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Land Economics, Volume 90, Number 1, February 2014, pp. 1-25 (Article)

Published by University of Wisconsin Press

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ABSTRACT. *We explore how a landowner's bid to enroll in the Conservation Reserve Program (CRP) is influenced by his parcel's designation as a Conservation Priority Area (CPA). A theoretical model of a landowner's optimal bid is presented, and we demonstrate the ambiguity in a landowner's optimal bid response to CPA designations. The bid choice is analyzed using a data set of accepted and unaccepted offers during three CRP sign-up periods. We focus empirically on a subset of offers from the Prairie Pothole CPA to identify whether bid responses to exogenous location factors differ across landowners with varying opportunity costs to enrollment.* (JEL Q15, Q18)

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 30 million acres—a land mass about the size of Mississippi—at an annual cost near $1.7 billion. CRP participants are owners or operators of agricultural land that contract with the U.S. Department of Agriculture (USDA) to idle their cropland from production and agree to install conservation-type covers for a period of 10 to 15 years. Participants receive an annual payment, and for funding these payments, U.S. taxpayers receive ecosystem services that include enhancements to wildlife habitat, carbon sequestration, and benefits deriving from reduced soil erosion. The program has been evaluated as having substantial positive benefits on net, yet perennially high local enrollment of large-scale cropland retirement is associated with negative effects on some rural communities, including losses of jobs and farm-related businesses (Sullivan et al. 2004). Anecdotally, the rural outmigration associated with CRP is said to permeate even to threaten the institution of six-man football in small towns like Geraldine, Montana (Hardin 2003).

The mechanism by which land is enrolled in the CRP has evolved over time. It now consists of an elaborate bidding system in which landowners can make enrollment more likely by offering to idle crop production on land whose characteristics program administrators deem desirable, by agreeing to engage in efforts that enhance the ecosystem services of the parcel, and by reducing the payment they receive. The evolved details of the bidding system are codified in the Environmental Benefits Index (EBI), a scoring system that weights the putative ecosystem services from a parcel and the rental rate demanded by the land owner. A portion of each parcel's EBI score is predetermined by the federal government in the establishment of EBI factors and weights and is, therefore, exogenous to the landowner. For example, land enrolled from areas determined to have particular conservation value, such as Conservation Priority Areas (CPAs), is given bonus points in the EBI. These points produce an advantage in acceptance for the offers that receive them. But part of the EBI score constitutes an endogenous choice by the landowner. Most notably, the per-acre rental rate bid by a landowner in his offer enters into the EBI with a negative weight, and the more expensive par-

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Land Economics • February 2014 • 90 (1): 1–25
ISSN 0023-7639; E-ISSN 1543-8325

cels are moved down the priority list for enrollment. The straightforward implication of this mix of exogenous and endogenous components of the EBI is that a landowner's bid to enroll in the CRP will be chosen strategically to adapt to changes in the scoring mechanism. When the EBI is revised to induce more enrollments from certain areas, 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 a landowner's bid to enroll in the CRP is influenced by his parcel's designation as a CPA. We present a theoretical model of a landowner's optimal bid and demonstrate that the theoretical model results in an ambiguity in a landowner's optimal bid response to CPA designations and other such exogenously determined points. The bid choice is explored using a data set of the approximately 270,000 accepted and unaccepted offers from three CRP sign-up periods in 1997, 1998, and 2000. We focus empirically on a subset of offers from the Prairie Pothole CPA and cluster offers by crop reporting district (CRD) to identify whether bid responses to exogenous EBI points differ across landowners from regions with varying opportunity costs to enrollment.

II. HISTORICAL PERSPECTIVE AND PREVIOUS ANALYSES OF THE CRP

There have been over 43 CRP enrollment periods, or sign-ups, since the program's inception in 1985.[1] Qualifying agricultural lands—those with a previous cropping history and that meet certain soil and erodibility criteria—are enrolled under either general sign-up or continuous sign-up guidelines. Both sign-up types require landowners to install and maintain one or more conservation-type covers on the parcel during the idle period. In exchange, landowners are paid annually a per-acre rental rate for each parcel enrolled and a maintenance payment to partially offset the costs of maintaining the established cover. The distinguishing features of each sign-up type are the land and cover types targeted and the enrollment process each employs. General sign-up enrollments are typically whole fields or large portions of fields idled to one or more covers such as native and introduced grasses, trees, wildlife habitat, and wildlife food plots. The continuous sign-up focuses on practices and covers to mitigate wind and water erosion on smaller portions of fields, such as riparian buffers, shelterbelts, and other field and stream borders. Landowners with eligible parcels can enroll in the continuous sign-up at any time at a known rental rate; however, general sign-up enrollments occur less frequently and include a competitive bidding process where enrollment is not certain.[2] In the general sign-up, landowners are provided an incentive to lower their bids; there is no such incentive in the continuous sign-up. This paper's focus is the general sign-up CRP.

Since its inception in 1985, the general sign-up CRP has undergone important changes in how it enrolls land and the information provided to landowners during bidding. The first nine sign-up periods were general sign-ups between the spring of 1986 and summer of 1989. Administered in the context of the 1985 farm bill, the program's primary objective was to reduce soil erosion.[3] Multicounty "bid pools" were established, each with a predetermined number of acres to enroll and an undisclosed maximum bid for all offers within the pool. During the offer solicitation period, the USDA did not provide information to landowners about how their offers would be prioritized for enrollment. A landowner simply identified the parcel he wanted to enroll and submitted a bid and conservation cover proposal. Enrollment for each

[1] The 43rd sign-up was a general sign-up period through April 13, 2012, and enrolled 3.9 million acres.

[2] A historical and institutional accounting of the program is provided by Jacobs (2010).

[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.

bid pool was accomplished by selecting the lowest per-acre bid prices from among the offers received.

The research that focused on CRP bidding behavior during these initial sign-up periods found that landowners who made offers to enroll did not account for expected future onsite productivity gains from reduced soil erosion in their bids (Miranda 1992) and were bidding in excess of their opportunity cost (Shoemaker 1989), resulting in higher program costs than what would have been required had landowners bid their opportunity cost (Reichelderfer and Boggess 1988; Smith 1995).[4] Miranda (1992), Shoemaker (1989), and Reichelderfer and Boggess (1988) offered the explanation that landowners submitted bids in excess of their true opportunity cost in order to learn the maximum competitive bid and extract rents from the program. Their explanations suggest that learning influences bid behavior by reducing uncertainty, but they did not test directly for learning. Smith (1995) used mechanism design theory under assumptions of information asymmetry to identify whether an offer system or auction to enroll lands is least-cost given the bid pools approach to enroll land into the CRP. Smith showed that a nonlinear price schedule based on farm size is optimal when the marginal return to land increases with farm size, but absent that, the government may not be able to do better than a single enrollment price (bid) per county. The research from this period lent support for county-based pricing schemes as an alternative to the multicounty bid pools.

Sustainable agriculture emerged as a theme in the commodity and conservation titles of 1990 farm bill, and the CRP's objectives were expanded to include improvements in surface water and groundwater quality along with reductions in soil erosion. Given the early criticisms over the use of the bid pools for general sign-ups 1–9 and the program's targeting of multiple objectives, an index was developed (initially black box) and used in general sign-ups 10–13 that allowed the USDA to prioritize offers based on their ratio of expected environmental benefits to cost (Osborne 1993; Thurman 1995).[5] Subsequently, research efforts turned to understanding the CRP's ability to target multiple objectives in a cost-effective manner. Babcock et al. (1996, 1997), using county average CRP bids to identify heterogeneity in the agricultural productivity of enrolled lands and measures of the environmental quality of land, showed that wind erosion benefits are negatively correlated with land values, while other environmental indicators such as surface water quality and water erosion are positively correlated with land values. They concluded that when the targeted environmental benefits are positively correlated with land productivity, maximizing the acres enrolled in the CRP based on cost alone, like the targeting of the first nine sign-ups, will perform poorly in terms of capturing environmental benefits.

To this point, work that considered bidding behavior in the general sign-up CRP and strategies to target multiple program objectives advocated for an enrollment mechanism that prioritizes enrollments based on maximizing enrolled land's benefit-to-cost ratio. As a result of the language in the conservation title of the 1996 farm bill and the USDA's interpretation of the program's parameters, a new index—the EBI—was developed that permit-

[4] Miranda (1992) used offers data from the first sign-up to examine whether or not landowners formulate their offer to account for future on-farm productivity gains that result from reduced soil erosion in the postcontract period. Other work that followed also incorporated the idea that landowners should account for soil productivity gains when the land reverts to production. Intuitively, we expect that landowners consider the benefits to future productivity from reduced soil erosion, increased soil organic matter, and so forth. In the current EBI scoring mechanism, the N3 factor (see Table 1) assigns points to cover types based on the expectation that soil productivity gains accrue; however, there has been no formal identification in the literature that soil productivity does actually increase in the postcontract period.

[5] The precise ranking criterion of the index was "black box" in the sense that the rules for determining each offer's rank or score were not released. However, we do know that the index comprised seven conservation and environmental goals: (1) surface-water quality improvement, (2) potential for groundwater improvement, (3) soil productivity preservation, (4) providing assistance to farmers negatively affected by conservation compliance, (5) encouragement of tree plantings, (6) preference for hydrologic unit areas identified by the Water Quality Initiative, and (7) enrollment in CPAs. Acceptance into the CRP was determined by the Consolidated Farm Service Agency based on eligibility criteria and some comparison of the landowners bid and a cropland rental rate target.

ted the USDA to prioritize general sign-up offers by a cost-adjusted environmental benefits measure. The EBI includes five environmental factors and a cost factor, and it expands upon the prior index to include measures of expected benefits to wildlife and air quality. [6] The environmental score is based on the parcel's physical properties and on the conservation cover chosen by the landowner; the environmental score is known to the landowner when he submits his offer to enroll. The cost score is based on the rental rate bid by the landowner and parameters set by program administrators, and it is undetermined until after all offers are evaluated by the USDA.[7] For each offer, a maximum rental rate is calculated based on the parcel's county and the Natural Resources Conservation Service rental values, which are intended to reflect the dryland cash value of the predominant three soil series in their most productive use. Because the maximum rental rate for a parcel is specific to the county-and-soil-series combination, the maximum values for parcels even within the same county differ significantly.[8] When formulating a bid, the landowner knows his parcel's environmental score and must bid at or below his parcel's maximum rental rate. Enrollment in the general sign-up CRP is competitive, and a landowner can receive additional cost-factor EBI points for lowering his bid, a strategy that increases the likelihood that his offer will be accepted. The offer's total EBI score is the sum of its environmental and cost scores.

