How Cost-Effective Are Land Retirement Auctions? Estimating the Difference between Payments and Willingness to Accept in the Conservation Reserve Program

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The Conservation Reserve Program (CRP), established by the Food Security Act of 1985, offers annual rental payments to farm operators who voluntarily retire environmentally sensitive cropland under ten- to fifteen-year contracts. The CRP is notable for the size of both its budget and its environmental benefits. The CRP currently pays about $1.7 billion per year to retire about 34 million acres (equal to about 8% of U.S. cropland, or the size of Iowa). For comparison, Congressional appropriations for toxic waste cleanups under the Superfund program, one of the nation's highest profile environmental initiatives, totaled $1.3 billion in 2003. To date, the CRP has disbursed over $26 billion in direct payments. Researchers have estimated that the environmental benefits exceed the program's costs (Feather, Hellerstein, and Hansen; Ribaudo et al.).

This paper measures the cost-effectiveness of the CRP's bidding mechanism. Currently, landowners submit bids that are ranked according to a score that comprised both an environmental benefits index (EBI), which includes erodibility and other environmental factors, as well as the landowner's proposed rental rate, subject to soil-specific maximums.[1] Bids with the highest scores are accepted into the program after each sign-up period. Landowners with especially high EBI scores and especially low opportunity costs for their land can potentially submit rent bids above their reservation rents and still have their lands accepted into the program, resulting in windfall gains to these landowners. Our objective is to estimate the size of these premiums from bidding behavior observed in data on all administrative bids from regular CRP sign-ups since 1997.

We estimate the relationship between farmers' proposed rents net of costs and their bid score, which is endogenous: farmers can increase the environmental component of their score via their proposed conservation practice and the cost component of their score via their bid rent. To deal with this issue, we use exogenous components of the EBI—those that cannot be influenced by farmers' proposed rent or practices—as instruments for the total score.

In earlier research on CRP bidding behavior, Shoemaker examined rental premiums obtained by farmers in the first two years of the CRP, before the current EBI-based mechanism was established; and Cason and Gangadharan used experimental auctions akin to CRP auctions to examine bidding behavior. These studies all suggest that landowners adjust their bid rents upward with increasing likelihood of acceptance into the program.

The CRP Bidding Mechanism

Initially focused on reducing soil erosion, CRP's environmental objectives were broadened with the introduction of the EBI in 1990. In an effort to reduce costs, soil-specific maximum rental rates also replaced earlier rate caps set at state and substate levels. Starting with sign-up 15 in 1997, the EBI was revised

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The authors thank Ken Baerenklau, Alex Barbarika, Daniel Hellerstein, Patrick Sullivan, and Utpal Vasavada for helpful comments. All errors are the authors' responsibility. Views expressed are the authors' alone and do not necessarily correspond to those of the U.S. Department of Agriculture.

This article was presented in a principal paper session at the AAEA annual meeting (Providence, Rhode Island, July 2005). The articles in these sessions are not subjected to the journal's standard refereeing process.

[1] In the literature from the Farm Service Agency (FSA), the total contract "score" is called the EBI and the environmental components are termed the environmental EBI. Here, we use EBI to refer to just the environmental components and "score" to refer to the overall total. In this way, we seek a more intuitive usage of the term "environmental benefits index."

Amer. J. Agr. Econ. 87 (Number 5, 2005): 1239–1247

to include wildlife habitat and air quality benefits in addition to water quality and soil erosion. Since then, CRP offers have been scored as follows.

Landowners offer a parcel of land with a set of proposed conservation practices for enrollment in CRP. The offer receives an environmental score equal to the sum of six factors, $N1$ through $N6$ (collapsed to five factors beginning with sign-up 26 in 2003). The six factors contain points delineated as follows: $N1$ for grass covers, tree planting, location, and wetland restoration practices that create wildlife benefits; $N2$ for water quality benefits from reduced erosion, runoff, and leaching; $N3$ for on-farm benefits from reduced erosion; $N4$ for benefits that will likely endure beyond the contract period; $N5$ for air quality benefits from reduced wind erosion; and $N6$ for state or national conservation priority areas.[2] Landowners can influence the number of environmental points they receive mainly via factors $N1$ and $N4$, depending on the type of grass or tree covers and wetland restoration practices (if applicable) they choose to offer for their enrolling land.

