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How Farmers Bid into the Conservation Reserve Program: An Empirical Analysis of CRP Offers Data

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I. Introduction

The Conservation Reserve Program (CRP) constitutes the largest-scale experiment to date in government payments for ecosystem services. Begun in 1985, the CRP currently idles approximately 31 million acres (a land mass about the size of Mississippi) at an annual cost near $1.9 billion. In return for idling land, CRP participants receive annual streams of payments during their 10 year contract period and, for funding those payments, U.S. taxpayers receive a stream of conservation, or ecosystem, services that includes enhancements to wildlife habitat, carbon sequestration, and benefits deriving from reduced soil erosion.

The method by which land is enrolled in the CRP has evolved over time. It now consists of an elaborate bidding system,[1] in which participants increase their likelihood of enrollment by offering land with certain characteristics and agreeing to engage in enhanced conservation practices. The evolved details of the bidding system are codified in the Environmental Benefits Index (EBI) – a scoring system that takes into account the putative ecosystem services from a land parcel and the rental rate demanded by the land owner. A portion of the EBI score a parcel receives is determined exogenously by the federal government. For example, land enrolled from areas determined to have particular conservation value (Conservation Priority Areas) is given bonus points – priority-area points – in the EBI, thus giving the offer an advantage in enrollment acceptance. But part of the EBI score constitutes an endogenous choice by the landowner. Most notably, the per-acre rental rate demanded by a landowner enters into the EBI with a negative weight: more expensive parcels are moved down the priority list for enrollment. The

[1] The standard terminology in the CRP literature describes the process by which landowners formulate offers as "bidding." In typical usage, one "bids" to buy and "offers" to sell goods or services. In this sense, landowners are offering the environmental services of their land in the CRP. However, for ease of exposition, we concede to established convention and refer to a contract submitted as an "offer" and the rental rate component of the offer as the landowner's "bid."

straightforward implication of this mix of exogenous and endogenous components of the EBI is that the rental rates that landowners bid to enroll in the CRP will be chosen strategically to adapt to changes in the scoring mechanism. If the EBI is revised to induce more enrollment from areas deemed to be rich in ecosystem services, the bid response from landowners in such areas will temper (or, perhaps, magnify) the area's enrollment response, depending on the strategic choice of landowners. Further, not only will the enrollment outcome depend upon the endogenous bid response to a change in the scoring mechanism, so too will the ultimate payments to landowners and the costs of the program to taxpayers.

This paper is about how CRP offers are influenced by a parcel's designation as a Conservation Priority Area. We present a theoretical model of a landowner's optimal bid and analyze the choice empirically from an as-yet unexamined data set of the approximately 270,000 accepted and unaccepted offers from CRP signups in 1997, 1998 and 2000. We focus empirically on a subset of offers from the Prairie Pothole Conservation Priority Area, which includes parts of Iowa, Minnesota, Montana, North Dakota, and South Dakota—states that account for 35% of the land enrolled in the CRP.

II. Previous Analysis of the CRP

Since 1985, there have been 41 CRP enrollment periods, or signups.[2] The first nine were general signups administered within the context and guidelines established in the 1985 Farm Bill. The CRP's primary objective during this period was mandated to be reduced soil erosion with secondary objectives that included protection of production capacity, farm income support,

[2] The 40th signup is a continuous one and will be ongoing through September 30, 2011.

improved water quality, and improvement in fish and wildlife habitat.[3] In these initial signups, offers to enroll were solicited but no information was made public about how offers were to be ranked for enrollment. Enrollment was accomplished using regional "pools" and, in Signup 1, not even the maximum allowable bid was known. Miranda (1992) used offers data from the first signup to examine whether or not landowners formulate their offer to account for the future on-farm productivity gains that result from reduced soil erosion. She found a weak connection, concentrated in the Corn Belt, between landowners' bids and the onsite productivity gains to enrollment.

After the first signup, landowners learned the maximum rent they could offer for their land, which was the same for all landowners in a multi-county pool. Shoemaker (1989) decomposed land value growth data over a period that coincided with the first four signups and estimated the extent to which CRP rents were capitalized into land values. He observed that land was offered at successively higher rental rates with each signup and attributed this fact to learning. He concluded that landowners were able to extract additional rent from the program in excess of their individual opportunity costs. Reichelderfer and Boggess (1988) analyzed CRP data from the first three signups and concluded that learning by landowners can lead to lower-than-average valued land being offered at average values. Smith (1995) characterized the properties of a least-cost CRP using mechanism design theory under assumptions of information asymmetry and marginal lands rents and found that while an offer system, much like what is currently used, is preferred to an auction when land rents are independent of the size of the farming operation, the first nine general signups cost more than they would have if landowners had bid their opportunity cost.

[3] Thurman (1995), Cochrane and Runge (1992) and Orden, Paarlberg and Roe (1999) provide discussions of the early CRP and implications of the conservation policies resulting from the 1985 Farm Bill.

The CRP that resulted from the 1990 Farm Bill looked different from that which came out of the 1985 Farm Bill. Sustainable agriculture emerged as a theme in nearly all the commodity and conservation programs and, as a result, the CRP's objectives were redirected to water quality improvement in addition to reducing soil erosion. Subsequently, the literature's focus turned to understanding the CRP's ability to target multiple objectives in a cost-effective manner. The first signup of the new CRP era, Signup 9, began using an index (initially a black box) that accepted offers based on their ratio of expected environmental benefits to cost (Osborn 1993, Thurman 1995). Babcock et al. (1996, 1997) used heterogeneity in the agricultural productivity and environmental quality of a county's enrolled land to evaluate the performance of the CRP under various environmental targeting criteria. They concluded that to the extent that environmental quality is positively correlated with land productivity, enrolling land into the program based on cost alone will perform poorly in terms of capturing water and soil erosion benefits.

Two recent papers relate closely to the analysis in this paper. Kirwan, Lubowski and Roberts (KLR) (2005) estimate the premiums for CRP participants above their "true" reservation rents and apply a state fixed-effects model to identify the relationship between a contract's environmental score (the non-cost EBI score) and the per-acre premium a landowner receives. Similarly, Marra and Vukina (1998) and Vukina et al. (2008) model bids from CRP offers to enroll land to understand how landowners formulate their optimal "bidding" strategies, whether the offers reveal information about the landowners' preferences towards conservation, and if the bids exhibit a "strategic" effect. Like KLR (2005), they find that farmers condition their bid on their parcel's EBI score. Additionally, they found that landowners valued the environmental benefits of conservation, particularly as they led to perceived improvements in their parcels'

future productivity. Marra and Vukina's (1998) and Vukina et al.'s (1998) work is novel in that they analyze all offers for enrollment into the program for the 15th Signup in North Carolina. Previous works relied on information from accepted contracts only.

The present paper analyzes how, given the current auction structure of CRP enrollment, a landowner's bid should and does change when an offer's probability of acceptance is exogenously increased. Like KLR (2005), Marra and Vukina (1998) and Vukina et al. (2008), the theoretical and empirical model posits that landowners condition their bid on their perceived probability of acceptance, identified by their EBI score. The theory developed in this paper, as in Vukina et al. (2008), accounts for pecuniary and well as the non-pecuniary benefits landowners derive from participation in the program. It extends their work and that of KLR by isolating an exogenous component of the EBI – conservation priority area points – to identify landowners' optimal bid responses from all offers to participate in the CRP, accepted and rejected, not solely those offers that were eventually accepted for enrollment.

The theory is implemented empirically utilizing data for all submitted offers during the 16th, 18th and 20th general signups, in 1997, 1998, and 2000.[4] Accepted and rejected offers are observed and all offers within a relatively small geographic area are compared using a natural experiment approach to identify the effects of exogenous changes in the probability of acceptance on landowners' bids. The ability to compare the population of CRP offers in a small geographic area, where assumptions of homogeneity in the production and factor markets are plausible, offers a unique opportunity to exploit the theoretical model in a way that, to our knowledge, has not been done.

[4] The program years for these signups are 1998, 1999, 2000 and 2001. Therefore, some of these offers resulted in contracts that are effective yet in 2011.

