Are Friendly Farmers Environmentally Friendly? Environmental Awareness as a Social Capital Outcome[f]

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Abstract

This paper examines the hypothesis that social capital at the individual level affects environmentally friendly practices. Social capital represents the social connectedness of the individual. An individual with higher social capital is more likely to have better exposure and access to information about the importance of environmentally friendly practices. We study sustainable agricultural practices among Georgia farmers and examine whether their social capital levels have any effect on, (1) their adoption of sustainable agricultural practices, and (2) the extent to which they engage in these practices. Using the *Georgia Social Capital Survey* our measure of social capital is associational activities. We address a number of econometric issues: potential endogeneity of the social capital variable, peer-group effect in the form of social pressure, and a sorting issue.

Key words: Social capital, membership, sustainable agriculture, environmental awareness, test of endogenous regressor, sorting, neighborhood effect.

1. Introduction

The fundamental motivation for studying social capital is that it promotes cooperation, collaboration and coordination, and thereby has a variety of positive outcomes for the individual and the society. Some of the most widely discussed outcomes concern civic matters such as political participation and good governance, philanthropy, increased judicial efficiency and decreased government corruption, and promotion of cooperative movements (Putnam 1995, 2000, DiPasquale and Glaeser 1999, LaPorta et al. 1997, Paldam and Svendsen 2000). Environmental awareness is an important embodiment of social consciousness and civic responsibility. In this paper, we ask if social capital has any influence in determining the individual's environmental awareness.

An extensive literature studies environmental awareness at the aggregate level (Saxton and Benson 2005), especially in the form of cross-country comparisons (Grafton and Knowles 2003, Duroy 2005). Social capital, via the mechanism of collective actions, plays an important role in these discussions (Pretty and Ward 2001). However, behind any group level action, there are individuals solving their own decision problems. Before we can study the collective actions in environmental movements, we must have an understanding of the factors that shape the environmental attitudes of the individual. This will not only help us improve aggregate level policies but also devise micro level policies that may be complementary to aggregate level policies. Besides, micro level policies may be effective enough to merit discussions independent of aggregate level policies.

Empirical studies of determinants of environmentally friendly practices at the individual level are relatively rare (Anderson, Leigh, and Nugent 2002). This paper focuses on factors that govern sustainable agricultural practices among farmers. In particular, we ask if levels of social capital of the farmer have any effect in shaping her practice of environmentally friendly, sustainable agriculture.

Sustainable agriculture refers to an agricultural production and distribution system that (1) achieves the integration of natural biological cycles and controls, (2) protects and renews soil fertility and the natural resource base, (3) optimizes the management and use of on-farm resources, (4) reduces the use of non-renewable resources and purchased production inputs, (5) provides an adequate and dependable farm income, (6) promotes opportunity in family farming and farm communities, and (7) minimizes adverse impacts on health, safety, wildlife, water quality and the environment (Jordan 2004a).

First and foremost, sustainable agricultural practices are those that produce an economic profit, and, at the same time, employ methods that do not degrade the environment. Such practices are environmentally friendly in that they substitute on-farm inputs for off-farm chemical purchases. Therefore, in this paper, we use the phrases "sustainable practices" and "environmentally friendly practices" interchangeably. Importantly, we use information about the agricultural practices – rather than a subjective self-assessment of the farmer – to identify the environmentally friendly farmers.

1.1. Social Capital and Associational Membership

Social capital at the individual level represents the individual's social connectedness (Dasgupta 2002, Durlauf and Fafchamps 2004). Associational membership as a social capital measure – popularized by Robert Putnam – is one of the most commonly used.[1] Despite criticism, there is no denying that they *are* a measure of the social connectedness and civic engagements of the individual.[2]

Robert Putnam's research is well-known for linking associational activities with a variety of social attributes (Putnam 1995, 2000). In Halliwell and Putnam [2000], an index of associations, among other measures, was associated with higher growth. Miguel et al. [2001] showed that industrialization is associated with rising density of organizations. Costa and Kahn [2003] showed that declining volunteering is strongly related to higher female labor force participation. In

Beugelsdijk and van Schalk [2001], European regions group participation helps explain growth. Narayan and Pritchett [1999], using households data from rural Tanzania, showed that indices based on memberships in groups, characteristics of the groups, and household values and attitudes, affect per capita household expenditure. Carter and Maluccio [2003] found that the number of associations in community and interaction of family income with community income help ameliorate effects of individual specific economic shocks. In Grootaert [2000], an index based on the number of memberships in associations, diversity of memberships, number of meetings of associations, index of participation in decision-making, measure of cash contribution to associations, measure of time contribution to association, and measure of orientation towards community, were statistically significant in explaining per capital household expenditure. In this paper, much in the same spirit of these above mentioned studies, we look at the impact of social capital on environmental awareness of the individual.

1.2. Social Capital and Environmental Awareness

The individual's environmental awareness and involvement in environmentally friendly practices are likely to be influenced by the individual's social connectedness. As the individual becomes engaged in various social organizations he has heightened exposure and access to information about the environment and environmental practices. He may learn new techniques and know-how, obtain informal trainings from others who have already adopted such practices, and even obtain help adopting various practices. Above all, there might arise a realization and positive change in outlook about the environment as people find themselves more socially invested.

There are, however, a number of other factors that we must account for in order to isolate the effect of social capital. We itemize these factors into the following categories: structural factors, demographic factors, peer-group effect in the form of social pressure, and sorting issues.

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 poultry. Structural factors also refer to the size of the farm and age of operation. Larger and older farms with higher earnings have a different attitude towards risk vis-à-vis the smaller and newer farms. Demographic factors appeal to sources other than social capital that influence the farmer's attitude and exposure towards environmental and sustainable practices.

