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The Effect of Social Capital on the Choice to Use Sustainable Agricultural Practices

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We investigate whether social capital in the form of community involvement affects farmers' choice to use sustainable agricultural practices. Using associational memberships as a measure of community involvement we study its effects on agricultural practices among Georgia farmers. Our findings show that, first, community involvement had a positive effect on the decision to adopt sustainable agricultural practices, and, secondly, it also had a positive effect on the extent to which farmers adopt these practices. These findings establish an additional dimension to the benefits that would accrue to policies that promote social interaction and civic engagement in rural areas.

Key Words: adoption, associational memberships, community involvement, social capital, sustainable agriculture

JEL Classifications: Z1, Q16, Q56

The purpose of this paper is to explore the effect of social capital, in the form of associational memberships, on decisions by farmers to use sustainable agricultural practices. We use a survey instrument that provides information about agricultural practices and associational involvements for a sample of the farmers in the state of Georgia. We hypothesize a positive relationship between associational memberships and the adoption and extent of use of sustainable agricultural practices. While testing this hypothesis we also address the issue of possible endogeneity of the membership variable.

Social capital, as built through community involvement, may enhance social responsibility and thereby promote the use of sustainable agricultural farming practices. We view the practice of sustainable agriculture as both good farming and socially responsible behavior. Sustainable agriculture refers to an agricultural production and distribution system that encompasses diverse methods of farming and ranching that is more profitable, environmentally sound, and is good for communities. Such practices integrate natural biological cycles and controls, protect and renew soil fertility, and optimize on-farm resources and reduce purchased production inputs, particularly non-renewable resources. While profitability is a key ingredient to sustainable agriculture, studies on the issue present a mixed picture. For example, organic cropping systems produce yields that are generally lower and labor requirements that are higher than in conventional agriculture but with lower purchased input costs (National Research Council, 2010). Studies (Greene et al., 2009; U.S. Department of Agriculture–Economic Research Service, 2009) have shown that price premiums for organic farmers, for example, can

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range from 5% to 70% of the market price for conventional produce. Lotter (2003) showed that when price premiums were not included, conventional systems were generally more profitable.

The issue of social responsibility is a major theme in the agricultural technology adoption literature. Lynne and Casey (1998) find that farmer motivation is multifaceted—farmers are motivated by self-interest, as well as values and beliefs. A decision to adopt a new agricultural practice can be influenced by attitudes toward the efficacy (and profit potential) of the practice, as well as the public-interest values and beliefs related to social norms. Chouinard et al. (2008) model farmer's behavior in an expanded utility framework with two utility components: self and social interests. They find evidence that some farmers are willing to forego some profit to engage in sustainable farm practices.

Community involvement can also facilitate information channels; the individual may gain an understanding of the importance of the environment and obtain knowledge and training about sustainable agricultural practices. When individuals interact with one another, a transfer of information often takes place. The channeling of information and information diffusion are some of the most widely discussed aspects of social networks, especially at the individual level (Durlauf and Fafchamps, 2005).

Associational involvement may also contribute to learning and training in sustainable agriculture practices. The National Environmental Education and Training Foundation illustrates the importance of knowledge and information on successful environmental practices (Coyle, 2005). A farmer may learn new techniques and know-how, obtain informal training from others who have already adopted such practices, and even obtain help implementing various practices. Barr (2000) argues that social networks among Ghanaian entrepreneurs served to channel information about new technology. The role of business networks in conveying information about employment and market opportunities has been much emphasized (Fafchamps and Minten, 1999; Granovetter, 1995; Montgomery, 1991; Rauch and Casella, 2001). In the literature on knowledge spillover, social ties and contacts play a crucial role not only in dissemination of ideas but also in the cross breeding of ideas through social interaction (Jacobs, 1969; Krugman, 1991).

The literature on technology adoption and information diffusion also indicates that the spread of information and knowledge may in fact be more effective if it is shared through social interactions (Casey and Lynne, 1999; Lynne, 1995; Lynne and Casey, 1998). When individuals share common interests and beliefs, which is often the case in associational activities, communication among them is more likely to be effective. As a result, learning from groups may be more effective as compared with other avenues of learning. Studies on agricultural technology adoption show that weaker and more moderate forces such as attitude and norms can be more effective than highly visible, more demanding external controls (Lynne et al., 1995).

Researchers have proposed several explanations for observed socially responsible behaviors consistent with neoclassical economics (Lynne, 1995). One of the most common approaches is to model these behaviors as a "warm-glow" effect where the apparent selfless act causes a utility enhancement (Andreoni, 1989; Artikov et al., 2006). Alternatively, models of deontological altruism assume that a certain charity threshold must be reached before a person can derive any satisfaction from private consumption (Asheim, 1991). The general theme is that apparently selfless socially responsible behaviors may in fact enhance an individual's utility.

