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Does Participation in the Conservation Reserve Program and/or Off-Farm Work Affect the Level and Distribution of Farm Household Income?

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Abstract

Since both release resources from agricultural production, it is not surprising that decisions to work off the farm and to participate in the U. S. Conservation Reserve Program (CRP) are correlated. By incorporating these decisions into a heteroskedastic specification of a farm household income function, we identify their effects on mean income, as well as on the variability in income for groups of farm households participating in combinations of these activities. Our results indicate participation in CRP and off-farm work by the operator and the spouse increase farm household income, but these choices also decrease the variability in household income among participant households relative to that of other farm households with otherwise similar characteristics.

Key Words: Conservation Reserve Program, farm household income, income distribution, off-farm work.

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Introduction

The dependence of farm households in the United States and elsewhere on income from non-farm sources has increased steadily, narrowing, or actually reversing in some instances, the gap between incomes of farm and non-farm households (Offutt 2002). In the United States, off-farm income is now the largest component of farm household income, $120 billion at the start of the new millennium, compared with net income from farming of only $50 billion (Mishra, *et al*. 2002).

Until the mid-1980's, these changes in the composition of farm household income occurred against the backdrop of a commodity-oriented U. S. farm policy. Through the conservation compliance provisions of the 1985 farm bill, environmental goals were elevated along side commodity policy objectives. Spending on an expanded number of provisions offering incentives to participate in environmentally-related programs was to rise by 80 percent under recent farm legislation—to a 10-year total of $38.6 billion. The Conservation Reserve Program (CRP) is the largest Federal program targeting land use. Through this voluntary program, agricultural producers can receive annual rental payments and cost-share assistance to establish long-term, resource conserving covers on eligible farmland. To date, about 35 million acres have been removed from agricultural production and thus reduce soil erosion by an estimated 450 million tons per year, at an annual cost to the Federal government of about over $2 billion (Farm Service Agency 2007).

While total CRP payments are small compared with the income from off-farm work, the payments or income from each can be a significant source of reliable income to farm households unrelated to price and yield risk inherent in agricultural production. Since CRP and off-farm work remove substantial resources from agricultural production, the decisions may well be interrelated, and may affect the allocation of other resources in farm production, as well as between the farm and the farm household. Phimister and Roberts (2006) find evidence that while fertilizer intensity may decline as off-farm labor increases, the use of crop protection inputs per hectare increases. Goodwin and Mishra (2004) show that off-farm work reduces the efficiency of agricultural production. By recognizing the correlation between the decisions to work off the farm and to participate in CRP in estimating a stochastic production frontier, Chang (2006) shows that operators' off-farm work decisions (both separately and combined with participation in CRP) improve resource allocation between farm and productive activities by farm households.

Our purpose in this paper is to determine how these same decisions may also affect farm household income. There are two major components to the analysis, and each has unique aspects. Huffman (1991, p.106) has underscored the importance of accounting for labor supply and other decisions that are likely to be determined endogenously with household income. Therefore, we first estimate a discrete choice model for CRP participation and off-farm work. In modeling these three choices jointly, we extend the already considerable research to explain decisions to work off the farm by both farm operators and spouses,[1] and to participate in programs such as the CRP (e.g., Isik and Yang 2004; Parks and Schorr 1997).

Next, to account for the endogeneity among these decisions and income we include the estimated probabilities of participation in CRP and off-farm work in the equation for farm household income. By also specifying a heteroskedastic farm household income function, we identify any effect of these three decisions on both average farm household income and its variability (or inequality) among households with similar characteristics and participating in

[1]The literature on off-farm work by the farm operator is summarized in Hallberg, *et al*. (1991). Other research documents the likelihood that off-farm work decisions of the operator and spouse are interrelated (e.g. Huffman and Lange 1989; Lim-Applegate, *et al*. 2002; and Ahearn, *et al*. 2006).

various combinations of these three activities.[2] Thus, through this specification we gain insights into how the reallocation of resources released from agriculture by each decision contributes differently to the farm household income and its distribution. We also identify how participation in agro-environmental programs such as the CRP contribute to the long-standing income objectives of more traditional agricultural policies.

To proceed, we outline a conceptual framework to establish the linkage between the discrete choice model and farm household income, and to motivate our econometric specification. We then describe the data, discuss the results, and conclude with a brief policy discussion.

