Experimental auctions to evaluate incentives for cost-effective agricultural phosphorus abatement in the Great Lakes

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Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2014 AAEA Annual Meeting, Minneapolis, MN, July 27- 29, 2014.

Abstract

Research on payments for environmental services (PES) largely focuses on two contract types – cost-share and annual stewardship payments. But other types of transactions, such as tax credits, green insurance, and price premiums tied to environmental stewardship certification, can also promote conservation. Using experimental conservation procurement auctions we evaluate farmers' willingness to adopt agricultural best management practices (BMPs) that reduce phosphorus runoff from farm land in the Maumee watershed to help abate damaging algal blooms in western Lake Erie. We determine how bids change depending on the type of transaction offered (e.g. payment, payment with green BMP insurance, tax credit, price premium tied to stewardship certification) to identify cost-effective incentive mechanisms that reduce the most phosphorus runoff per dollar of payment. Two kinds of transactions were found to be less cost-effective: a price premium for product certification and PES with green insurance to protect against yield loss from BMP adoption. The certification price premium cannot spatially target conservation practices to vulnerable locations, so average impact per dollar of payment (and hence cost-effectiveness) is reduced. Green insurance is perceived to have high transaction costs so it elicits demand for higher payments, reducing its cost-effectiveness.

JEL categories: Q15, C93, Q57

I. INTRODUCTION

Agricultural nutrient loss degrades aquatic resources causing negative impacts for ecosystem health, drinking water, fisheries, recreation, tourism, and property values. Agricultural conservation practices can reduce the negative impacts of crop production on surrounding ecosystems, but they require additional management and often increase operating costs for farmers. Financial incentives such as payments for environmental services (PES) are commonly used to promote voluntary adoption of conservation practices in the United States where farmers hold the property rights to manage their land as they deem appropriate (Kroeger and Casey 2007). A substantial amount of research has examined PES programs for cost-share or annual stewardship payments, but little is known about farmer preferences for other types of transactions. Tax incentives, green insurance, and stewardship certification programs have been suggested as alternative transactions to promote conservation. Using experimental conservation procurement auctions, this research evaluates farmer preferences for different incentive designs.

Despite the benefits of agricultural conservation, widespread adoption of many so-called best management practices (BMPs) has not occurred. It is estimated that cover crops are only planted on 3-7% of farms in the United States, which translates to about 1% of crop acreage (Wallander 2013). No-till operations are more common, accounting for about 35% of U.S. cropland (USDA ERS 2013), but continuous no-till is less prevalent. Limited adoption can be attributed to several factors. Sometimes conservation practices reduce profits due to higher operating costs or lower yields, especially in the first few years of adoption while the farmer is learning how to successfully incorporate the new practice(s). Other BMPs, like filter strips and buffers, displace cropland, creating high opportunity costs due to profits foregone on those parcels.

As long as farmers hold the property rights to manage land as they wish, economic incentives will be an important tool to motivate conservation. But not all incentives are equal. Determining what kind of economic incentive programs are most cost-effective is an important challenge and a necessary precursor to get the most environmental benefits from limited funds. Cost-effectiveness can be achieved by allocating payments to the subset of conservation projects that result in the highest benefit per dollar spent. The measure of benefit depends on the goals of the program. For example, some programs focus on increasing biodiversity of native species whereas others target reductions in soil erosion (sedimentation) or nutrient runoff (marine hypoxia and freshwater eutrophication). For algal blooms and eutrophication, the expected benefit is strongly related to reducing phosphorus runoff. A cost-effective program would select and fund projects that result in the highest reduction in phosphorus loss per dollar (or, equivalently, the lowest cost per unit of phosphorus reduction). Selecting such programs requires the ability to predict changes in phosphorus loss from a particular conservation practice on a specific field and requires knowledge of the payment that the farmer would demand to implement that practice.

Research on PES largely focuses on two contract types – uniform cost-shares and annual stewardship payments. Cost-share payments (e.g., under the USDA Environmental Quality Incentives Program, EQIP) offset a portion of the cost to implement a conservation action and are typically based on average costs in the state or region. Stewardship payments, like those disbursed under the USDA Conservation Reserve Program (CRP), offset the opportunity costs of managing land in a manner that promotes positive environmental outcomes. For example, landowners can receive payments for maintaining natural prairie habitat instead of producing crops. Both programs provide farmers a direct PES.

Direct PES may not be the most attractive type of transaction for some farmers. Depending on their tax liability, attitudes toward risk, and marketing strategies, alternative transactions that may be attractive include tax credits, green insurance, and price premiums for stewardship certification. If such farmer preferences affect their willingness to accept for BMP adoption, certain transactions may be relatively more cost-effective and promote conservation actions on a larger scale.

Evaluating alternative transactions is also interesting from a political standpoint because these transactions involve a variety of payers, which may mobilize funding outside of federal conservation spending appropriated by the Farm Bill. For example, price premiums for stewardship certification are a market-based PES financed by consumers in the private sector. Tax credits, on the other hand, are off-budget expenditures that are allocated through legislative decisions. If farmer preferences about transaction types affect their willingness to participate in a conservation program, then those preferences will also impact the success and cost-effectiveness of the conservation initiative.

In this paper, we present a theoretical framework to evaluate farmer preferences for different conservation incentives. We use a series of experimental procurement auctions to test empirically how the cost-effectiveness of various transaction types differs depending upon farmer willingness to enroll in the program. We conduct our field experiments in the Maumee Watershed, a basin that spans parts of Ohio, Michigan, and Indiana and where land use is 80% agricultural. The Maumee River is the major tributary to Western Lake Erie, where in 2011, a record setting harmful algal bloom (HAB) drew attention to land management in the Maumee Watershed. Subsequent HABs heightened attention on the region and pushed stakeholders to address the chronic nutrient loading problem. Unlike eutrophic conditions in the 1960s and

1970s that were primarily fueled by point source polluters (e.g. municipal sewage treatment plants), current phosphorus loadings are being driven by nonpoint source nutrient loss from agriculture (Michalak et al. 2013; International Joint Commission 2014). Identifying cost-effective conservation transactions to abate phosphorus runoff associated with HABs could enable limited conservation budgets to accomplish greater impacts.

II. THEORETICAL FRAMEWORK

This research explores cost-effective ways to induce adoption of BMPs that generate ecological benefits by testing four types of transactions: 1) direct payment, 2) direct payment with cost-free green BMP insurance, 3) tax credit, and 4) a price premium tied to stewardship certification. Before testing these transactions in the field, we present an empirical model that highlights the importance of farmer preferences on the relative cost-effectiveness of different conservation incentives.

Assume a farmer's utility is derived from marketed goods (M) and their conservation preferences (V).[1] A farmer's budget constraint is such that the cost of consumption of market goods cannot exceed per acre profit (π) and non-farm income (NFI) minus a money-metric measure of transaction costs (TC) associated with participation in a conservation program. The utility function is strictly increasing, strictly concave, and twice differentiable with respect to M and V, and is contingent on farmer preferences (F).

Adapting and expanding upon a model proposed by Mitchell and Hennessy (2003), we consider a representative producer who manages a homogeneous unit (acre) of land. Crop output,

[1] Farmer utility is likely influenced by the existence of ecosystem services (ES) that enhance productive resources (e.g., soil fertility) or provide nonmonetary benefits (e.g., recreation). ES are impacted by agricultural practices over time; however, in this static framework, we ignore the potential benefits that actions today will generate in the future. Research extensions should consider the dynamic decision making process of farmers when actions in one time period can generate ecological or agronomic benefits in future time periods.

$f(x(a), z(a), \theta, \varepsilon)$, is a function of two purchased inputs, x and z, and two stochastic inputs, θ and ε. Input x is a productive input (e.g. fertilizer), where $f_x > 0$ and $f_{xx} < 0$. Input z is a conservation input (e.g. conservation tillage, variable rate technology), where $f_z \gtreqless 0$ and $f_{zz} < 0$, depending on the technology. Purchased inputs are functions of a, the farmer's level of conservation actions. Farmers choose a level of conservation action, which then determines the mix of purchased inputs. Stochastic input θ can be naturally occurring production inputs that increase or decrease yields, like nutrients already present in the soil ($f_\theta > 0$) or agricultural pests ($f_\theta < 0$). In addition to environmental inputs, θ reflects inputs that are more difficult to measure but directly impact performance of the system, such as the farmer's ability to implement a BMP. The farmer treats these inputs as stochastic because he is not certain how the complex processes and factors determining θ will impact yield. However, the distribution of θ depends on information (κ) available to the farmer. Before choosing x, the farmer gets an *ex ante* signal about the true value of θ that provides the conditional density of $g(\theta|\kappa)$. All random production shocks (e.g. rainfall and temperature) are aggregated into the random variable ε, which is independent of θ and has density $h(\varepsilon)$. The producer's objective is to choose the level of conservation action a that maximizes expected utility,

(1) $$\max_a \int_\theta \int_\varepsilon u(M, V(a)|F) g(\theta|\kappa) h(\varepsilon) d\theta d\varepsilon$$

(2) $$\text{s.t. } M \leq \pi(a) + NFI - TC$$

After tax profit, presented in Eq. (3), equals total revenue from crop production per acre minus the per acre costs of production (c) that have been normalized by the output price, accounting for income tax rate t. Cost is an increasing, concave, and twice differentiable function, where $c' > 0$ and $c'' > 0$. Purchased inputs are functions of conservation action a, where $x_a < 0$ and $z_a > 0$. Thus the impact of a on cost is ambiguous.