Of particular interest, in the present context, is the line of research that draws a connection between apparently altruistic socially responsible behaviors and social involvement. Artikov et al. (2006) finds that the norms in the community (which they view as a proxy for the utility gained from allowing oneself to be influenced by others) play a large role in agronomic decisions. The theoretical basis for this connection is that identifying with a group or a network and getting involved with it affects individual preferences and choices (Durlauf and Fafchamps, 2005).

The relationship between social capital and civic responsibility is a recurrent theme in the social capital literature (Krishna and Uphoff, 1999). Some of the most widely discussed outcomes of social capital concern civic matters such as political participation and good governance, philanthropy, increased judicial efficiency, decreased government corruption, and promotion of cooperative movements (DiPasquale and Glaeser, 1999; Goss, 1999; LaPorta et al., 1997; Paldam and Svendsen, 2000; Putnam, 1995, 2000). Putnam (2000) argues that civic engagement is one of the most important predictors of philanthropy. Other charitable behaviors such as volunteering time (Putnam, 2000; Ferrer-i-Carbonell and Gowdy, 2005) and making monetary donations (Brooks, 2005) have also been linked to social capital.

Surely, social capital does not always lead to civic responsibility or socially responsible actions. A frequently used counter-example is that of organized crime syndicates where high levels of social capital are associated with socially harmful and destructive outcomes. In this paper, we are focusing only on community involvement and our measure is the membership variable that includes the types of organizations (from school to professional to recreational groups) that are more likely than mafia organizations to produce social responsibility.

An extensive literature studies environmental awareness *at the aggregate level* (Saxton and Benson, 2005), especially in the form of cross-country comparisons (Duroy, 2005; Grafton and Knowles, 2004). Aggregate social capital, via the mechanism of collective action, plays an important role in these discussions (Pargal, Huq, and Gilligan, 1999; Pretty and Ward, 2001; Varughese and Ostrom, 2001). However, behind any group level action, there are individuals solving their own decision problems.

A number of studies, using aggregate level data in rural Tanzania, have looked at the connection between social capital and the individual's actions regarding agricultural practices. DeTray (1995) found that participatory associations in two regions of Tanzania had a significant positive effect on farmers' market orientation. Isham (2002) showed that social capital (measured by "ethnic affiliations") affects fertilizer adoption of farmers. Narayan and Pritchett (1999) calculated individual level social capital and studied its impact on household expenditures and found that households from villages with higher levels of the social capital indices (constructed based on organization memberships) were more likely to use modern agricultural inputs. While explaining the probability of adopting improved agricultural practices they only included village level social capital in their analysis.

Unfortunately, studies that use aggregate-level social capital necessarily face a serious conceptual challenge; what is the aggregation mechanism? The facts that social capital is subject to complementarities and that social capital does not have to be benign raise conceptual difficulties in aggregation (Glaeser, Laibson, and Sacerdote, 2002; Munasib, 2005). Furthermore, estimation of aggregate social capital effects is subject to serious identification problems (Durlauf and Fafchamps, 2005; Manski, 2000). In this paper, instead of looking at any aggregate-level measure of social capital for a location or a group, we focus on the individual farmer and ask if adoption of sustainable practices is related to more community involvement.

Data

The data for this study was obtained through a telephone survey of Georgia farmers using a random dial approach. The survey was conducted by the Georgia Agricultural Statistics Service (National Agricultural Statistics Service, U.S. Department of Agriculture) in the winter of 2004. There were a total of 431 telephone interviews, representing a statistically significant sample of Georgia farmers based on the use of a simple random sampling procedure, with a confidence level of 95% and a ±5% margin of sampling error. A total of 921 phone contacts were made with a 46.8% response rate. Incidents of non-response included respondents who were unavailable, respondents who refused to participate, non-working numbers, answering machines, no answer/busy, or strange noises. Usable data were available for 317 households. Table 1 presents a comparison of the demographic characteristics of our sample and the Georgia farm population indicating that the sample is representative. Georgia farmers are overwhelmingly male, white, and generally older than the typical person in the state.

Table 1. Comparison of Demographic Characteristics of the Sample and the Population

Category	Subcategory	Sample Respondents	Georgia Farmers[a]	All Georgia[b]
Male (% of sample)		89.54	87.00	49.20
Female (% of sample)		10.46	13.00	51.80
Age (years)		59.30	56.50	34.46
Race (% of sample)	White	95.00	96.00	65.10
	African-American	4.58	4.00	28.70

[a] Source: 2002 U.S. Census of Agriculture.
[b] Source: Statewide data from 2000 U.S. Census (available at http://www.epodunk.com and http://fisher.lib.virginia.edu/collections/stats/ccdb).