As with the program's prior enrollment schemes, identifying whether enrollment into the CRP by way of the EBI would achieve the program's goals in a cost-effective manner remained a research priority. Bids analyzed from general sign-ups following implementation of the EBI revealed that landowners condition their bids on the environmental component of their EBI score (Marra and Vukina 1998; Kirwan, Lubowski, and Roberts 2005; Vukina et al. 2008), and bids may include a premium above the "true" reservation rental rates for additional EBI points above a perceived minimum or threshold score (Kirwan, Lubowski, and Roberts 2005). At least a portion of a bid's premium may be attributed to the value landowners place on the perceived environmental benefits, particularly because higher EBI scores may signal improvements in the parcels' future productivity (Marra and Vukina 1998; Vukina et al. 2008). Kirwan, Lubowski, and Roberts (2005) also observed that estimated premiums implicit in the bids increased over time and stated that the behavior is consistent with diminished uncertainty over the minimum critical EBI score needed to gain acceptance, a sort of learning over time.

In the present paper we analyze changes in landowners' bids when the offers' probability of acceptance is exogenously increased. The theoretical model follows closely that of Kirwan, Lubowski, and Roberts (2005), Marra and Vukina (1998), and Vukina et al. (2008), positing that landowners condition their bid on their perceived probability of acceptance based on expectations of their EBI score. Our model does not attempt to place structure on

[6] The EBI used for general sign-ups 15, 16, 18, and 20 had six environmental factors. These are provided in Table 1. In the twenty-sixth general sign-up and those since, only the first five environmental factors (N1 through N5) remain. The sixth—the CPA—was absorbed into the other ranking factors and acts as a "multiplier" of other expected benefits.

[7] The cost-factor formula contains parameters set by the administrators after all offers have been received. A landowner's bid score is a linear transformation of his bid relative to a maximum per-acre dollar value set by the program's administrators after all offers in a sign-up have been submitted. The formula is $[a(1 - r/b) + \textit{cost share points} + \textit{points below maximum rent}]$, where a weights the bid score in the overall EBI score and b sets a single maximum rental rate the USDA will pay for any acres in the CRP. Both are set by the USDA and unknown to landowners at the time of bidding. For sign-ups 16, 18, and 20, $a = 125$ and $b = 165$. A landowner can receive 10 points for not requesting cost sharing of the conservation cover installation and can receive 1 point for every whole dollar discount in his bid relative to the parcel's maximum soil rental rate, up to 15 points. The parcel's maximum rental rate is determined by the county of the parcel, the predominant three soil series on the parcel, and the rental rate assigned to each of the soil series.

[8] A county committee assigns soil-specific rental rates in the CRP to individual soil series. These are intended to reflect the dry-land cash rental rate of the soil. A soil series in one county may not have the same rental rate as the same soil series in an adjacent county or in another state. A parcel of land may contain one or several soil series, but the predominant three are used to establish the weighted average soil rental rate. Therefore, the weighted soil rental rate and county combination results in a parcel-specific maximum bid in the CRP.

perception formulation but accommodates the situation where a landowner adjusts his bid based on his EBI score, expectations about program parameters, and learning. As in previous work, our empirical model makes explicit the relationship between a landowner's EBI score and his bid. We extend previous empirical work by isolating an exogenous component of the total EBI score—CPA points—to identify landowners' optimal bid responses due to an exogenous increase in their probability of acceptance. We allow the bid response to more EBI points to be positive or negative to exploit the ambiguity from the theoretical model.

III. THEORETICAL FRAMEWORK

A landowner maximizes his expected returns from enrolling in the CRP by choosing his bid in an environment of uncertainty over the program parameters, which are determined by the government. The bid a landowner makes is conditional on what he observes when his offer is submitted, which includes the offer's environmental score, the parcel's maximum soil rental rate, his expectation of and preferences for on-farm and off-farm conservation benefits, and his subjective evaluation of the strength of his offer relative to the other offers against which his competes.

The Government's Problem

The CRP is an entitlement program, and as such, it enrolls land with a target number of acres in each sign-up.[9] The government wants to enroll $\overline{A}$ acres by choosing offers with the highest total EBI scores (e), where e is computed using the landowner's bid (r) and his offer's environmental provision ($\overline{N}$), fixed at the time the offers are reviewed. An offer's total EBI score is calculated using the following rule:

$$e(r,\overline{N}) = \beta_r r + \beta_N \overline{N}, \qquad [1]$$

where $\beta_r < 0$ and $\beta_N > 0$ are program parameters set by the government that determine how the bid (cost) and conservation provisions are scored.[10] The cost scoring parameter β_r is set after offers are collected but prior to scoring; the environmental scoring parameters that determine β_N are set prior to the sign-up and known to landowners before they submit their bids. In this way, r and $\overline{N}$ are substitutes in the production of the total EBI score. Letting $g(e)$ describe the distribution of bids and acreage offered, the total acreage offered from the distribution of EBI scores is

$$\int_0^{\infty} g(e)de.$$

The government may not know $g(e)$ but accepts offers with the highest total EBI scores until $\overline{A}$ acres are enrolled, thus choosing the cut-off EBI (e^*) that enrolls $\overline{A}$ acres:

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

The Landowner's Problem

The landowner's problem is two-staged and 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.[11] If the landowner does not participate in the CRP, either because his offer was rejected or because he does not submit an offer, he receives an expected annual profit, denoted $E(\pi)$. If instead, the landowner submits an offer and is successful in enrolling into the CRP, he receives an annual return (R^{CRP}):

[9] The USDA knows current and expiring CRP acreage at any given time and decides how large the next general sign-up will be subject to the acreage limits set forth in the farm bill.

[10] This is an abstraction from the complex EBI formula but reflects the true form of the index in that the EBI is the sum of cost and noncost components. The cost component is linear in the landowner's bid.

[11] The alternative use for the land is assumed to be agricultural production. CRP rules require enrolled land to have a recent cropping history or have been continuously enrolled in the CRP. Other land use choices can be modeled in this framework without altering the results.

$$R^{\text{CRP}} = r + b(\overline{N}),$$

where $b(\overline{N})$ denotes the landowner's annual private net nonpecuniary benefit of participating in the CRP over the alternative.[12] Program rules cap the landowner's bid at the parcel's maximum rental rate ($r^{\max}$), a per-acre maximum annual rent known to the landowner and based on the productivity of the parcel's three predominant soil series and county cash rent values.[13] Subject to the restriction that $r \leq r^{\max}$, a landowner will not bid a rental rate that would leave him worse off in the program than out. Thus, the choice of r must satisfy a participation condition:

$$R^{\text{CRP}} \equiv r + b(\overline{N}) \geq E(\pi), r \leq r^{\max}. \quad [2]$$

Equation [2] implies that a landowner must be able to bid at least his expected returns from production less the nonrent benefits from participating in the CRP, or a bid will not be observed.

Subject to the participation condition and rent restriction in equation [2], the second-stage decision is over the choice of an optimal bid (r_0), and therefore an optimal EBI score (e_0), that maximizes the expected returns to enrollment. The landowner knows there is a trade-off between the increased CRP return that accompanies a higher bid against the lower probability of acceptance implied by the EBI score parameters. Ex post, the offer is accepted if the EBI score (e_0) is at least that of the cut-off EBI (e^*), so that $e_0(r_0,\overline{N}) \geq e^*$, and it is rejected otherwise; this is deterministic. Ex ante, the landowner is uncertain about the number of acres to be enrolled ($\overline{A}$) and the cost scoring parameter (β_r) and, therefore, does not know e^* with certainty.

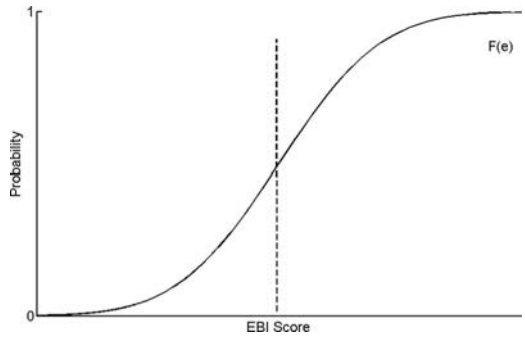

FIGURE 1
A Landowner's Probability of Acceptance into the Conservation Reserve Program Is Increasing in the Environmental Benefits Index (EBI) Score

Confronted with uncertainty over the parameters established by the government, the landowner's perceived probability of acceptance, denoted $F(e_0)$, depends on his parcel's environmental score, his beliefs about how his bid will be scored, and his beliefs over the strength of his parcel's score relative to other applicants' scores. The USDA enrolls offers with the highest total EBI scores first; therefore, a landowner's perceived probability of acceptance is increasing in his score ($F'(e_0) > 0$) and decreasing in his bid. Figure 1 provides one view of how a landowner might perceive the distribution of offers. The landowner cannot know for sure where his EBI score is in the distribution. However, learning about the program parameters from repeated experiences or shared information from others who have experience can influence a landowner's offered rental rate. If a landowner learns more about how his offers compare with others in the distribution, he incorporates that information into his bid decision. While we do not test explicitly for the effects or presence of learning, we presume,

[12] The net nonpecuniary benefits ($b(\overline{N})$) are unobserved by program administrators but known to the landowner. They include his expected increase in future on-farm productivity and measures of the private benefits associated with conservation and open space amenities that result from enrolling land in the CRP net of enrollment and practice-installation costs. A standard assumption with regard to these benefits is that the landowner has private information about the future on-farm and other benefits that accrue as a result of CRP enrollment (Marra and Vukina 1998; Vukina et al. 2008).

Landowners make a 10-year decision when submitting an offer to enroll in the CRP. Because both expected returns to agricultural production and the return to CRP enrollment are discounted by the same rate over the same horizon, we do not explicitly account for discounting in the theoretical model. The theoretical results would not change if discounting were incorporated explicitly.

