THE IMPACTS OF ALTERNATIVE INSTITUTIONS ON DISTRIBUTIONAL AND ENVIRONMENTAL EFFICIENCY IN ENVIRONMENTAL PROGRAMS

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Abstract: *Experimental auctions are used to examine the impacts of alternative constraints on environmental programs. Results show that use of a monetary constraint results in greater environmental efficiency at a lower total cost as compared to an acreage constraint.*

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Virginia Buller and Darren Hudson[1]

Introduction

Environmental programs are widely used in the United States to remove land from agricultural production and/or restore wetlands and natural habitats. The two most prolific of these programs are the Conservation Reserve Program (CRP) and the Wetland Reserve Program (WRP). According to the Natural Resources Conservation Service, as of August 2004, there were 34,713,701 acres enrolled in the CRP program, across 670,877 contracts. Also according the NRCS, there are currently 7,831 projects enrolled in the WRP program on 1,470,998 acres. Thus, these programs cover a large number of acres and affect many landowners/agricultural producers.

The primary objectives of these programs (from an environmental perspective) is to conserve highly erodible land to reduce soil erosion from wind and water, improve water and air quality, and/or restore wetlands for wildlife habitat and water filtration. There is some debate, however, as to what mechanism should be used to implement these programs to achieve the greatest environmental impact at the lowest possible cost (Cason and Gangadharan; GAO; Smith; Babcock et al.; Latacz-Lohmann and Van der Hamsvoort; Taylor et al.; Stoneham et al.; Wu and Babcock).

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Congress mandated that these programs be implemented through an auction mechanism because auctions were believed to generate the competitive forces necessary to secure land retirement/restoration at the lowest possible price (Smith).[2] However, there are two general means of constraining the outcome of these auctions—quantity and expenditures. For example, the government may place a cap on the number of acres that can be enrolled in a particular area, or the government may cap the amount of money it will spend on conservation in a particular area, or both.

In the CRP program, money is allocated by state based on the number of eligible acres in the state, thereby effectively capping expenditures by the government to enroll land (NRCS).[3] By contrast, the WRP program allocates acreage to each state for potential enrollment, with no effective ceiling on the amount of money expended to enroll acres (NRCS). However, as Babcock et al. point out, how these programs are constrained can have implications for the efficiency of achieving the stated program goals. By using a monetary constraint strategy, these authors suggest that the government obtains more land with its budget but fewer environmental amenities as compared to an acreage constraint strategy. This result implies that the monetary constraint yields more total conservation, but is much less efficient (in a dollars expended per environmental benefit perspective) in achieving environmental goals.

While theoretical analysis suggests this is a proper conclusion, there is little direct evidence of the impacts of alternative institutions, or implementation strategies, on the

[2] In general, the CRP program operates as a straightforward first-price multi-unit auction which is scored relative to the environmental benefits of each parcel of land submitted. The WRP program, by contrast, is operated by a bidding process, but there is more interaction between participants and the regulator and much more weight is placed on land characteristics.

[3] In addition to this cap, the price bid submitted by producers is also given a maximum value. This approach has led some to argue that the CRP auction has turned into an "offer system" whereby landowners simply bid the maximum amount (GAO; Smith). We abstract from the bid cap in this experiment.

outcomes in these environmental programs. The primary objective of this analysis is to test the impacts of alternative institutions on program outcomes in a controlled, laboratory setting. This approach allows a controlled test of the impacts of the institution without other confounding effects that likely exist in any available secondary data.

A second issue of increasing importance is the distribution of government program payments. Increasing pressure by groups such as the Environmental Working Group and others to decrease farm payment limits signals a desire by some portions of the population to prevent concentration of benefits in the hands of a small number of large producers. At the same time, the World Trade Organization (WTO) has called into question the legality of some current farm programs. One method of achieving WTO compliance is to divert farm income support to "Green Box" programs, of which environmental programs are a primary example. However, if environmental programs do not achieve wide-spread distribution of program benefits, this would fundamentally alter the flow of government support and concentrate these benefits in the hands of landowners who can provide environmental amenities. Thus, we will also examine the potential resulting distribution of program benefits across landowners under both monetary and acreage constraints in environmental programs.

Conceptual Framework

It is useful to visualize the environmental program auctions as first-price, sealed bid willingness-to-accept auctions where each potential seller submits a bid, and the seller with the lowest bid wins the auction. Farmers indicate in their bids the amount of incentive payment required to adopt the conservation practice. In this auction process, each producer has his or her independent private values of taking land out of production and enrolling it in the program.

Producers are assumed to know their own opportunity cost of program participation which should drive the determination of their bid. Each producer draws their valuations from different probability functions. A producer's opportunity cost of participation in the CRP is defined by Isik and Yang as the expected present value of the foregone agricultural returns from crop production plus the restoration costs[4]. Different land qualities will result in systematic differences regarding foregone profits and the potential for environmental improvements. Thus, if two bids are equal in monetary terms, the resulting provision of environmental services may differ.