The survey had 76 questions including demographic and economic information about the farmer and the farm, information about community involvement of the farmers, and whether the farmer uses one or more of 13 sustainable agricultural practices. We did not ask farmers whether they used sustainable agriculture techniques. Rather, a focus group of farmers and agriculture professionals who are part of the U.S. Department of Agriculture's Sustainable Agriculture Research and Education program were asked to develop a list of practices that are commonly known to be part of the sustainable agriculture "tool kit". The 13 practices were grouped as pest management (three questions), grazing (three questions), soil/nutrient management (five questions), and organic (two questions). Every practice is applied differently according to the individual sites and conditions as well as the specific needs of the farmer. One reason they are all classified as sustainable is that their use cuts down on the use of off-farm, purchased inputs. Most sustainable agricultural theory and principles were originally developed based on the soil. Sustainable agriculture looks at the soil as a living ecosystem that can be managed. Building organic matter through cover crops, no-till farming, mulching, manures, etc. is done so that a farmer can take advantage of the benefits of good soil organic matter. In addition, practices such as grazing multiple species together eliminates or reduces the need for chemicals to combat parasites, as well as the need to use hormone or antibiotic amendments to encourage growth which is slowed due to parasites. The strategy of mixing annual and perennial plant species in a pasture allows for new growth with different nutritional and energy benefits.

Table 2 shows that farmers with above average associational memberships adopted an average of 5.5 sustainable agricultural practices compared with an average of 3.9 such practices adopted by farmers with less than average associational memberships. We also see that a greater

Table 2. Association Memberships and Sustainable Agricultural Practices

	Less than Average Membership	More than Average Membership
Number of observations	172.0	149.0
Mean of total number of sustainable agricultural practices	3.9	5.5
Percent of the sample adopting at least one sustainable pest management practice	33.7	51.0
Percent of the sample adopting at least one sustainable grazing practice	68.0	70.5
Percent of the sample adopting at least one sustainable soil management practice	70.3	84.6
Percent of the sample adopting at least one organic practice	1.2	11.4

percentage of farmers with above average associational memberships adopted at least one sustainable agriculture practice in each category.

Table 3 presents the responses to questions regarding sustainable agricultural practices. Forty-two percent of all respondents were involved in at least one of the three environmental pest control practices, 69% in at least one of the three environmental grazing practices, and 77% in at least one of the five environmental soil management practices. Only 6% participated in any form of organic production practices. The most common sustainable practices were management-intensive grazing systems (53%), mixes of pasture forage in a single field (52%), cover crops (54%), and mulches/manures (52%). The least common were the organic practices.

The second part of the survey asked farmers a number of questions about associational activities. The questions were selected from the Social Capital Benchmark Survey 2000 conducted by the Roper Center for Public Opinion Research. The Benchmark survey was designed to measure people's civic engagements. The associational activities include religious organizations, adult sports, youth groups, parent/school groups, senior clubs, art clubs, hobby clubs, self-help clubs, internet groups, veterans groups, neighborhood associations, social welfare groups, unions, professional/trade groups, service clubs, civil rights, and political action organizations. These groups can be categorized as either personal (those groups for whom membership is primarily for personal growth or enjoyment) or professional (or non-altruistic) actions. The measure "number of associational memberships," the so-called "Putnam's Instrument" (Putnam, 1995, 2000), has a special place in the social capital literature as one of the most frequently used measures of social capital (Carter and Maluccio, 2003; Costa and Kahn, 2003; Grootaert, 2000; Helliwell, 1996; Maluccio, Haddad, and May, 2001; Narayan and Pritchett, 1999). When membership is used to measure individual social capital it is essentially based on the "network view" where social capital of an individual represents his social connectedness. This view also renders an optimization framework in a relatively straight-forward manner (Durlauf and Fafchamps, 2005). An alternative view of social capital is the so-called "trust/co-operation" view that defines social capital as the level of trust in the society (Paldam and Svendsen, 2000). This, however, is not conducive to individual optimization (Durlauf and Fafchamps, 2005; Glaeser, Laibson, and Sacerdote, 2002; Munasib, 2005).

Even under the network view of social capital, the membership measure is not a perfect measure of individual social capital because it does not take into account vital social network

Table 3. Sustainable Agricultural Practices

Practice	Percent Using	Practice	Percent Using
Pest management[a]	42	Soil/nutrient management	77
Biological, cultural, physical pest management tools	26	Strip cropping, reduced or no-tillage	36
Habitat for beneficial insects or trap crops	12	Cover crops	54
On-farm biological cycle	17	Soil organic matter	33
Grazing	69	Maintain micro-organisms in soil	34
Management-intensive grazing system	53	Mulches/manures	52
Mixes of pasture forage in single field	52	Organic	6
Animal management system with two or more species	27	Certified organic	2
		Process or value-added organic	6

[a] These all relate to using insects, bacteria, fungi, and mulch that are already in the soil to improve soil fertility and combat weed and insect pests.

links such as friends and neighbors (Fukuyama, 2000; Munasib, 2005; Paldam and Svendsen, 2000; Sobel, 2002). Therefore, in this paper, we use the membership measure simply as a measure of community involvement of the individual, which, quite possibly, is also a partial measure of the individual's social capital.

