Are Farmer Transaction Costs a Barrier to Conservation Program Participation?

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Selected Paper presented at the Agricultural and Applied Economics Association annual meetings in Minneapolis, MN, July 28-30, 2014. The views expressed are those of the authors and cannot be attributed to the U.S. Department of Agriculture or the Economic Research Service.

Abstract

A deeper understanding of barriers to participation in conservation programs, including farmer transaction costs, may improve program design and implementation as well as producer outreach, and thus improve water quality. Data on perceived barriers and transaction costs from the 2012 USDA Agricultural Resources Management Survey of soybean farmers were analyzed. For people who have not applied for programs, the percentage of people agreeing that applying for programs and documenting compliance were barriers, indicates that perceived transaction costs are a barrier to participation. The measured magnitudes of transaction costs of farmers who actually applied to these programs do not seem particularly onerous and are lower than the transaction costs that have been measured for European AESs. Regression analysis indicates there are fixed costs to applying to the programs and there is some evidence that complexity of the program and the farming system increases transaction costs.

Key words: Adoption, Conservation programs, Transaction costs

Introduction

Continuing water quality problems associated with nonpoint source pollution from agricultural production imply that increased adoption of best management practices (BMPs) and participation in conservation programs are needed. Increased commodity prices have the effect of increasing the use of inputs such as fertilizer as well as decreasing interest in land retirement programs such as the Conservation Reserve Program (CRP). There is thus an increased interest in barriers to participation in voluntary conservation programs such as CRP as well as "working lands" programs such as the Environmental Quality Incentive Program (EQIP) and the Conservation Stewardship Program (CSP).

A deeper understanding of barriers to participation in conservation programs may improve program design and implementation and thus improve water quality. Analysis of barriers, including farmer transaction costs, could aid in the redesign of program application processes and/or improve producer outreach at the federal, state, and local levels. Data on producer perceptions and transaction costs would also enhance research on conservation practice adoption, conservation program participation, and additionality in conservation programs. For example, including data on perceived barriers to conservation program participation in an analysis of these programs could show how these perceptions affect the likelihood of program application. This data may thus lead to more specific insights on program design and implementation. Estimates of transaction costs of participants could indicate which programs and which aspects of the process are most costly and whether there is a discrepancy between perceived costs and measured costs.

Some researchers have identified complexity of agri-environmental programs as well as transaction costs involved with the application process as barriers to participation. Falconer (2000) reports on a study of farmers in several European countries which showed that one third of non-participating farmers said the compensation was too low. This barrier is typically assumed in economic studies of participation, where the research question relates to the optimal level of compensation. However, 21 percent said the application was too costly and 49 percent said they didn't know enough about the schemes, both of which relate to transaction costs, rather than abatement costs. Reimer and Prokopy (2013), in a study of Indiana farmers, found that complexity of the U.S. conservation program system may limit participation. They also found that while knowledge of CRP was fairly high, knowledge of EQIP was quite low.

Conservation program transaction costs are borne by government agencies and farmers. A small (but growing) empirical literature shows that transaction costs borne by program agencies can be large (McCann and Easter 1999 and 2000; Falconer *et al.* 2001). Studies in the U.S. and Britain indicate that these costs, which include conservation planning and technical assistance, may be over 30 percent of the total cost of conservation programs.

Measuring farmer's transaction costs is more recent and the magnitudes are lower, on the order of 15-20 percent, and appear to vary greatly by type of policy (Falconer 2000; Rorstad *et al.* 2007; Mettepenningen *et al.* 2009). To date, efforts to measure farmer transaction costs have been confined to Europe where a change in regulations allows countries to compensate farmers for these costs. To our knowledge, this effort is the first attempt to measure farmer transaction costs for government-sponsored conservation programs in the U.S.

This research consists of three components: 1) determine whether perceived high transaction costs were an important barrier to applying for conservation programs by asking non-applicants about the reasons for non-participation, 2) estimate ex-ante and ex-post transaction costs for producers who have applied for participation in government conservation programs, and 3) analyze the farm and farmer determinants of these transaction costs. A literature review of potential factors affecting transaction costs is presented in the next section. Then background on the USDA programs that are relevant to this research are explained as well as the source of the data. The results regarding perceived barriers to participation and the transaction cost estimates, in hours, follow. The discussion of the model begins with an explanation of the relevant explanatory variables and the summary statistics, followed by the theoretical model and the regression results.