The question of attitude brings up the issue of peer-group-type effects. This effect may go either way in the sense that, depending on the peers, social pressure may be positive or negative on the decision to engage in sustainable practices. "Sustainable agriculturalists" – especially in a community with a majority of conventional agriculturalists – may be viewed as 'deviants' within the community. And similarly, on the opposite side of the spectrum, they may be viewed as "champions of a worthy cause" (Flora 1995). The role that social norms play in influencing the individual farmer's decisions regarding agricultural practices is an issue rarely addressed in the current literature. If left unaccounted for it may bias the estimates of the effect of social capital.[3]

Another factor that may bias these estimates is the issue of sorting. Those who are environmentally conscious may also be more socially conscious. Such individuals, who are engaged in sustainable practices, may sort into more associational activities. If left unaccounted for, it would overestimate the effect of social capital in a regression analysis of sustainable practices on social capital.

The paper is arranged in the following sections. Section 2 describes our data source, *Georgia Social Capital Survey*, and explains the variables. Section 3 provides the econometric models and addresses the econometric issues. The results are discussed in section 4, which is followed by conclusions.

2. Data

2.1. Georgia Social Capital Survey

The analysis of this paper is based on a telephone survey of Georgia farmers using a random dial approach. The survey was conducted by the Georgia Agricultural Statistics Service (NASS-USDA) in the winter of 2004. The design of the study called for conducting a total of 431 telephone interviews, representing a statistically significant sample of Georgia farmers at the 95% confidence interval. To achieve 431 interviews, 921 phone contacts were made, representing a 46.8% response rate. The non-response rate included respondents who were unavailable, non-working numbers, answering machines, no answer/busy, or strange noise. The survey had 76 questions including demographic and economic information about the farmer and the farm, information about social capital of the farmers, and whether the farmer uses one or more of 18 sustainable agricultural practices.

In the survey, farmers were asked a series of yes-no questions regarding farming practices that seek to achieve sustainable goals. Farmers were asked whether they used a series of 18 practices that covered the range of sustainable agriculture. The practices were grouped as pest management (3 questions), grazing (3 questions), soil/nutrient management (5 questions), marketing (5 questions), and organic (2 questions). One important point to emphasize here is that the survey did not ask the farmers subjective assessment as to whether he is a sustainable farmer. Rather, specific questions about the practices were asked that give us numerical measures of a sustainable farmer.

After the farming practices questions, the respondents were asked about their attitude towards these farming practices. We believe that these attitudinal responses contain valuable information about the farmer's perception of environment and societal norm. In the next section, we discuss how this information can be very useful in addressing some of the econometric issues.

The farmers were also asked 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.[4] The Benchmark survey was designed to measure people's civic engagements. Associational activities included 18 categories including 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, and civil rights and political action organizations. Eighty-three percent of respondents belonged to at least one group.

In Tables 1 and 2, we describe the sample used in this study. Table 1 shows the demographic information of the respondents in the sample. This information is compared to the respondents from a statewide random-digit dial survey of residents of Georgia in the summer of 2003 (Jordan 2004b). Farm respondents were generally older than others in the state, have lived in Georgia longer, and have been at their current address considerably longer. Respondents were overwhelmingly more male, married, white, homeowners, voters, and lived in smaller communities. The educational background of farm respondents was similar to the general population. Total mean household income was generally higher among farm respondents than the general public.

Tables 1 and 2 also show the mean responses for several questions regarding farm operations. Acres cultivated, with a mean of 147 acres, show that the mean responses were from relatively small farm operations. Only 6 percent of respondents cultivated more than 500 acres while 61 percent cultivated less than 100 acres. When asked to characterize the primary farm enterprise, 76 percent responded livestock/poultry farms. This results from the large number of small cow/calf and poultry operations that dominate much of north Georgia agriculture. Thirty-seven 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 large farms having gross farm income of over $50,000. Finally, 53 percent are characterized as small farms (between limited resource and large farms). It, however, must be emphasized here that approximately 20 percent of the respondents refused to answer the household income or farm income questions. The income characterization, therefore, is by no means complete.

Table 3 presents the responses to questions regarding sustainable agricultural practices. Nearly every farm (98 percent) adopted at least one of the five types of sustainable practices. Almost half of all respondents are involved in at least one of the three forms of pest management practices (47 percent), 79 percent in at least one of the three grazing practices, 85 percent in at least one of the five soil management, and 52 percent were involved in at least one of the five marketing practices. Only 5 percent participated in any form of organic production practices. Most common sustainable practices are mulches/manures (60 percent), management-intensive grazing system (60 percent), mixes of pasture forage in single field (59 percent), and Cover crops (58 percent). The least common practices are replacing tobacco (2 percent) and certified organic (2 percent).

2.2. Dependent Variables

Our dependent variables are responses regarding sustainable practices. Table 4 lists the names and types of the variables used. First, indicator variables – PESTDUM, GRAZDUM, SOILDUM, MARKETDUM, and ORGDUM – indicating whether the farmer is engaged in a certain type of sustainable practice (e.g. PESTDUM indicates whether any of the pest control measures are practiced). These variables indicate *adoption of sustainable agricultural practices*. Secondly, ordered response variables (PEST, GRAZING, SOIL, and MARKET) that stand for the number of each type of sustainable practices 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*. And finally, SUSTPRAC is a continuous variable that aggregates over all five types of sustainable practices. This is a summary measure of the extent of sustainable practices. From the list of individual practices in Table 2, we see that all these practices are, directly or indirectly, beneficial for the environment, thereby justifying the assumption 'more is better' underlying in these measures. Note that we do not have a variable for the extent of organic practices. Since very few farmers adopted any of the two types of organic practices, the number of observations in each response is too small for a meaningful regression analysis. Table 5 provides the descriptive statistics of these variables.

2.3. Explanatory Variables

Our objective is to find whether associational activities (social capital) of the individual farmer have any independent effect on the adoption of sustainable agricultural practices. The variable of interest is the social capital variable. We measure social capital of each farmer as the total number of associational memberships, not including church memberships (Costa and Kahn 2003).

We control for a variety of factors. The sources of the confounding factors are demographic characteristics, farm activities and forward linkages, earnings, individual's attitude towards environment and sustainable practices, social pressure, and aggregate level location characteristics.