Points from the environmental factors are added to a cost factor to obtain the total score. The cost factor penalizes higher proposed rents and offers that propose sharing the conservation practice costs with the government. Specifically,

(1)
$$\text{Cost factor} = w(1 - r/(HIGH)) + 10(1 - s) + \text{Min}(15, r^m - r)$$

where r is the proposed rent, r^m is the parcel's soil-based maximum rent (r must be less than or equal to r^m), $HIGH$ is the highest allowed soil-specific rent for all contracts received, and s is the farmer's decision to share costs ($s = 1$ if share, $s = 0$ if not). If farmers elect to share costs, the government typically pays half the cost of establishing the proposed conservation practice; if they forgo cost-sharing, they receive an extra ten points on their bid score. The last term confers additional points for offering rent r below the maximum allowable rent r^m. This component was introduced starting with sign-up 16 and adds one point for each dollar offered below the maximum rent up to a limit of 15 points. The value of w is set at the government's discretion. It was 175 for sign-up 15 and 125 for subsequent sign-ups.

In this paper, the endogenous component of EBI refers to the sum of factors $N1$ and $N4$, and the exogenous component of EBI refers to the sum of the other environmental factors.[3] The total EBI score is the sum of these two components.

Summary Statistics

Our data are from the FSA's CRP bid files. We focus on five CRP general sign-ups (15, 16, 18, 20, and 26) conducted between 1997 and 2003.[4] Sign-up 15 is the largest in terms of both the number of bids submitted (251,959) and the number accepted (160,624). Sign-up 20 had the least number of bids submitted (56,093) and sign-up 26 had the least number accepted (38,621). In table 1, we report some summary statistics from these data, cross-tabulated by quartiles of the exogenous component of the EBI and quartiles of the soil-based maximum payment (r^m). For each subgroup, the table reports the average offered rent, the average discount below the maximum rent, the proportion offering a discount below the maximum, and the average endogenous EBI. We also report the proportion of offers accepted in the program according to each exogenous EBI component quartile.

Several patterns emerge from this presentation of the data. Most notably, farmers appear to offer higher rental rates if they have a high exogenous EBI score conditional on their maximum payment quartile. This pattern is somewhat visible in the mean rent offered, which generally increases across exogenous EBI quartiles within a maximum payment quartile. The behavior is most clearly visible in the mean discount offered. Since a farmer can increase his total EBI score

[2] Starting with sign-up 26 in 2003, the points for conservation priority areas were eliminated as a separate factor and incorporated in the wildlife and water quality factors. The cost factor (described in the next paragraph) became N6.

[3] Subfactor N5d for carbon sequestration, introduced in sign-up 26, depends on the choice of cover practice and is treated as an endogenous part of the EBI in our analysis of this sign-up. Other N5 components are considered to be exogenous.

[4] Data from the latest general sign-up 29 held in 2004, were not available at the time of this study. "General" sign-ups account for the bulk of CRP enrollment and are subject to the competitive bidding process discussed above. FSA conducts smaller "continuous" sign-ups on a rolling basis that offer fixed rental payments for enrolling specific high priority environmental practices.

Table 1. Summary Statistics by Exogenous Component of the Environmental Benefits Index and Maximum Payment Quartiles