[13] It is a common misperception that landowners in a county face the same maximum bid price or that a landowner's bid score in the EBI depends on his bid relative to a county average. This is not the case in a general sign-up after sign-up 13. Each bid submitted has a unique soil-specific maximum rental rate that is known to the landowner when he makes the offer. The components of the scoring formula are provided in note 7 and in Table 1.

as in previous work, that it is present and encapsulated in the bidding process. Further, we carry forward the result of our theoretical model that learning does not necessarily imply that a landowner will increase his bid, only that more is revealed about the government's parameters and other EBI scores against which his competes.

Optimal Rental Rate Choice and the Implied Optimal EBI

For a fixed level of conservation services ($\overline{N}$) provided by a parcel, the EBI formula in equation [1] determines a parcel's EBI score as a linear function of the landowner's bid. We characterize the landowner's problem as a choice of EBI score (e_0) that maximizes his expected returns to participating in the CRP, expressed as

$$\max_{e_0} ER = F(e_0)(r_0 + b(\overline{N})) + (1 - F(e_0))E(\pi).$$

The problem can be recast to include the explicit trade-off between his bid and EBI score from equation [1]:

$$\max_{e_0} ER = F(e_0)\left(\frac{e_0 - \beta_N \overline{N}}{\beta_r} + b(\overline{N})\right) + (1 - F(e_0))E(\pi). \quad [3]$$

Assuming an interior solution, the first-order condition (FOC) is

$$\frac{dER}{de_0} \equiv F'(e_0)\left(\frac{e_0 - \beta_N \overline{N}}{\beta_r} + b(\overline{N}) - E(\pi)\right) + F(e_0)\frac{1}{\beta_r} = 0. \quad [4]$$

The FOC expresses the equality of the marginal benefit (MB) and marginal cost (MC) due to a change in the bid and thus (e_0), expressed as

$$\text{MB} \equiv F'(e_0)\left(\frac{e_0 - \beta_N \overline{N}}{\beta_r} + b(\overline{N}) - E(\pi)\right)$$

$$\text{and MC} \equiv F(e_0)\frac{-1}{\beta_r}.$$

For a given $\overline{N}$, the landowner's marginal benefit to increasing his EBI score (e_0), accomplished by decreasing his bid (r_0), is a "probability of acceptance effect": the landowner substitutes a lower rental rate for a greater probability of acceptance that results from the higher EBI score. This is nonnegative by the participation condition in equation [2]. The marginal cost of increasing e_0 is a "rental rate effect": an increase in EBI score, achieved by reducing the bid, implies a reduction in CRP payments if the offer is accepted. A landowner will reduce his bid to increase his EBI score to the point at which the marginal benefit of doing so is just equal to the marginal cost. Corner solutions are possible when the marginal benefit of a change in EBI score equates to the marginal cost given a bid lower than the maximum bid ($r_0 > r^{\max}$). But participation is not ruled out if the participation condition is satisfied and the marginal benefit exceeds the marginal cost for a bid at its maximum ($r_0 = r^{\max}$).

The goal is to understand what the theoretical model predicts will be a landowner's optimal bid adjustment in response to an exogenous increase in his environmental score through an increase in $\overline{N}$. The total differential of equation [1] characterizes this response:

$$\frac{dr_0}{d\overline{N}} = \frac{1}{\beta_r}\left(\frac{de_0}{d\overline{N}} - \beta_N\right). \quad [5]$$

Given the parameter restrictions assigned previously, the direction of the bid change due to an increase in environmental points, $dr_0/d\overline{N}$, depends on the sign and size of the adjustment in the EBI score from an increase in environmental points. The total differential of the FOC in equation [4] implies that a landowner's EBI adjustment, accomplished by a bid response, in response to a change in $\overline{N}$ is

$$\frac{de_0}{d\overline{N}} = \frac{F'(e_0)\frac{\beta_N}{\beta_r}}{F''(e_0)\left(\frac{e_0 - \beta_N \overline{N}}{\beta_r} + b(\overline{N}) - E(\pi)\right) + 2F'(e_0)\frac{1}{\beta_r}}. \quad [6]$$

The denominator in equation [6] is the second-order sufficient condition for a maximum, guaranteed to be negative at the optimum by concavity conditions, and the entire expres-

sion is positive. An exogenous increase in a parcel's environmental score unambiguously increases the parcel's EBI score. However, the bid change expressed in equation [5] cannot be signed and depends on the size of the EBI adjustment relative to the program's other parameters. Further, it can be shown that $d^2 r_0/d\overline{N}^2 > 0$, which says that landowners with higher environmental scores have more positive bid responses to further increases in their environmental score. The major result we highlight is that an exogenous increase in a parcel's environmental score leads to an ambiguous adjustment in the landowner's bid (r_0) but an unambiguous increase in the parcel's overall EBI score (e_0). The composite effect of an exogenous increase in environmental points and an optimal positive or negative bid adjustment is a higher EBI score and, therefore, a higher probability of acceptance.[14]

The ambiguity of the bid response to an exogenous change in $\overline{N}$ makes it a fundamentally empirical question. That the theoretical model cannot predict the direction of response has important practical implications to program administrators and underscores the competitive incentives conveyed by use of the EBI during general sign-ups. Prior research on CRP bidding behavior observed increases in bids over time and estimated premiums to landowners in excess of their true opportunity cost in the CRP, positing that learning over time resulted in less uncertainty in bidding, which led high-EBI landowners to increase their bids. This model and the comparative statics that derive from it give footing to counter the view that CRP bidders are not incentivized to reduce their bids in the current offer selection scheme.

[14] The ambiguity of the effect on r_0 from a change in $\overline{N}$ derives from 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 of EBI scores 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 $\overline{N}$ can be negative. Conversely, the new position in the distribution occasioned by the increase in $\overline{N}$ could result in low expected gains to further bid reductions.

IV. IDENTIFICATION, DATA, AND EMPIRICAL MODEL

We test the ambiguities of the theoretical model using contract-level CRP offers data to investigate how an exogenous change in EBI points affects landowners' bids. We accomplish this by exploiting the structure of the EBI. The EBI used for general sign-ups 16, 18, and 20 was subdivided into six environmental ranking factors (N1 through N6) and a cost factor (N7). Each environmental ranking factor provides a basis for scoring the offer based on three criteria: the parcel's physical characteristics, its location, or what the landowner proposes to do on the parcel (the conservation cover or practice choice). Parcel characteristics and location are exogenous to the landowner and fixed; the conservation practice he proposes to install represents an endogenous choice. Table 1 provides a description of the ranking factors and the criteria type for each. For example, the N1 factor points an offer receives—points presumed to indicate the offer's provision of wildlife habitat benefits—depends on all three types of criteria: the cover established, the parcel's characteristics, and the location of the parcel. Thus, N1 points are both endogenous and exogenous to the landowner. The only ranking factor for which points are determined solely by a parcel's location during general sign-ups 16, 18, and 20 is the N6 component: CPAs. CPAs are designated regions in which an environmental concern (air, water, or wildlife related) has been identified. In the EBI, the N6 priority-area factor awards 25 points to eligible offers inside a designated priority area. CPA boundaries are county boundaries, and offers from a county designated as being in the CPA can receive the priority-area points. Thus, the CPA ranking factor permits a clean identification strategy for testing bid responses to exogenous EBI points. The priority area we explore here is the Prairie Pothole CPA.

Data

Offers from the Prairie Pothole region of the United States to enroll in the CRP for general sign-ups 16, 18, and 20 are used to im-

TABLE 1
General Sign-up EBI Factors and Subfactors

N-Factor	Description	Explanation	Criteria Type(s)	Sign-up 16	Sign-up 18	Sign-up 20
N1	Wildlife habitat benefits	Up to 50 points for the cover established and other points for proximity to permanent water, restored wetlands or protected habitat, benefits to endangered species, and food plots	Cover, location, parcel	(0–100)	(0–100)	(0–100)
N2	Water quality benefits	Up to 40 points based on sheet/rill index and proximity to population served by watershed; up to 20 points for soil leach index and proximity to population served by groundwater; points for cropped wetland criteria and state water areas	Location, parcel	(0–100)	(0–100)	(0–100)
N3	On-farm benefits	Uses higher of wind or water erodibility index	Parcel	(0–100)	(0–100)	(0–100)
N4	Long-term (enduring) benefits	Likelihood that practice will persist beyond contract period (wetlands, trees)	Cover, location	(0–50)	(0–50)	(0–50)
N5	Air quality benefits	Uses downwind population calculation by ZIP code and parcel's wind erodibility factors	Location, parcel	(0–35)	(0–35)	(0–35)
N6	Conservation Priority Area (CPA)	Parcels in CPAs; must receive at least 40% of the points available in the corresponding ranking factor	Location	(0, 25)	(0, 25)	(0, 25)
N7	Cost	Uses formula to convert offered rental rate: $[a-(a/b\times r)]$ + cost share points + below max points	—	(0–150) $a=125$ $b=165$	(0–150) $a=125$ $b=165$	(0–150) $a=125$ $b=165$
	Cost share	Points for not requesting cost share assistance	—	(0,10)	(0,10)	(0,10)
	Below maximum rent	1 point for each $1 the rental rate offered is below the maximum SRR (up to 15 points)	—	(0–15)	(0–15)	(0–15)

Note: SRR, soil rental rate.

plement empirical tests of the theory. The data contain each offer's environmental ranking scores for N1 through N6, its parcel's maximum rental rate, and the landowner's bid price. The advantage of these data over county averages or information from only the accepted offers is that we observe the behavior of all landowners who attempt to enroll in the program, not just landowners who are successful in enrolling. These sign-ups were selected because they represent three coterminous general sign-ups in which the EBI scoring rubrics were the same. Further, the EBI weights and points were unchanged over these sign-up periods, so we can be sure that landowners' bidding behavior is not confounded by effects on bids due to known changes in the environmental component scores.