Respondent's demographic characteristics include education, family size, and number of children. To account for the farm activities and effects accruing to forward linkages, we have used five dummy variables indicating farm types. We have also included the number of years farming, and acres cultivated. We did not include an explicit earnings variable. The income variables, both household income and farm income, have too many non-responses that significantly reduce the number of observations (by 21 percent). Instead of including an explicit income variable, we have included adequate proxies (education, years farming, acres cultivated, family size, etc.) that account for earnings.

We have included the attitudinal responses towards sustainable practices to account for the individual's environmental orientation and social circumstances. In this response the individual allocated 100 points indicating her subjective view about the sustainable practices ("*These practices are concerned about future farmers and their ability to use resources*," "*It is the right thing to do - the practices are sound*," and "*They earn higher profits or lower their costs*"). We interpret these three responses as environmental concern, social norm, and profit motives, respectively. The allocated points over these choices renders a measure of the respondent's attitude toward environment, profit motives, and what she believes the societal norms are regarding these practices.

There is little variation in the location of the farms. Less than 1 percent of the firms belonged to a location with population of 500,000 and 93 percent of the farms belonged to locations with population of less than 50 thousand. We have therefore not used any location dummies. However, we have included county per capital income to capture the aggregate level effects.

Church participation is an important phenomenon in the state of Georgia. Seventy-seven percent of the Georgians belong to churches and the number was even higher in our sample of farmers (86 percent). This is a deeply cultural and traditional phenomenon, and thus may have a variety of implications in terms of the individual's attitude and outlook. Although we have excluded church membership from our social capital measure, we have included it in our set of explanatory variables as a separate control to capture additional effects.

3. Estimation

3.1. Hypotheses and Econometric Issues

We test two hypotheses. First, social capital matters for adoption of sustainable agricultural practices. We test this by studying the regressions of the variables indicating involvement in sustainable practices. The second hypothesis is regarding the extent to which the farmers are engaged in sustainable practices. We test whether social capital matters in that aspect as well. Here, we study the regressions of the variables that indicate the number of sustainable practices that the farmers use. We use cross sectional regressions to test these hypotheses.

There are three main econometric issues that we address: endogeneity of social capital, peer-group-type social pressure, and the sorting issue. Flora [1995] hypothesizes that an increase in sustainable practices by the farmers may increase social capital. Although Flora's hypothesis was at the community level and she does not adopt an econometric framework to test this hypothesis, we acknowledge the possibility that even at the individual level, there may exist a reverse causality. One probably rationale is that farmers who are practicing sustainable agriculture may want to be involved in organizations to come across other sustainable practitioners to share information and other experiences. In that case, social capital would be endogenous.

We carried out Durbin-Wu-Hausman tests of endogenous regressors to verify whether that indeed is the case. We used the county level per capita income as the exclusion restriction for these tests. The decision to adopt sustainable practices (or the extent of sustainable practices) is not partially correlated with county level per capita income unlike the social capital variable. County per capita income affects associational activities from the supply side: aggregate income explains the variation in organizations across communities. In a high income area, the probability of emergence and sustenance of these organizations are higher. Adoption and extent of sustainable agricultural practice decisions of the individual farmers, on the other hand, are unlikely to be explained by variation in county per capita income.

The questions of peer-group effects and sorting issues are essentially problems of omitted variable bias. We use the motivation responses to address these problems. The response that indicates environmental awareness identifies an individual attribute. Similarly, the response that sustainable practices are the "right thing to do" indicates social norm, while the response regarding the "profit motive" expresses economic rationale. The latter is the omitted category and hence "environmental awareness" and "social norms" are measured against the economic rationale.

The sorting problem arises because those who are environmentally conscious may also be the kind of people who are social and thereby involved in associational activities. If this issue is unaddressed, then the coefficient of association memberships in a regression of sustainable practices would reflect uncontrolled individual differences. The "environmental awareness" response identifies this individual attribute and eliminates the possibility of overestimation of the effect of social capital.[5]

The peer-group-type social pressure essentially is a neighborhood effect which – as argued in section 1.2 – biases the effect of social capital. Ideally, one would use an appropriate neighborhood level variable such as the attitude of the neighborhood (say, county) regarding the environment. Given the unavailability of such data, we are using an individual level variable, the "social norm" response, as a proxy variable. What this variable provides is the individual's assessment of the neighborhood's attitude towards environment.

The progression of our analysis is the following. On the 'adoption' issue, we focus on the five variables PESTDUM, GRAZDUM, SOILDUM, MARKETDUM, and ORGDUM. We first carry out

Durbin-Wu-Hausman (DWH) tests of endogenous regressors to test whether social capital is endogenous in each of these regressions. Then we use probit regressions to test if social capital has any significant effect on the adoption decisions.

On the issue of the extent of sustainable practices the five dependent variables are PEST, GRAZING, SOIL, MARKET, and SUSTPRAC. We follow the same procedure of first testing for endogeneity of social capital. Since SUSTPRAC is treated as a continuous variable we use the OLS. The other variables are ordered responses and we use ordered probit regressions.

In what follows, we first explain the DWH test in the context of linear regressions. DWH tests for nonlinear models are simple and obvious extensions of those for linear models (Davidson and MacKinnon [2004]). Next we briefly describe the ordered probit regression model used for the individual practices, which, we believe, will help us explain our reported tables.

3.2. DWH Test: Test of Endogenous Regressor

Consider the model,

(1) $$y_1 = \mathbf{z}_1\beta_1 + y_2\beta_2 + \varepsilon_1, \qquad E(\mathbf{z}'\varepsilon_1) = 0,$$

where $\mathbf{z}$ is the set of exogenous variables, $\mathbf{z}_1$ is a strict subset of $\mathbf{z}$, and y_2 is a potentially endogenous regressor. We would also use the notation, $\beta \equiv (\beta_1, \beta_2)$. We want to test the null hypothesis that the error terms are uncorrelated with all the regressors against the alternative that they are correlated with one of the regressors. The DWH test is to check whether the difference $\hat{\beta}_{IV} - \hat{\beta}_{OLS}$ is significantly different from zero in the available sample.

