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THE IMPLICIT VALUE OF CORN BASE ACREAGE*

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U. S. commodity programs provide policy makers with tools for controlling trade imbalance, price instability, and low levels of farm income. Corn base acreage, in particular, has proven to be an important part of the regulation of agriculture in the United States. Base acreage is defined as the average number of acres planted, and considered planted, in the program crop during the preceding five crop years (Harl).[1] For each base acre, the producer gains access to the expected commodity program payments for that acre in the current crop year as well as to program benefits in future years. The perceived value of this access is apparent from the rate of participation in the corn program, which was over 90 percent in 1987-88. In 1988 there were 83.4 million acres of land established and maintained in corn base acreage, a number that has remained relatively constant throughout the late 1980's (Mercier).

Modifications to U. S. commodity programs have been enacted in the Food, Agriculture, Conservation and Trade Act of 1990. Increased flexibility and "triple base" provisions have changed the nature of the corn program and will influence the value of established corn base (Westoff). These changes will impact farmers directly by altering their access to the commodity program and indirectly by changing the asset value of their current base acreage holdings. In order to more fully evaluate these and other program changes, information is needed on the asset value of base acreage. Even without commodity program changes, this information is required in order to assess the impact of the corn program (and the potential loss of base acreage) on farm level decisions in response to less direct policy changes. For example, the efficacy of environmental regulations designed to discourage continuous corn rotations will depend, in part, upon the value farmers place on corn base acreage.

This paper provides an estimate of the implicit value of corn base acreage for twelve Iowan counties by assuming that the benefits of access to the commodity program are capitalized into farmland rents (Floyd). Since base acreage determines access to corn price support programs, the added revenues, current and anticipated, are capitalized into the value of the land. A hedonic price approach is used to estimate the implicit value of base acreage. Hedonic indices, originally developed by Griliches and Rosen, have been used extensively to impute the value of land quality attributes (e.g., Gardner and Barrow, Miranowski and Hammes, and Palmquist and

Danielson) and nonmarket commodities such as air quality (Brookshire, *et al.* and Harrison and Rubinfeld) and water quality (d'Arge and Shogren).

The hedonic approach is an indirect valuation technique that can be used to estimate implied values of individual characteristics of a multi-attribute product. In our application, the product of interest is farmland. Let R_i denote rent charged for the i[th] property and $\underline{Z}_i$ the vector of the property's characteristics. The hedonic technique assumes the market is in equilibrium with rent determined by a function $R(\underline{Z}_i)$ of land characteristics.[2] The implicit price of the k[th] characteristic is then given by $P_{ik} \equiv \partial R/\partial Z_{ik}$. Whole farm rent is comprised of a bundle of characteristics, one of which is the fraction of tillable acreage established as corn base. By comparing rent schedules for tillable acreage over several farms, and controlling for differences in characteristics other than base acreage, a hedonic rent equation can be estimated. The rent equation reflects the marginal implicit price for base acreage in the rental market for farm land.

The remainder of the paper is divided into four sections. The first section describes the data base constructed to estimate the implicit value of base acreage. A hedonic rent equation is developed in the second section, including specification of functional form and of the structure of the model's error components. The third section presents parameters estimates and the implied price of corn base.

Data

The primary data base used to estimate corn base acreage value was gathered by Iowa State University's Cooperative Extension Service in their annual East Central Iowa Rent Survey. The survey is mailed in April to approximately 3500 farm operators and land owners in twelve counties and typically yields between 600 and 900 completed surveys.[3,4] Survey respondents are asked to provide information on the amount and type of land rented and the lease arrangements being used. For cash rented land, information is provided by farm unit, including data on whole farm rent per acre, total acreage rented, ASCS corn base, ASCS corn program payment yield per acre, and expected corn yield per acre. The number of farms per survey respondent ranges from one to eight. Total acreage rented is further divided by farm into one of four land categories: (1) tillable, (2) hayland,

(3) unimproved non-tillable pasture, and (4) other.[5] For the empirical analysis to follow, survey data for years 1988, 1989, and 1990 were used.

In addition to variables collected in the rent survey, one would expect the region's crop prices to impact farm rents. In this analysis, county average corn, oat, and soybean prices from the previous marketing year were used to capture price information available to farm operators and land owners at the time leases were negotiated. For example for the 1988 rental survey, 1986 corn prices were used, covering the marketing year from September 1986 through August 1987. County average prices were obtained from Iowa Agricultural Statistics (1989,1990).