Literature review

Following Coase (1937) and Williamson (1985), there is a large literature on how transaction costs affect the behavior of firms. Characteristics of the transaction affect whether firms will produce a needed item themselves, contract with another firm to produce it, or buy it on the spot market. Williamson (1985) suggests that three characteristics are crucial, asset specificity, frequency and uncertainty. Asset specificity relates to whether an investment in physical or human assets is associated with one or a limited set of trading partners, which will generally increase transaction costs compared to the case where the same asset could be used with many other trading partners. Higher frequency of transacting allows the development of routine procedures, thus decreasing transaction costs. Rorstad *et al.* (2007) indicate that for agri-environmental programs, these two characteristics are unlikely to be correlated, i.e. transactions with high asset specificity tend to be infrequent. Williamson's last characteristic relates to both uncertainty of the behavior of trading partners (such as opportunism), as well as price or physical uncertainty, all of which would tend to increase transaction costs. For infrequent transactions that involve high asset specificity and uncertainty, one is likely to observe either contracting or hierarchy rather than spot market transactions (Williamson 1985). Rorstad *et al.* (2007) and Coggan *et al.* (2013) indicate that agri-environmental issues tend to have these three characteristics, in part because of the degree of heterogeneity across farms and landscapes. It is thus not surprising that farmers and government agencies contract for the provision of ecosystem services such as wildlife habitat or improved water quality. Farmers want to ensure that their specific investments, which would have few alternative buyers, will be compensated. Government agencies want to ensure that the public is receiving the environmental benefits that they paid for. In addition, measurability is a salient characteristic of agri-environmental issues and fundamentally underlies the distinction between point and nonpoint sources (McCann 2013). In both Europe and the U.S., farmers are usually paid for installation of specific practices rather than for environmental performance.

There are thus a number of reasons to suspect that transaction costs involved with addressing nonpoint source pollution issues will be substantial, and this has generally been supported by the empirical studies that have been conducted (McCann and Easter 1999, 2000; Falconer *et al.* 2001; Mettepenningen *et al.* 2009; Rorstad *et al.* 2007; Vernimmen *et al.* 2000) . Studies have typically shown that farmer transaction costs are lower than those borne by government agencies. The likely high transaction costs of point-nonpoint source water trading policies are perceived to be a barrier for these programs. In one case, the transaction costs eliminated any gains from trade for a point-nonpoint source trade in Minnesota (Fang *et al.* 2005). However, Ribaudo and McCann (2012) found that other aspects of the design of the point-nonpoint trading program in Pennsylvania were likely more limiting than transaction costs.

McCann (2013) surveys the literature on factors affecting transaction costs of environmental and natural resource policies in order to develop design recommendations. Transaction characteristics such as asset specificity are important but other issues are relevant in the case of agri-environmental programs. Heterogeneity of landscapes, soils, farming systems and farmers would all increase transaction costs since policies could not be "one size fits all".

Some have argued that this is related to asset specificity for programs that target specific landscapes (e.g. Coggan *et al.* 2013) but it fundamentally affects how agri-environmental programs are designed. Essentially it means that contracting must be done on an individual basis and thus frequency is low and standardization is problematic. For farmers, they may only contract once every few years and thus there is little scope for learning by doing, which has been shown to decrease agency costs (Falconer *et al.* 2001). Intermediaries may be able to lower some of these costs, particularly if transactions are infrequent and complex (a simple example is buying or selling a house using a real estate agent). McCann (2009) found that few farmers prepared comprehensive nutrient management plans themselves; most were done by Natural Resource Conservation Service (NRCS) staff or technical service providers. Vernimmen *et al.* (2000) found that farmers were more likely to outsource complicated tasks. Nevertheless, farmers who have more experience with conservation programs would be expected to have lower transaction costs for applying for new programs. If there are a larger number of operators, this would imply that some could specialize in tasks such as applying for conservation programs and this would be expected to reduce transaction costs. An alternative hypothesis would be that these farms would have more capacity and thus may be less time-constrained and would spend more time applying for programs.

Transaction costs are typically positively correlated with abatement costs or the magnitude of the change involved (Garrick and Aylward 2012; Krutilla and Krause 2011; McCann and Hafdahl 2007; Rorstad *et al.* 2007). In Europe, some environmental practices are mandated, and contracting in agri-environmental schemes (AES) is for practices that go beyond these minimum standards (Mettepenningen *et al.* 2009) so one would expect higher transaction costs than for programs that are entirely voluntary and thus may involve some practices that are low cost or even win-win. In the case of USDA programs, we would expect that the transaction costs of programs involving a higher level of environmental performance would have higher transaction costs.