The original form of the statistic turns out to be cumbersome to compute. Hausman [1978, 1983] points out a regression-based form of the test that turns out to be asymptotically equivalent to the original form of the test.[6] To derive the regression based test, consider the linear projection of y_2 on $\mathbf{z}$ as,

(2) $y_2 = \mathbf{z}\gamma + \varepsilon_2$, $E(\mathbf{z}'\varepsilon_2) = 0$.

Since ε_1 is uncorrelated with $\mathbf{z}$, it follows that y_2 is endogenous if and only if $E(\varepsilon_1\varepsilon_2) \neq 0$. In other words, y_2 is exogenous if and only if $\delta = 0$ in the equation,

(3) $y_1 = \mathbf{z}_1\beta_1 + y_2\beta_2 + \delta\varepsilon_2 + \upsilon$,

where υ is uncorrelated with $\mathbf{z}_1$, y_2, and ε_2 by construction.[7]

A test of $H_0 : \delta = 0$ can be done using a standard t test. However, ε_2 is not observable. So, we replace ε_2 with $\hat{\varepsilon}_2$ to have the equation,

(4) $y_1 = \mathbf{z}_1\beta_1 + y_2\beta_2 + \delta\hat{\varepsilon}_2 + \upsilon$.

The usual t statistic is a valid test of $H_0 : \delta = 0$ provided the homoskedasticity assumption $E(\varepsilon_1^2 \mid \mathbf{z}, y_2) = \sigma_1^2$ is satisfied. The test can be made robust to heteroskedasticity in ε_1 by applying the heteroskedasticity-robust t statistic.

To address the issue of potential endogeneity of the social capital variable in the discrete response cases, we conduct a Durbin-Wu-Hausman (DWH) test of endogenous regressor in the same spirit as we do the test for SUSTPRAC, the linear case. Of course, we need at least one exclusion restrictions in each case. For SUSTPRAC the exclusion restriction is per capita income of the county where the farm is located. County per capita income can be used for all the other dependent variables (indicator variables as well as ordered response variables) except GRAZDUM which is the indicator variable for grazing practices. Partial correlation between per capital income and GRAZDUM misses the 10 percent level of significance by a decimal point. Therefore, in this case, we used the number of children as the exclusion restriction.

3.3. Ordered Probit Model

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,

(5) $$y^* = \mathbf{x}\beta + \varepsilon, \qquad \varepsilon \mid \mathbf{x} \sim \text{Normal}(0,1),$$

where, $\mathbf{x}$ is the vector of explanatory variables and β is $K \times 1$. Let $\alpha_1 < \alpha_2 < \ldots < \alpha_J$ be unknown cut points, and define,

(2) $$\begin{aligned} & y = 0 && \text{if } y^* \le \alpha_1, \\ & y = 1 && \text{if } \alpha_1 < y^* \le \alpha_2, \\ & \vdots && \\ & y = 0 && \text{if } \alpha_{J-1} < y^* \le \alpha_J, \\ & y = 0 && \text{if } y^* > \alpha_J. \end{aligned}$$

Given the standard normal assumption about ε, probabilities of each response,

(6) $$\begin{aligned} & P(y = 0 \mid \mathbf{x}) = \Phi(\alpha_1 - \mathbf{x}\beta), \\ & P(y = 1 \mid \mathbf{x}) = \Phi(\alpha_2 - \mathbf{x}\beta) - \Phi(\alpha_1 - \mathbf{x}\beta), \\ & \vdots \\ & P(y = J-1 \mid \mathbf{x}) = \Phi(\alpha_J - \mathbf{x}\beta) - \Phi(\alpha_{J-1} - \mathbf{x}\beta), \\ & P(y = J \mid \mathbf{x}) = 1 - \Phi(\alpha_J - \mathbf{x}\beta), \end{aligned}$$

sum to unity.

When $J = 1$, we have the binary probit model $P(y = 1 \mid x) = 1 - \Phi(\alpha_1 - \mathbf{x}\beta) = \Phi(\mathbf{x}\beta - \alpha_1)$, 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 $\{0,1\}$, which is the case with ‘orgdum’, the single cut point is set to zero and the intercept is estimated, leading to the standard probit model.

For each observation i, the log-likelihood function is,

$$
\text{(7)} \qquad
\begin{aligned}
\lambda_i(\alpha,\beta) = {} & 1[y_i = 0]\log[\Phi(\alpha_1 - \mathbf{x}_i\beta)] \\
& + 1[y_i = 1]\log[\Phi(\alpha_2 - \mathbf{x}_i\beta) - \Phi(\alpha_1 - \mathbf{x}_i\beta)] \\
& \vdots \\
& + 1[y_i = J]\log[1 - \Phi(\alpha_J - \mathbf{x}_i\beta)].
\end{aligned}
$$

For this model, we have,

$$
\text{(8)} \qquad
\begin{aligned}
\partial p_0(\mathbf{x})/\partial x_k &= -\beta_k \phi(\alpha_1 - \mathbf{x}\beta), \\
\partial p_j(\mathbf{x})/\partial x_k &= -\beta_k [\phi(\alpha_{j-1} - \mathbf{x}\beta) - \phi(\alpha_j - \mathbf{x}\beta)], \quad 0 < j < J, \\
\partial p_J(\mathbf{x})/\partial x_k &= -\beta_k \phi(\alpha_J - \mathbf{x}\beta).
\end{aligned}
$$

The sign on β_k unambiguously determine the direction of the effect of x_k on the probabilities $P(y = 0 \mid \mathbf{x})$ and $P(y = J \mid \mathbf{x})$, but not the probabilities of the intermediate outcomes $1, 2, \ldots, J-1$. If $\beta_k > 0$, then $\partial p_0(\mathbf{x})/\partial x_k < 0$, $\partial p_2(\mathbf{x})/\partial x_k > 0$, but $\partial p_j(\mathbf{x})/\partial x_k$ 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. We report the detailed marginal effects for each response for the social capital variable.