The Prairie Pothole region (see Figure 2) was established as a priority area in the CRP prior to the sixteenth general sign-up and covers portions of Iowa, Minnesota, Montana, North Dakota, and South Dakota. Combined, these states account for approximately 35% of the land enrolled in the CRP. In the Prairie Pothole CPA, The priority of concern in the Prairie Pothole region is in preservation or reestablishment of "potholes" left behind by glacial recessions. In their natural state, the potholes act as important aquatic reserves; they enhance drainage systems, are rich in plant and aquatic life, and provide breeding, nesting, and migratory support to waterfowl

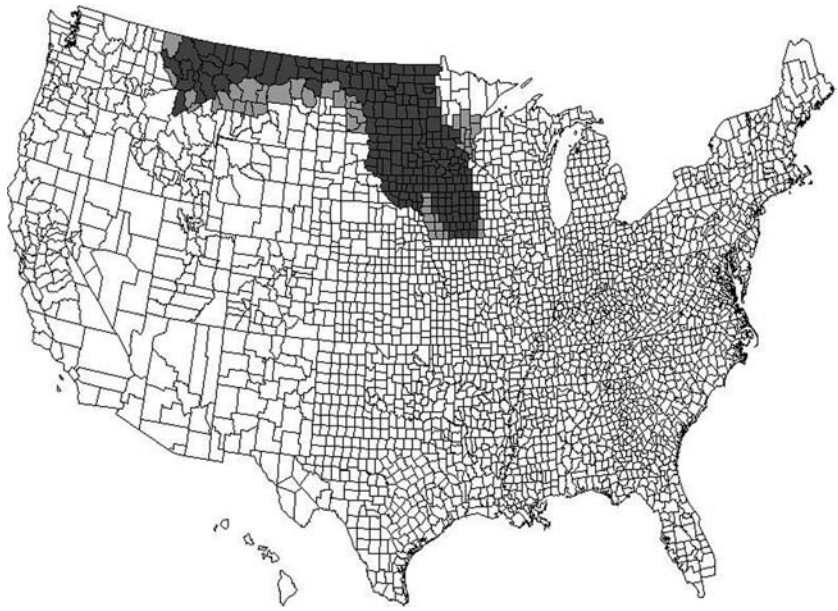

FIGURE 2
The Prairie Pothole National Conservation Priority Area (Darkest-Shaded Counties)

species. Other priority areas have been established, such as the Longleaf Pine and the Chesapeake Bay CPAs. The Prairie Pothole region is chosen for our analysis because it overlaps with a substantial agricultural production region that historically has consistent participation in the CRP.

The CRP's Prairie Pothole CPA is defined using county boundaries, so each county can be identified as being either a "Prairie Pothole county" or a "non–Prairie Pothole county." To identify the effects on bids from changes in exogenous EBI points, we exploit that the CPA uses as its boundaries county lines and group together for our analysis offers from Prairie Pothole counties and non–Prairie Pothole counties that all are also in the same CRD. A CRD, as defined by the National Agricultural Statistics Service, is a grouping of contiguous counties within a state that have common agricultural production characteristics. We assume that landowners within a CRD, regardless of whether they are in a Prairie Pothole–designated county or not, are homogenous in their factor input prices, output prices, production alternatives, weather risk, and other characteristics that are known in practice to matter to the CRP participation decision. Our analysis examines offers within a single CRD in a single sign-up period by comparing offers that received the 25 priority-area points (N6 factor points) with those in the same CRD that did not.[15] Our data do not identify other land and owner characteristics that may matter to CRP participation, such as age of operator, succession and estate plans, total farm size, and spread of the farming operation.

[15] We are not attempting to explain changes in participation due to CPAs or other exogenous points, but rather changes to bidding behavior conditional on being inside or outside the CPA. If participation is increased or decreased because of the CPA points, then we want to capture the bidding behavior. By comparing bids across counties on opposite sides of CPA boundaries, we measure the effect of CPA designation on the bids of those who would select into the bidding process with or without CPA designation, but also include the effect of CPA designation on bidding participation. This combining of the two effects is policy relevant in that it estimates the total budget-and-enrollment-relevant response to a counterfactual change in CPA designation. We are grateful to a reviewer for pointing out the two possible channels of influence from such a counterfactual change in designation.

To see how Prairie Pothole ($PP = 1$) and non–Prairie Pothole ($PP = 0$) offers differ within the CRDs, we report for each summaries of bids, maximum rental rates, discounts in bids from their maximums, and the environmental component of EBI scores in Table 2.[16] The reported environmental score here includes the sum of the factor points for N1 through N5 and does not include the CPA points (N6). Recalling that low bids (rental rates) and high environmental scores substitute in producing a high EBI score, it is useful to differentiate CRDs as high-rent or low-rent and having high or low environmental scores. Generally speaking, CRDs in Iowa and CRD 2750 in Minnesota are high-rent areas with high environmental scores, while CRDs in Montana and North Dakota are low-rent areas with relatively low environmental scores. CRD 2710 in Minnesota and CRDs 3050 and 3030 in Montana are low-rent with environmental scores higher than the other low-rent CRDs. Offers from the high-rent CRDs, despite their disadvantage in the cost component of the EBI, have high environmental scores and are able to participate in the CRP as a result. Conversely, offers from the low-rent regions have lower environmental scores but get an EBI boost from the cost factor that allows them to participate. It is basically true that the priority-area offers in high-rent CRDs have higher maximum rental rates than do the non-priority-area offers but have bids that are more heavily discounted relative to their maximums. Conversely, Prairie Pothole offers in low-rent regions tend to have bids closer to their maximums and lower maximum rental rates compared to non–Prairie Pothole bids and maximum rental rates.

The pattern that emerges is that offers from CRDs with the highest bids are more discounted from their maximum rental rates and also have the highest environmental EBI points. Also, landowners who receive the Prairie Pothole CPA points, when compared with those who do not, bid a greater discount from their maximum if they are from a high-rent region with high environmental scores but discount less if from low-rent regions with also lower environmental scores. To determine whether Prairie Pothole bids are statistically different on average from bids outside the CPA in the same region, we conduct equality of means tests on the average maximum rental rates, bids, and bid discounts for each CRD. Test statistics and significance levels of the tests are provided in Table 3; equality of the maximum rental rates and bids is rejected in all CRDs.[17] The idea that average bids and the discount in bids from their maximum rate within even a small geographical area such as a CRD are the same is not supported by the data. Further, these statistics suggest that the bid response may depend on whether the landowner is in a high-environmental-score or a low-environmental-score situation, a result predicted by the theoretical model and comparative statics results in equation [6].

Submitted offers compete in a national pool for limited acres based on their total EBI score. In every general sign-up that has occurred since and including sign-up 15, there have been more acres offered for enrollment than accepted. In addition to this nationally competitive factor where enrollment is capped at some ex-ante unknown level, the program statutes limit total county enrollment at any given time to a maximum of 25% of a county's agricultural land. This creates a local constraint, and stronger local competition influences the bidding behavior of landowners. Landowners know there is a maximum enrollment per county and, beyond their own observation about local CRP acres, have access to information about how competitive CRP acreage in their county may be, the current enrollment, and contract expirations, either online or by way of Farm Service Agency staff. To the extent that landowners seek out this information or casually observe it, it will be incorporated into their subjective evaluation of their own probability of acceptance through $F(e)$, and their bids may be conditioned accordingly.

[16] Sign-up 18 is provided as a sample to highlight the data and its characteristics. Summary statistics for sign-ups 16 and 20 are similar and available upon request.

[17] The tests were conducted with and without the assumption of equal variances using a standard pooled *t*-test and Satterthwaite's test when variances are not equal.

TABLE 2
Summary Statistics of CRP Offers by CRD, Sign-up 18

State	CRD	*PP*[c]	Number of Offers	MRR[a] ($)		Bid ($)		Discount of Bid from MRR ($)		EBI Score[b]	
				Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
IA	1950	0	418	115.76	16.28	105.06	13.57	10.70	11.04	217.8	34.7
		1	340	135.50	14.13	117.04	14.83	18.46	14.87	181.1	38.5
IA	1940	0	472	106.07	15.16	98.50	13.68	7.57	10.74	211.8	33.8
		1	106	133.38	14.40	110.64	15.13	22.74	16.67	174.0	34.6
IA	1910	0	130	107.88	17.19	92.02	14.78	15.86	16.11	179.6	50.0
		1	335	118.85	15.82	98.72	16.34	20.13	16.68	157.7	32.3
MN	2750	0	335	43.62	14.31	41.82	12.54	1.80	3.73	171.5	36.9
		1	446	79.56	18.89	73.14	16.58	6.42	8.10	177.6	34.6
MN	2740	0	32	65.88	6.77	60.23	9.38	5.65	6.65	140.9	28.1
		1	960	68.91	20.01	63.33	17.14	5.59	6.97	154.0	29.4
MN	2710	0	36	38.55	5.26	37.96	5.02	0.59	1.37	185.6	25.9
		1	3,467	43.87	8.10	42.34	7.70	1.53	2.83	166.0	26.7
MT	3050	0	292	33.44	5.26	33.00	5.39	0.45	1.71	159.1	32.5
		1	58	36.57	4.43	36.57	4.43	0.00	0.00	164.5	31.4
MT	3030	0	436	30.67	2.92	30.14	3.04	0.53	1.25	151.4	24.0
		1	1,201	29.94	2.69	29.73	2.78	0.21	0.94	147.5	26.5
ND	3890	0	28	55.78	7.21	51.92	6.55	3.86	4.75	139.5	22.4
		1	1,418	41.32	10.50	40.82	10.18	0.50	1.61	129.1	26.8
ND	3860	0	38	53.02	7.78	51.10	8.07	1.92	3.54	152.9	30.8
		1	862	40.32	6.91	40.01	6.75	0.30	1.23	151.2	22.0
ND	3830	0	213	45.85	5.31	42.20	6.43	3.64	4.96	144.4	25.8
		1	1,212	39.66	7.28	38.18	6.49	1.48	3.38	128.1	21.0
ND	3840	0	267	24.16	2.77	23.98	2.74	0.18	0.63	116.1	30.7
		1	238	32.22	3.17	31.65	3.47	0.57	1.49	114.1	20.4
ND	3880	0	230	26.01	2.14	25.02	2.11	0.99	1.56	110.9	27.0
		1	365	28.57	2.91	28.18	3.17	0.39	1.25	112.9	22.1

Note: CPA, Conservation Priority Area; CRD, crop reporting district; CRP, Conservation Reserve Program; EBI, Environmental Benefits Index; IA, Iowa; MN, Minnesota; MT, Montana; ND, North Dakota.
[a] MRR is the maximum rental rate the landowner can offer; this is unique for each parcel.
[b] The environmental EBI score excludes the priority-area points for factor N6 and cost-factor points.
[c] *PP* = 0 denotes offers that did not receive the Prairie Pothole CPA points; *PP* = 1 denotes offers that did.