More complex farming systems, such as farms with both crops and livestock, may have higher transaction costs. Ducos *et al.* (2009) hypothesized that on farms with more animals, transaction costs would be higher and thus there would be lower AES participation rates but there was no significant effect. More complex landscapes involving hilly rather than flat terrain, such as farms with land designated as highly erodible (HEL) would also be expected to have higher transaction costs.

The adoption literature finds that farmers with larger operations are more likely to adopt new technologies and also more likely to participate in conservation programs, partly because any fixed costs are spread over a larger output. A number of studies have found that there are fixed transaction costs involved with agri-environmental programs and thus there are economies of scale related to these costs in addition to the economies of scale involved in production and abatement (Ducos *et al.* 2009; Falconer 2000; McCann 2009). This may partially explain the lower participation rates of small farmers in Europe (Ducos *et al.* 2009; Falconer 2000). Value of production would be expected to slightly increase the magnitude of transaction costs but lower per acre transaction costs.

The adoption literature often finds that new farming practices are more likely to be adopted by farmers with higher education levels. This is also typically found for conservation practice adoption and participation in government programs (Prokopy *et al.* 2008). We would expect that higher education levels would be associated with participation in more complex programs and lower transaction costs. Full-time farmers would be more likely to be aware of government conservation programs and have more flexibility to meet with USDA staff so we would expect that they would be more likely to participate and also would devote more time to the application process, thus increasing transaction costs.

Background

The US Department of Agriculture offers a broad suite of voluntary payment programs to help farmers address conservation and environmental issues in agricultural production. Because our data is derived from a survey of soybean producers relating to a specific field planted to soybeans, we consider only relevant programs. The Environmental Quality Incentives Program (EQIP) can support a wide range of practices, applied narrowly within a single field or throughout the farm. The Conservation Reserve Program (CRP), through continuous signup for high priority practices, supports a subset of these practices including grass waterways, field-edge filter strips, or other "partial-field" practices that take very little land out of production but are typically used in or adjacent to fields in crop production. As in EQIP, CRP-funded practices can be applied to all or only a small part of the farm.

The Conservation Stewardship Program (CSP) can support a broad range of practices but, unlike EQIP and CRP, requires participants to (1) achieve a minimum level of conservation practice adoption before enrolling, (2) enroll all eligible land in the entire farm (most cropland, pasture, range, and forest land),[1] and (3) agree to further improve environmental performance by adopting additional practices over the 5-year life of the contract (which can be extended for another 5 years). In exchange, farmers can receive payments that support ongoing conservation

[1] Land that is not controlled by the farmer for the full 5-year contract period cannot be enrolled.

effort (not available from any other USDA conservation program) as well as payments for new practices. Unlike other programs, CSP payments can exceed the cost of installing, adopting, or maintaining practices.

The whole farm approach embodied in CSP is likely to have an effect on transactions costs because CSP applicants must provide extensive documentation of land use and land management practices throughout their farm. On cropland, that includes documenting crop rotations, tillage and other residue management practices, measures to reduce soil compaction, and a wide range of individual nutrient management, pest management, and irrigation management practices.

Transaction Costs and Barriers to Participation

Data on farmer transaction costs are from the field-level (phase 2) portion of the 2012 USDA Agricultural Resources Management Survey (ARMS). In 2012 the field-level survey was focused on soybean production. Survey respondents were asked to provide extensive information on production practices, conservation practices, and conservation program participation for a specific field selected at random from fields that were planted to soybeans in 2012. A total of 3,555 farmers in 19 states that account for more than 90 percent of soybean production were selected for the survey and 2,492 provided usable responses. Farm-level and demographic data is from the ARMS phase 3 follow-on survey of each individual who responded to the phase 2 survey. A total of 1,807 farmers provided usable responses to both surveys.

ARMS respondents who were not enrolled in a conservation program (or had not applied for enrollment during the past four years) were asked about perceived barriers to participation. Given response options of agree, neutral and disagree, survey participants were asked about the following factors: 1) lack of awareness of programs, 2) lack of awareness of environmental problems on the field, 3) payments being too low, 4) government standards are more expensive than necessary to solve the problem, 5) perception that the application wouldn't be accepted, 6) the application process being too complex or time-consuming, and 7) documentation of compliance being too complex. Items 6 and 7 are related to transaction costs[2].