Variable	Proportion of Bids Accepted	Mean Rent Offered				Mean Discount Offered				Proportion Offering Discount >0				Conservation Practice Points[a]			
Max. Payment Quartile:	All	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Sign-up 15 ($N = 251,959$)																	
0 <= Exog. EBI <= 69	0.41	29.1	37.9	52.3	93.4	0.8	2.0	3.4	8.4	0.46	0.62	0.69	0.79	43.1	40.7	47.0	44.6
69 < Exog. EBI <= 92	0.64	29.5	38.0	53.9	87.5	0.8	1.7	2.8	7.0	0.46	0.59	0.66	0.78	48.0	47.9	46.9	45.1
92 < Exog. EBI <= 125	0.81	28.9	37.9	56.0	85.1	0.7	1.8	2.4	6.2	0.43	0.58	0.62	0.79	51.3	45.1	39.2	42.4
125 < Exog. EBI	0.96	28.7	38.3	58.1	83.6	0.8	1.6	1.8	4.8	0.44	0.52	0.55	0.73	39.2	31.5	33.1	38.3
Sign-up 16 ($N = 126,232$)																	
0 <= Exog. EBI <= 77	0.18	29.8	39.2	53.4	87.3	1.2	2.8	6.4	19.0	0.35	0.54	0.74	0.92	52.3	62.5	68.8	73.0
77 < Exog. EBI <= 98	0.41	30.2	39.6	55.8	82.9	1.0	2.4	5.9	15.0	0.34	0.53	0.73	0.91	52.3	64.3	69.9	74.2
98 < Exog. EBI <= 123	0.67	30.3	39.4	57.7	83.2	0.7	2.4	5.2	13.9	0.30	0.57	0.72	0.91	53.1	67.0	64.1	74.0
123 < Exog. EBI	0.93	30.0	40.7	61.8	87.1	0.5	1.4	3.1	10.4	0.27	0.42	0.58	0.85	47.3	51.6	51.1	66.6
Sign-up 18 ($N = 90,306$)																	
0 <= Exog. EBI <= 64	0.38	30.5	39.4	51.9	85.2	0.9	1.9	4.7	14.0	0.31	0.43	0.64	0.85	73.4	87.2	91.2	88.5
64 < Exog. EBI <= 88	0.63	30.1	40.0	54.5	86.6	0.7	1.5	3.5	11.7	0.25	0.38	0.58	0.83	72.5	88.5	89.6	86.9
88< Exog. EBI <= 115	0.79	30.6	40.3	56.9	88.2	0.5	1.1	2.8	10.7	0.21	0.33	0.52	0.81	70.5	85.7	81.3	82.8
115 < Exog. EBI	0.94	30.4	40.3	61.3	92.0	0.4	0.8	1.8	5.6	0.20	0.30	0.44	0.66	61.7	68.8	61.6	73.5
Sign-up 20 ($N = 56,093$)																	
0 <= Exog. EBI <= 66	0.22	32.0	46.1	63.6	91.8	1.1	3.0	6.6	15.2	0.30	0.51	0.69	0.85	79.2	97.1	93.0	93.1
66 < Exog. EBI <= 93	0.53	32.8	47.5	67.4	94.3	0.6	1.9	4.6	13.4	0.23	0.41	0.61	0.83	79.4	94.3	88.5	90.9
93 < Exog. EBI <= 125	0.72	33.5	48.1	67.9	97.1	0.5	1.4	3.9	10.8	0.20	0.37	0.57	0.81	75.9	86.0	80.1	87.9
125 < Exog. EBI	0.92	32.6	50.4	70.0	99.7	0.4	1.2	2.0	4.9	0.19	0.33	0.43	0.62	68.5	66.3	68.6	77.8
Sign-up 26 ($N = 71,077$)																	
0 <= Exog. EBI <=82	0.30	34.9	48.6	69.1	102.0	0.5	2.1	5.4	10.7	0.17	0.34	0.53	0.71	75.8	86.6	81.1	83.7
82 < Exog. EBI <= 109	0.60	35.6	50.2	70.1	97.9	0.4	1.9	5.6	9.9	0.13	0.32	0.58	0.74	77.3	78.5	76.2	78.7
109 < Exog. EBI <=149	0.76	34.7	51.3	71.8	100.1	0.5	1.6	3.9	7.1	0.13	0.32	0.49	0.62	69.5	73.8	65.9	70.4
149 < Exog. EBI	0.91	34.4	54.9	72.4	100.9	0.4	1.3	2.5	3.7	0.13	0.27	0.38	0.43	69.1	58.1	58.5	66.6

Note: The maximum payment is the maximum soil-specific rent plus the maintenance allowance. Quartiles 1 through 4 denote 25th, 50th, 75th, and 100th percentiles of the observations, respectively. For sign-ups 15, 16, 18, and 20, the "exogenous" EBI is the sum of factors for water quality ($N2$), erosion ($N3$), air quality ($N5$), and conservation priority area ($N6$). In sign-up 26, $N6$ was redefined as the cost factor so this is excluded from the exogenous EBI along with the new subfactor 5d (carbon sequestration) which depends on the cover choice.