We construct the proportion of the county's agricultural land that is enrolled in the CRP at the time of the sign-up to identify the degree of competition for enrollment in the counties within a CRD. Table 4 reports, for each CRD, the range and mean of its counties' proportion of agricultural land enrolled in the CRP just prior to each of the three sign-ups. There are 36 counties represented in the three Iowa CRDs 1950, 1940, and 1910, and among these, only one had enrollment greater than 10% of its agricultural land base prior to the sign-up. During this time, average enrollment in the Prairie Pothole region of Iowa was approximately 4% of agricultural land; therefore, it is unlikely that CRP bidders in Iowa perceived a high degree of competition for CRP enrollment during these sign-ups. However, bidders in counties within CRDs such as 2710 in Minnesota, 3030 in Montana, and 3890, 3830, and 3860 in North Dakota may have perceived a locally competitive market for CRP lands and incorporated such into their optimal bid strategy.

An Empirical Model of the Effects of EBI Points on Bids

The theoretical model identified an ambiguity in landowners' bid responses to exogenous environmental EBI points that we wish to investigate empirically. Summary statistics of bids, bid discounts from the maximum rental rates, and the institutional features of the program suggest an empirical specification to test whether bidding behavior is influenced by the exogenous Prairie Pothole CPA points. We investigate this bidding behavior

TABLE 3
Equality of Means of the Components of Landowners' Bids by CRD, Sign-up 18

State	CRD	*PP*[b]	Number of Offers	Maximum Rental Rate[a] Mean ($)	Maximum Rental Rate[a] *t*-Stat.	Bid Mean ($)	Bid *t*-Stat.	Discount of Bid from Maximum Mean ($)	Discount of Bid from Maximum *t*-Stat.
IA	1950	0	418	115.76	−17.87***	105.06	−11.59***	10.70	−8.01***
		1	340	135.50		117.04		18.46	
IA	1940	0	472	106.07	−16.91***	98.50	−8.1***	7.57	−8.96***
		1	106	133.38		110.64		22.74	
IA	1910	0	130	107.88	−6.55***	92.02	−4.07***	15.86	−2.5**
		1	335	118.85		98.72		20.13	
MN	2750	0	335	43.62	−30.26***	41.82	−30.06***	1.80	−10.6***
		1	446	79.56		73.14		6.42	
MN	2740	0	32	65.88	−2.23**	60.23	−1.77*	5.65	0.05
		1	960	68.91		63.33		5.59	
MN	2710	0	36	38.55	−5.99***	37.96	−5.18***	0.59	−4.03***
		1	3,467	43.87		42.34		1.53	
MT	3050	0	292	33.44	−4.23***	33.00	−4.74***	0.45	4.46***
		1	58	36.57		36.57		0.00	
MT	3030	0	436	30.67	4.55***	30.14	2.47**	0.53	4.82***
		1	1,201	29.94		29.73		0.21	
ND	3890	0	28	55.78	10.39***	51.92	8.76***	3.86	3.37***
		1	1,418	41.32		40.82		0.50	
ND	3860	0	38	53.02	11.03***	51.10	9.83***	1.92	2.8**
		1	862	40.32		40.01		0.30	
ND	3830	0	213	45.85	14.74***	42.20	8.34***	3.64	6.12***
		1	1,212	39.66		38.18		1.48	
ND	3840	0	267	24.16	−30.22***	23.98	−27.33***	0.18	−3.73***
		1	238	32.22		31.65		0.57	
ND	3880	0	230	26.01	−12.33***	25.02	−14.63***	0.99	4.95***
		1	365	28.57		28.18		0.39	

Note: CRD, crop reporting district; IA, Iowa; MN, Minnesota; MT, Montana; ND, North Dakota.
[a] MRR is the maximum rental rate the landowner can offer; this is unique for each parcel.
[b] *PP* = 0 denotes offers that did not receive the Prairie Pothole CPA points; *PP* = 1 denotes offers that did.
* Significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

TABLE 4
Percent of County's Agricultural Land in CRP Prior to Sign-up, by CRD

CRD	Number of Counties	Sign-up 16 (%) Mean	Sign-up 16 (%) Min.	Sign-up 16 (%) Max.	Sign-up 18 (%) Mean	Sign-up 18 (%) Min.	Sign-up 18 (%) Max.	Sign-up 20 (%) Mean	Sign-up 20 (%) Min.	Sign-up 20 (%) 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

Note: CRD, crop reporting district; CRP, Conservation Reserve Program.

by estimating a model that relates the submitted CRP bid (r) to the parcel's maximum rental rate ($r^{\max}$), its environmental EBI score excluding priority-area points (ebi), and the proportion of the county currently enrolled in the CRP ($comp$). We include a Prairie Pothole priority-area dummy variable (PP) that is equal to one if the offer is in the priority area and zero otherwise.[18] By interacting the binary Prairie Pothole variable with the parcel's environmental score, the relationship between the bid and the EBI points is dependent on the offer's CPA designation. The empirical model is

$$r_i = \alpha + \beta_1 r_i^{\max} + \beta_2 ebi_i + \delta_1 PP_i + \delta_2 PP_i \cdot ebi_i + \beta_3 comp + \varepsilon_i, \quad [7]$$

where subscript i indexes individual offers within a CRD.

The identification assumption of our empirical model is that landowners in a CRD on one side of a CPA boundary are not systematically different with respect to the non-CPA determinants of their bidding behavior from those on the other side of the boundary, conditional on the bid-relevant characteristics of the bidder's specific maximum rental rate (specific to bidders because it varies by soil) and conditional on the county's enrollment level (relevant due to the 25% cap in county enrollment in the CRP). The residual heterogeneity in bidding behavior is captured in the model's error term. Our assumption of the exogeneity of CPA designation (conditional on maximum rental rate and county enrollment) is supported to the extent that a CRD is homogenous in its production opportunities and factor markets. Landowners within a few counties of each other face similar factor input prices, output prices, production alternatives, weather risk, and other characteristics that, in practice, are known to matter to the CRP participation decision. This is consistent with the National Agricultural Statistics Service's rationale for grouping counties into CRDs.[19] By conducting our analysis at the CRD level and for each sign-up period separately, we are invoking this assumption.

In the model, the maximum bid a landowner can submit ($r_i^{\max}$) plays an important role as a measure of the parcel's opportunity cost of enrolling in the CRP. The maximum rental rate reflects the dry-land cash value of the land in its most productive agricultural use and is based on the soils present on the parcel. It is also a control for the obvious heterogeneity among offers within a CRD.[20] In this respect, we expect a positive relationship between r_i and $r_i^{\max}$. Another important control variable used here is the degree of competition for CRP enrollment in a county, captured by the covariate $comp$. There are several counties within a single CRD, and each county faces a constraint that no more than 25% of its agricultural land can be enrolled in the CRP at a given time.[21] When landowners perceive this constraint to be effectual, they adjust their own subjective probability of acceptance into the program, altering their optimal bid.

Landowners condition their bid on their offer's EBI score (Marra and Vukina 1998; Kirwan, Lubowski, and Roberts 2005; Vukina et al. 2008), and our model incorporates this. We decompose each offer's environmental EBI score by separating the non-priority-area environmental points an offer receives, ebi_i, from the priority-area points, PP_i, to see if the

[18] Because the priority-area dummy variable implies an additional 25 points in the EBI, we divide each offer's environmental EBI score by 25 for the estimation; this permits a more straightforward comparison of the marginal effects of additional points.

[19] Other land and owner characteristics may also influence CRP bidding and participation, such as age of the operator, succession and estate plans, total farm size, and spread of the farming operation. Controlling for these variables would increase the statistical efficiency of our estimator of the CPA designation effect, but we have no way of identifying the demographic characteristics of bidders in the USDA data.

[20] That an offer's $r_i^{\max}$ reflects the opportunity cost of land also means that it can be used to control for the differences in land quality between two offers—one inside a Prairie Pothole–designated county and one in a county adjacent to a Prairie Pothole county in the same CRD—that are otherwise identical, particularly those differences that arise due to the unique nature of the pothole region that may influence agricultural productivity and returns to it.

[21] The U.S. Secretary of Agriculture can, under special circumstances, approve a county's request to exceed this limit. To our knowledge and based on our data, this allowance has not been exercised in the region we analyze.

priority-area points result in a treatment effect on bids that differs from the marginal effect of other environmental EBI points. Our theoretical results suggest that the marginal effect of exogenous points such as priority-area points on bids can be positive or negative depending on the landowner's subjective evaluation of his offer's strength, in terms of EBI, relative to others. The interaction term (δ_2) captures the treatment effect associated with being in a priority area. Differentiating the empirical model (equation [7]) with respect to both ebi and PP and evaluating the marginal effects at the sample means of each isolates two effects of interest:

$$\frac{\partial r}{\partial ebi} = \beta_2 + \delta_2 \overline{PP} \equiv \eta_1, \quad [8]$$

and

$$\frac{\partial r}{\partial PP} = \delta_1 + \delta_2 \overline{ebi} \equiv \eta_2. \quad [9]$$

The marginal effect of environmental EBI points on the bid (equation [8]) is given by η_1; the marginal effect of priority-area points on the bid (equation [9]) is denoted η_2. We estimate these marginal effects directly by reparameterizing equation [7] via substitution of equations [8] and [9], resulting in the regression equation

$$r_i = \alpha + \beta_1 r_i^{\max} + \eta_1 ebi_i + \eta_2 PP_i + \delta_2[(PP_i - \overline{PP})(ebi_i - \overline{ebi})] + \beta_3 comp + \varepsilon_i. \quad [10]$$

Each CRP sign-up provides a rich cross-sectional dataset, which we exploit to measure the effects of variation in maximum rental rates, CPA designations, and environmental scores across observations on CRP bids. We observe the offers of all landowners for whom the participation condition in equation [2] is met; however, we cannot link a single landowner within the same sign-up period or in other sign-ups. Our empirical identification strategy is to estimate separate models for each combination of three sign-ups and 13 CRDs. Separate analyses by sign-ups allow for time-varying effects, and separate analyses across CRDs hold constant the idiosyncratic geographic factors that cause bidding behavior to vary, thereby identifying the effects within CRDs of designation as a CPA.