Table 4 shows that the respondents to the survey were overwhelmingly married, homeowners, and registered to vote. Since there is little variation in these categories, they are excluded in the empirical analysis. Table 5 shows that the sample mean of acres cultivated were 162 acres; thus the mean respondent was a relatively small farm operation. Only 8% of respondents cultivated more than 500 acres while 62% cultivated less than 100 acres. Livestock and poultry farms were the primary farm enterprise for 71% of respondents. Thirty-six percent of the respondents had gross farm income of less than $10,000. Six percent of the respondents can be characterized as limited-resources farms, having total household income of less than $20,000. Twenty-two percent of farmers can be characterized as larger farms having gross farm income of over $50,000. Approximately 20% of the respondents refused to answer the household income or farm income questions.

The dependent variables are responses regarding sustainable agricultural practices classified as either indicator variables or ordered response variables. The indicator variables PESTDUM, GRAZDUM, and SOILDUM denote whether the farmer is engaged in a certain *type* of sustainable practice (e.g., PESTDUM indicates whether any of the sustainable pest control measures are practiced). These variables indicate *adoptions of sustainable agricultural practices*. The ordered response variables PEST, GRAZING, and SOIL stand for the number of each type of sustainable practice that the farmer is engaged in (e.g., PEST is the number of sustainable pest control measures that the farmer is practicing). These variables measure the *extent of sustainable agricultural practices*. We also created a continuous variable, SUSPRAC, which aggregates over all four types of sustainable practices. This is a summary measure of the extent of sustainable practices. Although SUSPRAC includes organic practices we do not have separate variables for organic practices since the number of observations is too small for meaningful regression analyses.

Since our objective is to find whether the number of associational activities of an individual farmer has an independent effect on her use of sustainable agricultural practices, the variable of interest is the total number of associational memberships (from the list of 18 as discussed above). The control variables may be classified as demographic characteristics, variables related to farm operation, and aggregate level location characteristics.

Respondent's demographic characteristics included education, family size, and number of children. Detailed categories of education are: high school dropout, high school graduate and some college, college graduate, and post graduate. We have included family size because it is likely to be correlated with the membership variable (since numerous associations relate to school or youth activities) and, when the farm is operated by the family, it could also be correlated with agricultural practices. We have also included number of children since some writers have postulated that people behave generously toward their progeny or future generations to neutralize future tax payments (Barro, 1974).

Table 4. Description of the Sample

Category	Subcategory	Georgia Farm Social Capital Survey
Marital Status (% of sample)	Married	86.72
	Divorced	6.64
	Widowed	4.15
	Never married/single	2.49
Owned home (% of sample)		98.32
Registered to Vote (% of sample)		95.00

Table 5. Descriptive Statistics: Explanatory Variables (n = 317)

Variable	Mean	Std	Min	Max
Number of memberships	3.70	2.76	0.00	16.00
Any pest control practice (PESTDUM)	0.42	0.49	0.00	1.00
Any grazing practice (GRAZDUM)	0.69	0.46	0.00	1.00
Any soil management practice (SOILDUM)	0.77	0.42	0.00	1.00
Total number of sustainable practices (SUSPRAC)	4.60	3.00	0.00	13.00
Number of practices in pest control (PEST)	0.53	0.71	0.00	3.00
Number of practices in grazing (GRAZING)	1.30	1.07	0.00	3.00
Number of practices in soil (SOIL)	2.03	1.61	0.00	5.00
High school dropout	0.11	0.31	0.00	1.00
High school graduate and some college	0.57	0.50	0.00	1.00
College graduate and post graduate	0.31	0.46	0.00	1.00
Family size	2.45	1.07	1.00	7.00
Number of children	2.36	1.42	0.00	9.00
Years farming	33.00	17.05	2.00	86.00
Acres cultivated (100 acres)	1.62	3.48	0.00	39.00
Farm type: poultry	0.71	0.45	0.00	1.00
Farm type: fruits and vegetables	0.04	0.20	0.00	1.00
Farm type: crops	0.10	0.30	0.00	1.00
Farm type: trees	0.12	0.33	0.00	1.00
Farm type: other	0.03	0.16	0.00	1.00
County per capita income ($10,000)	2.13	0.42	1.48	4.48
County unemployment rate	4.85	1.11	2.60	10.10
County population (100,000)	0.50	1.08	0.02	8.18

To account for the farm activities and effects accruing to forward linkages, we have used five dummy variables indicating farm types. Farm operation-related variables include the number of years of farm operation and acres cultivated. We did not include an explicit earnings variable. Survey results on the income variables, both household income and farm income, have many non-responses that significantly reduce the number of observations (by 21%). We use proxies for an explicit income variable including education, years farming, and acres cultivated that account for earnings.[1] To capture the aggregate level effects we have included county per capita income and county unemployment rate. Since farmers in our sample come from rural counties (or the rural parts of counties), we do not include population density as a variable. Instead, the county population is included with the expectation that it will capture some of the macroeconomic characteristics such as the size of market.