(3) $$\pi = (1 - t)\{f(x(a), z(a), \theta, \varepsilon) - c(x(a), z(a))\}$$

Eq. (3') builds monetary incentive transactions for conservation into the profit equation, including payments ($\rho_c > 0$), payments with green insurance ($\rho_g > 0$), and tax credits ($\rho_\tau > 0$). The impact of these transactions on profit is always positive $\pi_{\rho_i} > 0 \; \forall \; i \in \{c, g, \tau\}$. But the magnitude of the transactions will depend upon both the conservation action, a, and the effect of location (l) on environmental benefits. This equation also builds in a per bushel price premium $\rho_b > 0$, which is tied to stewardship certification for conservation actions $a \geq \tilde{a}$, but is not dependent on the effect of location on environmental benefits.

(3') $$\pi = (1 - t)\{f(\cdot)[1 + \rho_b(\tilde{a})] + \rho_c(a, l) + \rho_g(a, l) - c(\cdot)\} + \rho_\tau(a, l)$$

Farmer utility is also affected by preferences about both the environment and the type of conservation incentive offered. Farmers who value the environment receive utility from improving ecological outcomes through their conservation actions. Farmer utility is also impacted by attributes of the incentive transaction being offered. Preferences for one incentive relative to others affect farmers' willingness to participate in certain conservation programs.

We expand our utility framework with an adjustment for utility derived through preferences, drawing on Bowles and Polanía-Reyes (2012). Eq.(4) defines conservation preferences $V(\cdot)$ in money-metric terms where, $\lambda^0 \geq 0$ denotes the farmer's baseline conservation preferences in the absence of an incentive program. A transaction ρ_i serves as a financial incentive for a farmer to adopt BMPs, where incentive $i \in \{c, g, \tau, b\}$ such that $c =$ *cash payment*, $g =$ *green insurance plus a cash payment*, $\tau =$ *tax credit*, *and* $b =$ *price premium per bushel tied to environmental stewardship certification*. The indicator $\mathbf{1}\{\rho_i > 0\} = 1$ if $\rho_i > 0$ and zero otherwise such that $\lambda_i^\rho \geq 0$ measures the utility impact from the presence of a conservation incentive. We assume that a farmer enrolls in only one conservation program.

(4) $$V(a, \rho_i; \lambda^0, \lambda_i^\rho) = a\left(\lambda^0 + \mathbf{1}\{\rho_i > 0\}\lambda_i^\rho\right) \quad st. i \in \{c, g, \tau, b\}$$

A farmer maximizes utility (Eq. (5)) by choosing a level of conservation action, a, depending on how that action will impact profitability and how the action aligns with his conservation preferences. The conservation practices adopted in a given program also impact costs (see Eq. (3)), an effect which can differ across farmers due to differences in equipment ownership, input access, and other farm characteristics.

(5) $$u = \pi(a, l, \rho_i, \theta, \varepsilon) + a\left(\lambda^0 + \mathbf{1}\{\rho_i > 0\}\lambda_i^\rho\right) \qquad st. i \in \{c, g, \tau, b\}$$

Modeling alternative conservation transactions

Farmers will enroll in a conservation program if the utility derived from being in the program is at least as great as their utility when they exert the status quo conservation effort a^0, such that,

(6) $$u(\pi(a^0) + NFI, V(a^0)|F) \leq u(\pi(a^1, \rho_i) + NFI - TC_i, V(a^1)|F)$$

Where, TC_i is the transaction costs involved with enrolling in a conservation program.

One alternative to direct PES is to reduce current taxes or fees incurred by the farmer. Farmers may simply dislike taxes, either because they are loss averse (Ericson and Fuster 2011) or because they dislike financing the government. These preferences could imply that conservation programs could be more cost-effective by offering tax benefits (deductions or credits) or fee reductions instead of making payments for conservation, thus $\lambda_\tau^\rho > \lambda_c^\rho$.

If the farmer is risk averse and perceives higher risks from BMP adoption, they may insist upon higher PES compensation to compensate the risks. BMP insurance, also called "green insurance" has been identified as one tool to promote BMP adoption by allowing farmers to try the management practices risk-free. Crop yield insurance linked to BMP implementation may be more cost-effective than payments when farmers are risk averse, especially if the farmer perceives exaggerated downside risk of BMPs on farm profitability (Mitchell and Hennessy 2003). In principle, if a risk averse farmer was provided with subsidized (free) green insurance, the farmer should only require additional payment equal to the difference between costs with the conservation action and costs under status quo management.

A third alternative means to induce improved agro-environmental management is via programs that certify environmental stewardship. Programs that certify environmental stewardship provide signals about farmers' actions to promote ecosystem health and can induce conservation actions if farmers value benefits from the certification (e.g. price premiums, increased market access, social recognition, protection from future regulation). Benefits to farmers could take the form of price premiums for sustainably produced agricultural goods or increased access to markets. In this model, assume benefits from stewardship certification exist as a price premium paid per bushel if a farmer adopts a sufficient level of conservation practices denoted as $\tilde{\alpha}$.

A certification to recognize producers using conservation practices may evoke a sense of pride in farmers. In turn, farmers may adopt BMPs for a price premium that pays less per acre than the payment they would have required. Even without financial benefits, some farmers may seek certification for social recognition or because the standards align with their personal preferences for environmental stewardship.

III. FIELD EXPERIMENTS

In four experimental conservation procurement auctions, we evaluate farmer willingness to adopt agricultural management practices that reduce phosphorus runoff from farm land in the Maumee watershed and help abate damaging algal blooms in Western Lake Erie. We identify farmer preferences for different conservation incentives by comparing bids for four transaction types, 1) payment, 2) payment coupled with green insurance, 3) tax credit, and 4) price premium tied to stewardship certification.

Development and Pretesting

Auction protocols were developed in three stages. The first stage involved the development, pre-testing, and implementation of a simplified auction that was conducted with 72 students at Michigan State University. The second stage involved the development of the farmer experimental auction protocols, directions, and information handouts about mock farms and conservation practices. Comparing types of conservation incentive transactions requires controlling for other factors that may influence the cost-effectiveness of phosphorus abatement. Past research has shown that farmer willingness to accept PES depends on direct costs and benefits, opportunity costs, personal beliefs, and capital stock (Ma et al. 2012). To test preferences for different transactions we used a questionnaire to identify farmer characteristics and then controlled for farm characteristics by presenting auction participants with hypothetical, “mock” farms at specific locations in the Maumee watershed. Mock farms allowed replication of the same farm settings at different auction sites; they also facilitated the real-time ranking of bids using previously simulated environmental data for each farm. As described in the results section, panel data resulting from the auctions was subsequently used to compare the preference effect for a given transaction type with random effects regression techniques using the mock farms to control for otherwise unobservable farm characteristics.

Sixteen mock farms were developed to represent corn and soybean farms in the Maumee Watershed. Experts provided input about common cropping systems and practices in the region. For simplicity, we made each mock farm 200 acres divided between two 100-acre fields[2]. We assumed one field was planted in corn and the other in soybeans to represent a typical corn-soybean rotation. Farms were clustered in four groups as depicted in Figure 1. Within the group of four farms, pairs of farms had unique soil types and average crop yields, meaning that there were eight unique geographic farm characteristics among the 16 mock farms (see Table 1). Soil type was assigned based on the two predominant soil types in each farm cluster. Crop yields for each farm were estimated using the Soil and Water Assessment Tool (SWAT) model (Bosch et al. 2011; Gassman et al. 2007; http://swat.tamu.edu/) and were adjusted to align with the average yield of farms in the county to which each farm was assigned.