4. Results and Discussion

The DWH test results are presented in Tables 6 and 7. Table 6 presents results for the adoption regressions whereas Table 7 for the extent regressions. The residual $\hat{\varepsilon}_2$ is estimated in regression (1). Regression equation (4) is estimated for all the ten cases. We see that the coefficient of the residual is not significant in any of the cases. We conclude that the social capital variable is not endogenous in these regressions.

Although our DWH tests do not show any endogeneity of the social capital variables, we still included the "environmental awareness" variable to take care of the sorting problem in case DWH test is not convincing enough.[8] Apart from the issue of sorting, this also takes care of any independent effect due to environmental awareness as an individual level attribute.

To address the issue of peer-group effects in the form of social pressure we have used the "societal norm" variable, which is a proxy and not a direct measure of social pressure. It may not completely account for the neighborhood effects arising from social pressures, but it surely captures some of these effects.

Table 8 presents the probit regressions of the adoption indicators. We find that associational membership matters for the adoption decision in all five aspects of sustainable practice. For instance, we find that one unit increase in social capital (from its mean level) increases the probability of adoption of pest control measures by 4 percent, grazing practices by 3.2 percent, soil management practices by 2.4 percent, and organic practices by 1 percent. This is economically significant because this implies that if social capital increases by a unit for every farmer in the state of Georgia, we would see approximately 2000 more farmers adopting sustainable pest control practices. Other variables that matter are: societal norm, years farming, farm types, family size, and church membership.[9]

We also find that associational memberships matter when we consider the extent of sustainable practices (Table 9), in all five regressions. In the regression of the summary measure of the extent of sustainable practices, SUSTPRAC, an increase in social capital leads to increase in the number of sustainable practices that the farmers adopt: with every three unit increase in social capital, we expect to see the farmer engaging in an additional sustainable practice. The ordered probit regressions show similar results; an increase in associational membership leads to incremental increase in adoption of sustainable practices. The marginal effects are reported in Table 10. They are evaluated at the mean values of the explanatory variables. In the cell associated with PEST and $i = 2$, for example, the value 0.0132 indicates that there will be a 1.32 percent increase in the probability of the decision to adopt a second pest control measure if associational membership of the farmer increases by one more unit from its mean of 2.81. As table 10 shows, with the exception of GRAZING and SOIL, associational membership positively affects the probability of adoption of each incremental sustainable practice. For GRAZING the same is true for two or more practices and, in case of SOIL, for three or more practices.

5. Conclusion

Social capital has been traditionally associated with positive outcomes of citizenship and promotion of the civic society. We found yet another civic matter – namely, environmental consciousness – where social capital plays a role. We studied agricultural practices of Georgia farmers and their social capital. Our findings showed that, first, social capital had a positive effect on the decision to adopt environmentally friendly sustainable agricultural practices, and secondly, that social capital also had a positive effect on the extent to which farmers adopt these practices.

We addressed a number of econometric issues in our estimation. We tested for endogeneity and found that social capital was not endogenous in these regressions. We used additional controls to account for sorting problems as well as peer-group effects in the form of social pressure. The social capital effects that we calculated were strong and economically significant. This establishes an additional dimension to the benefits that would accrue to policies that promote social interaction and civic engagement.

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Tables

Table 1. Demographic Information: State Versus the Sample Under Study

Category		Georgia*	Farmer respondent
Male (percent)		49.20	89.54
Female (percent)		51.80	10.46
Family size		2.65	2.46
Age (years)		34.46	59.30
Marital Status (percent)	Married	50.50	86.72
	Divorced	10.30	6.64
	Separated	5.90	0.00
	Widowed	5.95	4.15
	Never married / Single	27.40	2.49
	Living together	0.00	0.00
	Refused	0.00	0.00
Race (percent)	White	65.10	95.00
	African-American	28.70	4.58
	Asian	2.10	0.00
	Other / Refused	4.10	0.00
Education (percent)	Less than high school		3.75
	Some high school		5.83
	Graduated high school	28.70	32.92
	Some college	25.60	26.67
	College graduate	16.00	22.92
	Post graduate	8.30	7.92
	Other / Refused		0.00
Own home (percent)		68.00	98.32
Registered to Vote (percent)			95.00
Household income	Per capita median ($)	42,433.00	
	>$20,000		5.79
	$20,000 - $39,999		14.46
	$40,000 - $59,999		15.29
	$60,000 - $79,999		11.98
	$80,000 - $100,000		8.26
	Over $100,000		23.14
	Refused / Don’t know		21.07
Farm income	None		6.61
	Less than $1,000		4.55
	$1,000 - $4,999		11.98
	$5,000 - $9,999		13.22
	$10,000 - $49,999		21.90
	Over $50,000		22.31
	Refused / Don’t know		19.43

* Statewide data from 2000 US Census.[10]

Table 2. Descriptive Statistics: Explanatory Variables

	Obs	Mean	Std	Min	Max
Number of memberships	242	2.81	2.66	0.00	15.00
Proportion of sample engaged in any sustainable practices	242	0.98	0.13	0.00	1.00
Motivation: environmental concern	242	42.45	29.98	0.00	100.00
Motivation: norm	242	30.02	27.52	0.00	100.00
Motivation: profits	242	27.43	27.10	0.00	100.00
High school dropout	242	0.10	0.29	0.00	1.00
High school graduate and some college	242	0.59	0.49	0.00	1.00
College graduate and post graduate	242	0.31	0.46	0.00	1.00
Years farming	242	33.43	16.25	5.00	80.00
Acres cultivated (100 acres)	242	1.47	2.47	0.00	18.00
Farm type: poultry	242	0.76	0.43	0.00	1.00
Farm type: fruits and vegetables	242	0.05	0.21	0.00	1.00
Farm type: crops	242	0.08	0.28	0.00	1.00
Farm type: trees	242	0.09	0.28	0.00	1.00
Farm type: other	242	0.02	0.14	0.00	1.00
Number of children	242	2.33	1.43	0.00	9.00
Family size	242	2.46	1.07	1.00	6.00
Not a member of the church	242	0.14	0.35	0.00	1.00
County per capita income ($10,000)	242	2.14	0.42	1.48	4.48