In the case of a risk-neutral producer, the net present value (NPV) rule suggests that the farmer should participate in the environmental program if the expected present value of the land rental payment to be received is greater than or equal to the expected present value of the foregone returns from crop production plus the restoration costs. Assume *R* is the constant rental rate across the planning horizon. Assume *C* is the foregone returns across time, and *K* is the cost of restoration. The producer's decision of whether to participate is defined by:

$$NPV(R\ ) \geq NPV(C\ ) + K$$

However, according to Latacz-Lohmann and Van der Hamsvoort, risk-averse bidders produce larger expected revenues to the auctioneer; because the conservation payment decreases farmers' income uncertainty, they lower their bids to increase their acceptance probability. So, a risk-averse producer's bid would be:

[4] However, in many environmental programs, restoration cost is either shared or fully funded by the government.

$$NPV(R) \leq NPV(C\ \ ) + K$$

For this analysis, we assume risk-neutrality for simplicity, which is incorporated into the experimental design as discussed later. Conceptually, then, the bid a producer submits is directly linked to the productive value of the land, or the "use-value."

After all bids have been submitted, the selection process begins and an Environmental Benefits Index (EBI) is used to rank bids from highest to lowest.[5] The EBI translates several measures of environmental quality into a single number, which allows analysts to compare different parcels of land with each other even though they have different characteristics. With each signup, applicants submit their offers, or WTA bids, for land diversion. The EBI scores for each parcel of land are then matched with bids and a combined EBI value/bid is produced. The combination values are then ranked and the producer with the highest EBI value/bid is accepted into the program.[6]

This process accepts the most environmental efficient lands based on the EBI index. It must be a high priority for conservation suitable as riparian buffer, filter strip, grass waterway, shelterbelt, field windbreak, living snow fence, contour grass strip, salt tolerant vegetation, or shallow water area for wildlife (Parkhurst and Shogren). This allocates all of the government funding to producers with the most environmental efficient lands, which is the goal of the program.

[5] Here, we are borrowing the term used in current programs. However, our EBI can refer to any index used to provide information about the relative environmental amenities provided by each parcel of land.
[6] In current programs, the Farm Service Agency (FSA) will provide participants with annual rental rates, including certain incentive payments, as well as cost share assistance. The FSA bases these payments on relative productivity of soil within each county. Before the bids are taken by farmers, FSA calculates the maximum rental rate for each offer. Producers will then have the choice to bid the maximum rental rate or to bid a lower rate to increase their chances of being accepted. For this analysis, we are ignoring the maximum rental rate aspect of the program.

Consider the hypothetical example in Figure 1 of an objective to develop a riparian buffer. The cross-hatched areas along the river (gray shaded) are the lands of highest conservation priority. Above and below the conservation priority area are the areas with a lower EBI according to the objective. Assuming the same bid by the producers, the EBI points divided by the dollars per acre will always be less for the producer with a high EBI (EBI_H) than for the producer with a low EBI (EBI_L):

$$\frac{EBI_H}{\$/AC} > \frac{EBI_L}{\$/AC}$$

For example, assume there are two producers that would like to enroll in the conservation program. Producers will submit a bid based on their alternative opportunity costs of production. Assume that both producers have the same productivity per acre. Each producer will bid higher than or equal to their total productivity value if they are risk neutral. Producers bidding higher than their productivity value are trying to capture an additional rent above opportunity costs. Now, assume that Farmer A's land has a higher EBI than Farmer B's land. When the EBI number is divided by the per acre productivity value, Farmer A will always get a higher score, thus receiving the funding for the contract.

There are two possibilities that may occur: 1) Farmer A can bid more than his forgone productivity value and extract a rent or 2) Farmer A could have more productive land. In situation one, even if Farmer A were to bid more than his opportunity cost, which is assumed to be the same across farmers, because of Farmer A's higher EBI score, he will be accepted before Farmer B as long as Farmer A's bid is not too high. Thus, Farmer A earns an excess rent relative to foregone productivity because he/she lies in the desired conservation area. In the second scenario, if Farmer A had more productive land than Farmer B, Farmer A would still have a higher EBI value so that the EBI value/bid could still be higher than Farmer B. This is a very important point when considering the objectives of this study. The producer with a higher EBI will be receiving the funds from the program, while the producer with the lower EBI may not be allocated any funds. Thus, the distribution of program benefits is driven solely by conservation motives, leading to a concentration of benefits in the hands of a smaller number of landowners than if distribution of benefits were the motive. While wide-spread distribution of program funds is not a program goal at the present time, it may increasingly become a political issue, and has some direct relationship to future farm program implementation to reach WTO compliance.