III. Theoretical Framework: Landowner's Expected Return

We develop a theoretical model to describe a general signup of the CRP. A landowner maximizes his expected returns from enrolling in the CRP by choosing his bid in an environment of uncertainty over the program parameters. The landowner's bid is assumed to be made conditional on the offer's environmental score, the parcel's maximum soil rental rate, the landowner's expectation of and preferences for on-farm and off-farm conservation benefits, and the landowner's subjective evaluation of the strength of his offer relative to the other offers against which his competes.[5]

The Government's Problem

The government wants to enroll $\bar{A}$ acres by choosing offers with the highest EBI scores (e) where e, the separable and additive sum of points an offer receives, is based on the bid and environmental provisions of the offer. Every offer's EBI score is determined using the following rule:[6]

$$e(r, N) = \beta_r r + \beta_N \bar{N} \tag{1.1}$$

where β_r and β_N are program parameters set by the government that determine how cost and conservation provisions are score, $\beta_r < 0$, $\beta_N > 0$, r is the offered rental rate (bid) and $\bar{N}$ is the level of environmental services offered, considered here to be fixed.

[5] The environmental score an offer receives is the non-cost component of the Environmental Benefits Index. The index and scoring is discussed in a subsequent section.

[6] This is an abstraction from the complex EBI formula but reflects the true form of the EBI in that the EBI is separable and additive in the cost and non-cost components. Further, the cost component is linear in the bid.

For a concrete example, suppose that the shape of $g(e)$ is that of a normal distribution and $g(e)$ is normalized such that

$$\int_{-\infty}^{\infty} g(e)de = 1. \tag{1.2}$$

The total acreage offered from the distribution of EBI scores across farmers, whose bid is described by $g(e)$, is

$$\int_{-\infty}^{\infty} g(e)de. \tag{1.3}$$

The cut-off EBI (e^*) is chosen by the government after landowners reveal their bids, such that

$$\int_{e^*}^{\infty} g(e)de = \bar{A}. \tag{1.4}$$

It is not assumed that the government knows $g(e)$. It simply ranks bids by EBI (e) and, starting from the highest e, accepts offers of acreage into the CRP until $\bar{A}$ acres are enrolled. The distribution $g(e)$ is normalized for analytical convenience such that

$$\int_{\infty}^{\infty} g(e)\mathrm{d}e = 1. \tag{1.5}$$

Then, the cut-off EBI can formally be derived from properties of the normal distribution as

$$P(e < e^*) = P\left(\frac{e-\mu}{\sigma} < \frac{e^*-\mu}{\sigma}\right) = P\left(z < \frac{e^*-\mu}{\sigma}\right) = 1-\bar{A}. \tag{1.6}$$

This implies that $\frac{e^* - \mu}{\sigma}$ is the $(1-\bar{A})\times 100^{th}$ percentile of the z (standard normal) distribution, implying further that, by symmetry of the distribution:

$$\frac{e^* - \mu}{\sigma} = z_{1-\bar{A}} = -z_{\bar{A}}. \tag{1.7}$$

Thus, the government chooses the cut-off EBI, e^*, which enrolls $\bar{A}$ acres from the distribution of all EBI scores, $g(e)$, such that

$$e^* = \mu - z_{\bar{A}}\sigma. \tag{1.8}$$

In this example, to know with certainty the cut-off requires knowledge of the mean and variance of the distribution of offers as well as the targeted level of enrollment. In other situations, where the distribution of offers was not described by the normal distribution, features of $g(e)$ beyond the first two moments would have to be known.

The Landowner's Problem

The landowner's problem is two-staged and his offer reflects uncertainty over the government's actions and the supply of competing acres. The first-stage decision compares the returns to participating in the CRP with the alternative choice, agricultural production.[7] If the landowner does not participate in the CRP he receives with certainty an annual profit, π. Participating in the CRP results in a fixed annual return:

[7] The alternative use for the land is assumed to be agricultural production. The CRPs rules require that enrolled land having a recent cropping history or have been continuously enrolled in the CRP. Other land use choices can be modeled in this framework so long as in the alternative choice, the landowner formulates his expectations about both the pecuniary and non-pecuniary returns from the land use activity when no CRP contract is made.

$$R^{CRP} = r + b(\bar{N}), \tag{1.9}$$

where r is the bid and $b(\bar{N})$ the net non-pecuniary benefits of participating in the CRP over the alternative.[8]

The bid is restricted by the program's rules to be less than the maximum soil rental rate $(\bar{r})$, a per-acre maximum annual rent payment established by the Farm Service Agency (FSA) based on the parcel's three predominant soil types and their productivity as established by the Natural Resources Conservation Service (NRCS). Thus, a participation condition exists and must hold for each offer to enroll in the CRP:

$$R^{CRP} \equiv r + b(\bar{N}) \geq \pi, \tag{1.10}$$

for some $r \leq \bar{r}$. The condition states that there exists an r for which the net value of participating if accepted is greater than or equal to the profits if not accepted. An offer is observed only if condition (1.10) holds and implies that for a bidding landowner the bid that satisfies this participation condition is in the set:

$$\left\{ r \in \mathbb{R} \mid \underline{r} \leq r \leq \bar{r} \right\}, \tag{1.11}$$

where $\underline{r} = \pi - b(\bar{N})$. Offers are not observed when the maximum rental rate does not satisfy the participation condition in (1.10), when

$$\bar{r} < \pi - b(\bar{N}). \tag{1.12}$$

[8] Non-pecuniary benefits are a function of N and include the expected increase in future on-farm productivity and measures of the private net benefits associated with conservation and open space amenities that result from enrolling land in the CRP. These benefits are assumed to be net of the enrollment and practice-installation costs.

The participation condition implies that a landowner will bid no less than $\underline{r}$, which implies through equation (1.1) an EBI no higher than $\overline{e}$. Similarly, the programmatic upper bound on bids of $\overline{r}$ implies a lower bound on EBI of $\underline{e}$. Thus, for a given landowner, the feasible set of EBI values is given by:

$$\left\{e \in \mathbb{R} \mid \underline{e} \le e \le \overline{e}\right\} \text{ where } \overline{e} = \beta_r \underline{r} + \beta_N \overline{N} \text{ and } \underline{e} = \beta_r \overline{r} + \beta_N \overline{N}. \tag{1.13}$$

In this way, r and N are substitutes in the production of e.

In the second stage, the landowner implicitly chooses an optimal e_0 by choosing an optimal r_0 such that, e*x post*, the offer is accepted if $e_0\left(r_0, \overline{N}\right) \ge e^*$ and rejected otherwise; this is deterministic. *Ex ante*, the landowner is uncertain about $g(e)$, β_r, and $\overline{A}$ and therefore doesn't know e^* with certainty. But the subjective probability of his acceptance can be seen to increase with e. His uncertainty reduces to that over (μ, σ^2) and β_r. To consider the problem formally, assume σ^2, $\overline{A}$, and β_r are known and that the landowner's prior belief over μ is given by:

$$p(\mu) = n(\mu_0, \tau_0^2). \tag{1.14}$$

Then the landowner's subjective probability of acceptance, $P_a(e)$, where μ is random is:

$$P_a(e) = P(e_0 > e^* = \mu - z_{\overline{A}}\sigma), \tag{1.15}$$

which further implies:

$$P_a(e) = P(\mu < e_0 + z_{\overline{A}}\sigma) = P\left(\frac{\mu - \mu_0}{\tau_0} < \frac{e_0 + z_{\overline{A}}\sigma - \mu_0}{\tau_0}\right). \tag{1.16}$$

Utilizing an expression for the standard normal distribution, equation (1.16) is alternatively expressed:

$$P_a(e) = \Phi\left(\frac{e_0 - (\mu_0 - z_{\bar{A}}\sigma)}{\tau_0}\right), \tag{1.17}$$

where $\Phi(.)$ is the standard normal cumulative distribution function (CDF). The landowner's expectation of the cut-off bid is:

$$E(e^*) = \mu_0 - z_{\bar{A}}\sigma, \tag{1.18}$$

and so the landowner's subjective probability of acceptance is given by:

$$P_a(e) = F\left(\frac{e_0 - E(e^*)}{\tau_0}\right). \tag{1.19}$$

The expression in equation (1.22) interprets the CDF in terms of the landowner's understanding of the parameters of the government's problem and centers the distribution of all other offers around $E(e^*)$, the landowner's expectation of the cut-off bid.

The acceptance outcome is a random variable and the landowner's perceived probability of acceptance depends on (1) his choice variables, which determine e, (2) the landowner's beliefs about the characteristics of offers from all other CRP applicants (μ, σ^2), and 3) the landowner's expectations of the rules of the program $(\beta_r, \bar{A})$. Figure 1 illustrates that the acceptance probability is increasing in e. That the probability is bounded between zero and one implies that the relation between P_a and e cannot be globally concave or convex.