Finally, urban influences may alter the level of farmland rents. Following the approach of Palmquist and Danielson, population density was used in this analysis to measure current urban pressure on farmland rents, while rate of population growth was used as a proxy for anticipated pressure from future urban development. County level density and population growth rates were obtained from Goudy and Burke.

Table 1 provides a list of variables constructed from the survey and price data sets. The mean and standard deviation of each variable are computed for the three survey years. All reported variables were relatively constant over the time period exception for crop prices, which increased substantially in the wake of the 1988 drought. The vast majority of rented land was tillable, with less than one percent of total acreage in hayland and less than four percent in pasture. Base acreage was established on slightly less than 70% of the tillable acres reported in the sample. Average population density declined from 96 to 82 individuals per square mile during the three years of study, with a population growth rate of approximately -5 percent per year.

Model Specification

The objective in estimating the hedonic rent equation is to measure implicit value of corn base acreage. Level of base acreage should directly influence the equilibrium rent schedule for tillable acreage but not the schedule of rents for the other three land types. Thus, the first step in specifying the rent equation is to allocate whole farm rent per acre (WHLRNT) to the four land types. Let R(Z) denote the equilibrium rent schedule for farmland given the vector of land characteristics Z. R(Z) is assumed to have the general additive structure given by:

$$(1) \qquad WHLRNT_{ij} = R(Z_{ij})$$

$$= R_{OTHER}(Z_{ij})POTHER_{ij} + R_{HAY}(Z_{ij})PHAY_{ij} + R_{PAST}(Z_{ij})PPAST_{ij}$$

$$+ R_{TILL}(Z_{ij})PTILL_{ij} + \varepsilon_{ij}$$

where subscript ij is used to denote the j^{th} farm of the i^{th} survey respondent, ε_{ij} denotes random error associated with the ij^{th} observation, and $R_k(Z)$ is the hedonic rent equation associated with land type k, k=OTHER, HAY, PAST, and TILL. Variables POTHER, PHAY, PPAST, and PTILL denote the fraction of total acreage in each of the land groups (See table 1).[6]

Tillable rents are assumed to depend upon the fraction of corn base acreage established (BASE), expected corn yield (AEXPYLD), ASCS program payment yield (AASCSYLD), population density (ADENSITY), population growth rate (APOPCHG), and county average prices for corn (ACORNP), oats (AOATS), and soybeans (ASOYB). The first three variables are specified to enter quadratically in the rent schedule function, while remaining variables enter linearly. Nonlinear terms in BASE allow the implicit price of base acreage, $\partial R_{TILL}/\partial BASE$, to depend upon the level of base. This structure may be appropriate if base level restricts the farm operator's flexibility in using desirable crop rotations while maintaining base acreage. The tillable rent equation becomes:

$$(2) \qquad R_{TILL}(Z) = \alpha_{TILL} + \beta_B BASE + \beta_E AEXPYLD + \beta_A AASCSYLD + \beta_{DENSITY} ADENSITY$$

$$+ \beta_{POPCHG} APOPCHG + \beta_{CORNP} ACORNP + \beta_{OATSP} AOATSP + \beta_{SOYBP} ASOYBP$$

$$+ \gamma_{BB}(BASE)^2 + \gamma_{BE}(BASE)(AEXPYLD) + \gamma_{BA}(BASE)(AASCSYLD)$$

$$+ \gamma_{EE}(AEXPYLD)^2 + \gamma_{AA}(AASCSYLD)^2$$

Since yield, price, and population terms are zero for the average sample farm, α_{TILL} measures the average rent for tillable acreage when no corn base is established (i.e., BASE = 0).[7] Parameters β_{CORNP}, β_{OATSP}, and β_{SOYBP} measure the impact of crop prices on equilibrium rent for tillable acreage. With higher prices for the land's potential outputs, rent is expected to be higher (i.e., $\beta_{CORNP} > 0$, $\beta_{OATSP} > 0$ and $\beta_{SOYBP} > 0$). Similarly, one would expect more productive land and land with a higher established program yield to command a higher rent (i.e., $\beta_E > 0$ and $\beta_A > 0$). Current and expected urban pressures should also result in higher farmland rents, with $\beta_{DENSITY} > 0$ and $\beta_{POPCHG} > 0$.