[a]Conservation practice points are the sum of EBI points for wildlife ($N1$) and long-term/enduring benefits ($N4$), with subfactor 5d (carbon sequestration) included in sign-up 26.

Source: Farm Service Agency (FSA) CRP bid file.

by offering to accept a rental rate below the soil-specific maximum, we uniformly observe farmers with lower exogenous EBI scores offering a larger discount even after conditioning on the maximum payment quartile. For instance, in sign-up 16 among farmers in the lowest quartile of maximum payments, farmers in the lowest exogenous EBI quartile offer a discount more than twice as large as those in the highest exogenous EBI quartile (1.2 versus 0.5). This pattern holds across all maximum payment quartiles in sign-up 16 and across virtually all sign-ups. Discounts were lowest in sign-up 15 and greatest in sign-up 16. This may reflect initial uncertainty about the new program structure in sign-up 15 and the influence of additional points, introduced in sign-up 16, for bids below the maximum allowable rent.

Although land owners may increase their total EBI score by offering a discount, that is, bidding below the maximum, a large share of bids do not offer discounts, especially in the lower payment categories. The proportion offering nonzero discounts tends to increase as the maximum rent increases and tends to decrease for higher exogenous EBI scores. For example, in sign-up 26, the proportion of nonzero discounts declines within the first maximum rent quartile from 30% to 19% and declines from 85% to 62% in the highest maximum rent quartile, suggesting that the likelihood of asking for the maximum rental rate increases as the exogenous EBI increases.

Another way for farmers to increase their total EBI is by adopting more valuable conservation practices, such as plantings of native grasses. The set of columns in table 1 labeled conservation practice points demonstrate the tendency to adopt a more valuable conservation practice at lower exogenous EBI scores. In other words, less (more) environmentally sensitive land, as measured by the exogenous EBI, receives more (less) beneficial conservation practices. Conservation practice points tend to increase with the maximum payment quartiles, but the pattern is not universal. In general, the summary statistics would seem to indicate the landowners decrease the endogenous components of their bid as their exogenously determined EBI increases. This pattern is consistent with the hypothesis that landowners with higher exogenous EBI scores are able to command greater windfall gains from the program.

A Model of Bidding Behavior

Although reservation rents are not directly observed, they are implicit in farmers' proposed rents and conservation practices. Under the program's incentive structure, the exogenous components of the EBI encourage farmers to propose higher rents and less costly covers and wildlife practices, all else remaining the same. In this section, we spell out these incentives using a simple model.

Define F as the distribution function of farmers' subjective beliefs about E^*, the critical bid score. All scores above E^* are accepted into the program and all scores below E^* are rejected, but farmers do not know E^* when they submit their bids. The Secretary of Agriculture makes this decision after all bids have been submitted.[5] Farmers choose their proposed rent, r, conservation practice with annualized establishment cost, c, and whether or not they propose to share costs with the government, s.[6] Higher proposed rents negatively influence the total EBI. The environmental component of the EBI is a function of exogenous factors and of the conservation practices chosen with associated costs c.

Assume farmers choose r, c, and s in order to maximize the expected net benefit from their proposed contract given their reservation rent $\bar{r}$ and the maximum rental payment r^m. Once a bid is accepted, the farmer's yearly net benefit is the rent minus their reservation rent (the opportunity cost of their land) and the annualized value of establishing the proposed conservation practice, $(r - \bar{r} - ac)$, for the duration of the contract. We call this net benefit the farmer's premium, *PREM*. The parameter a equals 1 if $s = 0$ and a equals 1/2 if $s = 1$. Thus, the farmer's objective is:

$$\max V(r, c, s) = PREM \times F + \bar{r} \quad \text{subject to : } (r^m - r) \geq 0 \tag{2}$$

[5] The weight w in $N7$ is also uncertain in the eyes of landowners. We do not explicitly examine this source of uncertainty, though it should affect marginal incentives to bid in a similar way as uncertainty about E^*. Although this weight can be changed at the government's discretion, this value has been the same in sign-ups 16, 18, 20, and 26 so we expect variation in beliefs about this weight to be small. While the weight is not explicitly reported, it could be approximated from publicly available statistics on each sign-up.