Methods

We test two hypotheses: that associational memberships matter for *adoption* of sustainable agricultural practices, and that associational memberships affect the *extent* to which the farmers are engaged in sustainable practices. We use cross sectional regressions to examine the relationship between the number of associational memberships of the individual and sustainable practices adopted by that individual. This is a fundamentally different problem from the issue of estimating a group level effect. Therefore, the problems of correlated effects and the question of joint endogeneity are not likely to arise (Manski, 2000). Social effects (or effects of group level variables) on the individual

[1] We did separate regressions on a reduced sample with household income. The results did not significantly change. First, after including the proxies for income, income is no longer significant in all but one of the seven regressions. Secondly, inclusion of income, in this reduced sample, does not substantially change the effect of membership.

are difficult to measure, in large part due to identification problems described in Manski (2000). The correlated effects arise because decisions of individuals within a group are similar due to shared (and possibly unobservable) characteristics. It becomes difficult to distinguish the so-called endogenous interactions, in which individual decisions are influenced directly by the decisions of their peers, from the correlated effects. A second difficulty arises when the observed choices are jointly endogenous: the choices of the group members cannot be regarded as exogenous influences since they are in turn influenced by the choice of the individual. There are, however, a number of other econometric issues that do arise. We categorize them as structural factors and the potential endogeneity of the membership variable.

Structural factors refer to the farm operation, particularly to its forward linkages. This is especially important for Georgia farms because a majority of these farms are small and the predominant farm type is livestock and poultry. Structural factors also refer to the size of the farm and the age of farm operation. Farms with higher earnings are likely to be less risk-averse vis-à-vis the lower-earning farms in adopting new technology (Wandel and Smithers, 2000). Demographic factors appeal to sources that influence the farmer's attitude and exposure toward sustainable agricultural practices.

Flora (1995) hypothesized that an increase in sustainable practices by farmers may increase social capital. Although Flora's hypothesis was at the community level and she did not adopt an econometric framework to test this hypothesis, we acknowledge the possibility that even at the individual level, a reverse causality may exist. For instance, farmers who are practicing sustainable agriculture may want to be involved in organizations to meet other practitioners of sustainable agriculture to share information and other experiences. In that case, the membership variable would be endogenous. We carried out Durbin-Wu-Hausman (DWH) tests of endogenous regressors to verify whether the membership variable is endogenous.

On the adoption issue, we focus on the variables PESTDUM, GRAZDUM, and SOILDUM. We first carry out Durbin-Wu-Hausman tests of endogenous regressors to test whether associational membership is endogenous in each of these regressions. The tests show that associational membership is not endogenous in PESTDUM and GRAZDUM. We, therefore, use probit regressions for PESTDUM and GRAZDUM, and instrumental variable probit for SOILDUM to test if associational memberships have any significant causal effect on the adoption decisions.

On the issue of the extent of sustainable agricultural practices, the dependent variables are PEST, GRAZING, SOIL, and SUSPRAC. We follow the same procedure of first testing for endogeneity of the membership variable. We find that associational membership is not endogenous in any of these regressions. So, we continue with an ordinary least squares (OLS) regression for SUSPRAC (since SUSPRAC is treated as a continuous variable) and ordered probit regressions for PEST, GRAZING, and SOIL (since they are ordered responses). The maximum value of SUSPRAC is 13. To allow for the possibility that the variable is right censored, we have also run tobit regressions. Since the tobit regressions produced essentially the same results as the OLS regressions, we have reported only the OLS regressions.

For the DWH tests we follow the procedure presented in Wooldridge (2002) and Davidson and MacKinnon (2004). We first run an OLS of the membership variable on all the exogenous variables and the instrument and calculate the residual. Then we run an OLS of SUSPRAC on all the right-hand-side variables and this residual. The test of significance (with a t statistic) of the estimated coefficient of the residual is the DWH test. To make the test robust to heteroskedasticity we employed the heteroskedasticity-robust t statistic. To address the issue of potential endogeneity of the membership variable in the discrete response cases, we conduct a DWH test of endogenous regressor the same way we do the test for SUSPRAC, the linear case (Davidson and MacKinnon, 2004).

The DWH test requires an exclusion restriction, a valid instrument which econometric estimations with social network variables often lack. When detailed information is available about the characteristics of the individuals within the social networks, it may be possible to devise exclusion restrictions from that information (Calvó-Armengol, Patacchini, and Zenou, 2009). Such data sets are extremely rare. In the absence of such information we were unable to find a valid instrument outside the model. We therefore adopted the approach of using an "inside instrument" which is common in macroeconomic literature. We used the solution proposed in Lewbel (1997) where instruments are devised based on higher order moments of the data. The idea is closely related to instruments frequently used in generalized method of moments (estimations where the characteristics of the data are exploited to obtain instruments. Lewbel's application was for a case where endogeneity is arising from measurement error in the right-hand-side variable; Millimet and Osang (2007) use the approach for endogeneity arising from reasons other than measurement errors. In our case, we used higher order moments of the membership variable as instruments in the DWH tests.