The hedonic rent equation in (2) can be used to derive an implicit corn base rent equation, $R_{BASE}(Z)$, with

$$(3)\quad R_{BASE}(Z) \equiv \partial R_{TILL}(Z)/\partial BASE$$

$$= \beta_B + 2\gamma_{BB}BASE + \gamma_{BE}AEXPYLD + \gamma_{BA}AASCSYLD$$

In general, one would expect β_B to be positive, indicating that base acreage increases the value of farmland (and rental rate) due to expected benefits from the commodity program. As the level of base acreage increases, however, marginal returns to the commodity program may diminish (i.e., $\gamma_{BB} < 0$) because base acreage level reduces the farm operator's flexibility to use rotations involving crops other than corn (e.g., soybeans, oats, and hay). Higher program yields should also drive up the implicit value of base acreage (i.e., $\gamma_{BA} > 0$), since these yields determine the level of program payments. The sign of γ_{BE} is expected to be positive, indicating that high yielding base acreage would be more valuable than its low yielding counterpart.

The remaining three land types are assumed to have simple hedonic rent schedules, with $R_k(Z) = \alpha_k$ measuring the average rent for land type k.[8] In general, one would expect tillable acreage to be more valuable than hayland, which in turn should be more valuable than non-tillable pasture (i.e., $\alpha_{TILL} > \alpha_{HAY} > \alpha_{PAST}$). The relative magnitude of α_{OTHER} will depend upon the quality of roads, buildings and other structures established on this land category.

Substituting rent equations for the four land types in equation (1) yields the following hedonic rent equation to be estimated:

$$
\begin{aligned}
(4)\qquad WHLRNT_{ij} = {} & \alpha_{OTHER}POTHER_{ij} + \alpha_{HAY}PHAY_{ij} + \alpha_{PAST}PPAST_{ij} \\
& + \{\alpha_{TILL} + \beta_{B}BASE + \beta_{E}AEXPYLD + \beta_{A}AASCSYLD + \beta_{DENSITY}ADENSITY \\
& + \beta_{POPCHG}APOPCHG + \beta_{CORNP}ACORNP + \beta_{OATSP}AOATSP + \beta_{SOYBP}ASOYBP \\
& + \gamma_{BB}(BASE)^2 + \gamma_{BE}(BASE)(AEXPYLD) + \gamma_{BA}(BASE)(AASCSYLD) \\
& + \gamma_{EE}(AEXPYLD)^2 + \gamma_{AA}(AASCSYLD)^2\}PTILL_{ij} + \varepsilon_{ij}
\end{aligned}
$$

Now that the form of the rent equation is established, the structure of error term ε_{ij} remains to be specified. An error components model was used to capture potential correlation across the multiple farm observations of a single survey respondent. That is, ε_{ij} is assumed to have the form:

$$(5)\qquad \varepsilon_{ij} = \eta_i + \tau_{ij}$$

where $\eta_i \sim \text{iid } N(0,\sigma^2_\eta)$, $\tau_{ij} \sim \text{iid } N(0,\sigma^2_\tau)$ and $cov(\eta_i,\tau_{ij}) = 0 \ \forall \ i,j$. The term τ_{ij} captures the farm-specific error component, whereas η_i represents errors common to all farms for the same survey respondent. The covariance structure of the model is given by:

$$(6)\qquad cov(\varepsilon_{ij},\varepsilon_{i'j'}) = \begin{cases} \sigma^2_\eta + \sigma^2_\tau & i=i' \text{ and } j=j' \\ \sigma^2_\eta & i=i' \text{ and } j\neq j' \\ 0 & i\neq i' \text{ and } \forall\ j,j' \end{cases}$$

The rent equation in (4) was estimated using the estimated generalized least squares (EGLS) procedure outlined in Judge *et al.* (pp. 331-336). For this application, the procedure was modified to reflect the fact that the number of farms varied by survey respondent.[9]

Results

Tables 2 and 3 present four versions of the hedonic rent equation.[10] Model 1 provides unconstrained estimates of the rent parameters estimated separately for each survey year. With the exception of β_{POPCHG}, coefficients generally have expected signs and most are statistically significant at the 10% significance level or better. Estimates of error component terms σ_η and σ_τ are provided at the bottom of table 2. The respondent-specific error term, η_i, accounts for approximately 40 percent of overall variance in the model.