Conceptual Framework

We assume that farm household decisions are made by the operator, *m*, and the spouse, *s*. There are fixed endowments of farmland ($\overline{A}$) and time for the operator ($\overline{E}_m$) and spouse ($\overline{E}_s$). Time is allocated to leisure (l_m, l_s), farm production (L_m^F, L_s^F), and off-farm work (L_m^{OF}, L_s^{OF}). Land is allocated between crop production (A), and CRP (A_e). The household receives income from agricultural sales, off-farm work at respective off-farm wages (w_m, w_s), CRP per acre payments (P_e), and decoupled farm payments, (M). Utility depends not only on farm household consumption (x) and leisure, but also the improvement in environmental quality (e) generated by land committed to CRP. Agricultural production, y, depends on land and labor, where $y = f(L_m^F + L_s^F, A)$ is a well-behaved concave production function. To reflect the risky environment in agricultural production, we assume that the commodity price, P, is random; $P = \overline{P} + \eta$, where $\overline{P}$ is the expected price and the random error follows an arbitrary distribution with mean zero and variance σ_η^2.

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[2] A similar heteroskedastic specification is used by Low and Ormiston (1991) and Mullahy and Sindelar (1995) to examine the effects of schooling and alcoholism on family income; neither accounts for endogeneity between the decisions and income.

Farm households maximize expected utility, subject to income, time, and acreage constraints:

(1) $\underset{x, l_m, l_s, A_e}{Max} = E\{U[x, l_m, l_s, e(A_e)]\}$ s.t.

(2) $x = (\overline{P} + \eta) f(L_m^F + L_s^F, A) + w_m L_m^{OF} + w_s L_s^{OF} + P_e A_e + M$

(3) $\overline{E}_m = L_m^F + L_m^{OF} + l_m$

(4) $\overline{E}_s = L_s^F + L_s^{OF} + l_s$

(5) $\overline{A} = A_e + A$.

After substituting equations (2) through (5) into equation (1), the problem becomes:

(6) $\underset{A_e, L_m^F, L_m^{OF}, L_s^F, L_s^{OFs}}{Max} = EU\{[(\overline{P} + \eta) * f(L_m^F + L_s^F, \overline{A} - A_e) + w_m L_m^{OF} + w_s L_s^{OF} + P_e A_e + M],$

$[\overline{E}_m - L_m^F - L_m^{OF}], [\overline{E}_s - L_s^F - L_s^{OF}], e(A_e)]\}$.

Assuming an interior solution for all endogenous variables, except (A_e, L_m^{OF}, L_s^{OF}), the first-order conditions for maximization are: [3]

(7) $\frac{\partial EU(.)}{\partial A_e} = E\{U_x[-(\overline{P} + \eta) f_A + P_e] + U_e e_{A_e}\} \leq 0$; $\quad A_e \geq 0$; $\quad A_e \frac{\partial EU}{\partial A_e} = 0$

(8) $\frac{\partial EU(.)}{\partial L_m^{OF}} = E\{U_x w_m - U_{lm}\} = w_m E(U_x) - E(U_{lm}) \leq 0$; $\quad L_m^{OF} \geq 0$; $\quad L_m^{OF} \frac{\partial EU}{\partial L_m^{OF}} = 0$

(9) $\frac{\partial EU(.)}{\partial L_s^{OF}} = E\{U_x w_s - U_{ls}\} = w_s E(U_x) - E(U_{ls}) \leq 0$; $\quad L_s^{OF} \geq 0$; $\quad L_s^{OF} \frac{\partial EU}{\partial L_s^{OF}} = 0$

(10) $\frac{\partial EU}{\partial L_m^F} = E\{U_x[(\overline{P} + \eta) f_{L_m^F}] - U_{l_m}\} = 0$

[3] To make the analysis tractable, we assume marginal utilities of leisure and CRP land are independent: $U_{AeL} = U_{LAe} = 0$ (e.g. Fabella 1989).