The assumptions of a normally shaped distribution of offers, $g(e)$, and a normal prior for the landowner regarding the mean of $g(e)$, μ, results in the normal CDF depicted in figure 1. In more general settings, $P_a(e)$ need not be a normal CDF; however, the weak monotonicity of $P_a(e)$ in e is a general property.

Optimal rental rate choice and implied optimal EBI

Landowners bid an offered level of payments should they be accepted into the CRP. For a fixed level of conservation services, $\bar{N}$, the formula for the EBI in equation (1.1) implies a linear correspondence between r and e. We use this fact to characterize the landowner's problem as a choice of e. Therefore, the landowner's maximization problem becomes:

$$\begin{aligned} \max_{e_o} ER &= F\left(e_0\right)\left(r_0 + b(\bar{N})\right) + \left[1 - F\left(e_0\right)\right]\pi \\ &= F\left(e_0\right)\left(\frac{e_0 - \beta_N \bar{N}}{\beta_r} + b(\bar{N})\right) + \left[1 - F\left(e_0\right)\right]\pi \end{aligned} \tag{1.20}$$

where the last line in equation (1.20) makes use of equation (1.1) and the implied dependence between r_0 and e_0:

$$r_0 = \frac{e_0 - \beta_N \bar{N}}{\beta_r}. \tag{1.21}$$

Assuming an interior solution, the first-order condition (from (1.20)) implies:

$$\frac{dER}{de_0} \equiv F'\left(e_0\right)\left(\frac{e_0 - \beta_N \bar{N}}{\beta_r} + b - \pi\right) + F\left(e_0\right)\frac{1}{\beta_r} = 0 \tag{1.22}$$

or

$$F'(e_0)\left(\frac{e_0-\beta_N\overline{N}}{\beta_r}+b-\pi\right)=-\frac{F(e_0)}{\beta_r}. \tag{1.23}$$

The FOC expresses the equality of the marginal benefit (MB) and marginal cost (MC) from a change in e_0:

$$\text{MB}\equiv F'(e_0)\left(\frac{e_0-\beta_N\overline{N}}{\beta_r}+b-\pi\right) \text{ and } \text{MC}\equiv F(e_0)\frac{-1}{\beta_r}. \tag{1.24}$$

The landowner's MB of increasing e_0 (accomplished by decreasing r_0) is a "probability of acceptance effect": the landowner substitutes a lower rental rate if accepted for a greater probability of acceptance that results from the higher e_0. In the expected value payoff, the change in probability, $F'(e_0)>0$, is weighted by $r_0+b-\pi$, the size of the advantage to being enrolled relative to not being enrolled.

The MC of increasing e_0 is a "rental rate effect": an increase in e_0, achieved by reducing r_0, implies a reduction in payments in the accepted state by $\frac{-1}{\beta_r}>0$. The payment reduction generated by the lowered bid is weighted by $F(e_o)$, the probability of acceptance. A landowner will increase e_0 to the point at which the MB of doing so is just equal to the MC. It is possible that this point $(MB=MC)$ occurs where $r_0>\overline{r}$. Participation is not ruled out if at $\overline{r}$ the participation condition is satisfied and $MB>MC$.

The second-order condition, evaluated at the optimal choice value is:

$$\frac{d^2ER}{de_0^{\,2}}\equiv F''(e_0)\left(\frac{e_0-\beta_N\overline{N}}{\beta_r}+b-\pi\right)+2F'(e_0)\frac{1}{\beta_r}<0. \tag{1.25}$$

A comparative statics analysis of a landowner's adjustment of e_0 due to a change in $\bar{N}$ can be found from the total differential of (1.25):

$$\left[F''(e_0)\left(\frac{e_0-\beta_N\bar{N}}{\beta_r}+b-\pi\right)+2F'(e_0)\frac{1}{\beta_r}\right]de_0+\left[-F'(e_0)\frac{\beta_N}{\beta_r}\right]d\bar{N}=0, \qquad (1.26)$$

which implies the following:

$$\frac{de_0}{d\bar{N}}=\frac{F'(e_0)\dfrac{\beta_N}{\beta_r}}{F''(e_0)\left[\dfrac{e_0-\beta_N\bar{N}}{\beta_r}+b-\pi\right]+2F'(e_0)\dfrac{1}{\beta_r}}, \qquad (1.27)$$

and, given (1.21):

$$\frac{dr_0}{d\bar{N}}=\frac{1}{\beta_r}\left(\frac{de_0}{d\bar{N}}-\beta_N\right). \qquad (1.28)$$

By the SOC in equation (1.25) the denominator of equation (1.27) is negative and therefore $\frac{de_0}{d\bar{N}}$ is unambiguously positive. An exogenous increase in $\bar{N}$ unambiguously increases *e*, even given the possibility of an EBI-reducing increase in r. However, the effect on the optimal bid itself, $\frac{dr_0}{d\bar{N}}$, cannot be signed. We do know that $\frac{dr_0}{d\bar{N}}>0$ when $\frac{de_0}{d\bar{N}}<\beta_N$ and that $\frac{dr_0}{d\bar{N}}<0$ when $\frac{de_0}{d\bar{N}}>\beta_N$. Thus, in response to an exogenous increase in the parcel's $\bar{N}$ – a ceteris paribus increase in the offer's EBI – the landowner will adjust his optimal rental rate either higher or lower depending on the MB and MC of doing so. However, the total effect of such changes – the increase in $\bar{N}$ and the resulting increase or decrease in r_0 – in all cases results in a higher e_0.

On net, the landowner's probability of acceptance is higher than before the additional non-cost EBI points.[9] It can further be shown that $\frac{d^2 e_0}{d\bar{N}^2} < 0$ and $\frac{d^2 r_0}{d\bar{N}^2} > 0$. The latter says that higher-EBI landowners (landowners with more N) have higher (more positive) rental rate responses to increases in their N, a result that ties directly to the marginal benefits and costs associated with increasing the bid.

The ambiguity of bid response to an exogenous change in $\bar{N}$, such as a change in EBI scoring that awards points based on location, makes the bid response to such a change a fundamentally empirical question.

IV. Identification, Data and Empirical Model

We apply our theoretical model using contract level Conservation Reserve Program offers data to investigate how bids are affected by changes in EBI points. In particular, we are interested in identifying the bid effect from exogenous EBI point changes. Identification of the effects of changes in EBI points on rental rate offers is achieved by decomposing the EBI scoring mechanism.[10] The EBI used for general signups 16, 18 and 20 was subdivided into six environmental (non-cost) ranking factors (N1 through N6) which identify targeted concerns (wildlife, water quality, etc.), and one cost-based ranking factor (N7). Each offer receives a

[9] The ambiguity of the effect on r_0 from a change in $\bar{N}$ relates to the size of the changes in MB and MC. An exogenous increase in EBI points leapfrogs a bidder ahead of others and places him in a different part of the distribution of offers. If that part of the distribution is thicker with offers, then the benefit of further increases in e_0 by reducing r_0 can be large and the optimal response of r_0 to an increase in $\bar{N}$ can be negative. Conversely, the new position in the distribution occasioned by the increase in $\bar{N}$ could result in low expected gains to further bid reduction.

[10] Jacobs (2010) provides a thorough exposition of the EBI scoring mechanism and how it has changed through the program's history.

score – the sum of the non-cost (environmental) factors – that is intended to reflect the parcel's provision of environmental benefits and the non-cost score is provided to the landowner when his offer is submitted. The last component of the offer's EBI score is the cost factor. The landowner must offer a rental rate (bid) at or below his parcel's maximum rental rate, which is known. He does not know how his bid – the primary component of the cost factor – will translate to EBI points when the FSA determines the cost factor scoring parameters.[11] The cost factor points are added to the non-cost points in determining the parcel's total EBI score.

While a portion of the non-cost points a landowner receives depend at least in part on the conservation-type practices undertaken, some of the factors are, wholly or in part, exogenous. One exogenous ranking factor during general signups 16, 18 and 20 was the N6 component – conservation priority areas. Conservation priority areas (CPAs) are state- and federally-designated regions in which an environmental concern (air, water, or wildlife related) has been identified. In the EBI scoring mechanism, the N6 priority area factor awarded 25 points to eligible offers inside federal CPAs. CPAs are exogenous to the landowner and the associated EBI points therefore represent an exogenous increase in his offer's probability of acceptance. This program mechanism permits a straightforward way for us to identify landowner's rental rate responses to exogenous EBI points and, further, to test whether these points have the same effect on rental rate as the other ranking factor points, some of which are thought to be endogenous with the bid.