As expected, pasture rents (i.e., α_{PAST}'s) are estimated to be the lowest among the four land groups, ranging from just under five dollars to over eighteen dollars in 1989. Hayland is more valuable, increasing from \$28 in 1988 to over \$70 in 1990. Tillable acreage, even without established corn base (i.e., BASE=0), commands the highest rent and remains just below \$100 per acre for all three years. The value of the "other" land category also remains relatively constant over the three survey years, with α_{OTHER} estimated to lie between \$51 and \$65 per acre.

Base acreage is found to significantly alter the equilibrium rent for tillable acreage, with β_B being positive and statistically different from zero at the 1% significance level. The value of established corn base appears to diminish as the fraction of base acreage increases (i.e., $\gamma_{BB} < 0$). However, these diminishing returns are not precisely measured, with γ_{BB} being statistically insignificant at the 10% level for all three survey years.

Land's yield potential, proxied by AEXPYLD, strongly influences the equilibrium rent that the farmland can command in the marketplace. In all three years, β_E is statistically different from zero at the 1% level. A one bushel per acre increase in expected corn yield increased equilibrium rent by between \$0.50 and \$0.61 per acre. ASCS program payment yields have a similar, though somewhat smaller, impact on farmland rents, increasing equilibrium rent by between \$0.23 and \$0.47 per acre. Second order terms involving base acreage, expected yield, and program payment yield are generally small and statistically insignificant. The one exception occurs in 1988, when γ_{EE} is negative and statistically significant, indicating a diminishing marginal impact of expected corn yields on farmland rents. Model 2 provides a constrained version of the basic model, with second order terms constrained to zero (i.e., $\gamma_{ij} = 0 \ \forall \ i,j$). While this specification implies a constant implicit value for corn base, the specification is not rejected as a restriction on Model 1 for either the 1989 or 1990 survey years.

While land quality attributes often appear nonlinearly in hedonic rent models, the linear form may be appropriate in this application since base acreage can be pooled across farm units. Combining two farms with 50% corn base each provides the same commodity program access as combining two farms where one has no established base and the other has 100% corn base. In 1988, the restriction is rejected at the 5% level but not at the 1% level. Even in this year, however, the restriction has little impact on the remaining parameters of the model.

Price effects, captured by β_{CORNP}, β_{OATSP}, and β_{SOYBP}, are not precisely measured in the estimated rent schedules. This is not surprising given the lack of price variability in the data base. County average prices for corn, oats, and soybeans are relatively constant throughout the region, differing by less than 7% across the twelve counties in the study. Only in 1988 are price parameters significant. Both corn and oat prices have the expected impact of increasing rental values. Soybean prices, however, have the perverse impact of reducing farmland rents. Model 3 constrains the price effect to zero (i.e., $\beta_{CORNP} = \beta_{OATSP} = \beta_{SOYBP} = 0$). As indicated by the F-statistics at the bottom of table 3, this restriction is not rejected at any reasonable significance level in 1989 and 1990. The price terms' significance leads to rejecting the hypothesis in 1988. Again there is little impact on remaining parameter estimates.

Finally, population density and growth rates in Models 1 through 3 are found to significantly alter farmland rental rates. As expected, $\beta_{DENSITY}$ is positive in all three years and significantly different from zero at the 5% level. Population growth rate, however, has an unexpected negative impact on farm rents and is generally statistically significant. One explanation for this result is that, unlike in Palmquist and Danielson, historical growth rates provide a poor proxy for expected future urban pressure on farmland rental rates. Instead, they may be correlated with other regional factors excluded from the model that negatively influence rental rates. In fact, the generally poor performance of price and population growth terms may be due to the county level nature of the data and omission of other regional factors. These factors can, however, be controlled for by using county dummy variables. Specifically, the formulation of $R_{TILL}(Z)$ in equation (2) can be replaced by the following:

$$R_{TILL}(Z) = \alpha_{TILL} + \beta_B BASE + \beta_E AEXPYLD + \beta_A AASCSYLD + \sum_{k=2}^{12} \delta_k AD_k \qquad (7)$$

where

$$(8) \qquad D_k = \begin{cases} 1 \text{ if the observation is in county k} \\ 0 \text{ otherwise} \end{cases}$$

and AD_k denotes the mean adjusted version of D_k.[11] Price and population parameters can no longer be separately identified, but estimates of the impact of base acreage, expected yields, and program payment yields can be obtained. Resulting parameter estimates are presented as Model 4 in table 3. The individual dummy variable parameters δ_k's capture a combination of county level effects. Although the dummy variables do indicate a statistically significant difference across counties, they are for the sake of brevity left unreported here.