Each bid is constrained to be equal to or less than the parcel's maximum rental value ($r^{\max}$). We observe landowners who bid their maximum and others who bid less than their maximum. For those in the former group, we cannot know whether their bid at the maximum is their optimal bid or whether they would prefer to bid a value larger than their maximum if their decision were unconstrained by the program's rules. The result is a nontrivial mass of bids (the dependent variable) that are constrained but otherwise are continuous over other values. This suggests an underlying latent variable and limited dependent variable model, the form of which is

$$r^* = x\beta + u,$$
$$r = \min(r^{\max}, r^*).$$

We observe $r = r^{\max}$ when it is optimal to bid the maximum rental rate and also when a landowner would bid more than the maximum but cannot. We otherwise observe $r = r^*$ whenever the optimal bid is less than the maximum. Optimality relies on the expected returns to participating in the CRP over the expected returns to the next best alternative use for the land. We deal with this complication by estimating maximum likelihood censored regression models (Tobin 1958) for equation [10].[22] Our estimator incorporates observation-specific censoring so that the censored value of the observed bid (r_i) is the parcel's maximum rental rate ($r_i^{\max}$).[23]

[22] The validity of the Tobit estimator depends on the assumption of normality of the disturbance. In the absence of normality, the Tobit estimator has been shown to result in inconsistent estimates (Goldberger 1983). Tests for normality have been proposed (Newey 1987; Vella 1989), but these alternative tests are also problematic in finite sample applications and may not be reliably consistent under the null and alternative hypothesis in many cases (Jeong and Jeong 2010). While we acknowledge the challenges of using Tobit estimators, it remains the most appropriate available estimation technique for our purposes.

[23] An alternative specification to the one analyzed here would be one in which the dependent variable was the participant's bid expressed as a fraction of the maximum allowable bid: $r_i/r_i^{\max}$. By moving the maximum allowable bid from the right-hand side of the equation to the denominator

Empirical Results

Estimated marginal effects—the variables' effect on the bid conditional on the observation not being censored—evaluated at the variable means are provided for each sign-up and CRD combination in Tables 5, 6, and 7.[24] The marginal effect on bids of higher county-level enrollment given the USDA's rule that CRP enroll not more than 25% of a county's agricultural land is an interesting question. While the effect is not fully explored in this paper, we do incorporate the variable that measures the proportion of a county's agricultural land enrolled in the CRP ($comp$) to control for its effect on bid behavior. With two exceptions in each of sign-ups 16 and 18, the statistically significant estimated marginal effects are negative, indicating that landowners reduce their bids to compete for dwindling county-level enrollment space in the CRP.

The Role of Maximum Rental Rates on Bids

A parcel's maximum rental rate ($r_i^{\max}$) is important in explaining the variation in observed 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. A bid at its maximum rental rate can be described as constrained in the sense that the landowner cannot increase his bid in response to a change in his environmental EBI points or subjective evaluation of his offer relative to others. We cannot know for sure which landowners or the proportion of these landowners that would submit a higher bid if they were not constrained, and we further recognize that a bid at its maximum is not guaranteed to be less than the landowner's optimal bid.

The proportion of a CRD's bids at their maximum is reported for each sign-up and CRD in Tables 5, 6, and 7. A large proportion of bids at or very close to their maximum may lead to uninformative or imprecisely estimated Tobit marginal estimates, and this will be revealed in the standard errors and statistical significance of the estimates. In North Dakota CRD 3860 during sign-up 18, for example, 85% of the bids are at the maximum; however, there are a number of bids well below their maximum on which Tobit marginal effects can be estimated. In this case, the estimates and reported standard errors identify statistically significant marginal effects. The extreme case occurs when, in Montana CRD 3050 during sign-ups 18 and 20, for example, all of the Prairie Pothole bids are constrained and the marginal effects cannot be estimated.

The incidence of bids at their maximums increases in sign-ups 18 and 20 relative to sign-up 16, and there are a number of things that could contribute to this. The sign-ups we consider occur within a few years of each other (1997–2000). It is possible that landowners who gained experience bidding in sign-up 16 used that experience to increase their bids in sign-ups 18 and 20. This type of learning is one explanation. However, whether this is a result of landowners learning about programmatic parameters to extract rent premiums from the program cannot be identified with the data available, and we caution against drawing this conclusion in the absence of individual panel data to directly test for

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of the left-hand side, the specification becomes amenable to analysis by fractional regression methods. See Papke and Wooldridge (1996) for the seminal contribution. The fraction just mentioned is an interesting and meaningful economic summary of the bid and allows ready comparison of bids across counties and soil series. We are grateful to a referee for suggesting this alternative empirical specification. In the results presented here, we maintain a specification with $r^{\max}$ on the right-hand side so as to not restrict the CRP bid to move in proportion to changes in the maximum allowable bid and to allow us to investigate the differential responses of actual bids to maximum bids across CRDs. We note that maximum bid emerges as an important empirical determinant of actual bids, statistically significant with relatively low standard errors.

[24] We are grateful for comments on earlier drafts that caused us to consider a linear regression strategy as a means of comparison of our censored regression estimates. A linear estimation strategy would treat all offers as unconstrained, and the greater the proportion of constrained bids, the larger the difference we would expect between the linear coefficient estimates and estimated marginal effects from the censored regression. Coefficient estimates from the linear regression model were found to have the same sign as our reported Tobit marginal effects; the primary difference between the two estimation strategies is in the statistical significance of the estimates and the magnitude of the marginal effect, particularly in cases where a larger number of observations on bids are constrained.

TABLE 5
Sign-up 16: Estimated Marginal Effects on Bids

State	CRD	Number of Offers	Proportion of Bids at Their Maximum	LogL.	Constant	Maximum Rental Rate	Proportion of County in CRP	Environmental EBI Score[a]	*PP*	*PP* × EBI Interaction Term
IA	1950	1,304	0.053	−5,189.0	26.522***	0.419***	50.059***	0.962***	11.032***	1.5***
					(5.205)	(0.028)	(18.887)	(0.286)	(1.362)	(0.53)
IA	1940	1,016	0.081	−3,655.8	20.422***	0.413***	−45.229***	2.523***	5.023***	−2.173***
					(3.76)	(0.024)	(13.068)	(0.27)	(1.47)	(0.668)
IA	1910	903	0.064	−3,495.7	19.851***	0.556***	−67.917***	0.471	2.917**	−0.636
					(4.462)	(0.031)	(22.793)	(0.298)	(1.275)	(0.558)
MN	2750	1,401	0.295	−3,800.5	6.744***	0.443***	−26.758***	1.021***	2.85***	0.959***
					(1.273)	(0.015)	(7.481)	(0.159)	(0.534)	(0.309)
MN	2740	1,941	0.148	−5,946.3	4.74***	0.594***	−8.923	0.939***	−0.364	−0.619
					(1.697)	(0.011)	(7.07)	(0.149)	(1.238)	(0.933)
MN	2710	2,429	0.382	−5,210.2	9.02***	0.352***	−6.2***	0.081	1.015***	−0.222
					(0.619)	(0.011)	(1.06)	(0.064)	(0.166)	(0.145)
MT	3050	456	0.836	−345.8	3.545***	0.059***	−31.366***	0.103**	0.416**	−0.247*
					(0.66)	(0.017)	(5.44)	(0.048)	(0.201)	(0.138)
MT	3030	1,952	0.706	−1,867.3	2.175***	0.21***	−3.65***	−0.027	0.494***	−0.144***
					(0.277)	(0.012)	(0.482)	(0.017)	(0.043)	(0.034)
ND	3890	1,266	0.750	−1,119.0	0.874***	0.172***	6.17***	−0.006	0.148	−0.025
					(0.235)	(0.012)	(1.25)	(0.023)	(0.118)	(0.097)
ND	3860	874	0.715	−933.4	1.708***	0.211***	−0.384	0.105***	0.240	−0.352***
					(0.483)	(0.015)	(1.52)	(0.039)	(0.188)	(0.133)
ND	3830	1,836	0.607	−2,519.0	4.978***	0.21***	−17.313***	0.257***	0.756***	−0.615***
					(0.425)	(0.011)	(1.49)	(0.048)	(0.111)	(0.117)
ND	3840	497	0.757	−386.9	0.98***	0.2***	1.640	−0.020	−0.046	0.031
					(0.233)	(0.02)	(1.64)	(0.023)	(0.088)	(0.047)
ND	3880	833	0.825	−485.6	0.481***	0.131***	−1.59*	0.025*	0.308***	0.002
					(0.154)	(0.013)	(0.866)	(0.014)	(0.044)	(0.028)

Note: Standard errors are in parentheses. Marginal effects evaluated at the mean of the variables. CRD, crop reporting district; CRP, Conservation Reserve Program; EBI, Environmental Benefits Index; IA, Iowa; MN, Minnesota; MT, Montana; ND, North Dakota.

[a] The environmental EBI score excludes the priority-area points for factor N6 and cost-factor points.

* Significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

TABLE 6
Sign-up 18: Estimated Marginal Effects on Bids

State	CRD	Number of Offers	Proportion of Bids at Their Maximum	LogL.	Constant	Maximum Rental Rate	Proportion of County in CRP	Environmental EBI Score[a]	*PP*	*PP* × EBI Interaction Term
IA	1950	758	0.146	−2,626.0	18.252***	0.504***	−1.632	1.75***	2.099	0.497
					(5.564)	(0.031)	(20.733)	(0.304)	(1.294)	(0.533)
IA	1940	578	0.254	−1,797.0	33.328***	0.347***	−96.356***	0.972***	−4.05***	−0.501
					(4.285)	(0.031)	(23.071)	(0.3)	(1.475)	(0.726)
IA	1910	465	0.097	−1,772.0	27.768***	0.406***	−33.230	1.742***	2.186	1.029
					(6.804)	(0.044)	(68.223)	(0.465)	(1.721)	(0.829)
MN	2750	781	0.423	−1,779.0	7.311***	0.409***	−4.421	0.196	0.870	0.512*
					(1.138)	(0.019)	(8.795)	(0.129)	(0.542)	(0.263)
MN	2740	992	0.290	−2,609.0	7.455***	0.513***	−30.332***	0.41***	1.963*	0.027
					(1.521)	(0.015)	(8.11)	(0.152)	(1.077)	(0.858)
MN	2710	3,503	0.572	−5,585.0	3.792***	0.31***	−8.725***	0.188***	0.710	−0.438
					(0.598)	(0.009)	(0.862)	(0.036)	(0.508)	(0.401)
MT	3050	350	0.897	—	Cannot be estimated; all offers where *PP* = 1 are censored.					
MT	3030	1,637	0.813	−1,204.5	0.845***	0.138***	−2.5***	0.066***	0.41***	−0.078**
					(0.28)	(0.011)	(0.623)	(0.019)	(0.048)	(0.039)
ND	3890	1,446	0.790	−1,281.9	−0.011	0.162***	4.361***	0.122***	0.736***	−0.142
					(0.328)	(0.011)	(1.061)	(0.032)	(0.203)	(0.193)
ND	3860	900	0.850	−605.4	−0.312	0.113***	2.209**	0.185***	0.277**	−0.084
					(0.379)	(0.012)	(0.956)	(0.036)	(0.134)	(0.113)
ND	3830	1,425	0.668	−1,913.9	6.312***	0.099***	−13.582***	0.513***	1.257***	−0.071
					(0.641)	(0.013)	(1.37)	(0.077)	(0.176)	(0.156)
ND	3840	505	0.760	−446.3	1.118***	0.187***	−5.760	0.08**	0.248	0.112
					(0.385)	(0.022)	(4.879)	(0.038)	(0.283)	(0.078)
ND	3880	595	0.703	−643.0	1.62***	0.225***	−0.696	−0.003	0.761***	0.182*
					(0.574)	(0.026)	(2.57)	(0.055)	(0.14)	(0.106)

Note: Standard errors are in parentheses. Marginal effects evaluated at the mean of the variables. CRD, crop reporting district; CRP, Conservation Reserve Program; EBI, Environmental Benefits Index; IA, Iowa; MN, Minnesota; MT, Montana; ND, North Dakota.

[a] The environmental EBI score excludes the priority-area points for factor N6 and cost-factor points

* Significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

TABLE 7
Sign-up 20: Estimated Marginal Effects on Bids

State	CRD	Number of Offers	Proportion of Bids at Their Maximum	LogL.	Constant	Maximum Rental Rate	Proportion of County in CRP	Environmental EBI Score[a]	*PP*	*PP* × EBI Interaction Term
IA	1950	672	0.190	−226.4	6.430	0.537***	30.571	2.308***	3.09**	1.628***
					(4.894)	(0.029)	(30.402)	(0.298)	(1.436)	(0.553)
IA	1940	611	0.308	−1,742.2	6.251*	0.477***	−90.404***	1.966***	2.009	0.065
					(3.604)	(0.027)	(15.759)	(0.262)	(1.437)	(0.817)
IA	1910	375	0.160	−1,350.3	24.078***	0.432***	−193.718*	2.331***	−2.316	3.311***
					(7.797)	(0.046)	(104.273)	(0.539)	(1.878)	(1.047)
MN	2750	653	0.498	−1,383.8	5.281***	0.349***	−26.848***	0.585***	2.064***	0.337
					(1.186)	(0.02)	(10.126)	(0.16)	(0.583)	(0.338)
MN	2740	762	0.392	−1,758.2	2.73***	0.448***	−18.259**	0.508***	2.696**	1.089*
					(1.557)	(0.017)	(8.068)	(0.149)	(1.205)	(0.627)
MN	2710	1,076	0.571	−1,838.8	12.07***	0.275***	−24.5***	0.008	−2.326**	−2.158
					(1.25)	(0.019)	(1.61)	(0.098)	(0.961)	(1.51)
MT	3050	189	0.931	—	Cannot be estimated; all offers where *PP* = 1 are censored.					
MT	3030	481	0.848	−313.9	1.17*	0.103***	−3.185**	0.071	0.475***	−0.137
					(0.627)	(0.021)	(1.39)	(0.044)	(0.105)	(0.102)
ND	3890	478	0.856	−326.9	0.628*	0.112***	0.780	0.097**	0.259	0.046
					(0.378)	(0.016)	(1.835)	(0.044)	(0.213)	(0.152)
ND	3860	332	0.886	−191.4	0.001	0.092***	1.910	0.047	0.791***	−0.295*
					(0.528)	(0.018)	(1.487)	(0.055)	(0.233)	(0.17)
ND	3830	569	0.671	−788.8	2.945***	0.16***	−8.594***	0.384***	2.85***	−0.612*
					(0.755)	(0.021)	(2.461)	(0.106)	(0.362)	(0.356)
ND	3840	339	0.779	−294.3	1.667***	0.148***	1.500	0.079	0.189	−0.31***
					(0.497)	(0.026)	(5.63)	(0.056)	(0.275)	(0.117)
ND	3880	274	0.799	−210.0	1.173***	0.097***	−17.4***	0.037	1.091***	0.271***
					(0.419)	(0.027)	(3.22)	(0.034)	(0.188)	(0.076)

Note: Standard errors are in parentheses. Marginal effects evaluated at the mean of the variables. CRD, crop reporting district; CRP, Conservation Reserve Program; EBI, Environmental Benefits Index; IA, Iowa; MN, Minnesota; MT, Montana; ND, North Dakota.

[a] The environmental EBI score excludes the priority-area points for factor N6 and cost-factor points.

* Significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

learning.[25] Based on the timing of these sign-ups, the increase in bids relative to their maximum can alternatively be explained by other circumstances: the parcels enrolled into the CRP during the first five years of the program were expiring during this time and eligible for another round of bidding (reenrolling), the least costly lands in terms of landowners' opportunity costs were already enrolled, land values may have been increasing during this period, and perhaps the Natural Resources Conservation Service maximum soil rental rates were not recently updated to reflect agricultural production conditions.

Tobit marginal effects reveal that in all CRDs and sign-ups, landowners' bids (r_i) are conditioned on the maximum rental rates ($r_i^{\max}$). However, the magnitudes of these marginal effects are not constant for all CRDs, an indication of the heterogeneity that exists between landowners from different regions, and there is not a one-to-one effect on landowners' bids. In the high rent CRDs (Iowa and Minnesota), 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 North Dakota and Montana, 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 but generally greater relative to the region's rental rates. A test of the restriction that the marginal effect of an increase in maximum rental rates creates an equal increase in bids ($H_0: \beta_1 = 1$) is rejected in all CRDs and sign-ups (Table 8). Also, the ceteris paribus increase in bids due to an increase in maximum rental rates is generally smaller in sign-ups 18 and 20 compared with sign-up 16.

Taken together, the summary statistics and estimated marginal effect on bids from maximum rental rates convey that high-rent landowners bid further below their maximum than do low-rent landowners, but their bid response to an increase in the maximum rental rate is generally greater in absolute terms. Recalling that the high-rent landowners in our data also have high environmental scores, this result is expected. Owners of high-valued land are penalized in the EBI cost factor because the primary weighted component in the cost scoring factor does not consider the maximum soil rental rate of the parcel but instead applies equally to all offers a maximum rent the USDA is willing to pay in the particular sign-up. Landowners perceive this penalty and bid further below their maximum rental rate in an attempt to increase their probability of acceptance. Because they have relatively high environmental scores, a further increase in maximum rates is met with an increase in bids that is less than they could have taken, a strategy that increases their probability of acceptance while still increasing their returns to participating if they are accepted. The low-rent landowners who also have low environmental scores respond strategically to an increase in the maximum rental rate by increasing their bid by a small amount, thus improving their chance of a successful enrollment.

The Effect of Additional Environmental EBI Points on Bids

A feature of our theoretical model is that landowners condition their bids on their EBI scores, and the model predicts that higher EBI landowners will have higher rental rate responses to additional EBI points than will lower EBI landowners. In response to one additional EBI point, which increases his probability of acceptance and the expected return to participating in the CRP, a landowner can increase his bid with an offsetting reduction in his EBI. Landowners from high-rent areas increase their bid more than landowners from low-rent areas because doing so does not decrease by much their probability of acceptance. Further, if their offer is accepted, the

[25] A comprehensive treatment of learning would require panel data to relate a change in an individual's bidding behavior to past experience. A referee has suggested that changes in the average bids over time by CRD could also reveal the effects of learning. This is a useful suggestion but one that we do not take up in the present paper. Instead, we separate our analysis by sign-up and do not assume the behavioral parameters to be constant over time, which they might not be under the influence of learning. While this insulates our empirics from misspecification that could be induced in a panel model by learning, it does not allow us to investigate the issue. Whether or not the effects of learning are dramatic enough to be picked up in the short time series of signups at the CRD level is a question that we leave for future research.