Since the validity of the instrument is crucial for the DWH test, we carried out extensive tests to verify that the instruments are indeed valid. First, the instrument has to be "relevant" in the sense that it should be able to explain variations in *number of memberships*. Secondly, it should not be a "weak instrument" so that identification is not weak. And finally, it should be exogenous so that it can be excluded from the regressions of the outcome variables (i.e., the sustainable practice variables). We ran first stage regressions to check if the instrument explains variations in the membership variable. We carried out the Stock and Yogo (2005) test of weak instruments. To check if the instrumental variable can be "excluded", for each sustainable variable we ran a regression with the instrument, the membership variable, and the rest of the independent variables on the right-hand-side. Our instruments satisfied all these diagnostics.

To facilitate the interpretation of the parameter estimates in the ordered probit regressions we let y be an ordered response taking on the values $\{0,1, .., J\}$ for some known integer J. Assume that a latent variable y^* is determined by $y^* = \mathbf{x}\beta + \varepsilon$ where $\mathbf{x}$ is the vector of explanatory variables, β is $K \times 1$, and $\varepsilon|\mathbf{x} \sim \text{Normal}(0.1)$. Let $\alpha_1 < \alpha_2 < \ldots < \alpha_J$ be unknown cut points. Define, $y = 0$ if $y^* \leq \alpha_1$, $y = 1$ if $\alpha_1 < y^* \leq \alpha_2, \ldots,$ $y = J - 1$ if $\alpha_{J-1} < y^* \leq \alpha_J$, and $y = J$ if $y^* > \alpha_J$. Given the standard normal assumption about ε, probabilities of the responses, $P(y = 0|\mathbf{x})$, $P(y = 1|\mathbf{x}), \ldots, P(y = J - 1|\mathbf{x})$, and $P(y = J|\mathbf{x})$, sum to unity. When $J = 1$, we have the binary probit model where $-\alpha_1$ is the intercept inside Φ. In this formulation of ordered probit model, x does not contain an intercept. When there are only two outcomes $\{0,1\}$, the single cut point is set to zero and the intercept is estimated, producing the standard probit model.

The sign on β_k unambiguously determines the direction of the effect of x_k on the probabilities $P(y = 0|\mathbf{x})$ and $P(y = J|\mathbf{x})$, but not the probabilities of the intermediate outcomes $1, 2, \cdots, J - 1$. If $\beta_k > 0$, then $\partial P(y = 0|\mathbf{x})/\partial x_k < 0$, $\partial P(y = J|\mathbf{x})/\partial x_k > 0$, but $\partial P(y = j|x)/\partial x_k$ *for* $j \in [1, J - 1]$ can have either sign. Therefore, to analyze the effect of a regressor in a meaningful way we have to look at the marginal effects on each ordered response.

Results and Discussion

From the DWH tests we conclude that the membership variable may be endogenous in the SOILDUM regression but exogenous in the other six regressions. As a result, we can continue with the following regressions to estimate the causal effects of the membership variable on adoption (and the extent) of sustainable agricultural practices: probit for PESTDUM and GRAZDUM, OLS for SUSPRAC, and ordered probit for PEST, GRAZING, and SOIL. For SOILDUM we used instrumental variable probit regression with the same valid instrument that we used for the DWH test.

Table 6 presents the probit estimates of the adoption indicators. We find that associational memberships matter in adoption of environmental pest control and grazing practices. A one unit increase in membership (i.e., one more associational involvement) from its mean level raises the probability of adoption of pest control measures by 2.6% and grazing practices by 1.9%. These are economically significant quantities because, for instance, if memberships increase by a unit for every farmer in the state of Georgia, we would see roughly 1,300 more farmers adopting sustainable pest control practices. Adoption of

Table 6. Estimated Marginal Effects ($\partial p_1/\partial x$): Adoption of Sustainable Agricultural Practices

	PESTDUM	GRAZDUM	SOILDUM
	Probit	Probit	IV-Probit
Number of memberships	0.0259	0.0186	0.0155
	(0.0114)**	(0.0118)*	(0.0609)
High school and some college	0.1666	0.0556	0.2179
	(0.0960)*	(0.0889)	(0.2658)
College grad and post graduate	0.2221	0.1454	0.316
	(0.1109)**	(0.0907)	(0.3192)
Family size	−0.0549	0.0079	−0.0207
	(0.0292)*	(0.028)	(0.082)
Number of children	0.0137	−0.0214	−0.0248
	(0.0214)	(0.0214)	(0.0618)
Years farming	0.0017	0.0008	0.0045
	(0.0018)	(0.0018)	(0.0052)
Acres cultivated	0.0108	−0.0038	0.0711
	(0.0102)	(0.0100)	(0.0354)**
Farm type: fruits and vegetables	0.4404	−0.7195	0.4868
	(0.1201)***	(0.0526)***	(0.5490)
Farm type: crops	0.1384	−0.3367	−0.2171
	(0.1044)	(0.1044)***	(0.2988)
Farm type: trees	−0.1324	−0.5984	−1.3125
	(0.0872)	(0.0741)***	(0.2641)***
Farm type: other	−0.2131	−0.6075	−0.7674
	(0.1464)	(0.1099)***	(0.4537)*
County per capital income	0.0954	0.2746	0.8511
	(0.1310)	(0.1400)**	(0.4113)**
County unemployment rate	−0.0889	0.0206	0.1262
	(0.0372)**	(0.0358)	(0.1094)
County population	−0.0253	−0.0339	−0.212
	(0.0493)	(0.0564)	(0.1491)
Observations	317	317	317
Pseudo R^2	0.1	0.26	
Wald $\chi^2(14)$, (Prob > χ^2)			37.26, (0.0012)