The remaining parameters in Model 4 change little from their corresponding values in Models 1 through 3. The four land categories continue to have estimated values declining as we move from tillable acreage to unimproved and untillable pasture. Both expected yields and program yields increase land rental values. Base acreage continues to have a positive and statistically significant impact on rental rates and land values. The implicit price of base acreage, β_B, ranges from \$13.04 in 1989 to \$10.50 in 1990. That is, loss of base acreage status for an acre of tillable land reduces market rent for that acre by between \$11 and \$13.[12] It is interesting to note that Floyd argued nearly 25 years ago that price support programs would increase land values substantially, estimating the increase to be somewhere between 5 and 55 percent, depending upon the nature of the program restrictions. Our estimates fall in the lower end of this range, with land values increasing by roughly 11 to 14 percent.

With a real discount rate of r, the asset value of base acreage (V) can be computed as the discounted stream of returns, where $V \equiv \sum_{t=0}^{\infty} BASE(1+r)^{-t}$.[13] Using the parameter estimates from Model 4 and a real discount rate of 6 percent, the asset value of established corn base is given by \$222.07 in 1988, \$230.37 in 1989, and \$185.50 in 1990. Evaluating the reasonableness of these estimates is difficult given the lack of other studies in the area. Feinerman *et al.*, however, provide an alternative estimate of BASE and V. Using a quadratic risk programming model, the authors calculate BASE as the shadow value of a representative farm's base acreage constraint (i.e., the restriction on the number of acres that can be enrolled in the commodity program). Using a 6% discount rate and assuming a farm with 65% corn base, V is calculated to be approximately $600 per acre. While this estimate is considerably higher than the V computed using the hedonic approach, it is of the same order of magnitude. Further, the QRP estimate should be upwardly biased because this procedure constrains a farmer's choice of rotations and tillage practices and, hence, his or her flexibility in responding to loss of corn base. Finally, the QRP estimate assumes that farmers expect program payments to remain constant forever. To the extent farmers anticipate reductions in program payments over time, the implicit value of base acreage will be overstated in the QRP framework.[14]

Conclusions

There is considerable debate concerning the structure of the U.S. commodity program and, in particular, the role of base acreage. Changes in rules for calculating base acreage and base yields will affect farm operators directly by influencing their program returns in the current year and indirectly by altering the value of their land holdings and rental costs. The indirect effect arises because base acreage, as currently defined, provides a guaranteed access to the program in future years, thereby supplying a form of insurance. Loss of this access will reduce farmland values. Understanding the value of base acreage is also important in analyzing other farm and environmental programs, as it potentially reduces producers' flexibility.

This paper has provided an estimate of the implicit price of corn base established in the U. S. commodity program. Using data from an Iowa rental survey, the rent gradient for base acreage is estimated to be on the order of $11 to $13 per acre. The discounted stream of returns to base acreage suggests an asset value for established corn base of approximately $200 per acre. This estimate provides the appropriate measure of the value of base acreage if small changes to the program are considered. With large scale changes, however, the equilibrium rent equation may change and our estimate is likely to provide only an upper bound on the value of corn base.

References

d'Arge, R., and J. Shogren, "Okoboji Experiment: Comparing Non-Market Valuation Techniques in an Unusually Well-Defined Market for Water Quality," *Ecological Economics* 1(1989):251-259.

Feinerman, E., J. A. Herriges, and D. Holtkamp, "The Role of Crop Insurance in Reducing Pesticide Usage," presented at the annual meetings of the American Agricultural Economics Association, Vancouver, B.C., August, 1990.

Floyd, J. E., "The Effects of Farm Price Supports on the Returns to Land and Labor in Agriculture." *Journal of Political Economy*, 73(1965):148-158.

Freeman, A. M., III *The Benefits of Environmental Improvement: Theory and Practice*. Baltimore, MD: Johns Hopkins University Press, 1979.

Gardner, K., and R. Barrow. "The Impact of Soil Conservation Investment on Land Prices." *Amer. J. Agr. Econ.* 67(1985):943-47.

Goudy, W., and S. C. Burke. *Iowa Counties: Selected Population Trends, Vital Statistics, and Socioeconomic Date, 1990 Edition*. Census Services, Department of Sociology and Anthropology, Iowa State University, Iowa State University, October, 1990.