[Figure 1 here]

[Table 1 here]

Auction participants were provided with a map that identified the location of their farm within the watershed (Figure 1). Table 2 presents the additional information provided to participants about their mock farm, including acreage, soil type, cropping system, average crop yield and prices, and cost of conservation practices. Acreage, cropping system, and average crop prices were held constant across farms while soil type, average yield and cost of conservation practices varied among mock farms to account for the heterogeneity among farms in the region and control for factors that may influence farmers' willingness to adopt conservation practices, specifically the location effect on payment (soil type, location in watershed), yield risk and

[2] Average farm size in the Ohio portion of the Maumee Watershed is approximately 240 acres.

opportunity cost of land (yield, price), and direct cost of conservation practices. Other hypothesized determinants of adoption decisions and willingness to accept PES are either unobservable or captured in bidder traits.

[Table 2 here]

Information about baseline production practices was provided, including 1) planting and harvesting dates, 2) fertilizer application rate, source, and timing, 3) tillage practices, 4) cover crops, and 5) filter strip placement. The baseline cropping system is presented in Table 3. The same baseline cropping system was assumed for all mock farms.

[Table 3 here]

Costs of conservation practices were selected based on information from two sources, 1) the cost-share payment schedule for conservation projects in Ohio funded by Natural Resources Conservation Service's (NRCS) Environmental Quality Incentives Program (EQIP) and 2) opinions from farmers interviewed at the Michigan State Ag Expo (East Lansing, MI, July 18, 2013). Costs were selected to be representative of the typical costs faced by Maumee producers when adopting each of the four BMPs.[3] Four cost levels were assigned to the 16 mock farms using an orthogonal design presented in Table 4.

[Table 4 here]

The final stage of pretesting involved vetting the mock farm descriptions and auction directions with farmers and knowledgeable experts. Experts from The Ohio State University Extension, a crop and soil science professor at Michigan State University, and a nutrient management consultant from a northwestern Ohio agricultural retailer were consulted to develop and approve the baseline cropping system and characteristics of the mock farms. Additionally,

[3] Conservation practice implementation costs for the mock farms range roughly from 50% to 150% of the EQIP payment levels. This range was selected to reflect the heterogeneity of costs among farmers.

three farmers were recruited during the Michigan Ag Expo to review the auction directions and mock farm descriptions. Farmer feedback was use to improve the design of the auctions.

Design of Auction Experiments

Farmers were mailed personalized invitations to the experimental auction meeting with a cover letter explaining the purpose of our auction. To enhance credibility, the cover letters were co-signed by leaders in the agricultural community in which each auction was held. Producer addresses were obtained from four sources, 1) the local Soil and Water Conservation District (SWCD) office, 2) the Ohio Farm Bureau, 3) an agricultural input supplier in northwest Ohio, and 4) county property tax records.

Upon arrival, participants were asked to sign a consent form, were paid a $50 participation payment, and were provided with a folder that included details about their mock farm and general instructions (See attachment A. 1). The auction leader presented an introduction and review of the general instructions. Farmers were told the purpose of the auctions and informed about how the auctions would be conducted, but were not told the exact number or type of auctions in which they would participate.

In a series of auctions, farmers submitted bids for different types of transactions. Several characteristics of the auctions were consistent across all auctions. First, farmers were invited to submit bids for two year contracts to adopt one or more of the following in field conservation practices, 1) cover crops, 2) conservation tillage, and 3) spring fertilization instead of fall fertilization.[4] If a farmer bid on more than one practice, then the group of practices was

[4] Participants had the option to bid on filter strips in the payment and tax credit auction, but filter strips were not an option in the green insurance and certification premium auctions. We focus our analysis on in-field practices so that we can compare bidding behavior for the same practices across all four auctions.

evaluated as a package[5]. The predicted ecological impacts due to the conservation practices proposed in each bid were calculated using the Soil and Water Assessment Tool (SWAT) model. Bids were always ranked based on the cost per pound of reduced total phosphorus runoff. Contracts were offered to the farmers who made the most cost-effective bids until the budget was exhausted. The budget for each auction was set at 100,000 experimental dollars, but was unknown to farmers. Bids were sealed and no information about outcomes was provided between rounds.

In addition to the $50 participation payment, participants were paid based on their relative performance in the auctions. Payments to winning farmers were calculated by subtracting the costs of adopting the funded conservation practice (implementation and opportunity costs) and adding the payment awarded in the auction. Total auction payments ranged from $38 to $68.25, with an average payment of $52.

Treatments

In this paper, we will report outcomes from four auctions in which farmers submitted individual bids for different transactions to incent adoption of conservation practices.[6] To familiarize farmers with the auction process, the first round involved farmers bidding for a direct payment, which is the most straightforward transaction. After the direct payment auction, farmers were asked to submit another bid for a direct payment if they were also provided with

[5] Combinations of practices were evaluated together for computational tractability because we could estimate environmental benefits for all possible practice combinations in SWAT before the auction. However, future work should be designed to evaluate parts of the combinatorial bid so that acceptance is not "all or nothing." For a comprehensive review of design issues associated with combinatorial auctions see Iftekhar, Hailu and Lindner 2012.

[6] In this research we also explored the impact of joint bidding on auction performance. Auctions with joint bidding were conducted after the four auctions testing conservation transactions and thus these experiments do not impact the results reported in this paper.

green insurance free of cost. In the following rounds farmers submitted bids for a state tax credit and then a price premium per bushel that was tied to an environmental stewardship certification.

The direct payment auction represented a typical conservation auction in which farmers bid the payment that they would require to adopt one or more conservation practices. After the payment auction was completed, farmers were informed about "green insurance" that they would automatically receive if their bid for a payment was accepted in the second auction. Farmers were told that green insurance would protect them from income loss due to yield reductions associated with implementing the conservation practices (compared to conventional production). Insurance indemnities were based on the county-wide performance of cropping systems using conservation practices compared to conventional systems. Thus, insurance payouts would be made to farmers if the county-wide average yield of conservation systems falls below the county-wide average yield of conventional systems. Farmers then submitted a bid for the additional payment that they would require to adopt the BMP when provided with the green insurance free of cost.

In the tax credit auction, farmers submitted bids for the tax credit that they would request in exchange for adopting conservation practice(s). This auction was most similar to the direct payment auction, only with a different payment vehicle. Tax credits were offered at the state level to link regional environmental benefits and regional (state) incentives. Participants at our first auction site indicated that state tax liabilities for most farmers are less than the payment they would require to implement some conservation practices (e.g., cover crops on large acreage). In the latter three auctions, we included an auction for federal tax credits in addition to the auction for state tax credits, as the level of federal taxes would be better able to fund conservation practices. Results between auctions for the two tax credits are the same; therefore, we report results for state tax credits because this transaction was tested at all four auction sites.

A Becker-DeGroot-Marschak (BDM) mechanism was used to test farmers' interest in certification premiums. In the BDM procedure, farmers wrote down the price premium that they would require to implement the set of three in field practices (cover crop, conservation tillage, and spring fertilizer application). Then we randomly drew a price premium for corn and soybeans from a uniform distribution with known supports. Possible premiums ran from $0 to $1 for corn and $0 to $2 for soybeans in one cent increments. If, for both crops, the price premium requested by farmers was less than or equal to the premium drawn, then participants' mock farms were enrolled in the stewardship certification program and they were assumed to receive the per bushel premium drawn.

IV. RESULTS

Outcomes from the experimental auctions are evaluated in two ways. First, we evaluate farmer preferences among transactions by comparing their "net bids" (i.e., the difference between their bid and assigned cost of BMP implementation). Next we evaluate the cost-effectiveness of the auctions based on how much environmental benefit was acquired per dollar.

Overview and descriptive analysis

Fifty-one farmers participated in the experimental auctions, yielding 49 records that could be used in the analysis.[7] Sixty-nine percent of the participants included in our analysis were part of the Soil and Water Conservation District mailing list that was used for recruitment. 15%, 10%,

[7] One participant was not a corn and soybean farmer and the other participant failed to complete the background questionnaire. We only report information and bidding results for the 49 participants included in the analysis.

and 6% of farmers were recruited using mailing lists provided by the Farm Bureau, input suppliers, and tax records, respectively. Characteristics of participants at each auction location are presented in Table 5.

[Table 5 here]

Participants were all male with a mean age of 56 years and mean farming experience of 38 years. Forty-nine percent of participants had continued their education beyond high school and 45% of farmers were from households earning $50,000 or more in off-farm income. Participants were row crop farmers following a corn and soybean rotation with some wheat in the rotation. In 2012, farmer participants planted an average of 1477 acres in corn or soybeans. Thirty-eight percent reported being a member of an environmental organization.