Table 3. Sustainable Agricultural Practices

Practice	Percent using
Pest management	47
Biological, cultural, physical pest management tools	29
Habitat for beneficial insects or trap crops	11
On-farm biological cycle	21
Grazing	79
Management-intensive grazing system	60
Mixes of pasture forage in single field	59
Animal management system with two or more species	31
Soil/nutrient management	85
Strip cropping, reduced or no-tillage	39
Cover crops	58
Soil organic matter	36
Maintain micro-organisms in soil	36
Mulches/manures	60
Marketing	52
Greater variety of crops than in past	6
Replacing tobacco	2
Direct marketing	15
Ag coop or commodity group	33
Value added	17
Organic	5
Certified organic	2
Process or value-added organic	5

Table 4. Dependent Variables

Name	Label	Type
PESTDUM	any sustainable pest control practice	Indicator variable $\{0,1\}$
GRAZDUM	any sustainable grazing practice	Indicator variable $\{0,1\}$
SOILDUM	any sustainable soil management practice	Indicator variable $\{0,1\}$
MARKETDUM	any sustainable marketing practice	Indicator variable $\{0,1\}$
ORGDUM	participation in organic production practices	Indicator variable $\{0,1\}$
PEST	number of sustainable practices in pest control	ordered response $\{0,1,2,3\}$
GRAZING	number of sustainable practices in grazing	ordered response $\{0,1,2,3\}$
SOIL	number of sustainable practices in soil	ordered response $\{0,1,2,3,4,5\}$
MARKET	number of sustainable practices in marketing	ordered decision $\{0,1,2,3,4,5\}$
SUSTPRAC	total number of sustainable practices	Continuous variable

Table 5. Descriptive Statistics: Dependent Variables

	Obs	Mean	Std	Min	Max
Indicator variables					
PESTDUM	242	0.47	0.50	0.00	1.00
GRAZDUM	242	0.79	0.41	0.00	1.00
SOILDUM	242	0.85	0.36	0.00	1.00
MARKETDUM	242	0.52	0.50	0.00	1.00
MARKET01	237	0.06	0.24	0.00	1.00
ORGDUM	242	0.05	0.23	0.00	1.00
Continuous and ordered response variables					
PEST	242	0.60	0.73	0.00	3.00
GRAZING	242	1.49	1.03	0.00	3.00
SOIL	242	2.25	1.55	0.00	5.00
MARKET	242	0.72	0.85	0.00	5.00
SUSTPRAC	242	5.12	2.81	0.00	13.00

Table 6. Augmented Regressions of Durbin-Wu-Hausman Test of Endogenous Regressor

	(1)	PESTDUM	GRAZDUM	SOILDUM	MARKETDUM	ORGDUM
Regression model	OLS	Probit	Probit	Probit	Probit	Probit
Number of memberships		0.201	0.116	0.417	0.085	0.636
		(0.74)	(0.35)	(1.10)	(0.33)	(1.89)*
Motivation: environmental concern	-0.0003	-0.0049	0.0009	-0.0025	-0.0029	-0.0075
	(0.05)	(1.39)	(0.23)	(0.58)	(0.83)	(1.42)
Motivation: norm	-0.0080	-0.0027	0.0125	-0.0038	-0.0089	0.0030
	(1.12)	(0.63)	(2.18)**	(0.69)	(2.17)**	(0.58)
High school & some college	1.395	0.101	0.092	-0.130	0.298	
	(2.49)**	(0.22)	(0.19)	(0.20)	(0.67)	
College grad & post graduate	2.494	0.109	0.480	-0.363	0.351	-0.508
	(4.05)***	(0.14)	(0.58)	(0.34)	(0.48)	(0.91)
Years farming	-0.0119	0.0040	-0.0046	0.0044	0.0123	-0.009
	(1.13)	(0.65)	(0.66)	(0.52)	(2.02)**	(0.93)
Acres cultivated	0.041	0.038	-0.077	0.042	0.042	-0.0043
	(0.59)	(1.01)	(1.98)**	(0.78)	(0.97)	(0.08)
Farm type: poultry				-5.866		
				(14.34)***		
Farm type: fruits and vegetables	0.629	1.312	-3.496		0.385	-0.133
	(0.79)	(2.40)**	(6.58)***		(0.91)	(0.27)
Farm type: corps	0.051	0.169	-1.131	-6.384	0.413	0.724
	(0.08)	(0.53)	(3.55)***	(12.46)***	(1.26)	(1.76)*
Farm type: trees	0.336	0.085	-1.498	-7.136	0.130	-0.325
	(0.55)	(0.25)	(4.14)***	(.)	(0.37)	(0.53)
Farm type: other	-1.665	-0.326	-1.395		-0.236	
	(1.44)	(0.40)	(1.62)		(0.34)	
Number of children	0.222	-0.002		-0.056	-0.117	-0.065
	(1.89)*	(0.02)		(0.51)	(1.38)	(0.72)
Family size	0.255	-0.246	-0.085	-0.048	0.036	-0.065
	(1.58)	(2.13)**	(0.59)	(0.38)	(0.34)	(0.33)
Not a member of the church	-0.980	0.414	1.187	-0.046	-0.170	0.053
	(2.11)**	(1.23)	(2.40)**	(0.10)	(0.52)	(0.09)
County per capital income	0.768		0.661			
	(1.93)*		(1.61)			
Residual of regression (1)		**-0.098**	**0.033**	**-0.228**	**-0.026**	**-0.488**
		(0.36)	**(0.10)**	**(0.58)**	**(0.10)**	**(1.45)**
Constant	-0.855	-0.162	-0.526	6.470	-0.399	-2.809
	(0.70)	(0.32)	(0.59)	(7.18)***	(0.80)	(3.61)***
Observations	242	242	242	242	242	242
R^2 / Pseudo R^2	0.17	0.11	0.36	0.18	0.08	0.22

Notes: (a) Regression (1) is OLS of number of memberships on all the exogenous variables. (b) Robust *t* and *z* statistics in parentheses. (c) * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7. Augmented Regressions of Durbin-Wu-Hausman Test of Endogenous Regressor