Griliches, Z., ed. *Price Indexes and Quality Change*. Cambridge, MA: Harvard University Press, 1971.

Harl, N., "A Summary of Provisions in the Food, Agriculture, Conservation and Trade Act of 1990, S.2830," mimeograph, Iowa State University, 1990.

Iowa Agricultural Statistics. *1989 Agricultural Statistics*. Des Moines, Iowa. July, 1989.

Iowa Agricultural Statistics. *1990 Agricultural Statistics*. Des Moines, Iowa. July, 1990.

Judge, G. G., W. E. Griffiths, R. C. Hill, and T. Lee. *The Theory and Practice of Econometrics*. New York: John Wiley and Sons, 1980.

Mercier, S., *Corn: Background for 1990 Farm Bill Legislation*, U. S. Department of Agriculture, Economic Research Services, 1990

Miranowski, J. A., and B. D. Hammes. "Implicit Prices of Soil Characteristics for Farmland in Iowa." *Amer. J. Agr. Econ.* 66(1984):745-49.

Palmquist, R. B. "Land as a Differentiated Factor of Production: A Hedonic Model and Its Implications for Welfare Measurement." *Land Economics* 65(1989):23-28.

Palmquist, R. B., and L. E. Danielson. "A Hedonic Study of the Effects of Erosion Control and Drainage on Farmland Values." *Amer. J. Agr. Econ.* 71(1989):55-62.

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *J. Polit. Econ.* 82(1974):34-55.

Westoff, P., "The 1990 U. S. Farm Bill: A Preliminary Assessment," FAPRI Staff Report #9-90, Iowa State University, November, 1990.

Footnotes

1. This definition applies to base acreage established for feed grains and wheat. A three year average is used for cotton and rice with a number of exceptions.

2. A number of additional conditions are required in order to properly apply hedonic pricing techniques, including the presence of a large number of products with varying characteristics. Freeman and Palmquist provide a more extensive discussion of the hedonic approach and its limitations.

3. The twelve counties include: Benton, Cedar, Clinton, Iowa, Jackson, Johnson, Jones, Linn, Muscaline, Poweshiek, Scott, and Tama.

4. Individuals were selected for the survey by local county agents. Explicit instructions on the selection process were not given to agents and, as a result, the sample need not be random. However, discussions with county agents did not reveal any obvious biases in the selection process. In a number of cases, the survey was simply mailed to every fourth or fifth name in the county's plat book directory. The low response rate to the survey results in part from the fact that the survey was administered to farm operators or land owners that do not necessarily rent land.

5. Hayland consists of acreage in hay production but unsuited for row crops. The "other" land category includes land tied up in buildings, roads, waterways, etc.

6. The form of the hedonic rent equation in (1) implicitly assumes that the production process is separable with respect to outputs of the four land types.

7. The yield, population, and price terms are mean-adjusted to simplify the interpretation of intercept terms. Thus, for the average farm the tillable rent equation becomes $R_{TILL} = \alpha_{TILL} + \beta_B BASE + \gamma_{BB} BASE^2$.

8. A more general specification would allow the rent schedules for these land types, and for particularly hayland and pasture, to depend upon land characteristics similar to those used in defining $R_{TILL}(Z_{ij})$. However, because the other three land categories are not suited to row crops, they are not likely to be influenced by commodity program variables, including base acreage and program payment yields, nor by row crop prices. A hedonic rent equation model was estimated allowing R_{PAST} and R_{HAY} to have specifications analogous to R_{TILL}. The joint

hypothesis that $R_{PAST} = \alpha_{PAST}$ *and* $R_{HAY} = \alpha_{HAY}$ could not be rejected at any significance level below 40% in any of the three survey years.

9. Specifically, the transformation matrix becomes $P = diag[P_1,...,P_N]$, where N denotes the number of survey respondents, $P_i \equiv I_i - (1 - \sigma_\tau/\sigma_i)J_i/n_i$ is the $n_i \times n_i$ transformation matrix for respondent i, n_i is the number of farms for respondent i, I_i is an $n_i \times n_i$ identity matrix, J_i is an $n_i \times n_i$ matrix of ones, and $\sigma_i^2 \equiv n_i\sigma_\eta^2 + \sigma_\tau^2$.