Farmer preferences among transaction types

Farmer preferences among the four transactions types were evaluated by comparing net bids in each auction. The net bid was calculated for each farmer as the bid for that transaction minus the assigned cost of BMP implementation.[8] Recall that the cost of implementing each conservation practice was assigned among the mock farms using an orthogonal design with four cost levels and all farm characteristics were held constant across auctions. The only variable that differed among auctions was the type of transaction for which the farmers were bidding, thus changes in bidding behavior reveal farmer preferences among different transaction types. The four transactions tested include, 1) payment, 2) payment linked with green insurance, 3) tax credit, and 4) price premium tied to stewardship certification.

[8] If farmers bid on multiple practices, the net bid was calculated by subtracting the total cost of all practices from the total bid. We then controlled for which practices the farmer bid on our regression model.

Figure 2 summarizes the bidding behavior using a scatterplot of participant bids against their given implementation costs in four auctions. The 45 degree line connects points where bids equal costs. Points above the line represent bids that exceed the cost of implementation. Bids below the line fall below implementation costs. Two important results are observed. First, the variation among bids is smallest for direct payments and greatest in the auction for payments with green insurance. Greater variation among bids mirrors the variation in farmer preferences. Some farmers were interested in green insurance to minimize perceived down-side yield risk associated with BMP adoption and thus required a lower payment when green insurance was provided free of cost. Other farmers showed strong aversion to green insurance by bidding for payments that far exceeded implementation costs.

[Figure 2 here]

A second result depicted in Figure 2 is that farmers bid both above and below their costs. Previous studies have concluded that bidding below one's cost is a mistake that inexperienced farmers make when bidding in conservation auctions in an attempt to increase their chances of winning (Cason, Gangadharan and Duke 2003). However, the frequency of bidding below costs that occurred in our study suggests that other factors may be influencing farmers bidding decisions. Farmers' desire to have their project selected is still a possible explanation for the behavior. But farmer bids may also reveal their environmental preferences or their expectation of private benefits from implementing the BMP(s). It is highly likely that farmers were considering their environmental preferences when submitting bids and this result is supported by the econometric analysis that we present next. Participants took the experimental auctions seriously and repeatedly related their decisions for their mock farm to real decisions they make on their own land. During debriefing following the auction, farmers stated that they are willing to accept some of the costs associated with conservation practices on their own farm and do not always require payments equal to or above expected costs. In this way, farmers considered the payments more like a cost-share and bid accordingly.

Table 6 presents the summary statistics of net bids across the auctions and Figure 3 presents the frequency distributions. Mean net bids are highest in the auction for payments with green insurance, but the mean is being pulled upward by farmers with strong aversion to green insurance who bid significantly higher than they did in the payment auction. Net bids are lowest for the tax credit, but due to the high variance and relatively small sample size, the difference between net bids in the tax credit auction and the auction for direct payments is not statistically significant.

[Table 6 here]

[Figure 3 here]

We formalize our analysis with a random effects regression model that can control for farm and farmer characteristics to identify differences in bidding behavior across transaction types. Relative to direct payment, results reveal aversion to green insurance incentives, but no significant differences in preferences for tax credits or premiums tied to stewardship certification (Table 7). The continuous dependent variable is the net bid, the difference between the bid to adopt conservation practices and the assigned cost of adopting those practices. Independent variables include dummies for, 1) the treatment (transaction type), 2) the BMPs included in the bid, 3) farm characteristics, 4) the auction site, and 5) both continuous and binary variables for bidder characteristics (e.g. age education, income, farming experience, acreage planted, and environmental organizations).

[Table 7 here]

Relative to the auction in which farmers bid for a direct payment only, net bids were 14 dollars higher on average when green insurance (provided free to the farmer) was offered in addition to a direct payment. This result may seem counterintuitive if one expects required payments for BMP adoption to decrease with reduced risk, but debriefing after the auction revealed that many farmers were skeptical of green insurance and were uncertain about the administrative hurdles that the program may involve. Farmers also lacked confidence that the green insurance program would pay indemnities in the event that yield loss on their farms from the adoption of conservation practices correlated poorly with county average effects.

Among the three conservation practices, bids diverged from costs more when spring fertilizer application was one of the conservation practices included in the tender. Average net bids increased by over 21 dollars when spring fertilization was included. Although changing the timing of fertilizer application may seem simple, farmers explained that spring fertilization requires extra time in an already short planting window and increases the risk of delayed planting that results in yield losses. They also reported that driving equipment over wet fields in the spring increases soil compaction in the heavy soils that prevail in the Maumee watershed. Soil compaction can interfere with planting and can decrease crop yields.

Farmers that were members of environmental organizations placed net bids almost $18 lower per acre than nonmember farmers. If one assumes that being a member of an environmental organization is a proxy for environmental preferences, then the significance of this attribute supports our hypothesis that farmers' preferences for the environment affect their willingness to participate in conservation programs. Farmers that care about the environment are willing to accept lower financial incentives to adopt conservation practices that improve water quality.

Cost-effectiveness of different transactions

We assume that budget constrained agencies would want to minimize the cost of each unit of environmental benefit procured so that the benefits per dollar spent are maximized within the constraints of a limited budget. Farmers with greater willingness to participate in a specific contract submitted lower, more cost-effective bids whereas farmers that disliked the incentive demanded more. There were no significant differences between the combinations of practices being bid on, so this result is driven by differences in requested payments (bids). Differences in cost-effectiveness also originate from the ability to target payments to farms with high environmental impact.

To evaluate the relative cost-effectiveness of each transaction, we construct supply curves to compare the cost to procure each unit of additional environmental benefit across the different auctions. Figure 4, presents supply curves that were created by aggregating the bids in each of the four auctions, ranking them by the cost to reduce one pound of phosphorus runoff, and plotting the cumulative benefits procured against the cost of each unit of environmental benefit. Figure 4(a) presents the supply curves for payments, green insurance, and tax credits, which overlap considerably and show no significant difference in cost-effectiveness of bids until the upper limit of the supply curve. As cumulative environmental benefits exceed 8,500 pounds of reduced annual phosphorus runoff per acre, the cost per pound of further reduction increases exponentially, especially among bids in the green insurance auction.[9] One should note that this analysis does not take into account the administrative costs involved with running a conservation program. Relative to PES programs that make direct payments to farmers, BMP insurance is administratively cumbersome. Therefore, although cost-effectiveness is not significantly

[9] A bid at $1202 per pound/acre is beyond the scale of Figure 4.

impacted by farmer bids, it would be reduced for BMP insurance when total costs of the program are considered.

[Figure 4 here]

Figure 4(b), compares supply curves for three levels of certification premiums to the supply curve constructed from bids for direct payments. Points on the supply curve “Certification premium – A” represent the cost per pound of phosphorus reduction if farmers were paid price premiums for corn and soybeans equal to their bids. In this scenario, cost-effectiveness of bids for price premiums is no different than for bids to receive direct payments. However, an environmental stewardship certification program would not pay farmers unique price premiums based on their willingness to accept or the amount of environmental benefits that their conservation actions provide. Instead, a certification program would set a price premium and allow farmers to opt in and adopt the required practices or not. This type of program is not targeted, thus cost-effectiveness is reduced relative to targeted conservation payments. Certification programs B and C (Figure 4(a)) represent non-targeted incentive programs in which enrollment is determined by farmers’ willingness to accept the established price premium. Price premiums for program B are set at $0.43 per bushel of corn and $0.90 per bushel of soybeans, which were the mean bids submitted for the respective premiums. The supply curve for program B increases sharply after land with high environmental benefits is enrolled. The program then begins paying the same price premium to farmers with limited ecological impact, thus decreasing the overall cost-effectiveness of the program. Relative to program A and the auction for direct payments, fewer benefits are procured at a greater cost per unit of benefit. By increasing the price premiums to $0.50 and $1.00 per bushel for corn and soybeans, respectively, certification program C has greater overall environmental impact that program B because more farmers are willing to enroll in the program for the higher price premium. But paying a higher premium means that farmers are paid more per unit of environmental impact. If the premium is paid in the market, this transaction may be acceptable, but in the context of agencies with limited conservation funding, there are more cost-effective ways to allocate economic incentives by targeting funds to cost-effective conservation proposals.