Notes: Robust standard errors are in parentheses.
In case of SOILDUM, since the DWH test shows that *number of membership* may be endogenous, we used IV-Probit.
Each regression has a constant that has not been reported.
* Denotes significance at 10%; ** denotes significance at 5%; *** denotes significance at 1%. In case of GRAZDUM, the coefficient of the membership variable has a *t*-statistic of 1.6. So, we have marked it with * as well.

sustainable soil management practices, however, does not seem to be influenced by community involvement.

Among other variables that matter, most important are education of the farmer and the farm type. Farmers with college or post-graduate education are more likely to adopt sustainable practices (high school dropout is the omitted category). The effects of farm type on adoption of sustainable practices are very much in line with the type of farm operation (livestock and poultry is the omitted category). One curious finding is that compared with livestock and poultry farmers, tree farmers are less likely to adopt sustainable soil management practices. In some of the regressions family size, acres cultivated, and the county level variables (per capital income and unemployment rates) also mattered.

In Table 7, we find that associational memberships matter when we consider the extent of sustainable agricultural practices. In the regression of the summary measure of the extent of sustainable practices, SUSPRAC, an increase in

Table 7. Regression Coefficients: Extent of Sustainable Practices

	SUSPRAC	PEST	GRAZING	SOIL
	OLS	Ordered Probit	Ordered Probit	Ordered Probit
Number of memberships	0.3171	0.0724	0.0573	0.1009
	(0.0596)***	(0.0260)***	(0.0250)**	(0.0241)***
High school and some college	1.1443	0.5366	0.144	0.3444
	(0.5040)**	(0.2465)**	(0.2107)	(0.2011)*
College grad and post graduate	1.6145	0.6086	0.3006	0.4834
	(0.5713)***	(0.2725)**	(0.2389)	(0.2277)**
Family size	0.046	−0.1572	0.0036	0.073
	(0.150)	(0.0692)**	(0.062)	(0.059)
Number of children	−0.0568	0.028	−0.0152	−0.011
	(0.1127)	(0.0502)	(0.0470)	(0.0448)
Years farming	0.0168	0.0027	0.0023	0.005
	(0.0096)*	(0.0044)	(0.0040)	(0.0038)
Acres cultivated	0.0833	0.025	0.00003	0.0484
	(0.0464)*	(0.0192)	(0.0240)	(0.0183)***
Farm type: fruits and vegetables	−1.0227	0.7857	−2.4974	−0.3068
	(0.7915)	(0.3228)**	(0.5360)***	(0.3051)
Farm type: crops	0.4373	0.3192	−0.983	0.2853
	(0.5415)	(0.2371)	(0.2329)***	(0.2153)
Farm type: trees	−3.0349	−0.3479	−1.5239	−1.1452
	(0.4993)***	(0.2301)	(0.2316)***	(0.2124)***
Farm type: other	−2.608	−0.4057	−1.4015	−0.7009
	(0.9792)***	(0.4751)	(0.4586)***	(0.3880)*
County per capital income	0.9597	0.2982	0.3467	0.5461
	(0.6980)	(0.3075)	(0.2857)	(0.2757)**
County unemployment rate	−0.1011	−0.161	0.1139	−0.012
	(0.1922)	(0.0864)*	(0.0811)	(0.0755)
County population	−0.1474	−0.0267	−0.0108	−0.1477
	(0.2642)	(0.1150)	(0.1076)	(0.1038)
Observations	317	317	317	317
R^2/Pseudo R^2	0.24	0.07	0.13	0.07

Notes: Estimates of the cut points of the ordered probit regressions have not been reported.
Robust standard errors are in parentheses.
The SUSPRAC regression has a constant that has not been reported.
* Denotes significance at 10%; ** denotes significance at 5%; *** denotes significance at 1%.

membership leads to an increase in the number of sustainable practices that farmers adopt: with every three unit increase in memberships, we expect to see the farmer engaging in an additional sustainable agricultural practice. The ordered probit regressions show similar results; an increase in associational memberships lead to incremental increase in adoption of all three types of sustainable practices.