[11] The cost factor formula contains parameters set by the administrators after all offers have been received. The general formula is $\left[a-\left(\frac{a}{b}r\right)\right]+\text{cost share points + points below maximum rent}$, where a and b are determined based on the offers received and r is the landowner's bid. The landowners receive 10 points for not requesting conversation practice installation cost sharing (0 points for requesting any cost share) and can receive 1 point for every whole dollar that the bid is below the maximum soil rental rate, up to 15 points. For signups 16, 18 and 20, $a=125$ and $b=165$.

Data

CRP offers from the Prairie Pothole region in the United States[12] for general signups 16, 18 and 20 are used to implement empirical tests of the theory.[13] The offers data are landowners' submitted offers to enroll in the CRP and contain the components of individual EBI scores, the maximum rental rates for each offer, and the rental rate submitted by the landowner. The advantage of these data is that we observe the behavior of all landowners who attempt to enroll in the program, not just landowners who are successful in enrolling. The Prairie Pothole region (see figure 2) covers portions of Iowa, Minnesota, Montana, North Dakota and South Dakota and was deemed a conservation priority area (CPA) prior to the 16th general signup.[14] There are other conservation priority areas (not overlapping with the Prairie Pothole region) established for the purposes of the program; this CPA is chosen because it overlaps with a substantial agricultural production region that historically has high participation in the CRP.

Identifying the effects on rental rates from changes in exogenous EBI points is achieved by comparing, for several crop reporting districts (CRDs), offers that received the exogenous priority-area points from the N6 factor with those that did not. A CRD, as defined by the National Agricultural Statistics Service, is a grouping of counties that are adjacent to each other and that have common agricultural production characteristics. The counties in a CRD always lie within the same state and a CRD is small enough that we may be willing to assert that

[12] The Prairie Potholes region also extends into Canada

[13] In general, the EBI scoring mechanism for general signups can change from one signup to the next. These signups were selected because they represent three coterminous general signups for which the EBI scoring rubrics were the same. The fact that the EBI used to ranked offers did not change over these three signup periods supports our presumption that what we are measuring is not confounded by effects on bid by changes in the EBI.

[14] In the Prairie Pothole CPA the priority of concern is in preservation or re-establishment of the "potholes" left behind by glacial recessions. In their natural state, the potholes are rich in plant and aquatic life and provide breeding, nesting, and migratory support to many species of waterfowl. They act as important aquatic reserve an enhance drainage systems.

landowners within it face similar production economies and decisions. The fact that the Prairie Pothole CPA is defined using county boundaries permits us to identify Prairie Pothole counties and non-Prairie Pothole counties within the same CRD. Thus, we can compare, at the CRD level, offers that received the 25 Prairie Pothole CPA points for N6 – call these "Prairie Pothole offers" – with those in the same CRD that did not, the "non Prairie Pothole offers."

A summary of the offered rental rates and EBI points during Signup 18 from CRDs used in this analysis are shown in table 1.[15] Here we identify, for each CRD, the number of offers in (PP=1) and out (PP=0) of the Prairie Pothole region and for each type of offer, the average of and variability in the maximum rental rates and amount by which bids are discounted from the maximum, and the average of the offers' non-cost EBI scores (excluding priority area points). CRDs are listed approximately in order from those with the highest average maximum soil rental rates to the lowest. Interestingly, it is roughly true in this sample of offers that the CRDs with the highest rental rates have the highest sum of environmental (non-cost) EBI points excluding the priority area points for N6 and the largest discount in their bids (Iowa and Minnesota, for example). Further, the average rent discount for Prairie Pothole offers relative to non Prairie Pothole offers is larger in higher rent areas. This difference in discounting disappears as the maximum rental rate decreases and even reverses in the low rent areas.[16] Generally speaking, the proportion of non-Prairie Pothole offers to Prairie Pothole offers in a CRD is stable over signups 16, 18 and 20 as are the maximum soil rental rates. The average discounts of bids from maximum rental rates in a CRD exhibit some variation over the three signup periods; however, the difference in the discounting between Prairie Pothole and non Prairie Pothole offers is

[15] Signup 18 is provided as a sample to highlight the data and its characteristics. Summary statistics for signups 16 and 20 are available upon request.

[16] Note that the difference in discount between Prairie Pothole and non Prairie Pothole offers is not statistically significant in most of the low rent areas.

preserved. Also, while the average non-cost EBI point totals by CRD vary over the signup periods, the relative size of the average of these points for Prairie Pothole offers and non Prairie Pothole offers do not vary much.

Offers to enroll in the CRP in the general signup compete in a national pool against all offers based on their total EBI score and it has always been the case that there are more acres offered for enrollment than accepted. Besides this nationally competitive factor where enrollment is capped at some *ex-ante* unknown level, the program statutes require that no more than 25% of a county's agricultural land be enrolled in the CRP at any given time. This creates a local constraint that is binding in some counties and may, because it is a source of uncertainty, influence the bidding behavior of landowners. Though this particular constraint is not made explicit in the theoretical model, it is a factor influencing landowners' subjective evaluation of the probability of being accepted for enrollment. To the extent that a landowner perceives this rule to be binding on offers from his county, he may condition his bid on knowledge of current CRP enrollment. We calculate enrollment in the CRP in the period just prior to the signup and construct the proportion of the county's agricultural land that is, at the time of the signup, enrolled in the CRP. Table 2 provides, by CRD, summary statistics of its counties' proportion of agricultural land enrolled in the CRP just prior to each of the three signups[17]. CRP contract expirations that occur just prior to or during the signup may not be accounted for in this measure; however, we can reasonably posit that high county level enrollment, particularly enrollment nearing the 25% maximum of agricultural land, is indicative of strong local competition in the current signup.

[17] Each CRD has a fixed number of counties over this period but the number of counties in CRDs varies.

Empirical Model of the Effects of EBI Points on Bids

Based on our theoretical model and the comparative statics, we implement the following empirical specification to identify the effects of exogenous EBI points (Prairie Pothole points) on bid behavior:

$$rent_{ijt} = \alpha_{jt} + \beta_{1jt} rmax_{ijt} + \beta_{2jt} ebi_{ijt} + \beta_{3jt} prop_{ijt} + \delta_{1jt} PP_i + \delta_{2jt} PP_i \cdot ebi_{ijt} + \varepsilon_{ijt} \qquad (1.29)$$

where $rent_{ijt}$ is the landowner's bid, $rmax_{ijt}$ is the offer's parcel-specific maximum rental rate, ebi_{ijt} is a measure based on the offer's non-cost (environmental) EBI score,[18] $prop_{ijt}$ is the proportion of the county from which offer i originated that is currently enrolled in the CRP at the time of signup, and PP_i, is a dummy variable that is to equal to one if the offer received 25 priority-area points and equals 0 otherwise. Throughout, *i* indexes the individual contract (offer), *j* indexes the CRD, and *t* identifies the signup; there are 13 CRDs and 3 signup periods in the sample and the number of offers varies by CRD and signup.

We assume a representative landowner because production decisions and local economies (basis, input prices, and so forth) that affect enrollment decisions are posited to be homogenous within a CRD. In the model, $rmax$ plays an important role as a measure of the parcel's opportunity cost of enrolling in the CRP and also to control for heterogeneity among offers within a CRD that cannot otherwise be accounted for. The interaction term between the priority-area dummy variable and EBI score provides two opportunities to identify landowner behavior: 1) whether landowners in the Prairie Pothole region condition their rental rate on other non-cost

[18] Here, ebi_{ijt} is the sum of the offer's non-cost EBI components excluding the priority area points (N6), divided by 25. This measure of the EBI score is diminished by a factor of 25 to be able to compare the coefficient estimate and marginal effects of ebi_{ijt} and PP_i, a dummy variable that is to equal to one if the offer received 25 priority-area points and equals 0 otherwise. In this way we can compare the effect of exogenous priority area points with other EBI points on the bid.

EBI points in the same manner as non Prairie Pothole landowners, and 2) whether landowners view the priority-area points as being equivalent to non-priority area points in the formulation of their bids. If it is the case that the marginal effect on the bid from priority-area points and non-priority area points is not different, then this suggests that priority area EBI are equivalent to non priority area EBI points in bid formulation, in which case the interaction effect becomes an empirical test of the theoretical comparative static result, $\frac{d^2 r_0}{d\bar{N}^2} > 0$.