V. CONCLUSION

In the United States, well-designed conservation incentives are critical to improve environmental outcomes across agricultural landscapes. This research highlights the importance of understanding farmer preferences for different conservation incentives in order to design cost-effective agri-environmental programs in which farmers are willing to participate. Using experimental procurement auctions we compare farmers' willingness to accept four different incentive transactions, 1) direct payment, 2) payment coupled with green insurance, 3) tax credit, and 4) price premium tied to stewardship certification. We evaluate bidding behavior across these auctions to identify transactions that generate the greatest ecological benefits per dollar of limited conservation funding. Rather than finding one transaction type to be most cost-effective, we find two traits that lead to less cost-effective transactions. First, when the transaction cannot spatially target conservation practices to vulnerable locations, impacts (and hence cost-effectiveness) are reduced, as in the case of the certification price premium. Second, transactions that are perceived to have high transactions costs will elicit demand for high PES, as in the case of green insurance. By contrast, both direct payments and income tax credits were perceived to have relatively low transaction costs and farmers are equally willing to accept these transactions in exchange for implementing conservation actions.

Crop yield insurance linked to conservation practices, also called "green insurance," has been proposed as a way to facilitate the adoption of environmentally sound production practices when farmers are risk averse and misperceive the downside risk of these practices on farm profitability (Mitchell 2004; American Farmland Trust 2012). However, results from our field experiment indicate that farmers demand higher payments when coupled with green insurance (provided free to the farmer) thus rejecting the null hypothesis that farmers prefer green insurance. Comments during debriefing suggest that uncertainty about how the insurance would be administered and transaction costs associated with obtaining the policy make green insurance a less cost-effective alternative to direct payments.

For BMP insurance to be successful, it must be integrated into the current crop insurance market. However, past programs have found it difficult to generate support for green insurance in the private sector due to high transactions costs and uncertainty surrounding the new policy (Campbell 2003; Mitchell 2004). The Risk Management Agency's (RMA) pilot green insurance project ended in 2005 after enrolling only three farmers (Green et al. 2011). Another program, the American Farmland Trust's BMP Challenge®, offers a type of BMP insurance and successfully enrolled 18,000 corn acres between 2000 and 2012 to test nutrient and tillage BMPs without risk to income (American Farmland Trust 2012). On a small scale, this project has made a big impact, but scaling up is a challenge. Attempts to offer BMP insurance have failed due to the high transaction costs imposed on private insurance companies and low demand from farmers. Our results suggest that BMP insurance is unlikely to promote widespread adoption of conservation practices and is even more unlikely to do so in a cost-effective manner.

Tax credits may be a worthwhile transaction for agricultural conservation, if designed correctly. Farmer bids for tax credits did not significantly differ from bids for payments, indicating farmers were indifferent between the two transactions. Farmers suggested that state tax credits would be insufficient to fund many conservation practices, but it may be feasible for relatively inexpensive BMPs. The relative cost-effectiveness of the two contracts would depend on the overhead and administrative costs incurred by the government to manage the program. Two caveats not explored in this research are important to note. First, our analysis of tax credits assumes that the farmer also owns his land and would benefit from tax incentives. In much of the Corn Belt, producers rent a significant portion of the land they farm. From our sample of 49 producers, we observed that farmers frequently rented-in almost twice as much land as they owned. When land is rented, benefits from tax incentives could be capitalized in rental rates, but may be difficult for the renter to take advantage of. Furthermore, there may be political resistance to a tax policy in which benefits are only available to landowners of parcels with high environmental impact. Targeting conservation payments to certain farmers is controversial and the controversy may be exacerbated if the conservation incentives were tied to property taxes.

Programs that certify environmental stewardship provide signals about farmers' actions to promote ecosystem health and can induce conservation actions if farmers value benefits from the certification (e.g. price premiums, increased market access, social recognition, protection from future regulation). Enrollment in a certification program only depends on the farmer's willingness to accept the premium offered. Auctions in which farmers bid the minimum price premium they would accept revealed that farmer willingness to enroll in conservation certification programs is high. But uniform price premiums would be paid to farmers for adoption of practices regardless of the environmental vulnerability of their cropland, resulting in more variable and less cost-effective outcomes relative to targeted PES or tax credit programs. Furthermore, recent research suggests that farm-level certification of row crops is unrealistic because of the current structure of the supply chain in which grain is aggregated at the elevator (Waldman and Kerr 2014). Corn and soybeans are not directly consumed, but instead used mainly in processed foods or as animal feed; therefore, consumer willingness to pay for sustainability produced row crops is limited. Strong farmer willingness to participate in verification programs warrants additional research to identify ways to increase cost-effectiveness of stewardship certification. But, if consumers and the private sector are unwilling to pay a premium for these products, certification programs will be unsuccessful. More environmental benefits can be procured with limited conservation funds using targeted approaches to allocation conservation payments.

Understanding farmer preferences for different types of transactions is critical to design effective agri-environmental programs. Our research begins to fill this gap by experimentally testing farmers' willingness to participate in conservation programs offering a variety of incentives for adoption of conservation practices. Farmers prefer incentive programs with low transaction costs such as those offering direct payments or tax credits. Compared to non-targeted policies, like environmental stewardship certification, agri-environmental programs that can successfully target conservation incentives to producers with environmentally sensitive cropland are more cost-effective.