There is some evidence of significant tradeoffs between environmental benefits when different targeting criteria are used in the CRP. According to Wu and Boggess, the total environmental benefit achieved in each watershed depends on both the amount and the location of resource preserved in the watersheds. We follow Wu and Boggess and assume there is a one-to-one relationship between the amount of resource preserved and the total environmental benefits within each watershed: $W_i = R_i$, where W_i is the social value of environmental benefit achieved in watershed *i* and R_i is the amount of resource preserved in watershed *i*. The benefit function may increase slowly with R_i until the cumulative effect is large enough to have a significant impact on water quality or wildlife habitat. The function will then increase rapidly as the amount of resource preserved approaches a threshold. Once the threshold has been met, any further conservation efforts will have little effect on environmental benefits. In this analysis, as the hypothetical buffer zone for our experiment is conserved (the cross-hatched area in

Figure 1), the rest of the conservation contracts have no effect on the environmental efficiency. The only parcels of land that are important to the environmental efficiency are those along the river.

Methods

A controlled laboratory experiment was used to examine the impact of alternative program institutions on environmental and distributional efficiency. Environmental efficiency simply refers to the ability of the auction mechanism to conserve the targeted land. Thus, for this analysis, environmental efficiency is measured as the percentage of the targeted parcels that are actually conserved, irrespective of the number of parcels outside of the targeted zone that are conserved/not conserved, which is consistent with the measure employed by Parkhurst and Shogren. The environmental objective of the experiment was to establish the hypothetical riparian buffer zone shown in Figure 1.

Distributional efficiency is measured as the deviation from an equal distribution of program payments across all participants. If each respondent received an equal allocation, each respondent would receive 8.33% of program benefits.[7] Actual allocation percentages were calculated and subtracted from 8.33%. The absolute value was taken, and then averaged across all respondents in each round. Thus, as program payments become more concentrated, our measure would increase, and distributional efficiency would decrease.

Experimental Design

[7] As discussed below, there are 12 respondents resulting in an equal 8.33% division of benefits.

The experiment was designed to mimic the general structure of existing environmental programs. To preserve clarity and to mitigate infusion of private values for "conservation," neutral language was used throughout the experiment.[8] The hypothetical river basin was divided into 12 areas (the bold-blocked large areas), with each respondent being assigned to one of the 12 areas.[9] Thus, each session consisted of 12 respondents drawn from the student population.[10] Twelve rounds of decisions were conducted in each session, and each respondent was placed in each of the 12 areas at random in each round.

Each of the 12 areas was further divided into 16 parcels of "land" (the smaller blocks within the large, bold blocked areas), which were called "units" in the experiment. A central element of the decision-making process is the forgone economic profits on each unit of land. Here, respondents were provided a "use value" for each of their 16 units. The use value represented the amount of "computer dollars" that they would receive if they did not win the auction for that unit. For simplicity, the use value was held constant at 40 computer dollars across all units and all respondents.

At the same time, respondents were provided information about the "non-use value" of each of their 16 units. The non-use values corresponded to the EBI of each unit, which was highest for units within the riparian buffer (400) and then decreased monotonically moving away from the riparian buffer, ending at a non-use value of 120.

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[8] A copy of the experimental instructions can be obtained from the authors upon request.
[9] While a grid system was used to visualize the assignment of respondents within the hypothetical river area, their actual placement is not relevant to the experiment and the respondents were not aware of the hypothetical area or the placement within it. The only relevant information was related to the economic decision variables discussed below.
[10] Normal recruiting procedures were used. Students were contacted in classes and asked to volunteer for an economic experiment where they would be paid in cash. Volunteers were randomly assigned to different sessions.

Respondents were told that the non-use values would be used in conjunction with their bids to determine the winners of the auction (discussed below).

After logging on to their computer, each respondent was verbally directed through a series of instructional screens to acquaint them with the experiment and procedures for participation. After completion of the instructions and collection of demographic information, questions were answered and the experiment began. Respondents were allowed three minutes to complete their decision-making and data entry in each round. Each auction round proceeded as follows:

Step 1. Respondents were shown a screen that contained a table representing their individual 16 units, clearly marked as unit 1, unit 2, etc. Each row, corresponding to each unit, contained a column that stated their use value (40 computer dollars). The next column contained their non-use value, which depended on where that respondent was placed in the hypothetical grid. The next column contained a data entry box for their bid. The final column automatically calculated their non-use value divided by their bid as the entered their bid. Other information on their screen was a countdown clock that showed the time remaining in that round. Also, respondents were provided with a history box that showed the number of units "used," the number of units "not used," and their profits for past rounds. Finally, the information screen showed their accumulated profits in computer dollars for the experiment.

Step 2. Respondent decide the minimum amount they must be paid on each unit to "not use" that unit and forego their use value for that unit.[11] Respondents were told that the non-use value divided by their bid (hereinafter, BV) would be used to determine

[11] Note here that the use value is known with certainty. Thus, respondents were expected to bid above 40 computer dollars if bidding rationally.

the winners of the auction. Once the respondents made all of their bid decisions (or three minutes had passed), the computer automatically submitted their bids and collected that information in a central database.[12]

Step 3. The BV values for all 12 respondents (16 units per respondent, or 192 values) were rank ordered from highest to lowest, with the winners being determined according to the treatment being used (discussed later). After the rank ordering and determination of winners, a screen appeared showing each respondent the number of units that were used and the number not used along with their individual profits. Respondents were allowed to review this information for a moment and then asked to proceed to the next step.