To examine reasons for non-participation, we first eliminated respondents who indicated the same response to all questions since these were not viewed as credible and were left with 1010 observations (table 1). The most common "agree" response (after lack of awareness of a problem on the field, 63 percent), was that government practice standards were more expensive than necessary to solve the problem (34 percent agreement) followed by documentation of compliance (31 percent) and a complex application process (29 percent). These latter options represent perceived transaction costs so these are an important barrier. The application process seemed to be more of a barrier among US soybean farmers compared to European farmers; Falconer 2000 reported that only 21 percent said that the application was too costly. Less important barriers were thinking the application wouldn't be accepted (23 percent) and the payments being too low (20 percent). The latter result is somewhat surprising since this is often suggested as a solution to low participation, and Falconer (2000) found about one third of European farmers gave this reason. Only 15 percent of respondents agreed with the statement "I was not aware of conservation programs". However, farmers may not be aware of the full range of programs available to them. Reimer and Prokopy (2013) found there was little knowledge among Indiana farmers of conservation programs available, other than CRP. Nunez and McCann (2005) found that 53 percent of Iowa and Missouri farmers were aware of EQIP.

[2] The potential barriers were identified from answers to an open-ended question in a previous survey.

Falconer (2000) found that 49 percent of European farmers said they didn't apply because they didn't know enough about the programs. Being aware there are programs, and knowing enough about them to be interested in applying are different questions but both relate to information costs and thus point to transaction costs as a potential barrier.

Using two-tailed tests (data not shown), farmers with highly erodible land were more likely to disagree that the application and documentation processes were too complex. Farmers who had past experience with conservation programs were less likely to agree and more likely to disagree that the application process is too complex compared to those without experience. Perceptions of transaction costs thus appear to be more of a barrier than actual transaction costs which is in line with Falconer (2000). On the other hand, Reimer and Prokopy (2013) indicate that one farmer they interviewed was not renewing his CRP contract because of the paperwork, even though he was leaving his land in conserving uses. Commercial size farms were more likely than smaller farms to agree that documentation of compliance was a barrier.

ARMS respondents were also asked whether the surveyed field was included in a current conservation program contract or had been included in an unsuccessful conservation program application during 2009-2012 (the period covered by the 2008 farm act), and which program they were participating in or had applied to. Choices included the Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP) or its predecessor the Conservation Security Program (2004-07), Conservation Reserve Program (CRP), or other programs[3]. A total of 149 respondents indicated that the surveyed field was currently enrolled in a conservation program while 20 indicated that they had applied but had not been accepted in a

[3] "Other" programs could include other federal or state programs. In 2012, USDA offered 23 different conservation programs, although the vast majority of working land conservation funding was directed through, EQIP, CSP, and CRP. Many states also have conservation programs that are designed to work with USDA programs.

conservation program during the previous four years. These 169 respondents were asked to report the number of hours spent on tasks typically involved in conservation program applications. Based on the literature (particularly Mettepenningen *et al.* 2007) and consultation with NRCS staff, questions were included to capture hours spent (1) learning about conservation programs, (2) planning conservation activities (to develop specific proposals need for the application), (3) collecting documents, (4) filling out forms and, if accepted for participation, (5) understanding and signing the contract, and (6) documenting compliance. Other studies of farmer transaction costs have also used time spent as a measure of transaction costs (Mettepenningen *et al.* 2009; McCann 2009).

Table 2 provides descriptive statistics for *ex ante* (before application acceptance) and *ex post* time, with CSP separated from EQIP, CRP, and other programs because CSP requires broader documentation of existing conservation practices and conservation treatment needs. We define *ex ante* transaction costs as the sum of learning about programs, planning conservation, collecting documents, and filling out forms. *Ex post* transaction costs are the sum of understanding/signing the contract and documenting compliance. On average, CSP applicants spent more than 20 hours on *ex ante* tasks and almost 8 hours on *ex post* tasks. In contrast, applicants for other programs spent only 8 hours on *ex ante* and less than 2 hours on *ex post* tasks, on average. At the median, CSP hours are 11 and 3 for *ex ante* and *ex post* tasks, respectively, while non-CSP hours are 6 and 2 for *ex ante* and *ex post* tasks, respectively. Pair-wise t-tests confirm that average time spent on both *ex ante* and *ex post* tasks is significantly higher for CRP applicants/participants (table 3). These magnitudes are much lower than the magnitudes found for European farmers applying for AESs. Mettepenningen *et al.* (2009) found *ex ante* costs of 7.2 days for information gathering, 7.3 days for field maps and soil samples, 3.3

days for consulting with the agency, and 2.6 days for filling out the application form. When the survey was conducted, few farmers knew that they might be eligible for payments to compensate them for transaction costs (Mettepenningen, personal communication) so the result does not seem to relate to strategic behavior. One difference is that the ARMS question asked for hours spent while the European survey asked for days spent, and responses may have included partial days. It is also the case that the European programs are more analogous to CSP since compliance with mandatory practices is required, and for CSP, farmers can only enroll after a minimum level of conservation effort has been achieved.