10. The adjusted R^2's associated with the models in table 2 and 3 range from .61 to .75. However, as noted by Judge *et.al.* (p. 254), R^2's can be misleading in the context of a nonscalar covariance matrix, with a theoretical range from $-\infty$ to 1. As a result, they should be viewed with some caution.

11. See footnote * of table 1.

12. As noted by one reviewer, deficiency payments were substantially lower in 1989 and 1990 compared to those in 1988. While the value of base is lowest in 1990, it peaks in 1989 and the differences between base values in 1988 and 1989 are small (less than 50¢ in both Models 3 and 4). One explanation for this pattern is that, despite the drop in deficiency payments in 1989, the perceived "insurance" benefits of the commodity program continued to insure a high implicit value for corn base in the wake of the drought. Alternatively, the rental market may have been slow to adjust, with the reduced value to base acreage showing up only after a lag. However, given the size of the standard errors associated with β_B, it is difficult to attach significant weight to the pattern of base acreage values over time.

13. This valuation procedure assumes, of course, no unanticipated changes in market conditions or program parameters.

14. We would like to thank Stan Johnson for pointing out this latter argument for the discrepancy between the QRP estimate and the estimate obtained using the hedonic approach.

Table 1
Variable Definitions and Summary Statistics

Variable	Definition	Mean (Standard Deviation) 1988	1989	1990
WHLRNT	Whole farm rent per acre	89.97 (21.05)	93.35 (21.37)	92.95 (22.79)
EXPYLD	5 year average expected corn yield per acre	134.9 (14.1)	134.6 (14.8)	133.5 (15.1)
ASCSYLD	ASCS corn program payment yield per acre	123.4 (10.1)	124.9 (9.8)	123.8 (9.7)
BASE	Corn base as a fraction of tillable acreage	.685 (.197)	.691 (.207)	.669 (.197)
CORNP	County average price for corn	2.12 (.04)	1.96 (.03)	2.54 (.05)
OATSP	County average price for oats	1.31 (.03)	1.73 (.04)	2.87 (.04)
SOYBP	County average price for soybeans	5.09 (.04)	5.99 (.02)	7.39 (.03)
DENSITY	County population density (individuals/square mile)	95.8 (96.4)	86.8 (86.9)	81.7 (86.3)
POPCHG	Percentage change in county population between 1980 and 1990.	-4.88 (6.80)	-4.66 (7.29)	-5.09 (6.71)
PTILL	Tillable acreage as a fraction of total acreage rented	.912 (.143)	.936 (.125)	.923 (.137)
PHAY	Hayland acreage as a fraction of total acreage rented	.009 (.046)	.006 (.036)	.008 (.037)
PPAST	Unimproved non-tillable acreage as a fraction of total acreage rented	.028 (.091)	.027 (.092)	.039 (.124)
POTHER	1 - PTILL - PHAY - PPAST	.051 (.099)	.031 (.076)	.030 (.059)
AEXPYLD	Mean adjusted expected yield*	0.0 (14.1)	0.0 (14.8)	0.0 (15.1)
AASCSYLD	Mean adjusted program payment yield	0.0 (10.1)	0.0 (9.8)	0.0 (9.7)
ACORNP	Mean adjusted corn price	.00 (.04)	.00 (.03)	.00 (.05)

*A mean adjusted variable is defined as the value of X minus the mean value of X in the sample. For example, AEXPYLD equals EXPYLD minus the mean value of EXPYLD in the sample.

Table 1
Variable Definitions and Summary Statistics

Variable	Definition	Mean (Standard Deviation) 1988	1989	1990
AOATSP	Mean adjusted oats price	.00 (.03)	.00 (.04)	.00 (.04)
ASOYBP	Mean adjusted soybean price	.00 (.04)	.00 (.02)	.00 (.03)
ADENSITY	Mean adjusted county density	.00 (96.4)	.00 (86.9)	.00 (86.3)
APOPCHG	Mean adjusted county growth	.00 (6.80)	.00 (7.29)	.00 (6.71)

Table 2
Estimated Coefficients, Models 1 and 2
(Standard Errors in Parentheses)