Step 4. Steps 1 through 3 were repeated for 12 trading rounds. At then end of the 12th round, a final screen appears showing their total accumulated profits in computer dollars, which were translated into actual dollars at a rate of 500 computer dollars = $1. Each respondent began the experiment with 2,500 computer dollars ($5) as a participation fee, which was included in this final total. All respondents were paid in cash and excused from the experiment. On average, the experiment lasted approximately 1.25 hours, and the average payout was $23.

Two treatments were analyzed (discussed below), with two replications of each treatments. One set of 12 respondents was used in each replication of each treatment, resulting in 48 total respondents. Each session was conducted independently with the same monitor by computer in an experimental economics laboratory.

[12] If the respondent ran out of time and the computer auto-submitted their information, all units for which a bid was not placed were removed from the ranking process, but the respondent received their use-value for those units. Respondents were also told that if they did not wish to bid on a particular unit, they could simply leave the bid blank on that unit and it would be treated as a 0 bid and they would receive their use value.

Treatments

To address the impacts of alternative implementation institutions, the experiment was divided into two treatments. The first treatment was implemented as a quantity constraint. Here, the top 48 IN values were accepted for "non-use."[13] The 48 was arbitrary, but was established because there were 24 units in the hypothetical riparian buffer. We doubled this value because the next 24 units would also be of high environmental value and would likely benefit the riparian buffer goal in a realistic situation.

The second treatment was implemented as a monetary constraint. However, in this experimental setting, there is no clear guide to establish the constraint. Thus, the average expenditure required to secure non-use of the central 24 units in the quantity constraint treatment was used as the cap in the monetary constraint treatment. Again, choice of this variable is arbitrary, but serves the purpose for testing the impacts of monetary versus quantity constraints. The IN values were ranked from highest to lowest as above. But, instead of the top 48 units, winners were chosen down the list until a cumulative total of 1,056 computer dollars had been expended.[14]

Results

Core Results

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[13] In case ties occurred that would have pushed total quantity above the cap of 48, respondents were told that the computer would randomly select from the tied bids the winners so that exactly 48 winners were determined for each round.
[14] If one more winner would push the total expenditures over the 1,056 limit, that winner would be excluded so that the total expenditures were less than or equal to 1,056.

Table 1 shows the average bid across non-use values under the acreage constraint.[15] These values represent the average of all bids, not just the winning bids.[16] Contrary to expectations, respondents appeared to bid higher values, on average, with lower non-use values. By contrast, respondents under the monetary constraint (Table 2) bid as expected, with higher average bids for higher non-use values.

Figure 2 shows the average of winning bids for both the acreage and monetary constraints. The average bid across all rounds for the acreage constraint was 44.49, while the average bid for the monetary constraint was 39.41, and these mean bids are significantly different using an unpaired t-test (p-value = 0.03). Thus, as hypothesized, use of a monetary constraint significantly lowers the average winning bid. Given the lower average winning bid value, total expenditures in the monetary constraint are significantly lower (p-value < 0.0001) (Figure 3) with average expenditures under the acreage constraint of 2,177.04 and 1,034.25 under the monetary constraint.

The primary objective of the environmental program, however, is to conserve a targeted area. Figure 4 shows the percentage of the target area conserved by round for both the acreage and monetary constraints. On average, 60.4% of the riparian buffer was conserved under the acreage constraint, while 55.9% was conserved under the monetary constraint, but these means were not significantly different using an unpaired t-test (p-value = 0.41). Taken with the expenditure results, these results suggest that the acreage constraint results in significantly higher expenditures for statistically the same environmental impacts.

[15] In all results reported here, averages represent the average across the two replications. In the case of Table 1, all bids for a particular non-use value within a replication were averaged, then those averages were averaged across replications.
[16] In the case where a 0 was entered (no bid), these observations were not included in the averages. The n value in Table 1 represents the total number of bids included in the average.

These results run counter to the simulation results by Babcock et al. in that a monetary constraint appears to generate the same level of environmental impact with less expenditure. The results found here, however, appear to make more sense from a competitive auction perspective. With a known, fixed budget, respondents likely are more acutely aware of the size of their bid relative to others, and thus bid lower to increase the probability of acceptance. On the other hand, respondents were aware under the acreage constraint that a total of 48 out of 192 (25%) would be accepted, no matter the size of the bids, which appears to be supported by the data presented in Figure 4.

Comparable Expenditures

The monetary constraint was constructed based on the average expenditure necessary to capture the lowest 24 bid units in the acreage constraint. To generate a comparison of results where total expenditures were comparable, the results for the acreage constraints were limited to the lowest 24 bids, but the monetary constraint remain unchanged. Here, total expenditures were statistically the same, with average expenditures for the lowest bid 24 units in the acreage constraint across the 12 rounds at 990 and the average expenditures for the monetary constraint at 1035 (p-value = 0.37 for unpaired t-test).