Broad variability in time spent across farms suggests that transaction costs may also vary with farm characteristics, the demographic characteristics of the farmer, and the practices to be installed or adopted. Unfortunately, the ARMS data is not directly linked to current conservation program contracts so information on specific practices funded is unavailable. We do, however, have information on a selected set of conservation practices used in the field and information on the farm and farmer.

Model of transaction cost determinants

The list of explanatory variables and the descriptive statistics for non-CSP and CSP programs are found in table 4. Human capital available to develop conservation program applications is measured by the level of producer education, whether farming is the primary occupation, and the number of operators on the farm. [4] Producer education is a binary variable and equals one if the primary operator has some college education, a college degree, or more. The proportion of farmers with some college was higher for farmers applying to CSP versus

[4] We also tried including age and experience of the primary operator but the resulting coefficients were not statistically significant. Removing these variables did not affect other model coefficients.

farmers applying to the other programs (65 percent versus 52 percent). Farmer occupation is described using a binary variable that equals 1 if the respondents' primary occupation is farming. Farmers applying to CSP were slightly more likely than others to indicate that their primary occupation was farming (90 percent versus 86 percent) and tend to have more operators (an average of 1.76 versus 1.48 for farms that applied to other programs).

To account for farm size and complexity we use the value of total agricultural production and the proportion of value derived from livestock. The total value of production from crops and livestock are developed for ERS farm income estimates and are based on producer responses regarding crop and livestock production in the farm-level portion of the ARMS survey. The value of production is higher for farmers who applied for CSP, $1.05 million versus 0.76 million with large variability in both cases. Those applying for CSP had a slightly higher proportion of their income from livestock, which would indicate a more complex farming system. A binary indicator of highly erodible land is also included to capture the fact that conservation on these acres may be complicated by steep slopes and that conservation compliance requirements may apply and thus could affect producer eligibility for conservation programs.[5] A lower proportion of farmers applying for CSP had highly erodible land (19 percent versus 26 percent).

Because CSP requires previous conservation action, we define three binary indicators of previous conservation performance which serve as a measure of early stewardship. Farmers who had a written soil conservation plan, a written comprehensive nutrient management plan, or an integrated pest management plan by 2004 (preceding the original CSP which held its first signup late in 2004) are more likely to be eligible for CSP and may have had some advantage in

[5] Farmers with highly erodible cropland must be in compliance with soil conservation requirements to be eligible for conservation programs. Practices included in these plans cannot be supported by conservation programs.

competing for enrollment.[6] Although some farmers may have adopted/installed practices after that time, farmers who indicated participation in CSP may have adopted practices after CSP enrollment as the CSP enrollment date is not known and a contract can last for up to 10 years with the optional 5 year extension. Therefore, practices that were in place before CSP began enrolling participants can be viewed as an indicator of their underlying stewardship ethic (Chouinard *et al.* 2008). Surprisingly, farmers applying to CSP were less likely to have a soil conservation plan, perhaps due to a lower percentage having highly erodible land. (A discussion of related regression results is found in that section.) On the other hand, as expected, a larger proportion of CSP applicants had a comprehensive nutrient management plan or an integrated pest management plan.

Given the differences between CSP and other conservation programs, we estimate determinants for CSP and other programs in separate equations. Because participation in USDA conservation programs is voluntary, OLS models may be biased due to producer self-selection for program application. An example of an unobserved variable that may result in selection bias could include a nearby stream that is very polluted. To account for self-selection, we use an endogenous switching model (Maddala, 1983; Abdulai and Huffman, 2014).

(1) $T_{0j} = \beta_0' x_j + \varepsilon_{0j} \ \ when \ \ D_j = 1$

(2) $T_{1j} = \beta_1' x_j + \varepsilon_{1j} \ \ when \ \ D_j = 0$

where:

T_{0j} is transaction cost for farm *j*, given application to a program other than CSP;

[6] Conservation practice questions in ARMS ask when practices were installed or first used.

β_0 is a vector of parameters to be estimated;

x_j is a vector of explanatory variables for farm *j*;

ε_{0j} is an error term that is assumed to follow a standard normal distribution (N(0,1)), and;

D_j =1 for producers who applied for CSP and =0 otherwise.