Our primary interests here are the marginal effects on bids from non-priority area EBI points and the exogenous priority area points on bids. Due to the interaction term (δ_{2jt}) these marginal effects vary with PP and ebi. Evaluating the marginal effects at the sample means of PP and ebi (for each CRD and signup combination) gives us two parameters of interest:

$$\frac{\partial rent_{jt}}{\partial ebi_{jt}} = \beta_{2jt} + \delta_{2jt}\overline{PP} \equiv \eta_1 \tag{1.30}$$

$$\frac{\partial rent_{jt}}{\partial PP} = \delta_{1jt} + \delta_{2jt}\overline{ebi} \equiv \eta_2. \tag{1.31}$$

To elicit directly these effects, Equation (1.29) is reparameterized by substituting for β_{2jt} and δ_{1jt}. The resulting empirical model is:

$$rent_{ijt} = \alpha + \beta_1 rmax_{ijt} + \eta_1 rebi_{ijt} + \eta_2 PP_i + \beta_3 prop_{ijt} + \delta_2\left[\left(PP_i - \overline{PP}\right)\left(ebi_{ijt} - \overline{ebi}\right)\right] + \varepsilon_{ijt} \tag{1.32}$$

The bid is conditioned on the parcel's maximum rental rate, the non-cost EBI score, the degree to which landowners might expect competition for enrollment into the CRP in their county, and the priority-area disposition of the offers. The expectation is that the coefficients on $rmax$ and ebi will be positive and statistically significant. The model also identifies whether the relationship

between the bid and EBI may be affected by priority-area designations. According to the theoretical comparative static results, landowners who receive an exogenous increase in their probability of acceptance will adjust their rental rate; the direction of the adjustment depends on the landowner's evaluation of the strength of his offer. Further, higher EBI landowners will have more positive rental rate responses to exogenous increases in EBI points. The coefficients that represent these two effects are η_2 and δ_2.

Each bid ($rent_{ijt}$) is restricted to be less than or equal to $rmax_{ijt}$ and, as a result, the dependent variable exhibits a mass of bids as their maximum. We deal with this complication by estimating maximum likelihood censored regression models for equation (1.32). Our empirical estimation allowed for observation-specific censoring of the dependent variable where the independent variable, $rmax$, is the upper-censoring point. Tobit marginal effects – the variables' effect on the bid conditional on the observation not being censored – evaluated at the variable means are provided by signup in tables 3a, 3b and 3c. The tables also provide a measure of the degrees of censoring. In general, landowners from low-rent areas such as ND and MT tend to offer the maximum rental rate with greater regularity than landowners from higher-rent areas of IA and MN. However, the degree of censoring from any one CRD increases over time.

The effects of interest – influences of maximum rental rates, non-cost EBI points, and priority area designations on bids – are discussed in turn below. The other explanatory variable – the proportion of the landowner's county's agricultural land enrolled in the CRP prior to the signup period – while likely an important control variable in a county-level analysis is not particularly informative from a predictive or marginal point of view of offers from CRDs. Further, this variable ranges from zero to approximately .25 (25%) and therefore a single county could not experience bidding behavior when $prop_{jt}$ is zero in one case and then incrementally

increased to one (100%). However, it may be informative in the sense that, across the CRDs and signups, it generally holds that the statistically significant coefficient estimates are negative. The fewer acres that can be accepted for enrollment in a county, the more competitive (lower) ought to be the bids submitted by landowners, ceteris paribus.

The Role of Maximum Rental Rates on Bids

The maximum rental rate for each parcel is an important variable in explaining the variation in bids. The reasons are two: landowners know the maximum rental rate they can bid and by construction the maximum reflects the agricultural productivity of the land. For our purposes, this parcel-specific measure is useful as a control for unobserved heterogeneity between offers. For all CRDs, we find that bids ($rent_i$) are clearly conditioned on maximum rental rates ($rmax_i$); marginal effects are positive, non-zero and statistically significant at a level greater than 1%. The size of the marginal effects is not constant for all CRDs – an indication of the heterogeneity that exists between CRDs – nor is the relationship one-for-one. The estimated marginal effects suggest that in the high rent CRDs (IA and MN) a $1 increase in maximum rental rates induces a $0.40 to $0.55 increase in the bids. In the lower rent areas such as ND and MT, the marginal effects on bids from a $1 increase in the maximum rental rate range from $0.05 to about $0.23, markedly lower than in the higher rental rate areas. A test of the hypothesis that $\beta_1 = 1$ in the estimations reveals that we should not expect a $1 increase in bids given a $1 increase in maximum rental rates and this holds at least at a 5% level of significance in all but a handful of cases, the exceptions to which occur in North Dakota CRDs in signup 20 only. The Wald test statistics for these restrictions are provided in table 4.

While the marginal effects on bids of increasing the maximum rental rates is not zero and not one, we observe that bid responses are changing over time. Bid responses to maximum rental rates appear to decline over time in CRDs in Minnesota, Montana and (generally) North Dakota. However, only CRD 1910 in Iowa (NW portion of the state) shows a decline in the bid response while the other two CRDs in Iowa exhibit increasing or at least variable bid responses over the period.

The primary observation from these marginal bid effects is that, on average, landowners in high rent areas bid further below their maximum rental rates than do landowners in low rent areas but have higher (more positive) bid responses to increases in their maximum rental rate. This highlights the major difference in the regions in this study and allows us to draw comparisons between them in terms of landowner bidding behavior. Iowa and Minnesota are, in relative terms, high rent areas while North Dakota and Montana are low rent. Landowners in Iowa and, to a lesser degree, Minnesota perceive (correctly) that they are penalized in the EBI cost scoring for being high rent enrollments which leads them to bid well below their maximum rental rate in an attempt to increase their probability of acceptance. The opposite case holds for landowners in low rent areas. This type of behavior is anticipated by our theoretical model.

The Role of Non-Cost EBI Points on Bids

Our theory posits that landowners condition their bids on the perceived strength of their EBI score relative to other offers. The empirical results agree. Across CRDs and signups, the marginal estimated effect of additional EBI points (ebi) – the offer's non-cost and non-priority area EBI points – on the bid are positive where statistically significant and are statistically significant in a majority of the CRDs in our sample. Again, this variable provides an opportunity

to contrast high rent and low rent regions. Landowners in high rent areas increase their bids by more than do landowners from low rent areas in response to an increase in their EBI score. We predict that higher EBI landowners will have higher rental rate responses to additional EBI points than will lower EBI landowners, a result that derives from the marginal benefits and costs involved in increasing a bid. Iowa and Minnesota are not just high rent areas but also have higher non-cost EBI points than do regions in North Dakota and Montana.

Giving landowners additional EBI points elicits a different response in bids based on how landowners perceive the relative strength of their offers among all other offers. In response to one additional EBI point – an increase in his probability of acceptance and therefore expected return from the CRP – a landowner can increase his bid, an offsetting reduction in his EBI. Landowners from high rent areas (in this case also high EBI areas) increase their bid more than landowners from low rent areas (lower EBI areas) because doing so doesn't decrease by much their probability of acceptance and, if accepted, guarantees a higher payment. On the other hand, low rent landowners (the lower EBI landowners in this case) receive an increase in their probability of acceptance via additional EBI points and increase their bid by a small amount such that their net probability of acceptance is greater than before the additional points.

The Role of Prairie Pothole CPA Points on Bids

The Prairie Pothole Conservation Priority Area provides an exogenous increase in landowners' non-cost EBI points during these signups of 25 points. The bid responses to these points do not mirror the marginal effects on bids of the non-cost EBI points in all dimensions. It is generally true that the marginal effects of priority points on bids is greater in high rent (high EBI areas) than in low rent areas. However, in signups 18 and 20, there are negative responses

indicating that landowners reduced their bids relative to their non-priority-area counterparts. While initially this might seem anomalous, our theory can explain this type of behavior. Again, landowners maximize the expected return from participating in the CRP. If they perceive the benefits (increase in expected return) to reducing their bid to be greater than the cost of doing so – what they give up in terms of annual rental payments – then such adjustment is optimal. This is precisely why we were unable to sign the comparative static result, $\frac{dr_0}{d\bar{N}}$.

Not all EBI Points are Created Equal

In the EBI scoring mechanism, a point is a point whether it is a priority-area point, a non priority point or a cost-factor point. However, the empirical results suggest that perhaps landowners view these points differently. Table 4 provides restriction estimates and p-values of Wald statistics from the restriction that non-priority area EBI points are equal to the priority-area EBI points. In over half of the CRDs in signups 16, 18 and 20 we can reject they hypothesis that the marginal effects on bids from these two point sources are statistically equivalent. That is, landowners who receive the Prairie Pothole priority area points perceive them to be somehow different than other EBI points in conditioning their bids. Further, the restriction estimates are predominantly negative, an indication that an increase in priority-area points results in a more positive effect on rental rates than does an increase in non-priority area points. While we cannot say with certainty why this is the case, a plausible explanation is that landowners perceive the priority area points to have a greater environmental value or conservation provision and therefore demand a higher return for providing them.