Figure 5 shows the average bids across rounds for the two constraints. Here, the average bid for the acreage constraint was 41.24, while the average bid for the monetary constraint remained 39.41. These means were not significantly different using an unpaired t-test (p-value = 0.50). Thus, when focusing on the lowest 24 units, there was no significant difference in bidding behavior between constraint types.

Figure 6 shows the environmental efficiency under the restricted acreage constraint and monetary constraint. The acreage constraint conserved 42.2% of the hypothetical buffer zone with the lowest bid 24 units, while the monetary constraint conserved 55.9%, on average, which was significantly different using an unpaired t-test (p-value = 0.01). These results confirm the general results above in that, given the same level of expenditures, the monetary constraint resulted in more targeted conservation. Thus, given a fixed budget, a monetary constraint was more efficient in reaching the environmental target.[17]

Figure 7 shows a measure of distributional efficiency under acreage and monetary constraints. Recall that distributional efficiency is measured as the average deviation from an equal allocation of program benefits across landowners. Results show the average deviation under the acreage constraint was 11.15%, while the average deviation under the monetary constraint was 9.78%, and these means are significantly different using an unpaired t-test (p-value = 0.001). These results suggest that distributional efficiency was greater under the monetary constraint, which implies that program benefits were distributed across a greater number of respondents.

Conclusions

Alternative constraint institutions have significant impacts on program outcomes. First, under identical environmental objectives, forgone profits, and auction mechanisms, an acreage constraint results in significantly higher winning bids and higher total

[17] It is critical to note here that the acreage constraint results were generated under the auction rules of 48 units being accepted. We have restricted these results to the lowest 24 units, but restricting total acceptance to 24 units in the auction could generate different bidding behavior. We make this comparison here for illustrative purposes, but the reader is cautioned not to over-interpret these results.

expenditures as compared to a monetary constraint. Even though total conservation is greater under the acreage constraint, total environmental impact is no different. While the auction mechanism used in this experiment does not precisely mimic those used in current environmental programs, these results do suggest that we need to reexamine the role of program constraint type on the resulting bidding behavior. For example, these results clearly indicate that under a monetary constraint, respondents tended to lower bids as compared to an acreage constraint.

When holding total expenditures constant, however, different conclusions are reached. Here, bids were not significantly different, but environmental efficiency was different. It is important to note, however, that the observed bids under the acreage constraint were under the conditions of accepting 48 bids, not 24. Bidding behavior may significantly change if the acreage constraint were altered in this manner during the experiment.

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Table 1. Average Bids by Non-Use Value Across Rounds Under the Acreage Constraint.

		Rounds												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Average**
400	Mean	178.38	105.25	200.04	123.77	149.73	88.90	77.57	135.69	57.81	46.50	82.73	57.50	**108.66**
	Sd	177.36	111.00	194.81	125.38	164.41	96.95	77.02	189.19	31.41	6.70	77.17	47.19	
	n	24	24	24	24	24	24	23	24	23	24	24	24	
360		139.25	78.35	155.27	160.06	108.19	92.21	113.06	173.92	60.78	55.02	76.96	72.98	**107.17**
		184.83	84.78	156.78	139.86	118.78	101.51	129.82	205.33	44.68	33.13	67.78	81.92	
		19	24	24	24	24	24	24	24	22	24	24	24	
320		228.96	82.91	148.05	185.27	92.67	132.79	76.69	177.27	82.56	71.85	72.31	62.27	**117.80**
		243.52	91.49	147.52	174.32	113.85	176.60	65.28	215.84	117.40	27.70	54.90	57.66	
		16	23.5	22	24	24	24	24	24	22.5	24	24	24	
280		96.11	85.05	192.68	193.71	95.08	96.13	83.98	204.54	131.27	71.27	150.44	44.78	**120.42**
		87.01	126.07	167.22	195.46	128.20	128.02	77.04	290.89	187.52	90.91	224.10	6.34	
		10.5	20	22	24	22	23	23	24	24	23	24	22	
240		186.60	89.96	178.90	138.10	82.96	148.33	101.10	86.27	200.02	97.88	57.54	62.72	**119.20**
		236.68	78.69	256.76	127.09	85.50	196.81	138.51	79.61	343.30	155.65	30.71	125.93	
		24	24	24	23	24	24	24	24	24	23	24	24	
200		163.21	62.17	148.46	143.26	85.17	145.58	140.31	96.38	200.85	96.62	80.06	58.19	**118.35**
		254.19	51.38	255.66	99.62	86.72	194.28	218.97	129.38	343.27	155.13	74.34	33.18	
		23	24	24	22	24	24	24	24	24	23	24	24	
160		80.08	135.67	118.65	172.50	100.44	148.29	143.81	107.35	194.35	97.50	93.54	53.88	**120.51**
		70.06	183.38	186.92	184.25	103.82	191.15	189.08	134.31	344.98	153.91	111.39	17.30	
		18	24	24	23	24	24	24	24	24	23	24	24	
120		105.46	134.56	99.11	139.95	93.79	161.96	148.00	112.31	190.38	94.07	104.88	48.88	**119.44**
		100.61	179.34	168.27	164.40	111.81	198.74	196.36	149.10	336.38	150.63	140.53	13.89	
		15	20	22	22	24	24	23.5	24	24	22	24	23.5	

Note: n refers to the number of bids accepted in the first price, multi-unit auction.