Equation (2) variables are defined identically, except that subscript "1" refers to CSP participants or applicants. Selection bias arises when the producer choice of program is correlated to the level of realized transaction costs. To test for and correct selection bias, we estimate a binary probit model of the decision to participate in CSP, along with the transaction cost equations:

(3) $D_j^* = \alpha' z_j + u_j;\ \ D_j = 1\ \ if\ \ D_j^* > 0,\ \ D_j = 0, otherwise$

Selection bias, if present, will lead to non-zero covariance among errors for the CSP application and transaction cost equations:

$$cov(\varepsilon_{0j},\ \varepsilon_{1j}\ , u_j) = \begin{bmatrix} \sigma_0^2 & \sigma_{01} & \sigma_{0u} \\ \sigma_{01} & \sigma_1^2 & \sigma_{1u} \\ \sigma_{0u} & \sigma_{1u} & \sigma_u^2 \end{bmatrix}$$

where:

σ_0^2 = variance of error for non-CSP transaction cost equation

σ_1^2 = variance of error for CSP transaction cost equation

σ_u^2 = variance of error for CSP application equation

σ_{01} = covariance for CSP and non-CSP transaction cost equations

σ_{1u}= covariance between the CSP transaction cost error and the CSP choice error; and

σ_{0u}= covariance between the non-CSP transaction cost error and the CSP choice error;

We note that σ_{01} cannot be estimated because there are no observations with data on both CSP and non-CSP transaction cost data and the error variance in the binary probit equation (σ_u^2) can be estimated only up to a scale factor (Maddala).

Given correlation between $\varepsilon_{1j}$and u_j , OLS estimation implies $E(\varepsilon_{1j}) \neq 0$. To correct for bias, the transaction regression equations are adjusted to account for the decisions to apply for CSP or non-CSP enrollment.

(4) $$E(T_{1j}|\, D^* > 0) = \beta_1' x_j + E(\varepsilon_{1j}|D^* > 0) = \beta_1' x_j + E(\varepsilon_{1j}|u_j > -\alpha' z_j)$$

$$= \beta_1' x_j - \sigma_{1u} \frac{\phi(-\alpha' z_j)}{\Phi(-\alpha' z_j)}$$

(5) $$E(T_{0j}|\, D^* < 0) = \beta_1' x_j + E(\varepsilon_{0j}|D^* < 0) = \beta_1' x_j + E(\varepsilon_{1j}|u_j < -\alpha' z_j)$$

$$= \beta_1' x_j + \sigma_{0u} \frac{\phi(-\alpha' z_j)}{1-\Phi(-\alpha' z_j)}$$

Which suggest new regression equations:

$$T_{1j} = \beta_1' x_j - \sigma_{1u} \frac{\phi(-\alpha' z_j)}{\Phi(-\alpha' z_j)} + v_{1j} \text{ where } v_{1j} = \varepsilon_{1j} + \sigma_{1u} \frac{\phi(-\alpha' z_j)}{\Phi(-\alpha' z_j)}$$

$$T_{0j} = \beta_0' x_j + \sigma_{0u} \frac{\phi(-\alpha' z_j)}{1-\Phi(-\alpha' z_j)} + v_{0j} \text{ where } v_{0j} = \varepsilon_{0j} - \sigma_{0u} \frac{\phi(-\alpha' z_j)}{1-\Phi(-\alpha' z_j)}$$

The model can be estimated using a two-step procedure where (α) is estimated with binary probit then $(\beta_0, \beta_1, \sigma_{0u}, \sigma_{1u})$ is estimated by OLS. Then σ_0^2 and σ_1^2 can be estimated from residuals, corrected for bias.

Finally, identification requires that at least one variable in z_j be excluded from x_j. We exclude the stewardship variables. While they indicate a history of stewardship and suggest which farms are more likely to be eligible for CSP or are more likely to be enrolled, they do not relieve farmers of documenting land use, production, and conservation practices in the process of applying for CSP enrollment. In fact, applicants to all programs are required to fill out extensive forms describing both land use and practices.

Regression Results

As indicated, unobserved factors may affect both CSP participation and the magnitude of transaction costs (measured in hours) incurred in applying for the program. Parameters are estimated separately for hours spent on *ex ante* and *ex post* activities (Table 5). Each model includes a probit regression for CSP participation versus participation in other programs and regressions to identify factors affecting the magnitude of transaction costs for non-CSP and CSP programs. Both regressions include bias correction based on the probit model. The three regressions indicated for *ex ante* were determined simultaneously as was the case for the regressions under *ex post*.

Selection bias is indicated only in the CSP equation for *ex ante* transaction costs. Estimated error correlation is positive (0.529)[7] and significant ($p<0.05$) implying that producers

[7] The sign is negative in Table 5 because σ_{0u} enters equations (4) and (6) with a minus sign.

who participate in CSP also have higher transaction costs. For the other equations, OLS models would be unbiased.