V. Conclusion

The CRP enrolls land by calculating an Environmental Benefits Index value that measures the environmental services that result from idling land from production. The index also takes into account the rental rate required by the landowner should his land be accepted. Those with the highest EBI points are accepted. Some of the environmental service points in the EBI depend upon the conservation cover the landowner proposes to install, while some EBI points are entirely exogenous to the landowner. Falling into the latter category are points resulting from land residing in Conservation Priority Areas like the Prairie Pothole region. Such lands are given favor in the CRP due strictly to location. Our empirical work addresses two aspects of the interaction between exogenous Conservation Priority Area points and endogenous rental rate bids. Specifically, we measure how bids respond to the additional non-cost EBI points awarded to bids from priority areas, and test whether landowners in priority areas condition their bids on EBI points differently than do landowners outside of such regions.

We find that landowners do condition their bids on EBI score, as our theory suggests. Further, we find that the response to additional EBI points depends on whether the bids are from high-rent or low-rent areas. This response derives from the theory, which highlights the trade-offs faced by landowners between the benefits of a high bid should the bid be enrolled and the benefits from a low bid in increasing the probability of acceptance. This trade-off creates opportunities for those from low-rent areas to increase their expected return to enrolling with small increases in their bid while landowners from high-rent areas optimally increase their bid by larger amounts.

We also find empirically that variations in priority area EBI points do not have the same impact on bids as do non-priority area points, despite their equivalence in their contributions to

the EBI score. One explanation for this finding is that farmers attach particular utility to EBI points that come from Conservation Priority Area designation. As a signal that valuable environmental services are attached to retiring land inside of a CPA, priority area designations increase landowners' probability of enrolling (acceptance). Landowners optimally respond by reducing or increasing the rental rates at which they are willing to enroll, both of which increase the expected returns to enrolling in the CRP.

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Table 1. Summary Statistics of CRP Offers Data by Crop Reporting District, Signup 18

State	CRD	PP‡	# Offers	MRR*		Discount of Offered Rent from MRR		Non-Cost EBI Points	
				mean	std	mean	std	mean	std
IA	1950	0	418	$115.76	$16.28	$10.70	$11.04	217.8	34.7
	1950	1	340	$135.50	$14.13	$18.46	$14.87	181.1	38.5
IA	1940	0	472	$106.07	$15.16	$7.57	$10.74	211.8	33.8
	1940	1	106	$133.38	$14.40	$22.74	$16.67	174.0	34.6
IA	1910	0	130	$107.88	$17.19	$15.86	$16.11	179.6	50.0
	1910	1	335	$118.85	$15.82	$20.13	$16.68	157.7	32.3
MN	2750	0	335	$43.62	$14.31	$1.80	$3.73	171.5	36.9
	2750	1	446	$79.56	$18.89	$6.42	$8.10	177.6	34.6
MN	2740	0	32	$65.88	$6.77	$5.65	$6.65	140.9	28.1
	2740	1	960	$68.91	$20.01	$5.59	$6.97	154.0	29.4
MN	2710	0	36	$38.55	$5.26	$0.59	$1.37	185.6	25.9
	2710	1	3467	$43.87	$8.10	$1.53	$2.83	166.0	26.7
MT	3050	0	292	$33.44	$5.26	$0.45	$1.71	159.1	32.5
	3050	1	58	$36.57	$4.43	$0.00	$0.00	164.5	31.4
MT	3030	0	436	$30.67	$2.92	$0.53	$1.25	151.4	24.0
	3030	1	1201	$29.94	$2.69	$0.21	$0.94	147.5	26.5
ND	3890	0	28	$55.78	$7.21	$3.86	$4.75	139.5	22.4
	3890	1	1418	$41.32	$10.50	$0.50	$1.61	129.1	26.8
ND	3860	0	38	$53.02	$7.78	$1.92	$3.54	152.9	30.8
	3860	1	862	$40.32	$6.91	$0.30	$1.23	151.2	22.0
ND	3830	0	213	$45.85	$5.31	$3.64	$4.96	144.4	25.8
	3830	1	1212	$39.66	$7.28	$1.48	$3.38	128.1	21.0
ND	3840	0	267	$24.16	$2.77	$0.18	$0.63	116.1	30.7
	3840	1	238	$32.22	$3.17	$0.57	$1.49	114.1	20.4
ND	3880	0	230	$26.01	$2.14	$0.99	$1.56	110.9	27.0
	3880	1	365	$28.57	$2.91	$0.39	$1.25	112.9	22.1

‡ PP = 0 denotes offers that did not receive the PP CPA points; PP=1 denotes offers that did receive the PP CPA points.
* MRR is the maximum rental rate the landowner can offer for the specific parcel.

Table 2. Proportion of County's Agricultural Land in CRP Preceeding Signups by CRD

		Signup 16			Signup 18			Signup 20		
CRD	# Counties	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
1950	12	5.2%	0.3%	11.4%	3.9%	0.4%	8.9%	3.2%	0.6%	6.9%
1940	12	5.1%	0.8%	8.8%	3.3%	0.6%	7.2%	3.5%	0.7%	7.7%
1910	12	3.7%	0.7%	7.6%	2.2%	0.6%	3.9%	1.7%	0.5%	3.1%
2750	14	4.5%	0.6%	8.5%	3.5%	0.4%	7.6%	3.3%	0.5%	7.8%
2740	12	7.1%	2.4%	12.8%	5.1%	1.9%	11.1%	5.5%	1.9%	10.7%
2710	11	16.3%	2.4%	23.4%	11.6%	1.1%	17.3%	12.6%	1.0%	20.2%
3050	10	3.6%	0.7%	5.8%	3.2%	0.5%	5.9%	3.3%	0.8%	6.5%
3030	8	10.4%	3.6%	18.5%	11.1%	3.4%	18.0%	10.9%	3.6%	15.0%
3890	7	7.5%	3.6%	11.1%	10.7%	3.1%	13.8%	9.9%	3.0%	14.0%
3860	5	5.5%	0.6%	10.8%	7.6%	0.9%	15.8%	8.2%	1.0%	19.4%
3830	7	7.5%	1.5%	11.2%	11.0%	3.4%	19.7%	11.9%	4.0%	21.0%
3840	5	5.1%	2.1%	8.5%	5.1%	2.1%	8.2%	4.2%	1.3%	6.5%
3880	5	7.1%	3.0%	11.2%	8.0%	1.7%	12.1%	6.3%	1.3%	10.6%

Table 3a. Signup 16: Tobit Marginal Effects on Offered Rental Rates Evaluated at the Variable Means