	SUSTPRAC	PEST	GRAZING	SOIL	MARKET
	OLS	Ordered Probit	Ordered Probit	Ordered Probit	Ordered Probit
Number of memberships	1.173	0.428	0.307	0.437	0.072
	(2.08)**	(1.62)	(1.95)*	(1.70)*	(0.31)
Motivation: environmental concern	-0.0083	-0.0038	0.0004	-0.0043	0.0004
	(1.34)	(1.26)	(0.13)	(1.73)*	(0.13)
Motivation: norm	-0.0034	-0.0008	0.0046	-0.0019	-0.0059
	(0.40)	(0.20)	(1.41)	(0.48)	(1.77)*
High school graduate and some college	-0.135	-0.052	-0.152	-0.157	0.394
	(0.14)	(0.13)	(0.43)	(0.36)	(1.01)
College graduate and post graduate	-0.683	-0.406	-0.259	-0.384	0.479
	(0.43)	(0.57)	(0.49)	(0.55)	(0.75)
Years farming	0.0155	0.0053	0.0014	0.0041	0.0091
	(1.25)	(0.96)	(0.29)	(0.75)	(1.90)*
Acres cultivated	0.105	0.015	-0.053	0.084	0.044
	(1.60)	(0.54)	(1.83)*	(2.22)**	(1.32)
Farm type: fruits and vegetables	-1.395	0.584	-3.076	-0.388	0.667
	(1.76)*	(2.25)**	(6.64)***	(1.39)	(1.44)
Farm type: corps	-0.014	0.138	-1.240	0.102	0.766
	(0.02)	(0.51)	(5.32)***	(0.30)	(2.55)**
Farm type: trees	-2.497	-0.035	-1.326	-1.247	0.137
	(3.48)***	(0.11)	(5.08)***	(3.74)***	(0.48)
Farm type: other	-0.061	-0.069	-0.654	0.515	-0.411
	(0.05)	(0.09)	(0.84)	(0.93)	(0.72)
Number of children	-0.221	-0.066	-0.043	-0.072	-0.087
	(1.33)	(0.86)	(0.79)	(0.96)	(1.20)
Family size	-0.241	-0.309	-0.133	0.003	0.010
	(1.17)	(2.75)***	(1.48)	(0.04)	(0.11)
Not a member of the church	0.684	0.650	0.588	-0.050	-0.194
	(0.96)	(2.11)**	(2.57)**	(0.15)	(0.66)
Residual of regression (1)	**-0.810**	**-0.331**	**-0.237**	**-0.319**	**0.014**
	(1.39)	**(1.24)**	**(1.52)**	**(1.22)**	**(0.06)**
Constant	3.185				
	(2.99)***				
Observations	242	242	242	242	242
R^2 / Pseudo R^2	0.23	0.08	0.13	0.07	0.07

Notes: (a) Regression (1) is OLS of number of memberships on all the exogenous variables.
(b) Robust *t* and *z* statistics in parentheses
(c) * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8. Marginal Effects $(\partial p_1 / \partial x)$ and Standard Errors of Probit Estimates (Adoption of Sustainable Practices)

	PESTDUM	GRAZDUM	SOILDUM	MARKETDUM	ORGDUM
Number of memberships	0.041	0.032	0.023	0.024	0.009
	(0.014)***	(0.013)**	(0.007)***	(0.014)*	(0.004)**
Motivation: environmental concern	-0.0019	0.0002	-0.0003	-0.0012	-0.00047
	(0.0014)	(0.0009)	(0.0006)	(0.0014)	(0.00039)
Motivation: norm	-0.0014	0.0027	-0.0007	-0.0036	-0.00005
	(0.0015)	(0.0011)**	(0.0006)	(0.0015)**	(0.00039)
High school graduate and some college	0.094	0.010	0.024	0.133	
	(0.119)	(0.077)	(0.043)	(0.116)	
College graduate and post graduate	0.140	0.078	0.024	0.163	0.003
	(0.133)	(0.076)	(0.044)	(0.126)	(0.021)
Years farming	0.0011	-0.0009	0.0002	0.0048	-0.001
	(0.0022)	(0.0016)	(0.0008)	(0.0022)**	(0.001)
Acres cultivated	0.017	-0.017	0.006	0.017	0.0012
	(0.015)	(0.010)	(0.006)	(0.015)	(0.0036)
Farm type: poultry			-0.398		
			(0.057)***		
Farm type: fruits and vegetables	0.446	-0.886		0.155	0.011
	(0.110)***	(0.036)***		(0.152)	(0.054)
Farm type: corps	0.069	-0.357	-0.978	0.160	0.077
	(0.127)	(0.138)***	(0.007)***	(0.120)	(0.074)
Farm type: trees	0.047	-0.498	-0.982	0.055	-0.008
	(0.125)	(0.137)***	(0.005)***	(0.124)	(0.028)
Farm type: other	-0.184	-0.452		-0.111	
	(0.227)	(0.239)*		(0.236)	
Number of children	0.008	-0.002	-0.001	-0.044	0.002
	(0.025)	(0.018)	(0.010)	(0.025)*	(0.007)
Family size	-0.088	-0.020	0.001	0.017	0.004
	(0.035)**	(0.025)	(0.014)	(0.034)	(0.008)
Not a member of the church	0.126	0.159	-0.039	-0.078	-0.018
	(0.098)	(0.036)***	(0.048)	(0.097)	(0.020)
County per capital income	0.030	0.136	0.022	0.008	0.019
	(0.083)	(0.083)	(0.033)	(0.085)	(0.019)
Observations	242	242	242	242	242
Pseudo R^2	0.11	0.36	0.18	0.08	0.21

Notes: (a) Regression (1) is OLS of number of memberships on all the exogenous variables.
(b) * significant at 10%; ** significant at 5%; *** significant at 1% .