Table 2. Average Bids by Non-Use Value Across Rounds Under Monetary Constraint.

		Rounds												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Average**
400	Mean	161.43	240.69	219.71	89.60	56.96	90.10	58.52	107.19	52.80	128.65	56.92	63.79	110.53
	Sd	122.77	269.03	214.17	74.07	13.04	75.57	13.33	138.71	9.74	158.82	12.29	22.30	
	n	23.5	24	24	24	24	24	24	24	23.5	24	23.5	24	
360		152.67	249.17	207.42	101.06	54.15	97.15	53.19	120.69	53.52	143.96	53.17	74.46	113.38
		117.81	299.12	204.72	91.40	10.75	106.25	8.38	149.63	12.55	159.21	11.40	59.02	
		22.5	24	24	24	24	24	23.5	23.5	24	24	23.5	24	
320		143.07	303.03	219.29	112.15	51.83	83.08	53.79	106.22	48.76	128.17	50.31	69.17	114.07
		106.64	341.32	218.89	141.02	10.60	79.52	13.98	119.20	8.54	122.48	9.80	55.43	
		21	21	24	24	23	24	23.5	23.5	23.5	24	23.5	24	
280		132.18	297.33	102.40	110.48	50.23	88.69	51.24	95.18	47.86	72.36	49.25	61.40	96.55
		85.47	309.21	82.95	146.80	10.69	81.80	12.32	105.49	8.82	55.57	10.27	44.13	
		20	22	20.5	24	23	24	23.5	23.5	22.5	23.5	23.5	24	
240		87.35	85.40	116.83	101.71	101.92	48.15	89.54	52.93	107.69	47.82	51.54	50.69	78.46
		58.31	64.75	127.76	112.19	124.26	7.57	93.15	18.49	112.20	10.91	15.35	15.98	
		24	24	24	24	24	24	24	23	24	23.5	24	23.5	
200		128.88	78.24	105.81	109.60	108.35	45.67	94.89	48.67	94.50	46.11	53.67	49.87	80.36
		161.22	58.50	129.71	123.08	135.41	5.86	102.00	19.38	105.93	8.16	20.05	12.14	
		22.5	23.5	24	24	24	23	22	21.5	24	23.5	24	21.5	
160		119.85	81.21	110.38	129.36	109.96	45.91	92.17	49.21	92.80	45.11	53.76	52.38	81.84
		133.23	81.60	142.08	172.78	133.01	7.28	77.06	16.68	87.09	5.70	17.64	19.94	
		19	21.5	24	21.5	24	21.5	22	22	22	21.5	22	21	
120		105.65	74.45	87.62	143.76	103.23	22.58	89.07	54.77	87.30	46.95	66.65	46.84	77.41
		135.25	65.72	96.09	3.96	134.87	6.46	92.81	26.30	73.43	13.67	103.30	11.57	
		18	19.5	24	18.5	24	19.5	21.5	19.5	22	19.5	21.5	19.5	

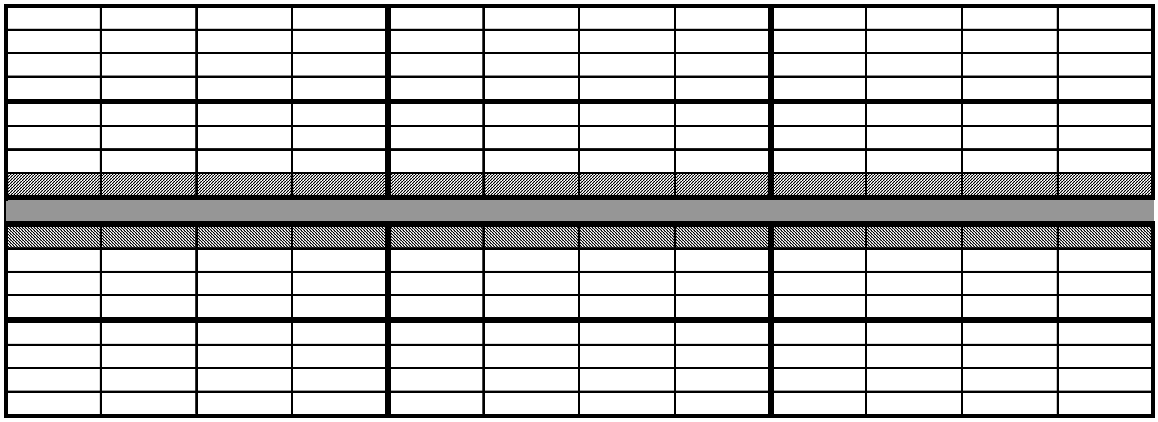

Figure 1. Hypothetical Riparian Buffer Zone (Cross-Hatched Area) Around a River (Gray-Shaded Area) as an Environmental Goal.