	Model 1			Model 2		
Variable	1988	1989	1990	1988	1989	1990
α_{OTHER}	60.76**	65.46**	51.05**	59.61**	65.47**	50.67**
	(5.65)	(8.44)	(10.26)	(5.67)	(8.40)	(10.22)
α_{HAY}	27.62†	35.65*	70.97**	29.05*	35.71**	70.72**
	(14.24)	(15.67)	(16.66)	(14.26)	(15.55)	(16.62)
α_{PAST}	4.87	18.26**	11.66*	1.98	18.14**	11.39*
	(6.82)	(5.93)	(4.69)	(6.77)	(5.90)	(4.67)
α_{TILL}	95.64**	98.03**	98.76**	94.75**	97.54**	97.85**
	(1.21)	(1.02)	(1.02)	(.81)	(.71)	(.74)
β_B	12.81**	14.69**	12.65**	12.67**	14.62**	11.54**
	(3.78)	(3.06)	(3.31)	(3.62)	(2.97)	(3.12)
β_E	.52**	.61**	.50**	.49**	.61**	.50**
	(.06)	(.06)	(.05)	(.06)	(.06)	(.05)
β_A	.23*	.34**	.47**	.24**	.34**	.48**
	(.09)	(.09)	(.08)	(.09)	(.08)	(.08)
$\beta_{DENSITY}$	.021*	.024*	.040**	.019*	.022*	.039**
	(.009)	(.010)	(.010)	(.009)	(.009)	(.010)
β_{POPCHG}	-.39**	-.18†	-.38**	-.43**	-.18	-.39**
	(.12)	(.11)	(.11)	(.12)	(.10)	(.11)
β_{CORNP}	61.08**	-8.39	-20.63	53.78*	-6.36	-21.81
	(22.94)	(25.82)	(18.67)	(22.95)	(25.60)	(18.61)
β_{OATSP}	291.04*	-62.66	15.94	355.04**	65.52	22.19
	(118.59)	(59.61)	(86.18)	(116.38)	(56.83)	(85.15)
β_{SOYBP}	-97.65**	-160.98	57.07	-121.41	-156.53	30.83
	(23.59)	(127.98)	(126.73)	(85.58)	(124.98)	(125.27)
γ_{BB}	-3.33	-2.57	-16.03			
	(19.93)	(14.97)	(15.06)			
γ_{BE}	-.43	.12	-.14			
	(.30)	(.26)	(.24)			
γ_{BA}	-.72	-.09	.01			
	(.46)	(.41)	(.39)			
γ_{EE}	-.007**	-.001	-.000			
	(.003)	(.002)	(.002)			
γ_{AA}	.003	-.001	-.003			
	(.005)	(.004)	(.004)			
N	595	662	718	595	662	718
F-stat	---	---	---	2.76*	.20	.40
σ_η	9.97	8.89	9.46			
σ_τ	11.64	12.17	11.78			

† Statistically significant at the 10% level
* Statistically significant at the 5% level
** Statistically significant at the 1% level

Table 3
Estimated Coefficients, Models 3 and 4
(Standard Errors in Parentheses)

	Model 3			Model 4		
Variable	1988	1989	1990	1988	1989	1990
α_{OTHER}	57.93**	64.91**	51.93**	59.92**	63.92**	49.72**
	(5.72)	(8.44)	(10.15)	(5.63)	(8.43)	(10.23)
α_{HAY}	27.97†	36.43*	71.53**	24.34†	41.34**	72.83**
	(14.39)	(15.53)	(16.58)	(14.35)	(15.69)	(16.67)
α_{PAST}	3.58	18.52**	10.96*	1.10	18.82**	12.38**
	(6.80)	(5.90)	(4.65)	(7.09)	(5.97)	(4.61)
α_{TILL}	94.67**	97.33**	97.87**	94.89**	97.33**	97.93**
	(.80)	(.70)	(.72)	(.80)	(.71)	(.72)
β_B	14.46**	14.47**	10.93**	12.57**	13.04**	10.50**
	(3.58)	(2.90)	(3.04)	(3.70)	(2.98)	(3.17)
β_E	.46**	.62**	.51**	.51**	.61**	.52**
	(.06)	(.06)	(.05)	(.06)	(.06)	(.05)
β_A	.31*	.35**	.48**	.16	.27**	.41**
	(.09)	(.08)	(.08)	(.10)	(.09)	(.08)
$\beta_{DENSITY}$	.020*	.017*	.032**			
	(.008)	(.008)	(.008)			
β_{POPCHG}	-.40**	-.15	-.34**			
	(.12)	(.10)	(.11)			
N	595	662	718	595	662	718
F-stat	3.64**	.55	.48	---	---	---

† Statistically significant at the 10% level
* Statistically significant at the 5% level
** Statistically significant at the 1% level