Table 9. Regression Coefficients and Standard Errors (Extent of Sustainable Practices)

	SUSTPRAC	PEST	GRAZING	SOIL	MARKET
	OLS	Ordered Probit	Ordered Probit	Ordered Probit	Ordered Probit
Number of memberships	0.363	0.096	0.070	0.117	0.086
	(0.067)***	(0.030)***	(0.029)**	(0.028)***	(0.030)***
Motivation: environmental concern	-0.0086	-0.0039	0.0003	-0.0044	0.0004
	(0.0068)	(0.0032)	(0.0030)	(0.0028)	(0.0030)
Motivation: norm	-0.0099	-0.0034	0.0027	-0.0045	-0.0058
	(0.0073)	(0.0034)	(0.0032)	(0.0030)	(0.0034)*
High school graduate and some college	0.995	0.410	0.179	0.288	0.375
	(0.576)*	(0.288)	(0.247)	(0.239)	(0.277)
College graduate and post graduate	1.337	0.421	0.332	0.413	0.444
	(0.647)**	(0.317)	(0.278)	(0.268)	(0.307)
Years farming	0.0058	0.0013	-0.0014	0.0003	0.0092
	(0.0108)	(0.0050)	(0.0046)	(0.0045)	(0.0049)*
Acres cultivated	0.138	0.029	-0.043	0.098	0.043
	(0.070)*	(0.031)	(0.034)	(0.030)***	(0.030)
Farm type: fruits and vegetables	-0.885	0.793	-2.927	-0.187	0.658
	(0.807)	(0.344)**	(0.591)***	(0.326)	(0.350)*
Farm type: corps	0.028	0.155	-1.228	0.118	0.765
	(0.625)	(0.286)	(0.285)***	(0.264)	(0.274)***
Farm type: trees	-2.225	0.077	-1.247	-1.140	0.132
	(0.615)***	(0.278)	(0.276)***	(0.267)***	(0.269)
Farm type: other	-1.409	-0.621	-1.048	-0.016	-0.388
	(1.181)	(0.661)	(0.535)*	(0.475)	(0.568)
Number of children	-0.041	0.008	0.010	-0.001	-0.090
	(0.120)	(0.056)	(0.052)	(0.050)	(0.058)
Family size	-0.034	-0.225	-0.072	0.085	0.006
	(0.164)	(0.080)***	(0.072)	(0.068)	(0.075)
Not a member of the church	-0.110	0.325	0.356	-0.363	-0.181
	(0.477)	(0.219)	(0.206)*	(0.198)*	(0.223)
County per capital income	0.622	0.255	0.182	0.245	-0.011
	(0.409)	(0.184)	(0.172)	(0.167)	(0.182)
Constant	2.492				
	(1.237)**				
Observations	242	242	242	242	242
R^2 / Pseudo R^2	0.23	0.08	0.13	0.07	0.07

Notes: (a) Estimates of the cut points of the ordered probit regressions have not been reported.
(b) Robust *t* and *z* statistics in parentheses
(c) * significant at 10%; ** significant at 5%; *** significant at 1%

Table 10. Marginal Effects $(\partial p_i / \partial x)$ and Standard Errors of Number of Membership in the Ordered Probit Regressions of Table 7

	Number of sustainable practices (i)					
	$i=0$	$i=1$	$i=2$	$i=3$	$i=4$	$i=5$
PEST	-0.0382	0.0226	0.0132	0.0024		
	(0.0121)***	(0.0078)***	(0.0046)***	(0.0014)*		
GRAZING	-0.0179	-0.0102	0.0126	0.0154		
	(0.0075)***	(0.0047)***	(0.0056)***	(0.0065)***		
SOIL	-0.0235	-0.0205	-0.0025	0.0127	0.0202	0.0135
	(0.0061)***	(0.0058)***	(0.0018)	(0.0040)***	(0.0058)***	(0.0040)***
MARKET	-0.0340	0.0155	0.0140	0.0043		0.0003
	(0.0119)***	(0.0059)***	(0.0054)***	(0.0020)***		(0.0004)

Notes: (a) Estimates of the cut-offs have not been reported but is available on request.
(b) * significant at 10%; ** significant at 5%; *** significant at 1%.

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[1] Carter and Maluccio [2003], Grootaert [2000], Narayan and Pritchett [1999], Costa and Kahn [2003], Malucccio, Haddad, and May [2001], Helliwell [1996), to name a few of the papers that used this measure.

[2] See Munasib [2005] for a detailed discussion of this measure (the so-called "Putnam's Instrument") and its various criticisms. It also discusses and makes use of an alternative approach. Also see Jordan Munasib [2005] for a discussion of the determinants of associational activities.

[3] See Haurin, Dietz, and Weinberg [2002] for a review of neighborhood effect. Although their exposition is in the context of housing and homeownership issues, the discussion is quite general.

[4] Visit http://www.ropercenter.uconn.edu/research/datasets/social_capital.html for the details of Roper Center Surveys.

[5] Note that this also is a source of endogeneity of the social capital variable and is covered by DWH test. However, we still include this control to convince those who are doubtful about DWH test.

[6] Here we follow the simple expositions presented in Wooldridge [2002] and Davidson and MacKinnon [2004].

[7] To check this, write the linear projection of ε_1 on ε_2 as,

$$\varepsilon_1 = \varepsilon_2 \delta + \xi ,$$

where, $\delta = E(\varepsilon_2 \varepsilon_1) / E(\varepsilon_2)^2$, $E(\varepsilon_2 \varepsilon_1) = 0$, and, since ε_1 and ε_2 are each orthogonal to $\mathbf{z}$, $E(\mathbf{z}'\varepsilon_1) = 0$. Plugging the above expression into equation (1) yields equation (3).

[8] We have also experimented with and without this variable. The coefficient of social capital remains virtually unchanged, which only reinforces the DWH test results.

[9] The results of the regression of ORGDUM has been reported for completeness. We do not believe that this regression returned a reliable set of estimates because ORGDUM =1 for only 12 out of 242 respondents (less than 5 percent).

[10] Available at http://fisher.lib.virginia.edu/collections/stats/ccdb, and http://www.epodunk.com.