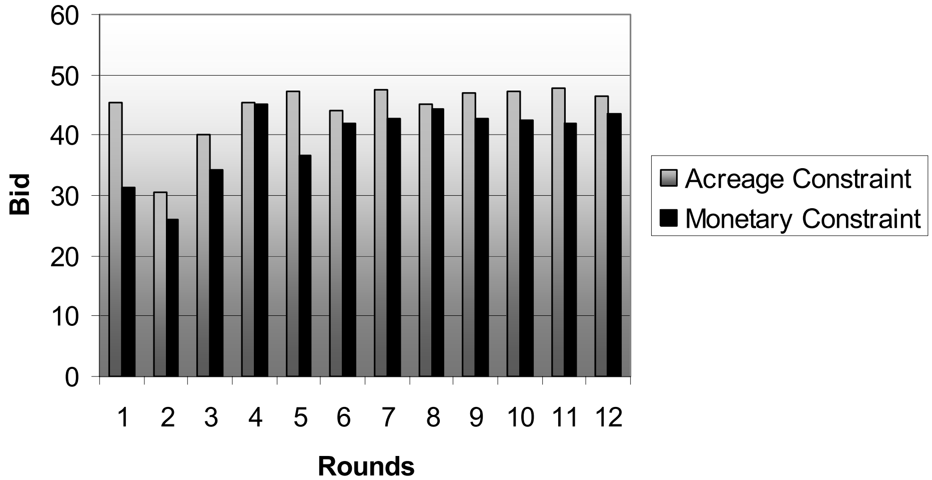

Figure 2. Average Winning Bids Across Rounds for Acreage and Monetary Constraints.

Note: The average bid for the acreage constraint is across the 48 lowest bids, while the average bid for the monetary constraint is across the lowest bids until the monetary limit is reached.

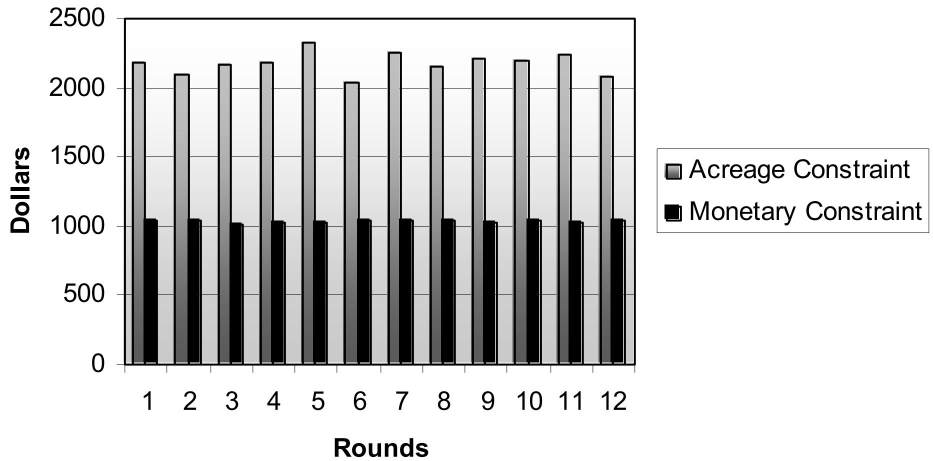

Figure 3. Total Expenditures by Round for Winning Bids Under Acreage and Monetary Constraints.

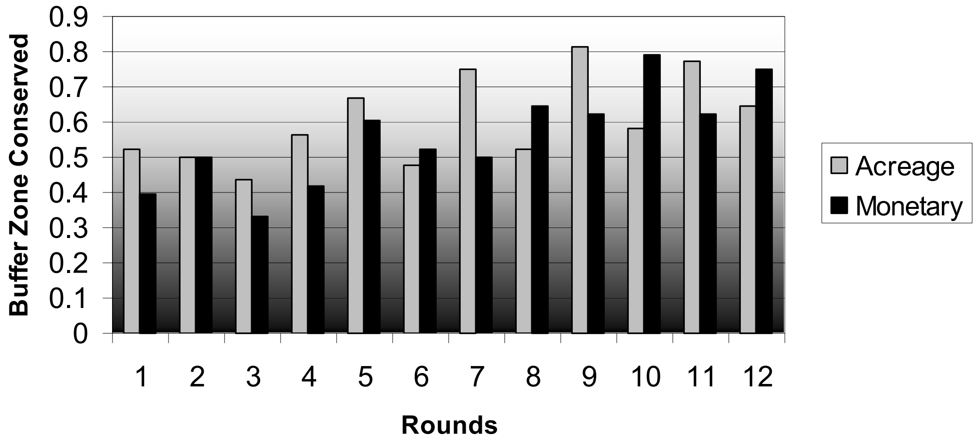

Figure 4. Percentage of the Hypothetical Riparian Buffer Zone Conserved (Environmental Efficiency) Under Acreage and Monetary Constraints.