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FIGURES

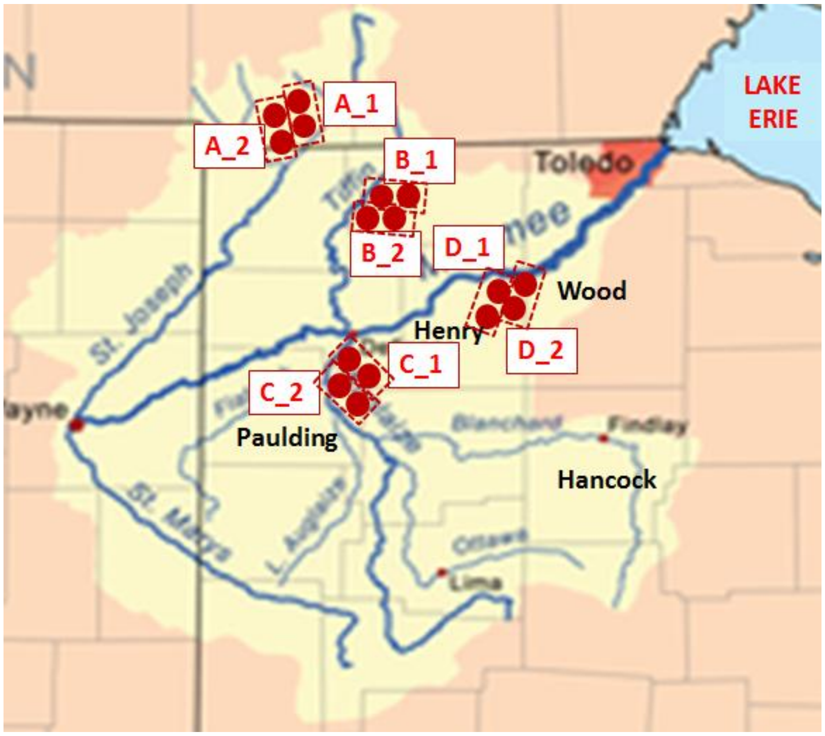


Figure 1. Locations of mock farms in experimental auctions

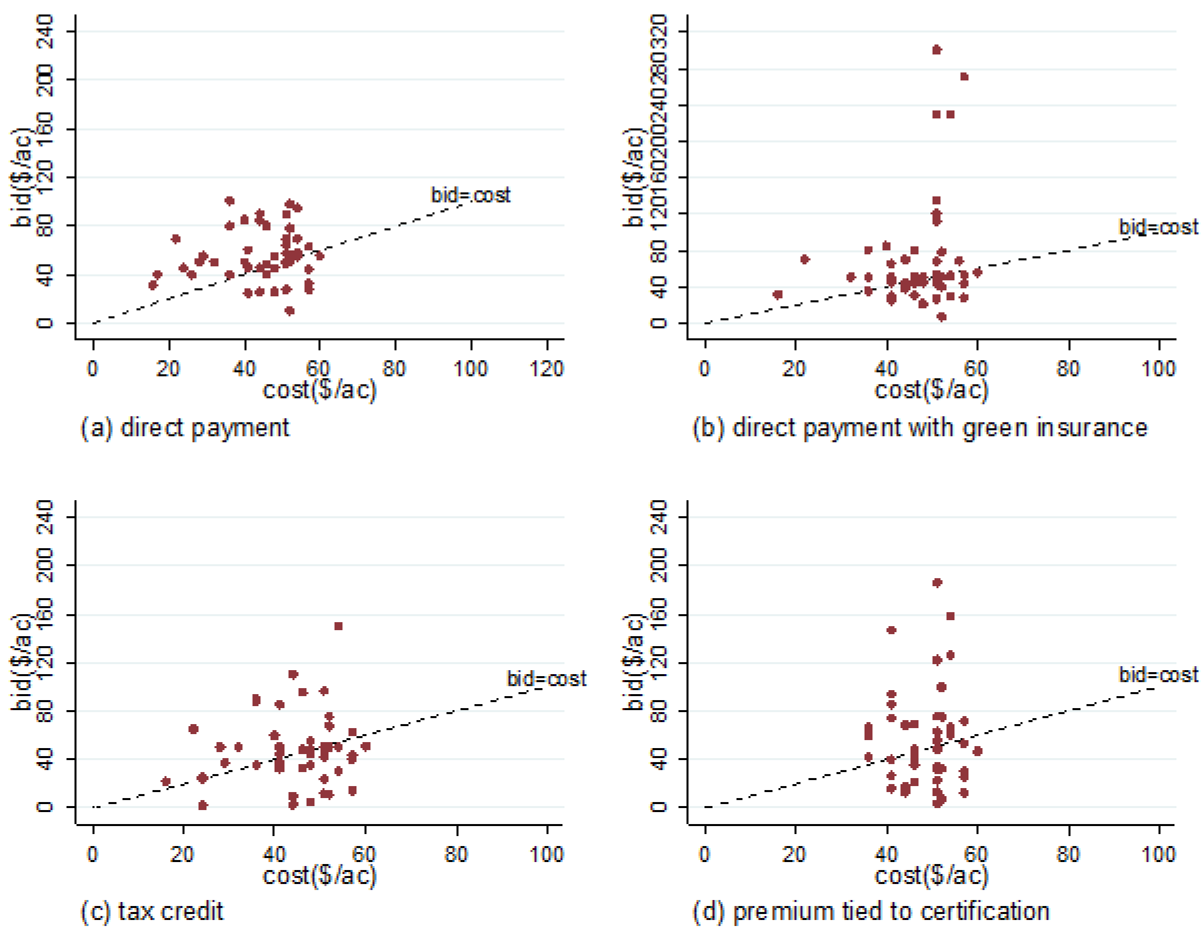


Figure 2. Scatterplots that compare producer bids and their costs to implement conservation practices show that producers bid both above and below their costs in all auctions.

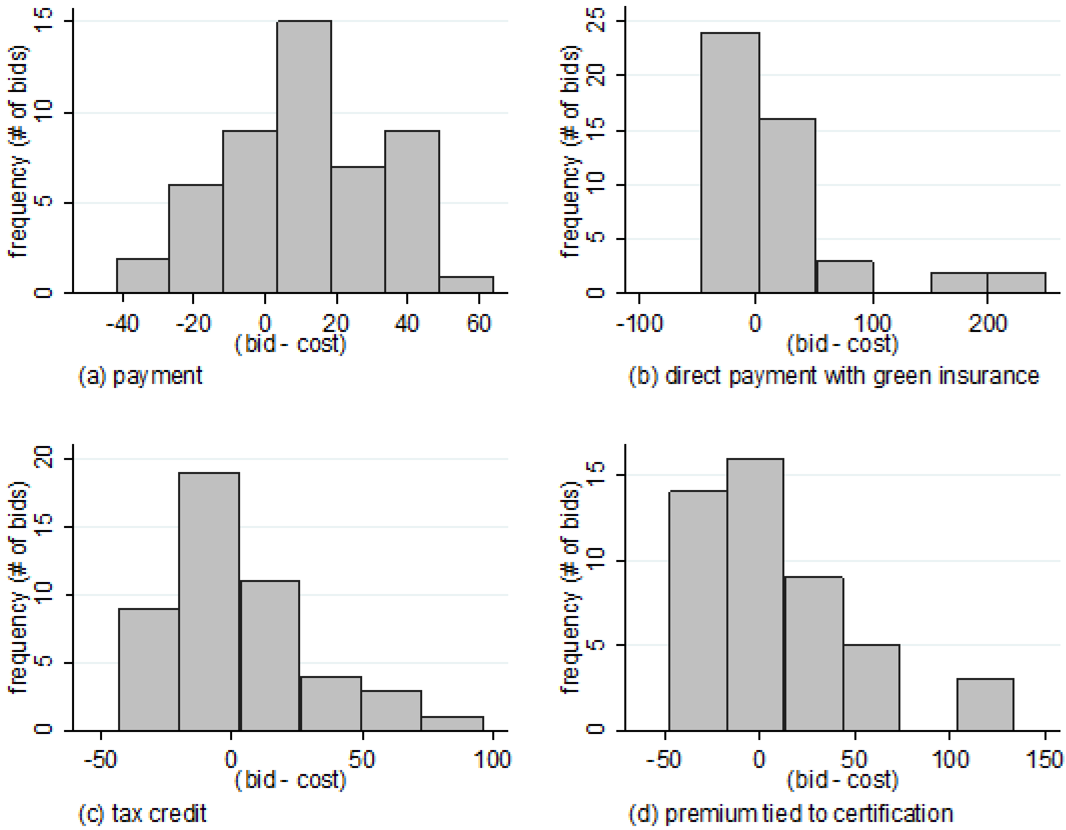
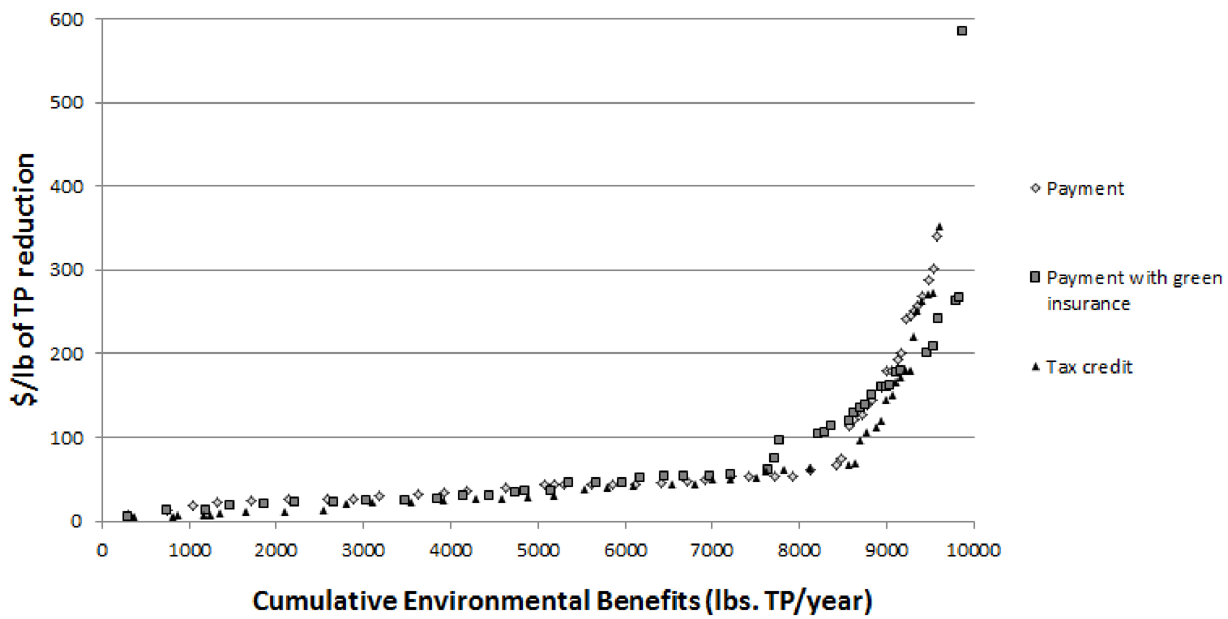
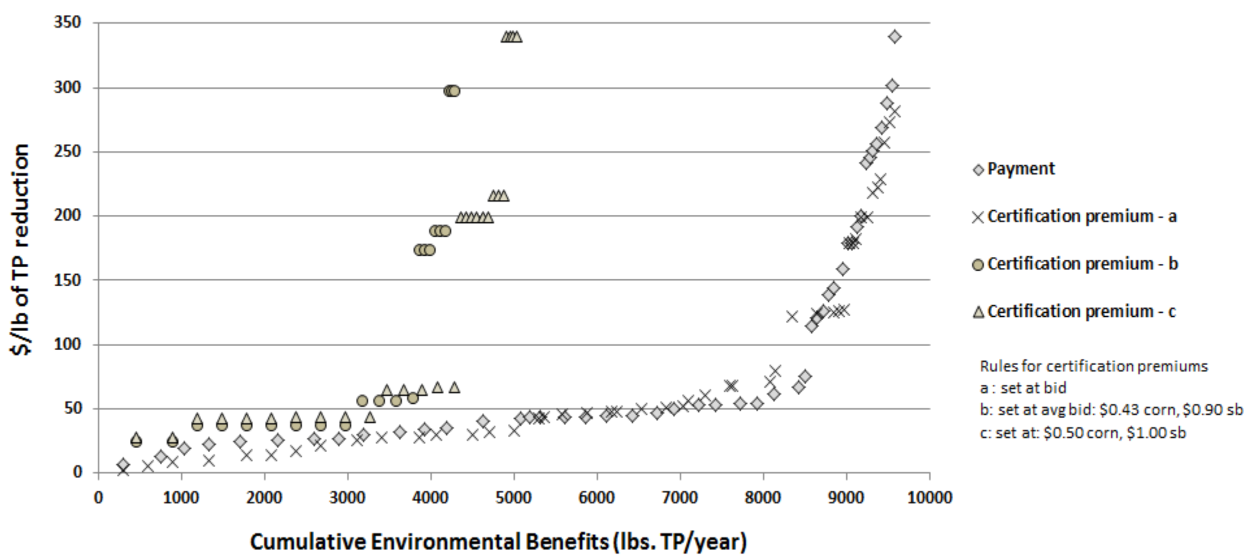