State	CRD	N	Proportion of N Censored	R^2	Constant	rmax	prop	ebi	PP	PP*ebi
					26.522	0.419	50.059	0.962	11.032	1.500
IA	1950	1304	0.053	0.329	(5.205)	(0.028)	(18.887)	(0.286)	(1.362)	(0.53)
					0.000	*0.000*	*0.008*	*0.001*	*0.000*	*0.005*
					20.422	0.413	-45.229	2.523	5.023	-2.173
IA	1940	1016	0.081	0.461	(3.76)	(0.024)	(13.068)	(0.27)	(1.47)	(0.668)
					0.000	*0.000*	*0.001*	*0.000*	*0.001*	*0.001*
					19.851	0.556	-67.917	0.471	2.917	-0.636
IA	1910	903	0.064	0.393	(4.462)	(0.031)	(22.793)	(0.298)	(1.275)	(0.558)
					0.000	*0.000*	*0.003*	*0.114*	*0.022*	*0.255*
					6.744	0.443	-26.758	1.021	2.850	0.959
MN	2750	1401	0.295	0.877	(1.273)	(0.015)	(7.481)	(0.159)	(0.534)	(0.309)
					0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.002*
					4.740	0.594	-8.923	0.939	-0.364	-0.619
MN	2740	1941	0.148	0.795	(1.697)	(0.011)	(7.07)	(0.149)	(1.238)	(0.933)
					0.005	*0.000*	*0.207*	*0.000*	*0.769*	*0.507*
					9.020	0.352	-6.200	0.081	1.015	-0.222
MN	2710	2429	0.382	0.749	(0.619)	(0.011)	(1.06)	(0.064)	(0.166)	(0.145)
					0.000	*0.000*	*0.000*	*0.209*	*0.000*	*0.126*
					3.545	0.059	-31.366	0.103	0.416	-0.247
MT	3050	456	0.836	0.837	(0.66)	(0.017)	(5.44)	(0.048)	(0.201)	(0.138)
					0.000	*0.001*	*0.000*	*0.033*	*0.038*	*0.074*
					2.175	0.210	-3.650	-0.027	0.494	-0.144
MT	3030	1952	0.706	0.862	(0.277)	(0.012)	(0.482)	(0.017)	(0.043)	(0.034)
					0.000	*0.000*	*0.000*	*0.115*	*0.000*	*0.000*
					0.874	0.172	6.170	-0.006	0.148	-0.025
ND	3890	1266	0.750	0.986	(0.235)	(0.012)	(1.25)	(0.023)	(0.118)	(0.097)
					0.000	*0.000*	*0.000*	*0.801*	*0.210*	*0.795*
					1.708	0.211	-0.384	0.105	0.240	-0.352
ND	3860	874	0.715	0.950	(0.483)	(0.015)	(1.52)	(0.039)	(0.188)	(0.133)
					0.000	*0.000*	*0.801*	*0.007*	*0.201*	*0.008*
					4.978	0.210	-17.313	0.257	0.756	-0.615
ND	3830	1836	0.607	0.864	(0.425)	(0.011)	(1.49)	(0.048)	(0.111)	(0.117)
					0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
					0.980	0.200	1.640	-0.020	-0.046	0.031
ND	3840	497	0.757	0.981	(0.233)	(0.02)	(1.64)	(0.023)	(0.088)	(0.047)
					0.000	*0.000*	*0.317*	*0.398*	*0.603*	*0.506*
					0.481	0.131	-1.590	0.025	0.308	0.002
ND	3880	833	0.825	0.973	(0.154)	(0.013)	(0.866)	(0.014)	(0.044)	(0.028)
					0.002	*0.000*	*0.067*	*0.073*	*0.000*	*0.953*

Standard errors are reported in parentheses, p-values below the standard errors.

Table 3b. Signup 18: Tobit Marginal Effects on Offered Rental Rates Evaluated at the Variable Means

State	CRD	N	Proportion of N Censored	R^2	Constant	rmax	prop	ebi	PP	PP*ebi
IA	1950	758	0.146	0.503	18.252	0.504	-1.632	1.750	2.099	0.497
					(5.564)	(0.031)	(20.733)	(0.304)	(1.294)	(0.533)
					0.001	*0.000*	*0.937*	*0.000*	*0.105*	*0.351*
IA	1940	578	0.254	0.512	33.328	0.347	-96.356	0.972	-4.050	-0.501
					(4.285)	(0.031)	(23.071)	(0.3)	(1.475)	(0.726)
					0.000	*0.000*	*0.000*	*0.001*	*0.006*	*0.490*
IA	1910	465	0.097	0.271	27.768	0.406	-33.230	1.742	2.186	1.029
					(6.804)	(0.044)	(68.223)	(0.465)	(1.721)	(0.829)
					0.000	*0.000*	*0.626*	*0.000*	*0.204*	*0.214*
MN	2750	781	0.423	0.931	7.311	0.409	-4.421	0.196	0.870	0.512
					(1.138)	(0.019)	(8.795)	(0.129)	(0.542)	(0.263)
					0.000	*0.000*	*0.615*	*0.128*	*0.109*	*0.051*
MN	2740	992	0.290	0.883	7.455	0.513	-30.332	0.410	1.963	0.027
					(1.521)	(0.015)	(8.11)	(0.152)	(1.077)	(0.858)
					0.000	*0.000*	*0.000*	*0.007*	*0.069*	*0.975*
MN	2710	3503	0.572	0.357	3.792	0.310	-8.725	0.188	0.710	-0.438
					(0.598)	(0.009)	(0.862)	(0.036)	(0.508)	(0.401)
					0.000	*0.000*	*0.000*	*0.000*	*0.162*	*0.275*
MT	3050	350	0.897	0.919	*Cannot be estimated; all offers where PP = 1 are censored.*					
MT	3030	1637	0.813	0.873	0.845	0.138	-2.500	0.066	0.410	-0.078
					(0.28)	(0.011)	(0.623)	(0.019)	(0.048)	(0.039)
					0.003	*0.000*	*0.000*	*0.000*	*0.000*	*0.043*
ND	3890	1446	0.790	0.975	-0.011	0.162	4.361	0.122	0.736	-0.142
					(0.328)	(0.011)	(1.061)	(0.032)	(0.203)	(0.193)
					0.973	*0.000*	*0.000*	*0.000*	*0.000*	*0.464*
ND	3860	900	0.850	0.965	-0.312	0.113	2.209	0.185	0.277	-0.084
					(0.379)	(0.012)	(0.956)	(0.036)	(0.134)	(0.113)
					0.410	*0.000*	*0.021*	*0.000*	*0.039*	*0.458*
ND	3830	1425	0.668	0.769	6.312	0.099	-13.582	0.513	1.257	-0.071
					(0.641)	(0.013)	(1.37)	(0.077)	(0.176)	(0.156)
					0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.649*
ND	3840	505	0.760	0.950	1.118	0.187	-5.760	0.080	0.248	0.112
					(0.385)	(0.022)	(4.879)	(0.038)	(0.283)	(0.078)
					0.004	*0.000*	*0.238*	*0.037*	*0.382*	*0.153*
ND	3880	595	0.703	0.820	1.620	0.225	-0.696	-0.003	0.761	0.182
					(0.574)	(0.026)	(2.57)	(0.055)	(0.14)	(0.106)
					0.005	*0.000*	*0.787*	*0.962*	*0.000*	*0.085*

Standard errors are reported in parentheses, p-values below the standard errors.

Table 3c. Signup 20: Tobit Marginal Effects on Offered Rental Rates Evaluated at the Variable Means

State	CRD	N	Proportion of N Censored	R^2	Constant	rmax	prop	ebi	PP	PP*ebi
IA	1950	672	0.190	0.581	6.430	0.537	30.571	2.308	3.090	1.628
					(4.894)	(0.029)	(30.402)	(0.298)	(1.436)	(0.553)
					0.189	*0.000*	*0.315*	*0.000*	*0.031*	*0.003*
IA	1940	611	0.308	0.738	6.251	0.477	-90.404	1.966	2.009	0.065
					(3.604)	(0.027)	(15.759)	(0.262)	(1.437)	(0.817)
					0.083	*0.000*	*0.000*	*0.000*	*0.162*	*0.937*
IA	1910	375	0.160	0.407	24.078	0.432	-193.718	2.331	-2.316	3.311
					(7.797)	(0.046)	(104.273)	(0.539)	(1.878)	(1.047)
					0.002	*0.000*	*0.063*	*0.000*	*0.218*	*0.002*
MN	2750	653	0.498	0.935	5.281	0.349	-26.848	0.585	2.064	0.337
					(1.186)	(0.02)	(10.126)	(0.16)	(0.583)	(0.338)
					0.000	*0.000*	*0.008*	*0.000*	*0.000*	*0.319*
MN	2740	762	0.392	0.923	2.730	0.448	-18.259	0.508	2.696	1.089
					(1.557)	(0.017)	(8.068)	(0.149)	(1.205)	(0.627)
					0.080	*0.000*	*0.024*	*0.001*	*0.025*	*0.082*
MN	2710	1076	0.571	0.813	12.070	0.275	-24.500	0.008	-2.326	-2.158
					(1.25)	(0.019)	(1.61)	(0.098)	(0.961)	(1.51)
					0.000	*0.000*	*0.000*	*0.937*	*0.016*	*0.152*
MT	3050	189	0.931	0.780	*Cannot be estimated; all offers where PP = 1 are censored.*					
MT	3030	481	0.848	0.870	1.170	0.103	-3.185	0.071	0.475	-0.137
					(0.627)	(0.021)	(1.39)	(0.044)	(0.105)	(0.102)
					0.063	*0.000*	*0.022*	*0.108*	*0.000*	*0.177*
ND	3890	478	0.856	0.983	0.628	0.112	0.780	0.097	0.259	0.046
					(0.378)	(0.016)	(1.835)	(0.044)	(0.213)	(0.152)
					0.097	*0.000*	*0.671*	*0.029*	*0.224*	*0.765*
ND	3860	332	0.886	0.973	0.001	0.092	1.910	0.047	0.791	-0.295
					(0.528)	(0.018)	(1.487)	(0.055)	(0.233)	(0.17)
					0.999	*0.000*	*0.199*	*0.398*	*0.001*	*0.083*
ND	3830	569	0.671	0.873	2.945	0.160	-8.594	0.384	2.850	-0.612
					(0.755)	(0.021)	(2.461)	(0.106)	(0.362)	(0.356)
					0.000	*0.000*	*0.001*	*0.000*	*0.000*	*0.086*
ND	3840	339	0.779	0.940	1.667	0.148	1.500	0.079	0.189	-0.310
					(0.497)	(0.026)	(5.63)	(0.056)	(0.275)	(0.117)
					0.001	*0.000*	*0.789*	*0.157*	*0.493*	*0.008*
ND	3880	274	0.799	0.850	1.173	0.097	-17.400	0.037	1.091	0.271
					(0.419)	(0.027)	(3.22)	(0.034)	(0.188)	(0.076)
					0.005	*0.000*	*0.000*	*0.270*	*0.000*	*0.000*

Standard errors are reported in parentheses, p-values below the standard errors.