[6] Practices may also involve annual maintenance costs, which are not subject to the cost-sharing option. Instead, the government typically pays a fixed maintenance allowance of $5 per acre. As long as the difference between the actual maintenance costs and this allowance is small, this will not significantly influence the farmer's decisions.

where $F = \text{Prob}[E^* < SCORE]$, and $SCORE = g(c) + z - \phi r + 10s$, the total EBI score. The function $g(c)$ gives the endogenous component of the EBI as a function of cost, c; z is the exogenous EBI component, and the parameter ϕ scales the marginal reduction in *SCORE* from a \$1 increase in the proposed rental rate.

If $r < r^m$ (the maximum rent constraint does not bind), the first-order conditions are:

$$(3) \qquad -\phi(r - \bar{r} - ac)F' + F = 0$$

$$(4) \qquad \frac{\partial_g}{\partial_c}(r - \bar{r} - ac)F' - aF = 0.$$

These conditions imply that the marginal expected benefit from an increase in the probability of acceptance equals the expected marginal cost from the decreased premium. If we define $G = F/F'$, an increasing function of *SCORE*, these conditions can be written as:

$$(5) \qquad -\phi(r - \bar{r} - ac) + G = 0$$

$$(6) \qquad \frac{\partial_g}{\partial_c}(r - \bar{r} - ac) - aG = 0.$$

Thus, $PREM = G/\phi = aG/\frac{\partial g}{\partial c}$, where G is the distribution function divided by the density function of farmers' beliefs regarding the critical EBI score. This implies farmers will balance their offered bids and costs until $\phi = \frac{\partial g}{\partial c}/a$, such that the marginal costs of raising the total EBI score by lowering the bid equal the marginal costs of doing so by increasing costs. The discrete cost-share decision (s) cannot be analyzed from these marginal conditions, but does influence the marginal trade-offs via a.

Both conditions imply *PREM* is an increasing function of *SCORE*, unless the constraint $(r^m - r) \geq 0$ binds, in which case $PREM < G/\phi = aG/\frac{\partial g}{\partial c}$. This is consistent with the intuition given in the introduction. Farmers with higher total EBI scores, all else the same, will have higher rental premiums, unless these are constrained by the maximum allowable rent.

Empirical Model

Because we do not observe *PREM*, we rewrite the first-order condition (5) in terms of rent net of costs:

$$(7) \qquad r - ac = \frac{G}{\phi} + \bar{r}.$$

Reservation rents are not observable and are embodied by the intercept, controls, and residual in our regressions. The intercept reflects the average reservation rent and the control variables plus the residual embody the difference between this average reservation rent and that of the current observation. Since $\bar{r}$ affects farmers' choice of the total EBI score, *SCORE* is endogenous. Dealing with the endogeneity of the total EBI score is our main econometric challenge.

By using the exogenous component of the EBI as an instrument for the total EBI score, we solve the problem that *SCORE* is a choice variable. However, a different form of endogeneity arises if $\bar{r}$ is correlated with the exogenous EBI, not because one variable affects the other, but because heterogeneous land attributes affect both land values and the exogenous components of the EBI. In order to reduce the unobserved heterogeneity of land, we include the soil-specific rental rate, measures of on-farm wind and soil erosion, and fixed effects for state.