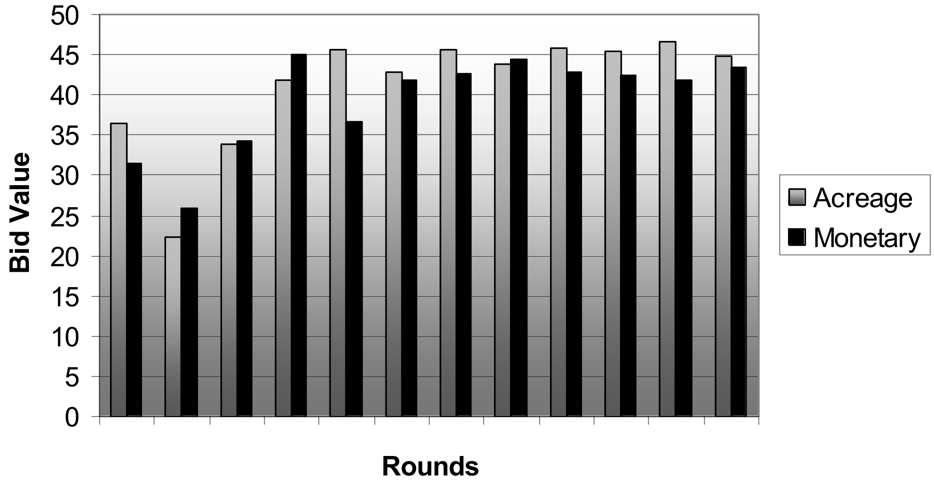

Figure 5. Average Bids Across Rounds for the Acreage and Monetary Constraints Using Only the Lowest 24 Bids in the Acreage Constraint.

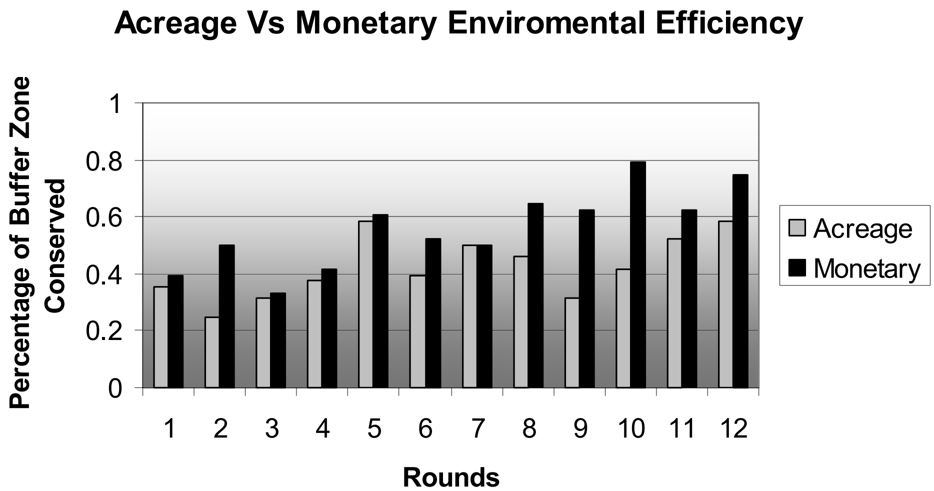

Figure 6. Percentage of Hypothetical Riparian Buffer Zone Conserved Under Acreage and Monetary Constraints, with Acreage Constraint Results Restricted to the Lowest 24 Bid Values.

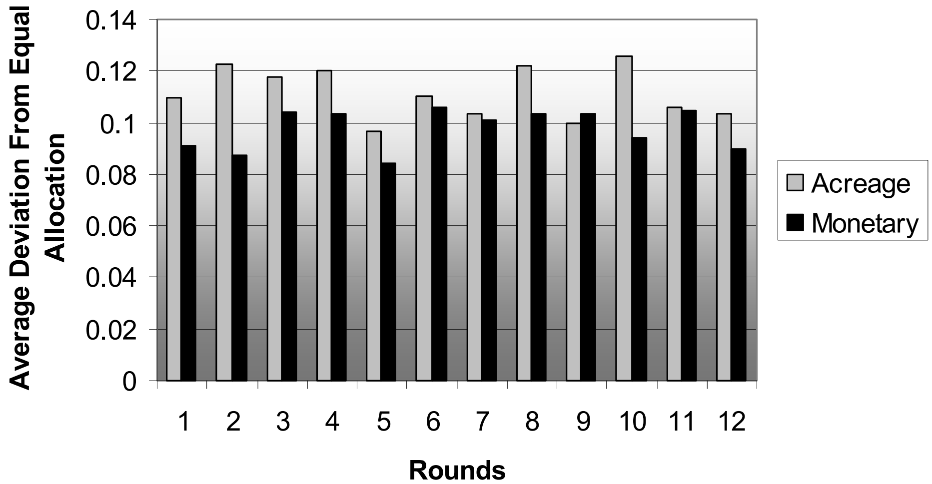

Figure 7. Average Deviation From Equal Allocation of Environmental Program Benefits Across Landowners By Round Under Acreage and Monetary Constraints with Acreage Constraint Results Restricted to the Lowest 24 Bid Values.