are estimated to be paid to landowners, even when tenants are assumed to be risk neutral. These figures are therefore the low-bound estimates of the percentages of expected rents going to landowners in cash and share leases respectively. Given that farm operators are probably risk averse to some degree in reality, the percentage should even be greater. (Risk aversion imposes a cost on the tenant's expected rents, making them lower than they would be were the tenant risk neutral. The lower expected rents, combined with a fixed lease price, result in a larger percentage of the tenant's expected rents paid to the landowner.) This study examined the effects of risk aversion by calculating the percentages for different levels of the constant risk aversion coefficient, ϕ. The study of cash leasing shows that a relatively moderate level of risk aversion ($\phi = 0.0005$) causes the expected rents going to landowners to equal 99% of the total. In share

leasing, a slightly larger value of risk ($\phi = 0.0025$) results in landowners capturing 96% of total expected rents. These figures do not indicate that economic rents are being concentrated in the hands of tenants.

Secondly, the results do not lend credence to the claim that income is being concentrated in the hands of the larger tenants. The largest two groups of tenants studied were seen to pay 99% and 93% in cash leases, and 86% and 73% in share leases, of their total expected rents ($\phi = 0$). Furthermore, the coefficient associated with the farm size variable was found to be statistically insignificant.

Tenants holding family leases appear to pay a lower-than-average portion of their expected rents, with 85% going to landowners in family-cash leases and 74% in family-share leases ($\phi = 0$). The coefficient associated with FL was estimated to be insignificant under all selected levels of risk aversion. Thus, although the percentages of total expected rents paid to the landowners in family cash and share leases are lower than those paid on average, regression results show the difference to be statistically insignificant.

The study casts doubts on the effectiveness of a policy dictating acreage restrictions on leasing in promoting a more widespread distribution of economic rents than already exists in the reclamation area studied (Imperial Valley, California). It is safe to say that the apparently limited benefits, which this study would predict for a strict enforcement of the policy in this reclamation area (assuming the Imperial Valley were subject to acreage restrictions), would have a good chance of being outweighed by the damage which could be done. As stated in the introduction to this paper, leasing restrictions can possibly make landowners worse off by discouraging the creation of economic rents.

References

Adams, Richard M. A Quadratic Programming Approach to the Production of California Field and Vegetable Crops Emphasizing Land, Water, and Energy Use. Unpublished Ph.D. thesis: University of California, Davis, 1975.

Bureau of Reclamation. Draft Environmental Impact Statement, 4 Appendices. 1980.

Freund, R. J. "The Introduction of Risk into a Programming Model." Econometrica, 24:253-263. 1956.

Huffaker, R. G. The Distribution of Economic Rents When Irrigated Farmland Is Leased. Unpublished Ph.D. thesis: University of California, Davis, 1983.

Just, Richard E. Econometric Analysis of Production Decisions with Government Intervention: The Case of California Field Crops. California Agricultural Experiment Station, Giannini Foundation Monograph No. 33. University of California: Berkeley, 1975.

Lin, Dean, and C. Moore. "An Empirical Test of Utility vs. Profit Maximization in Agricultural Production." American Journal of Agricultural Economics, 56(3). 1974.

Moody's Industrial Manual, Vol. 1, A-I. Moody's Investor's Service, Inc., New York. 1982.

University of California Cooperative Extension. Budget Generator User's Manual. University of California: Davis, 1977.