Figure 3. Histograms of net bids for each auction show that the variance of net bids is smallest in the auction for direct payments and largest among net bids for payments with green insurance.



a) payments, green insurance plus payments, and tax credits



b) payments and certification premiums

Figure 4. Supply curves for the reduction of total phosphorus runoff with different transactions in conservation auctions.

TABLES

Table 1: Information about mock farm location, soil type, and crop yields

Farm ID	Farm Cluster	Sub basin	Soil Type	Soil Description	Average Yield
1 & 2	A_1	St. Joseph	Miami	fine, moderately well-drained	Corn – 174 bu/ac Soybeans – 45 bu/ac
3 & 4	A_2	St. Joseph	Glynwood	fine-loamy and well-drained	Corn – 170 bu/ac Soybeans – 45 bu/ac
5 & 6	B_1	Tiffin	Colwood	fine-loamy, poorly-drained	Corn – 177 bu/ac Soybeans – 46 bu/ac
7 & 8	B_2	Tiffin	Ottokee	fine, moderately well-drained	Corn – 157 bu/ac Soybeans – 46 bu/ac
9 & 10	C_1	Lower Auglaize	Paulding	very fine, very poorly-drained	Corn – 167 bu/ac Soybeans – 44 bu/ac
11 & 12	C_2	Lower Auglaize	Toledo	fine, very poorly-drained	Corn – 167 bu/ac Soybeans – 44 bu/ac
13 & 14	D_1	Lower Maumee	Hoytville	fine, very poorly-drained	Corn – 172 bu/ac Soybeans – 48 bu/ac
15 & 16	D_2	Lower Maumee	Mermill	fine-loamy, very poorly-drained	Corn – 169 bu/ac Soybeans – 48 bu/ac

Table 2: Example information card for mock farms assigned in the experimental auction

Farm ID	**Farm A-1**
Acreage	You own 200 acres, which is divided into two 100ac fields.
Soil Type	Miami -- fine, moderately well-drained
Cropping System	corn-soybean rotation – assume that each year you grow 100 acres of corn and 100 acres of soybeans[1]
Average yield and prices	Corn – 174 bu/acre ($6/bu) Soybeans – 45 bu/acre ($12/bu)
Cost of conservation practices[1]	*Cover crop:* $20/acre *Conservation tillage:* $16/acre *No fall fertilizer* (spring fertilizer instead): $0/acre *Filter strips:* $28 for one acre of filter strips

[1] Details were attached and are shown in Table 3.

[2] Does not include costs or benefits of yield changes

Table 3: Baseline crop production system for mock farms

DESCRIPTION OF CROPPING SYSTEM: You own and farm 200 acres. Your land is divided into two 100 acre fields. Each year you produce corn on one field and soybeans on the other field. Following soybean harvest, corn land is field cultivated and fertilized in fall. Corn also receives starter and sidedress fertilizer. Soybeans are no-till drilled into corn stubble with no fertilization. No cover crops. Details below.

CORN FIELD

Plant: mid-April to mid-May

Fertilizer Application: (starter fertilizer)
Type: UAN 28% and Liquid Ammonium Polyphosphate mixed to: N-P-K 17-20-00
Rate: 18 gallons/acre
Time: day of planting

Fertilizer Application: (side dress)
Type: UAN 28%: N-P-K 28-00-00
Rate: 41.5 gallons/acre
Time: 6 weeks after planting

Harvest: end of October - November

No filter strips

SOYBEAN FIELD

Plant: May

Harvest: October

Tillage (before corn):
Type: Field cultivator
Time: October or November

Fertilizer Application (before corn): (broadcast)
Type: 08-15-00 + potash; mixed to: N-P-K 08-15-45
Rate: 200 lbs. /ac
Time: October or November (after fall tillage)

No filter strips

Table 4: Costs of conservation practices assigned for mock farms

Cost Levels	Cover Crops $/acre	Conservation Tillage $/acre	Spring Fertilizer $/acre	Filter Strip[1] $/acre
1	20	16	0	28
2	24	20	1	30
3	28	24	2	32
4	32	28	3	34

[1] Only includes cost of implantation/installation

Table 5: Descriptive statistics of the characteristics of auction participants

	Paulding County	**Henry County**	**Wood County**	**Hancock County**	**All**
Number of participants	12	10	16	11	49
Participant characteristics					
Gender (% male)	100%	100%	100%	100%	100%
Average Age (yrs)	61	62	44	64	56
Farming Experience (yrs)	42	44	25	47	38
Education beyond high school (%)	42%	50%	69%	27%	49%
Off-farm income > $50,000 (%)	33%	50%	44%	55%	45%
Acres planted in 2012	1580	1076	1848	1190	1477
Member of environ. org.	17%	60%	25%	55%	37%
Recruitment					
SWCD	100%	44%	56%	72%	69%
Farm Bureau	0%	0%	44%	0%	15%
Input Supplier	0%	56%	0%	0%	10%
Tax Records	0%	0%	0%	27%	6%

Table 6: Summary statistics of net bids (i.e., bid minus the cost of BMP implementation) for four transaction types.

Auction Transaction Type	n	mean	std. dev.	min	median	max
a) payment	49	11.03	22.73	-42.00	7.00	64.00
b) payment with green insurance	47	24.02	61.75	-46.00	3.00	249.00
c) tax credit	47	3.38	30.14	-43.00	-1.00	96.00
d) certification price premium	47	8.74	40.34	-47.39	2.34	134.24

Table 7: Determinants of farmer net bids (bid minus assigned costs of conservation practice(s)), random effects model

Variable	Coef.	Robust Std. Err.	p-value
cover crop dummy	-6.56	6.18	0.29
cons. tillage dummy	-15.04	12.38	0.23
spring fertilizer dummy	21.60***	5.56	0.00
Type of auction			
Green insurance	14.64*	8.84	0.10
State tax credit	-5.84	4.15	0.16
Certification premium	-5.00	6.11	0.41
Mock farm assignment			
Location A_2	-9.75	11.64	0.40
Location B_1	-7.09	10.76	0.51
Location B_2	-2.94	11.47	0.80
Location C_1	1.84	10.34	0.86
Location C_2	-36.16***	8.31	0.00
Location D_1	-6.82	13.02	0.60
Location D_2	-16.32	15.76	0.30
Farmer meeting			
Henry Co.	19.79***	6.17	0.00
Wood Co.	16.88*	9.19	0.07
Hancock Co.	39.32***	8.88	0.00
Demographics			
Age(years)	-1.11**	0.53	0.04
educ. beyond high school (=1 if yes)	8.33	7.02	0.24
farming experience (years)	0.68	0.63	0.28
Income (=1 if >$50,000 NFI)	-4.08	4.88	0.40
acres planted in 2012	0.00	0.00	0.75
environmental org. (=1 if a member)	-17.64***	6.68	0.01
_cons	47.65*	26.36	0.07

Appendix A: Auction Documents

A. 1 General Introduction and Instructions

General Introduction & Instructions

Thank you for joining us today!