Another issue concerns the functional form of G. In general, G has a positive slope. For most parametric distributions, G will be a nonlinear function of *SCORE*. Of course, we have no information about the shape of landowners' prior beliefs about E^*. Rather than explicitly modeling this unknown distribution of beliefs, we estimate (7) using a simple linear model:

$$(8) \qquad (r_i - ac_i) = \beta_0 + \beta_1 \hat{SCORE}_i + \text{controls}_i + u_i.$$

In this formulation, $G/\phi = \beta_1 \hat{SCORE}_i$, where $\hat{SCORE}_i$ is the predicted *SCORE* from the first stage. The estimated parameter β_1 gives the average slope of G/ϕ regardless of the function's shape or whether landowners have heterogeneous beliefs about E^*.[7] Simplicity is also necessary because we must estimate a censored regression model (with instrumental variables [IV]) to account for the constraint, $(r^m - r) \geq 0$. The reservation rent ($\bar{r}$) is embodied by the combination of the controls, the intercept β_0, and the residual u_i. Costs (ac_i)

[7] Besides the functional form of G and the maximum rental rate, the slope of the *PREM* and *SCORE* relationship is influenced by the EBI cost function, whether or not a farmer chooses to share costs with the federal government, whether or not a farmer's offered rent is more than \$15 below the maximum rental rate, and unobserved heterogeneity in beliefs about E^*. For these reasons, it is important to interpret estimates from our linear model as estimates for the average slope, which may not accurately reflect the slope associated with any particular offer.

are observed only for offers that propose cost-sharing with the government (where $s = 1$ and $a = 1/2$). We annualize these establishment costs by multiplying them by 0.10. For offers not sharing costs, we approximate costs from offers in the same county proposing the same practices that do share costs.

In order to estimate the effect of the total EBI score on the rent premium, we must account for the constraint that bids cannot exceed the soil-specific maximum payment. But for this constraint, farmers with very high EBI scores may offer a very high rental rate. In this sense, the farmer's true offered rent is censored by the soil-specific maximum rent. Farmers can circumvent the constraint to some degree by offering less expensive conservation practices, thereby netting a higher rental payment. A strictly constrained bid is one that offers to accept the maximum rental rate and to provide the least expensive conservation practice. Our inability to observe the least expensive conservation practice necessitates an estimation strategy that provides upper and lower bounds to the effect of the total EBI score. We estimate these bounds using (1) a linear IV model and (2) an IV-Tobit model that treats all bids that offer to accept the maximum payment as constrained. The linear IV underestimates the effect of the total EBI score by assuming that all bids are unconstrained and optimal, and the IV-Tobit overstates the effect by labeling too many bids as constrained and suboptimal, even though they may not be constrained by the cost of the conservation practice.

We estimate reservation rents as predicted values from the estimated models with the values for *SCORE* reset to the lowest observed value. This prediction is based on the theory, which tells us reservation rents equal the observed values minus $G(SCORE)$. Since we only approximate $G(SCORE)$ with a linear relationship, it is inappropriate to extrapolate beyond the region of our data by setting *SCORE* to zero. By setting *SCORE* to the minimum observed value in each sign-up, we approximate the minimum observed value of $G(SCORE)$, which is likely close to zero. This assumes those with the lowest bids believe they have a small chance of being accepted into the program and have negligible premiums. Because we interpret the intercept β_0 as part of the farmers' reservation rent, we implicitly assume that G/ϕ evaluated at the minimum total EBI score in the sample equals zero. If this value is greater than zero (a distinct possibly), then we underestimate the true premiums.

Results

Table 2 summarizes results from our IV and IV-Tobit regressions. For each sign-up, the table reports the estimated coefficient and standard error on *SCORE* for each of the two regressions. This coefficient gives the estimated increase in a landowner's premium for each additional total EBI point, holding all other factors the same. For example, the first row of column 2 reports the IV estimated coefficient on *SCORE* as 0.015. This estimate implies farmers received a premium of 1.5 cents per acre for each additional point they received in sign-up 15. If all farmers were to bid their reservation rents, their bids would effectively be exogenous, and this coefficient would be zero. In nearly every sign-up, the coefficient on the IV-Tobit regression is larger than the IV counterpart. In line with the reasoning given above, the IV estimate constitutes a lower bound on the marginal premium and the IV-Tobit constitutes an upper bound. The single exception is sign-up 15 where the difference between the estimates is negligible.