Table 4. Wald Tests of Restrictions on Marginal Effects

State	CRD	$\beta_1 = 1$			$\eta_1 = \eta_2$		
		Signup 16	Signup 18	Signup 20	Signup 16	Signup 18	Signup 20
IA	1950	-0.548	-0.413	-0.337	-10.882	-0.407	-0.966
		0.300	0.035	0.033	1.432	1.503	1.825
		0.000	*0.000*	*0.000*	*0.000*	*0.787*	*0.597*
IA	1940	-0.554	-0.529	-0.312	-2.700	6.825	-0.062
		0.251	0.039	0.032	1.566	1.985	2.004
		0.000	*0.000*	*0.000*	*0.085*	*0.000*	*0.975*
IA	1910	-0.394	-0.543	-0.475	-2.667	-0.500	5.653
		0.334	0.049	0.054	1.354	1.950	2.331
		0.000	*0.000*	*0.000*	*0.049*	*0.797*	*0.015*
MN	2750	-0.380	-0.271	-0.291	-2.560	-1.203	-3.002
		0.160	0.020	0.021	0.768	1.024	1.253
		0.000	*0.000*	*0.000*	*0.001*	*0.241*	*0.165*
MN	2740	-0.297	-0.270	-0.226	1.540	-2.211	-3.780
		0.114	0.014	0.014	1.470	1.561	2.105
		0.000	*0.000*	*0.000*	*0.295*	*0.157*	*0.073*
MN	2710	-0.395	-0.240	-0.323	-1.602	-1.281	5.752
		0.143	0.012	0.031	3.052	0.124	2.432
		0.000	*0.000*	*0.000*	*0.000*	*0.303*	*0.018*
MT	3050	-0.526			-2.502		
		0.104			1.719		
		0.000			*0.146*		
MT	3030	-0.202	-0.154	-0.254	-1.982	-2.111	-2.924
		0.028	0.044	0.110	0.173	0.324	0.754
		0.000	*0.000*	*0.021*	*0.000*	*0.000*	*0.000*
ND	3890	-0.120	-0.135	-0.136	-0.788	-3.274	-1.254
		0.015	0.021	0.046	0.612	1.087	1.698
		0.000	*0.000*	*0.003*	*0.198*	*0.003*	*0.460*
ND	3860	-0.179	-1.099	-0.082	-0.528	-0.729	-7.427
		0.027	0.039	0.072	0.731	1.075	2.025
		0.000	*0.005*	*0.256*	*0.470*	*0.498*	*0.000*
ND	3830	-0.366	-0.653	-0.463	-1.504	-2.621	-8.267
		0.018	0.036	0.046	0.342	0.612	1.179
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
ND	3840	-0.104	-0.135	-0.272	0.116	-0.774	-0.544
		0.039	0.061	0.083	0.415	1.318	1.472
		0.007	*0.026*	*0.001*	*0.779*	*0.557*	*0.712*
ND	3880	-0.102	-0.194	-0.123	-1.933	-2.731	-9.527
		0.035	0.071	0.138	0.321	0.574	1.818
		0.003	*0.007*	*0.372*	*0.000*	*0.000*	*0.000*

Restriction estimates reported, standard errors are in parentheses, Wald test statistic p-values below the standard errors are chi-square distributed.

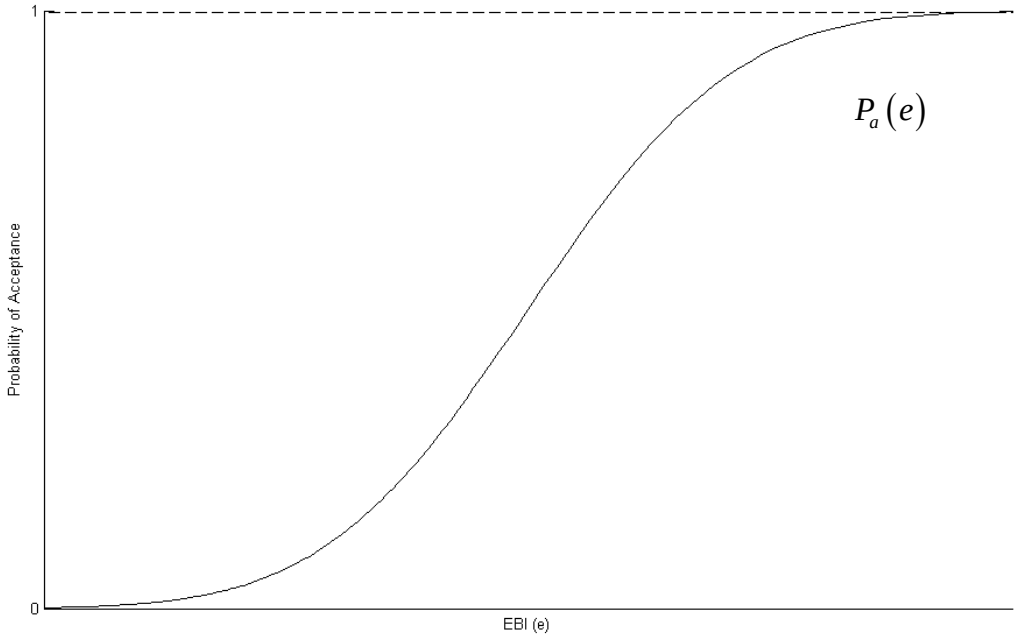

Figure 1. Probability of acceptance is increasing in the EBI

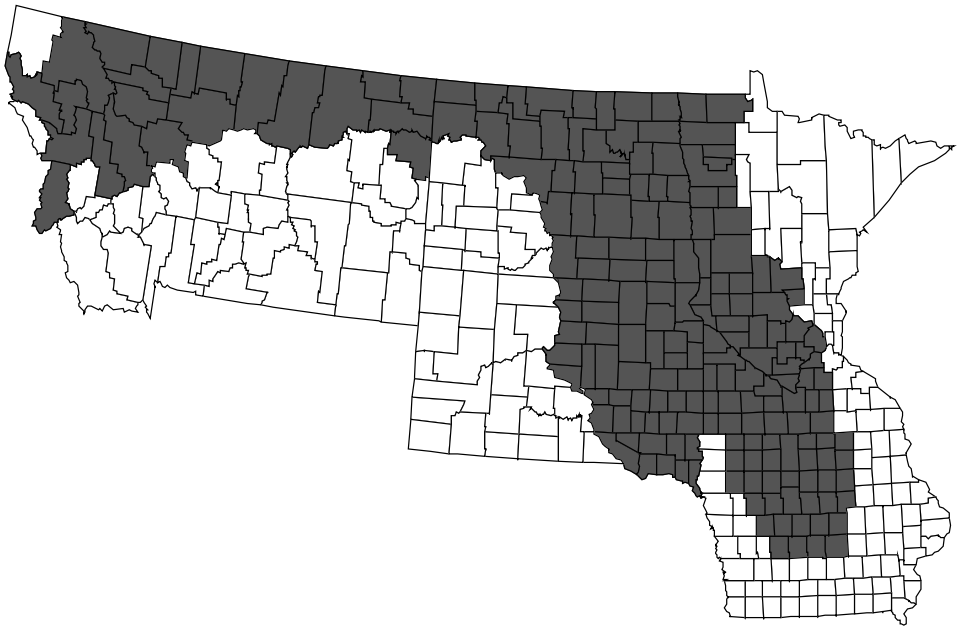

Figure 2. The Prairie Pothole National Conservation Priority Area (shaded counties)