The marginal effects are reported in Table 8. They are evaluated at the mean values of the explanatory variables. In the cell associated with PEST and $i=2$, for example, the value 0.01 indicates that there will be a 1% increase in the probability of the decision to adopt a second pest control measure if associational memberships of the farmer increase by one more unit from its mean of 3.7. As Table 7 shows, for PEST, GRAZING, and SOIL, associational memberships positively affect the probability of adoption of each incremental sustainable practice. Although membership does not affect the decision to adopt sustainable soil practices, the extent of soil practice seems to be strongly influenced by the membership variable. This could be because practices like the use of cover crops have been used by conventional farmers for many years prior to the introduction of most

Table 8. Estimated Marginal Effects ($\partial p_i/\partial x$) and Standard Errors of Number of Membership in the Ordered Probit Regressions of Table 8

	Number of Sustainable Practices (i)					
	$i = 0$	$i = 1$	$i = 2$	$i = 3$	$i = 4$	$i = 5$
PEST	−0.028	0.017	0.010	0.001		
	(0.010)***	(0.006)***	(0.004)***	(0.001)*		
GRAZING	−0.019	−0.003	0.012	0.011		
	(0.009)***	(0.002)**	(0.005)***	(0.005)***		
SOIL	−0.028	−0.011	0.001	0.012	0.016	0.011
	(0.007)***	(0.003)***	(0.001)	(0.003)***	(0.004)***	(0.003)***

Notes: Estimates of the cut-offs have not been reported but are available on request.
Robust standard errors are in parentheses.
* Denotes significance at 10%; ** denotes significance at 5%; *** denotes significance at 1%.

sustainable agricultural techniques (54% of the sample practices cover crops). They are less a new sustainable practice than just sound farming. In addition, since the profitability of sustainable agricultural practices may depend on the ability to generate price premiums in the market as compared with conventional practices, it may not be possible to translate sustainable soil practices into such price premiums. The results of the ordered probit regression, however, do indicate that community involvement encourages farmers to adopt additional sustainable soil management practices over and above the practices already adopted. For the rest of the explanatory variables, the results are similar to the adoption regression results. Among the other variables, education and farm type matter the most. Family size and the county level variables also matter in some cases.

Conclusion

Community involvement has been traditionally associated with positive outcomes of citizenship and promotion of the civic society. In this paper we suggest another civic matter by examining agricultural practices of Georgia farmers and their associational memberships. Using micro-data, our findings showed that associational memberships have a positive effect not only on the decision to adopt sustainable agricultural practices, but also on the extent to which farmers adopted these practices.

Additionally, we tested for endogeneity and found that the membership variable was not endogenous in all but one of these regressions (for the one case where possibility of endogeneity could not be eliminated, we used instrumental variable estimation). Our objective was to find whether associational involvement of the individual farmer has an independent effect on her adoption of sustainable agricultural practices. We tested two hypotheses. First, associational memberships mattered in the adoption of sustainable agricultural practices. Secondly, associational memberships positively affected the extent to which the farmers were engaged in sustainable practices. The effects of associational memberships that we calculated were statistically strong and economically significant: with every three unit increase in associational memberships, we expect to see the farmer engaging in an additional sustainable agricultural practice. Further, an increase in associational memberships leads to incremental increase in adoption of all types of sustainable practices studied.

There are two main channels through which community involvement may lead to sustainable agricultural practices—by promoting social responsibility and by providing knowledge, awareness, and training about sustainable agricultural practices. Through the former channel, community involvement may affect people's preferences and make them more socially responsible and, thereby, more sensitive to the environment. Through the latter channel, even for a given preference structure, community involvement can still have a positive impact. Consider the situation where a sustainable agricultural practice is also the profit maximizing practice. Then, associational memberships, by providing information, knowledge, and know-how about sustainable practices, contribute to profit maximization. In the case where sustainable agricultural practices are not necessarily profitable in the short-run the individual may still adopt these practices because they can be utility enhancing (possibly due to "warm glow" and "deontological altruism"). Associational memberships, by providing information, knowledge, and know-how about sustainable practices, can contribute to utility maximization.

Associational membership is a standard measure of social capital of the individual in the social capital literature. It is certainly not the most comprehensive measure since it does not capture a number of important aspects of the social connectedness of the individual (for example, existence and intensity of network links of the individual with her friends, relatives, neighbors). Additionally, notions of trust and reciprocity (often associated with group level social capital) are not directly enumerated in the membership measure. However, as a measure of community involvement embodying social responsibility and information dissemination due to community participations, it is certainly a relevant indicator.

This paper posits an additional dimension to the benefits that would accrue to policies that promote community involvement and civic engagement in rural areas associated with farming. Those devising rural development strategies and policies may want to consider the role that community involvement plays not only in community health but also on the health of the agriculture.

Although we emphasized that there might be multiple channels, social responsibility and information channels, through which associational memberships affect sustainable agricultural practices, due to data limitations we estimate the total effect and do not attempt to decompose this overall relationship into its separate components. We do however recognize that decomposing these effects and estimating their relative importance bear the potential for valuable future research.

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