For both sets of farmers, a higher number of operators associated with the farm significantly increased the likelihood of CSP participation. For the farmers who were successful, i.e. for whom we have *ex post* costs, education also positively affected CSP participation. We had expected that having a soil conservation plan, a nutrient management plan, or a pest management plan prior to 2004 would increase the likelihood of CSP participation. While this was true for nutrient and pest management plans in both probit regressions, having a soil conservation plan actually reduced the likelihood of applying for CSP versus other USDA programs examined in this study. The negative sign on the soil conservation equation may reflect the fact that soil conservation plans are required on highly erodible land for producers who receive income support, disaster, or conservation payments from USDA programs. These plans, however, may not fully address soil erosion (i.e., reduce erosion to levels and sustain soil productivity and minimize sedimentation). Under the Highly Erodible Land Conservation (HELC) provisions of the 1985 Farm Act, better known as Sodbuster, producers were allowed to implement plans that were less expensive than plans that would have fully protected the soil. As a result, these conservation plans may not indicate a level of stewardship that satisfies CSP requirements.

Turning to the factors affecting transaction costs/hours, a number of variables are significant for *ex ante* costs. In each case the intercept is significant, indicating that there is a fixed cost component to applying for these programs, in line with the findings of McCann (2009) for transaction costs of comprehensive nutrient management plan preparation and for Ducos *et al.* (2009) examining European AESs. Other significant variables affecting the number of hours spent differed by type of program. For the non-CSP programs, contrary to expectations, education increased the time spent, and full-time farmers spent less time than those whose primary occupation was not farming. Farm size, measured by value of production, increased the time spent, in line with expectations. Complexity of the farming system as measured by the proportion of the farm receipts from livestock, did not affect transaction costs nor did having highly erodible land. Only one factor significantly affected the magnitude of transaction costs for CSP program applicants; the number of operators increased transaction costs. Taken together with the participation equation, this may indicate that additional human capital on the farm allowed farmers to participate in the more complex program and to allocate more time to applying for it.

Regarding *ex post* transaction costs for non-CSP programs, only one factor, farmer occupation, significantly affected the costs of signing the contract and documenting compliance. While full time farmers spent less time on *ex ante* activities, they spent more time on *ex post* activities. This may be due to risk aversion since these farmers would have more of an incentive to be in compliance with USDA programs. For CSP *ex post* transaction costs, two factors are significant. The time spent on these activities was significantly and negatively related to value of production, perhaps due to time constraints, holding number of operators constant. They may also have proposed practices that were more easily documented, but this data is unavailable. In line with the theory of transaction costs, farmers with a higher proportion of value from livestock, and thus more complex farming systems, had higher *ex post* transaction costs.

Conclusions

Taken together, these results indicate that increased management capacity, and a demonstrated stewardship ethic on the farm increases the likelihood of participating in a more complex and demanding program, CSP. Given the farmers choice of program, there are some variables that are associated with increased time spent on applying for and, if accepted, complying with program requirements. There are some fixed costs associated with applying for the program that are separate from the size of the farm. As far as other factors that are hypothesized to affect transaction costs, no variables were significant for all types of programs and across *ex ante* and *ex post* activities. There is some support for farm complexity increasing *ex post* costs, particularly compliance documentation costs. The magnitudes of transaction costs of farmers who actually applied to these programs do not seem particularly onerous and are lower than the transaction costs that have been measured for European AESs. However, for people who have not participated, the percentage of people agreeing that applying for programs and documenting compliance were barriers, indicates that perceived transaction costs are a barrier to participation.

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Table 1. Barriers to Participation for ARMS Respondents Who Did Not Apply for Conservation Program Participation*

	Agree	Neutral	Disagree
	Proportion of Respondents		
I was not aware of USDA or other conservation programs	0.15	0.37	0.49
I was not aware of environmental problems (on surveyed field)	0.63	0.23	0.14
Payments are not high enough	0.20	0.68	0.12
Government standards make practices more expensive than they need to be to get the job done.	0.34	0.56	0.10
My offer would not have been accepted because the problems in this field are not national or state priorities.	0.23	0.61	0.15
The application process is too complicated and time consuming.	0.29	0.57	0.14
Documenting compliance would be too complicated and time consuming	0.31	0.55	0.12

*Based on 2012 field-level survey of soybean production and conservation practices
Source: 2012 Agricultural Resources Management Survey