TABLE 8
Tests of Restrictions on Marginal Effects from Empirical Model

		Test of Restriction: $\beta_1 = 1$			Test of Restriction: $\eta_1 = \eta_2$		
State	CRD	Sign-up 16	Sign-up 18	Sign-up 20	Sign-up 16	Sign-up 18	Sign-up 20
IA	1950	−0.548***	−0.413***	−0.337***	−10.882***	−0.407	−0.966
		(.300)	(0.035)	(0.033)	(1.432)	(1.503)	(1.825)
IA	1940	−0.554***	−0.529***	−0.312***	−2.7*	6.825***	−0.062
		(0.251)	(0.039)	(0.032)	(1.566)	(1.985)	(2.004)
IA	1910	−0.394***	−0.543***	−0.475***	−2.667**	−0.500	5.653**
		(0.334)	(0.049)	(0.054)	(1.354)	(1.95)	(2.331)
MN	2750	−0.38***	−0.271***	−0.291***	−2.56***	−1.203	−3.002
		(0.16)	(0.02)	(0.021)	(0.768)	(1.024)	(1.253)
MN	2740	−0.297***	−0.27***	−0.226***	1.540	−2.211	−3.78*
		(0.114)	(0.014)	(0.014)	(1.470)	(1.561)	(2.105)
MN	2710	−0.395***	−0.24***	−0.323***	−1.602***	−1.281	5.752**
		(0.143)	(0.012)	(0.031)	(3.052)	(0.124)	(2.432)
MT	3050	−0.526***	Cannot be estimated; all offers where $PP = 1$ are censored.		−2.502	Cannot be estimated; all offers where $PP = 1$ are censored.	
		(0.104)			(1.719)		
MT	3030	−0.202***	−0.154***	−0.254***	−1.982***	−2.111***	−2.924***
		(0.028)	(0.044)	(0.11)	(0.173)	(0.324)	(0.754)
ND	3890	−0.12***	−0.135***	−0.136***	−0.788	−3.274***	−1.254
		(0.015)	(0.021)	(0.046)	(0.612)	(1.087)	(1.698)
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)
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)
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)
ND	3880	−0.102***	−0.193***	−0.123***	−1.933***	−2.731***	−9.527***
		(0.035)	(0.071)	(0.138)	(0.321)	(0.574)	(1.818)

Note: Restriction estimates with standard errors in parentheses. CRD, crop reporting district; IA, Iowa; MN, Minnesota; MT, Montana; ND, North Dakota.

* Significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

strategy guarantees a higher payment. On the other hand, low-rent landowners 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. These optimal adjustments derive from the marginal benefits and costs involved in increasing a bid and a landowner's perception about the relative strength of his EBI score.

We calculate the estimated marginal effect on bids of an additional environmental EBI point (ebi_i) from the coefficient estimate of η_1 in the reparameterized empirical model in equation [10]. The estimated marginal effects provide evidence that landowners condition their bids on their environmental scores, and in response to an increase in their environmental EBI points, high-rent landowners increase their bids by more than do landowners from low-rent areas. Iowa and Minnesota are not just high-rent areas but also have higher environmental EBI points than do regions in North Dakota and Montana. Adjusting for the scaling of the variable values of ebi_i, our results suggest that the average CRP bidder in Iowa CRD 1950 during sign-up 16 increased his bid by approximately \$0.04 ($0.962 \div 25$) for each additional environmental point. An average bidder in the same sign-up in CRD 3830 increased his bid \$0.01 ($0.257 \div 25$) for the same EBI point increase. Though each CRD's per-EBI-point premium is not consistent over time, the high-rent CRDs consistently have a more positive bid response to additional environmental points than their low-rent counterparts. Further, with the exception of Minnesota CRD 2710, we find positive and statistically significant marginal

effects of additional environmental points on bids in at least two of the three sign-up periods. It is puzzling that a consistent relationship does not emerge across sign-ups between a landowner's environmental score and his bid. The high proportion of constrained bids in the low-rent CRDs as well as influences from the agricultural economy at the time could be determining factors.

The Effect of Prairie Pothole CPA Points on Bids

We use the Prairie Pothole CPA designation to compare participants' bid responses, relative to other landowners homogenous in their factor input prices, output prices, production alternatives, weather risk, and other characteristics that are known in practice to matter to the CRP participation decision, to an exogenous increase in environmental EBI points. In the reparameterized empirical model in equation [10], the coefficient estimate of η_2 evaluated at the variables' means is the marginal effect on bids from receiving the Prairie Pothole priority-area points.

Two observations emerge: the estimated bid response to Prairie Pothole CPA points does not mirror the marginal effects on bids from the other environmental points in the EBI, and the estimated bid response to CPA points can be negative. Considering the latter point, it is generally true that the marginal effect of CPA points on bids is greater in the high-rent areas than in the low-rent areas. However, in sign-ups 18 and 20, negative coefficient estimates indicate that landowners optimally reduced their bids relative to their non-priority-area counterparts. While initially this might seem anomalous, our theory explains this type of behavior. Landowners maximize the expected return from participating in the CRP, and the exogenous increase in points can be enhanced by the marginal benefit of a bid reduction. A bid reduction in response to additional EBI points is optimal if the increase in the subjective probability of acceptance, accomplished by increasing the cost-factor points (N7), is greater than the reduction in the return to participating in the CRP if the offer is accepted. Estimates from the Iowa CRDs indicate that as a result of being in the Prairie Pothole designated priority area, the average bid was increased \$5.02 in Iowa CRD 1940 during sign-up 16 and reduced \$4.05 during sign-up 18. CRP bidders from the Prairie Pothole CPA in Minnesota CRD 2710 bid an average of \$1.02 more than their non-CPA counterparts during sign-up 16 but \$2.33 less during sign-up 20. Conversely, Prairie Pothole bidders from North Dakota CRD 3830 bid \$0.76 higher on average compared with non–Prairie Pothole bidders during sign-up 16; that gap increased to \$2.85 in sign-up 20. While we do observe high-rent CPA landowners reducing their bids relative to the non-CPA bidders, we do not observe similar bid reductions in the low-rent regions. Low-rent landowners have an advantage in the cost component formula; they may not perceive a large enough increase in their probability of acceptance from lowering their bid compared with the reduction in payments if their offer is accepted. Landowners may also perceive that, because they are in a priority area, their participation conveys a greater environmental or conservation value, and they demand a higher return for providing it.

Not All EBI Points Are Created Equal

In the EBI scoring mechanism, a point is a point whether it is a priority-area environmental point, a non-priority-area environmental point, or a cost-factor point. However, the estimated bid response to Prairie Pothole priority-area points does not mirror the marginal effect on bids from the other environmental EBI points, suggesting that landowners may view these points differently. We impose a restriction in the empirical model in equation [10] to test for equality of the marginal effects on bids from priority-area points and non-priority-area points, forcing $\eta_1 = \eta_2$. Failure to reject the null hypothesis of the restriction is evidence that landowners condition their bids on priority-area points in the same manner as the non-priority-area environmental points. Table 8 provides restricted estimates of Wald statistics from the restriction that non-priority-area environmental EBI points are equal to the priority-area environmental EBI points. In over half of the CRDs in sign-ups 16, 18, and 20, we reject the hypothesis that the marginal effects on bids from these two point sources

are statistically equivalent. Landowners who receive the Prairie Pothole priority-area points perceive them to be somehow different than other environmental EBI points when deciding their optimal bid. In low-rent regions like North Dakota and Montana, the restricted estimates are predominantly negative and become more negative in each sign-up period. This signals 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. The estimated Tobit marginal effects from Tables 5, 6, and 7 support this. However, the statistically significant restriction estimates from CRDs in high-rent regions become less negative in each sign-up period. These bidders are leveraging the Prairie Pothole CPA points to reduce their bids or increase them by a small amount, a strategy that results in a higher probability of acceptance and expected return from participating in the CRP.

V. CONCLUSION

The CRP general sign-up enrolls land by calculating an EBI value for each parcel; this value is intended to reflect the level of environmental services provided by removing the land from agricultural production, and it takes into account the rental rate bid by the landowner should his offer be accepted. The landowner's bid enters with a negative weight, and parcels with the highest total 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 CPAs like the Prairie Pothole region. Such lands are given favor in the CRP enrollment process due strictly to the enhanced environmental services provided by retiring land in a certain location.

We present a theoretical model that describes a landowner's bidding behavior and characterizes the optimal bid adjustment when additional exogenous EBI points are given. The model predicts that landowners condition their bid on the environmental EBI score of their parcel and on their subjective evaluation of the strength of their score relative to other offers against which they compete. It also predicts that bidders with high environmental EBI scores will have a more positive bid response to additional points. Because of the uncertainty over certain scoring parameters and other offers, a landowner will optimally increase or decrease his bid in response to receiving additional exogenous environmental EBI points. Regardless of the direction of the bid adjustment, the expected return from participating in the CRP is greater after the bid adjustment.

Landowners' bid responses are explored empirically using a data set of accepted and unaccepted offers from three CRP general sign-up periods. Offers are clustered by CRD to identify whether bid responses to exogenous EBI points differ across landowners from regions with varying opportunity costs to enrollment. Because each landowner's bid is constrained by a maximum rate unique to his parcel, and a mass of bids are at their maximum, we use a censored regression estimation strategy. Bid summary statistics and regression estimates of the marginal effect on bids from maximum rental rates convey that high-rent landowners bid farther below their maximum than do low-rent landowners, but their bid response to an increase in the maximum rental rate is generally greater in absolute terms. Contrary to popular criticisms of the program, we find that landowners may not increase their bid by an amount equal to the increase in the maximum they are allowed to bid.

Our empirical work addresses two aspects of the interaction between exogenous Prairie Pothole CPA points and endogenous rental rate bids. Specifically, we measure how bids respond to the additional environmental EBI points awarded to bids within the CPA and test whether landowners in the priority area condition their bids on EBI points differently than do landowners outside of the priority area. As our theory suggests, we find that the non-priority-area environmental points induce greater bids, in general. Further, 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 offer 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.

CRP bidders face a trade-off in the EBI scoring mechanism between a higher bid and lower EBI points, and the trade-off incentivizes them to optimally reduce or increase their bids depending on their own subjective evaluation of the strength of their offer. It is very likely that other factors, in particular learning effects over time, influence their perceptions and bidding behavior. Local competition for enrollment is another factor that enters into landowners' bidding strategies. Revisions to the EBI are often intended to induce more enrollment from certain areas, and 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. 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. As program administrators and policymakers consider changes to the CRP, such as acreage reductions and EBI scoring changes, consideration of landowners' strategic bid responses will be useful in predicting enrollment and overall program costs. In times when the federal deficit is large and budgets are tight, knowing the sources and effects of landowners' strategic decisions, as developed in this study, become more important and should help to ensure a more cost-effective implementation of the CRP program.

Acknowledgments

The authors gratefully acknowledge the USDA Farm Service Agency Economic and Policy Analysis Staff and the Commodity Credit Corporation for access to the data. Skip Hyberg and Shawn Bucholtz were particularly helpful. The paper benefited greatly from comments received at the North Carolina State University Agricultural Economics seminar and the Iowa State University Economics seminar, and from suggestions provided by the editor and two anonymous reviewers.

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