The coefficient on *SCORE* increases markedly between sign-ups 16, 18, and 20, during which the configuration of the EBI remained unchanged. This pattern is consistent with a progressive decline in bidders' uncertainty regarding the critical score needed to gain acceptance into the program, enabling landowners to extract larger premiums. The estimated coefficients for sign-up 26 are below those for sign-ups 18 and 20. This may reflect greater uncertainty over the critical score in sign-up 26 due to the changes to the EBI introduced with this sign-up. For each regression, the table also reports the R^2, and an *F*-test from the first-stage regression, which indicate our instruments are strong predictors of *SCORE*.[8]

Table 3 reports average rents paid by the CRP and the average estimated premium for all contracts accepted in the U.S. and for all those accepted in each of the eleven states enrolling more than 1 million acres in total over the five sign-ups examined. The estimates show how much premiums have increased over time between sign-ups 15 and 20 before decreasing somewhat in sign-up 26. In sign-up 20, we estimate an average premium per acre of \$15.1–\$21.2 with an average rent paid of

[8] Parameter estimates for the controls and first-stage regressions are not reported for brevity but are available upon request.

Table 2. Linear and Tobit Instrumental Variables Estimates of Bid Rent Minus Cost

	Sign-Up 15		Sign-Up 16		Sign-Up 18		Sign-Up 20		Sign-Up 26	
	Linear IV	Tobit IV	Linear IV	Tobit IV	Linear IV	Tobit IV	Linear IV	Tobit IV	Linear IV	Tobit IV
Coefficient (standard error) on total EBI score (*SCORE*)	0.015 (0.0004)	0.011 (0.0005)	0.029 (0.0012)	0.038 (0.0012)	0.052 (0.0012)	0.076 (0.0016)	0.074 (0.0019)	0.104 (0.0026)	0.033 (0.0013)	0.063 (0.0025)
Log likelihood	−549,613		−298,587		−180,728		−118,435		−119,070	
First-stage F-stat	36,408.21		8,747.74		5,230.10		3,401.84		12,574.55	
First-stage R^2	0.77		0.55		0.51		0.52		0.61	

Note: All specifications include state fixed effects. All Tobit specifications correct for heteroskedasticity. Exogenous explanatory variables are: soil loss tolerance (t) factor (tfac), highly erodible acres (helac96), national cpa acres (uscpa96), state cpa acres—water (stwat96), state cpa acres—wildlife (stwild96), state crp acres—air (stair96), cropped wetland acres—wetland (cwet96), cropped wetland acres—wetland (assoc96), former water bank program acres (wtrbnk96), noncropped wetland associated acres (ncrop96), scour erosion acres (scour96), other acreage eligible acres (other96), EBI-N2 (water quality), EBI-N3 (soil erosion habitat), EBI-N5 (air quality habitat), EBI-N6 (conservation priority area), weighted avg. soil rent rate of up to three predominate soils (srr), nonrenewed CRP contract (new_contract). For sign-up 26, EBI-N6 is not applicable and dropped and the newly added subfactor EBI-N5d (carbon sequestration) is included as an additional exogenous explanatory variable.

$52.8, implying that about $37–$52 million of the $129 million in annual rent payments associated with this sign-up constitute windfall gains to participate landowners.

Conclusion

In this paper, we have estimated the premiums received by CRP participants above their reservation rents. Estimated premiums have generally increased over time and constitute 10–40% of the program's rental pay-outs under sign-ups 20 and 26, the two most recent sign-ups for which we have data. However, it is not clear whether the same lands with the same conservation practices could be retired for less money. These premiums may be necessary to induce landowners to reveal their reservation rents and enroll their land in CRP. Our estimates may begin to clarify the trade-offs being made in the current bidding scheme and inspire consideration of alternative payment mechanisms.

For example, a cost-effective alternative to the current program is one that institutes a Pigouvian tax or subsidy. Barring large administrative costs, the CRP could reduce economic costs by either offering rental rates on a schedule that pays a constant price per EBI point, or taxing plantings of those who do not retire cropland at a rate equal to a constant price per EBI point lost from nonretirement.[9] In both cases, this scheme would reduce societal costs, though not necessarily government outlays. Economic efficiency would be achieved so long as the price per EBI point was set equal to marginal environmental benefits in equilibrium. However, these options may be politically infeasible because they would entail potentially large transfers of wealth from taxpayers to farmers under the subsidy option and vice versa under the tax.