Table 2. Hours Spent on Conservation Program Applications

	EQIP, CRP, and other programs			CSP		
Activity	N	Mean	Median	N	Mean	Median
Learning about the program in general, on your own or at meetings?	91	2.8	2	77	4.1	2
Planning or designing specific practices for your farm (on your own or in meetings with USDA staff, contractors, or others)?	91	2.5	1	77	5.7	2
Collecting information (e.g. field characteristics, maps, soil test results) that was needed to fill out program application forms?	91	1.8	0	77	6.7	2
Filling out the program application forms?.	91	1.3	1	77	4.0	2
Total, *ex ante* hours	91	8.4	6	77	20.5	11
If your offer was accepted, understanding and signing the contract?	77	0.8	1	75	1.6	1
If your offer was accepted, documenting compliance after the practices were installed or adopted?	77	1.1	1	75	6.4	2
Total, *ex post* hours	77	1.9	2	75	8.0	3

Source: 2012 Agricultural Resources Management Survey

Table 3. T statistics for differences across programs with average *ex ante* transaction costs

	CSP		CRP		Other		N
EQIP	2.3537	**	-1.2134		0.0169		33
CSP	--		-3.3184	***	-1.9941	*	77
CRP	--		--		0.829		32
Other	--		--		--		23

Difference tested is column minus row

Table 4. Descriptive Statistics

	Non-CSP Programs			CSP		
Variable	N	Mean	Standard Deviation	N	Mean	Standard Deviation
Education	91	0.52	11.82	77	0.65	11.00
Farm Primary Occupation	91	0.86	8.23	77	0.90	6.81
Number of Operators	91	1.48	14.34	77	1.76	19.63
Value of Production (million $)	91	0.76	32.81	77	1.05	29.42
Proportion of Value from Livestock	91	0.11	5.48	77	0.14	5.69
Highly Erodible Land	91	0.26	10.32	77	0.19	9.10
Soil Conservation Plan, pre 2004	91	0.39	11.56	77	0.20	9.12
Comprehensive Nutrient Management Plan, pre 2004	91	0.08	6.25	77	0.18	8.86
Integrated Pest Management Plan pre 2004	91	0.04	4.74	77	0.11	7.13

Source: 2012 Agricultural Resources Management Survey

Table 5. Regression Results (s.e.)

Variables	*Ex Ante* Costs (N=167)						*Ex Post* Costs (N=151)					
	CSP Participation		Non-CSP Transaction Costs		CSP Transaction Costs		CSP Participation		Non-CSP Transaction Costs		CSP Transaction Costs	
Intercept	0.107		2.113	***	2.161	***	0.069		0.309		0.993	
	(0.135)		(0.313)		(0.691)		(0.136)		(0.231)		(0.734)	
Education	0.093		0.398	**	0.038		0.125	*	0.090		0.371	
	(0.073)		(0.171)		(0.267)		(0.076)		(0.135)		(0.299)	
Farmer Occupation	0.105		-0.768	***	0.076		0.180		0.329	*	-0.380	
	(0.111)		(0.238)		(0.389)		(0.110)		(0.169)		(0.430)	
Number of Operators	0.135	***	0.068		0.365	**	0.123	**	-0.024		0.262	
	(0.052)		(0.147)		(0.157)		(0.053)		(0.109)		(0.162)	
Value of Production	-0.018		0.114	*	0.089		-0.015		0.001		-0.315	***
	(0.029)		(0.061)		(0.100)		(0.031)		(0.051)		(0.109)	
Proportion of Value from Livestock	0.236		0.553		0.087		0.205		0.115		1.195	**
	(0.168)		(0.475)		(0.521)		(0.171)		(0.351)		(0.542)	
Highly Erodible Land	0.111		-0.013		0.014		0.066		-0.203		-0.003	
	(0.097)		(0.193)		(0.293)		(0.097)		(0.146)		(0.325)	
Soil Conservation Plan (pre 2004)	-0.364	***					-0.356	***				
	(0.090)						(0.092)					
Nutrient Management Plan (pre 2004)	0.300	***					0.279	**				
	(0.115)						(0.137)					
Pest Management Plan (pre 2004)	0.397	***					0.477	***				
	(0.138)						(0.183)					
Error standard deviation	0.448	***	0.745	***	1.045	***	0.442	***	0.536	***	1.017	***
	(0.025)		(0.060)		(0.175)		(0.025)		(0.043)		(0.089)	
Error correlation			0.104		-0.529	**			-0.008		0.084	
			(0.308)		(0.217)				(0.354)		(0.312)	

*p<0.10, **p<0.05, ***p<0.01