Background:

During today's meeting imagine that you own and farm the piece of land described on your information card. You have the option to change your current corn-soybean cropping system by introducing various conservation practices, which are outlined in your conservation practices handout.

In this exercise, imagine that I work for a conservation agency and our goal is to improve water quality in the Western Lake Erie Basin (WLEB). Our organization is willing to pay some farmers to adopt certain conservation practices that reduce phosphorus runoff. We want to pay for practices that provide a lot of environmental benefit for a low price so that we can fund as many projects as possible with our limited budget.

To achieve this goal, I will conduct a conservation auction and ask you to submit bids for the annual payment that you want per acre to adopt one or more conservation practices. **The conservation contract is valid for 2 years and you will be paid annually**.

You will be able to submit a private bid for the amount of money you want to adopt a new practice (per acre). Then, we will determine the environmental benefit of each practice. I will select bids that provide the highest environmental benefit for the lowest price – the selected bidders will be the winners of the auction. The auctions are hypothetical and will not involve any additional commitment after this focus group.

How are environmental benefits determined?

We determine the environmental value of conservation practices by calculating the predicted reduction in phosphorus runoff into the local waterway. The environmental value of the conservation practices differs among farms because of differences in soil types and location of the farm. Producers will not know the exact amount of phosphorus that will be reduced by adopting a conservation practice.

What are the costs of the conservation practices?

The hypothetical cost of adopting a new conservation practice is written on your farm information card. The cost of adopting these practices differs among farmers.

What money will be used for bidding?

You will not use your own money to bid in the auctions. Instead you are bidding the amount of money you would want to adopt a certain practice (just in the game). Although the auctions are hypothetical, you can real win money depending on how you bid.

How will the auctions be structured?

You will be participating in multiple auctions, but the exact number of auctions is unknown. We will not announce any bids during the auctions, so your bids will remain private. We will tell you which auctions you won at the end of the meeting.

Decisions you make in one auction will not affect the outcome in another. Before each auction, we will read the instructions and answer any questions you may have.

What information will you be given?

You have information about your hypothetical farm and current cropping system on your information card. Information about the conservation practices has also been provided. Feel free to ask any questions before we begin or during the auction.

How will winners be selected?

After bids are submitted, I will review the bids and select the ones that will provide the most environmental benefit for the lowest cost.

I will accept bids until I run out of money.

How will payment work?

After each auction we will calculate your net earnings. If you win the auction, your net earnings will equal the difference in your farm profits before and after adopting the conservation practice(s). This difference will equal the auction payment minus the costs of the conservation practice(s) plus any changes in farm profits due to yield changes (these changes can be positive or negative). If you do not win the auction, your cropping system will not change and no payment will be made.

At the end of all of the auctions we will calculate your total winnings and make real payments to each participant based on a predetermined rate. Auction payments will result from the outcomes of the auctions, which are determined by your decisions and the decisions of the other participants.

Any game winnings will be in addition to the $50 participation payment you got when you entered. Payment will be distributed at the end of today’s session.

Instructions for <u>Auction 1</u> –

In this auction you are bidding the amount of money that you would need to be paid per acre each year to adopt one or more of the practices listed on the bidding sheet. If you win the auction, you will receive this payment and then you will also be responsible for the cost of the new practice.

Contracts will be awarded to bidders who offer to adopt practices that provide the most benefit for the lowest price to the buyer (me). I will accept bids until my budget runs out. The buyer's budget is unknown to all bidders.

In this auction, it is important to keep your costs and bids confidential, so we kindly request that participants do not talk during individual auctions.

Instructions for <u>Auction 2</u> –

In this auction you are bidding the amount of money that you would need to be credited against your annual state income tax or annual federal income tax in exchange for adopting one or more of the practices listed on the bidding sheet. If you win the auction, you will get the tax credit that you requested in your bid. But you will be expected to pay the cost of adopting the new practice.

Contracts will be awarded to bidders with projects that provide the most benefit for the lowest price to the buyer (me). I will accept bids until my budget runs out. The buyer's budget is unknown to all bidders.

In this auction, it is important to keep your costs and bids confidential, so we kindly request that participants do not talk during individual auctions.

Green Insurance: ****Participant ID_______**

Think about the amount that you just bid to adopt one or more conservation practices. Would your bid change if you were also provided with a special type of insurance designed for conservation practices? We will call this type of insurance "green insurance."

What is green insurance and how does it work?

Green insurance is designed to protect producers against any yield losses that may occur due to using conservation practices (compared to conventional production). Farmers that agree to adopt cropping conservation practices (not filter strips) will receive green insurance coverage free of charge. This insurance is not a substitute for traditional multiple peril crop insurance (MPCI), which would need to be purchased separately.

Insurance payments are based on the county-wide performance of cropping systems using conservation practices compared to conventional systems. We will record the yields reported from farmers using conservation practices and compare these to the yields reported from conventional cropping systems. Payments will be made to farmers if the county-wide average yield of conservation systems falls below the county-wide average yield of conventional systems.

Below, indicate what your bid would be if you were also provided with green insurance (free of charge).

Bid Amount (annual payment per acre)	**Conservation Practice**
	cover crop – cereal rye after corn
	conservation tillage – leave at least 30% residue on the field
	no fertilizer application in the fall or winter – instead fertilize in the spring

Auction 3: Sustainable Certification ****Participant ID_______**

Imagine that there is a new certification program that certifies corn and soybeans that are grown using production systems that protect water resources. **Certified corn and soybeans will receive a price premium at the elevator.**

There is no fee to become certified, but producers must adopt the following practices:
1. cover crops
2. conservation tillage
3. no fall or winter fertilizer applications

We would like to know what price premium you would accept to enroll in the program.

After you state you premium, we will randomly draw a price premium per bushel of corn and a price premium per bushel of soybeans. If you indicated that you would accept both of the price premiums drawn, then you are allowed to enroll in the certification by adopting the three practices listed above.

If you win the auction, your net earnings will equal the difference in your farm profits before and after adopting the conservation practice(s), which will not include the new price premium. If you do not win, you will not make or lose money.

What is the lowest price premium that you would accept to enroll in this certification program?

***Remember that each year you plant 100 acres of soybeans and 100 acres of corn.*

Price premium for corn: _______ (per bushel)

Price premium for soybeans: _______ (per bushel)

Auction 1: ****Participant ID_______**

Individual Bid Sheet

Please **<u>indicate your bid</u>** to adopt the following conservation practice(s). **Your bid equals the annual per acre <u>payment</u> that you would require to adopt each conservation practice.**

You can bid any amount. If you do not wish to bid, please write "NA" in the space provided.

Bid Amount **(annual payment per acre)**	**Conservation Practice**
	cover crop – cereal rye after corn
	conservation tillage – leave at least 30% residue on the field
	no fertilizer application in the fall or winter – instead fertilize in the spring

In addition to your selection above, will you install filter strips? No Yes
(if yes, please write bid amount you would require) (***circle one***)

Bid Amount (annual payment for a 1 acre filter strip)	**Conservation Practice**
	filter strips

Auction 2a: ****Participant ID_______**

Individual Bid Sheet

Please **indicate your bid** to adopt the following conservation practice(s). **Your bid equals the annual per acre state income tax credit that you would require to adopt each conservation practice.**

You can bid any amount. If you do not wish to bid, please write "NA" in the space provided.

Bid Amount **(annual tax credit per acre)**	**Conservation Practice**
	cover crop – cereal rye after corn
	conservation tillage – leave at least 30% residue on the field
	no fertilizer application in the fall or winter – instead fertilize in the spring

n addition to your selection above, will you install filter strips? No Yes
(if yes, please write bid amount you would require) (***circle one***)

Bid Amount (annual tax credit for a 1 acre filter strip)	**Conservation Practice**
	filter strips

Auction 2b: ****Participant ID_______**

Individual Bid Sheet

Please **<u>indicate your bid</u>** to adopt the following conservation practice(s). **Your bid equals the annual per acre <u>federal</u> income <u>tax credit</u> that you would require to adopt each conservation practice.**

You can bid any amount. If you do not wish to bid, please write "NA" in the space provided.

Bid Amount **(annual tax credit per acre)**	**Conservation Practice**
	cover crop – cereal rye after corn
	conservation tillage – leave at least 30% residue on the field
	no fertilizer application in the fall or winter – instead fertilize in the spring

In addition to your selection above, will you install filter strips? No Yes
(if yes, please write bid amount you would require) (***circle one***)

Bid Amount (annual tax credit for a 1 acre filter strip)	**Conservation Practice**
	filter strips