The current system attempts to balance economic efficiency with limiting wealth transfer to farmers. By establishing maximum rental payments, the current scheme seeks to limit transfers to farmers, but it also inhibits farmers with reservation rents above maximum rents from submitting bids, even if their land would have high EBI scores. Furthermore, under the current scheme, those submitting bids with high exogenous EBI scores have

[9] The Farm Service Agency currently offers a fixed price for specific conservation practices under the continuous CRP sign-ups.

Table 3. Estimated Mean Rental Premiums for Accepted CRP Acres, by Sign-Up and States with Greatest Enrolled Acreage

	Sign-Up 15			Sign-Up 16			Sign-Up 18			Sign-Up 20			Sign-Up 26		
Location	Acres (1,000)	Rent/ Acre	Est. Prem./ Acre	Acres (1,000)	Rent/ Acre	Est. Prem./ Acre	Acres (1,000)	Rent/ Acre	Est. Prem./ Acre	Acres (1,000)	Rent/ Acre	Est. Prem./ Acre	Acres (1,000)	Rent/ Acre	Est. Prem./ Acre
Total U.S.	16,168	39.4	4.2–3.1	5,924	45.2	6.1–8.2	4,987	45.5	11.5–16.7	2,460	52.8	15.1–21.2	1,995	56.5	6.0–11.5
Texas	1,786	33.7	4.0–3.1	945	35.8	6.3–8.5	555	37.3	12.1–17.6	197	37.5	16.0–22.5	93	37.6	5.8–11.2
Montana	1,683	32.3	4.2–3.2	740	33.2	6.0–8.0	638	35.0	11.6–16.8	264	35.0	15.1–21.2	82	34.8	5.6–10.7
N. Dakota	2,006	32.2	4.5–3.4	550	32.7	5.7–7.6	603	34.2	10.7–15.5	182	34.3	14.2–19.9	11	29.4	5.4–10.3
Kansas	1,648	36.8	4.2–3.1	369	38.8	5.9–7.8	403	40.7	11.1–16.1	154	42.3	14.2–20.0	294	41.3	6.0–11.5
Colorado	1,226	29.6	3.9–3.0	363	32.8	6.3–8.4	290	34.3	11.9–17.2	122	34.5	15.4–21.7	112	34.2	5.7–11.0
Minnesota	393	47.4	3.8–2.9	455	53.2	6.3–8.4	381	48.3	12.2–17.7	128	55.4	15.0–21.0	79	61.7	5.8–11.2
Missouri	810	63.2	4.0–3.0	179	63.6	5.8–7.8	141	67.0	11.2–16.3	145	68.3	15.3–21.6	155	67.3	6.0–11.5
Iowa	523	80.0	3.9–3.0	341	89.9	6.2–8.3	229	99.0	11.7–16.9	179	103.1	14.2–21.4	127	101.0	6.1–11.7
S. Dakota	821	36.0	3.9–3.0	155	42.9	5.6–7.4	282	41.3	10.6–15.4	109	41.5	14.0–19.7	30	33.1	5.3–10.2
Washington	172	41.0	3.8–2.8	484	47.5	6.6–8.8	194	56.5	11.9–17.3	196	59.8	15.7–22.0	155	41.7	6.2–12.0
Nebraska	577	49.6	4.0–3.0	178	56.7	5.9–7.8	186	51.0	11.3–16.5	98	59.2	14.9–21.0	81	60.9	6.1–11.7

Note: Estimated reservation rents include a minimum and maximum based on the linear and Tobit specifications, respectively. States are those with more than 1 million acres enrolled in total over sign-ups 15, 16, 18, 20, and 26. All values are weighted by the contract acreage.

Source: Rents and acreage are from the Farm Service Agency (FSA) CRP bid file. Premiums are estimated with the parameters in table 2.

little incentive to adopt more valuable conservation practices, even at low private costs, since their bids are likely to be accepted regardless.

Might it be possible to implement a bidding scheme that achieves a more efficient balance between wealth transfer and environmental gain? Our findings suggest that potential cost savings could be substantial. Future research might fruitfully explore the implications of alternative bidding schemes and program structures.

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