$$(11)\quad \frac{\partial EU}{\partial L_s^F} = E\{U_x[(\overline{P}+\eta) f_{L_s^F}] - U_{l_s}\} = 0.$$

where U_i is the derivative of utility function w. r. t. argument *i*. Equations (8) and (9) provide optimal conditions for off-farm hours worked. If a corner solution obtains for either, the ratio of the expected marginal utility of leisure to the expected marginal utility of consumption may be greater than the off-farm wage. Similarly, the optimal CRP enrollment may be zero if the cost of participation is less than the benefit of participation (equation 7). After solving the equations for the endogenous variables, and substituting into equation (2), income can be expressed in terms of the exogenous variables:

$$(12)\qquad x = x(w_m, w_s, P_e, \overline{P}, \sigma_\eta^2, M)\ .$$

To retain all sample observations for empirical estimation, we adopt a *reduced form* approach similar to one by Goodwin and Holt (2002) in which (potentially unobservable) wages and CRP payments are replaced in equation (12) by their determinants. Since the participation decisions may be correlated with farm household income due to unobserved heterogeneity, we account for this endogeneity through an extension of the conventional endogenous treatment effect model by including predicted probabilities of each choice from the discrete choice model in the income function as proxies for their observed counterparts.

Econometric Framework

Decision Process

To characterize the decision process, we specify each participation decision as a binary probit choice, but allow for correlation between each pair of choices. Each decision is assumed to be determined by the comparison of the net benefit between participation and non-participation in each activity. If the latent binary choice variables (I_1*, I_2*, I_3*) represent the likelihood of participation in CRP, and off-farm work by the operator, and spouse, respectively, the *reduced form* participation equations are:

(15) $I_1{*} = H_1' X_1 + e_1$ $\quad I_1$=1 iff I_1*>0 otherwise I_1=0

$I_2{*} = H_2' X_2 + e_2$ $\quad I_2$=1 iff I_2*>0 otherwise I_2=0

$I_3{*} = H_3' X_3 + e_3,$ $\quad I_3$=1 iff I_3*>0 otherwise I_3=0

where I_1, I_2 and I_3 are dummy indicators for the observed decisions; $H_1, H_2,$ and H_3 and $X_1, X_2,$ and X_3 are vectors of parameters and exogenous variables, respectively; and (e_1, e_2, e_3) is assumed to be distributed trivariate normal with zero means, unit variances, and correlation coefficients between any pair of choices, ρ_{ij}. Based on observed outcomes and the probabilities of the eight possible regimes, the log likelihood function is (Greene 2003):

$$\text{(16)} \qquad \log L = \sum_{i=1}^{n} \log\Phi[k_1 H_1' X_1, k_2 H_2' X_2, k_3 H_3' X_3, k_1 k_2 \rho_{12}, k_1 k_3 \rho_{13}, k_2 k_3 \rho_{23}]$$

where $\Phi(.)$ is the cumulative trivariate normal distribution for each regime. The constants, k_1, k_2 and k_3 are ($2I_1$-1), ($2I_2$-1), and ($2I_3$-1), respectively. We estimate equation (16) with an approach based on the Geweke-Hajivassiliou-Keane (GHK) simulator, which is unbiased for any number of replications and generates smaller variances than other simulators (Hajivassiliou, *et al*. 1996).

Incorporating the Effects of these Decisions in a Farm Household Income Function

To account both for the endogeneity between the choices and income and for the effects of these choices on the variance in income among farms with similar characteristics, we specify a heteroskedastic farm household income function within a treatment effects model. Thus:

$$\text{(17)} \qquad Y = \beta' X + d_1\Phi_1(\hat{H}_1' X_1) + d_2\Phi_2(\hat{H}_2' X_2) + d_3\Phi_3(\hat{H}_3' X_3) + u$$

$$u = g^{1/2}[\alpha' K + r_1\Phi_1(\hat{H}_1' X_1) + r_2\Phi_2(\hat{H}_2' X_2) + r_3\Phi_3(\hat{H}_3' X_3)]\varepsilon$$

where Y is farm household income; X *and* β are vectors of factors affecting income and parameters, respectively; u is the disturbance term with a zero mean and variance, Var (u) = σ_u^2 = g(.), under the assumption that E (ε) = 0 and Var (ε) = 1. The function $g^{½}$(.) determines the variance in income, where K and α are vectors of explanatory variables and parameters, respectively. To capture the treatment effects (e.g. Vella and Verbeek 1999), the estimated marginal probabilities for CRP participation and for off-farm work by the operator and spouse, $\Phi(\hat{H}_1' X_1)$, $\Phi(\hat{H}_2' X_2)$ and $\Phi(\hat{H}_3' X_3)$ from the choice model serve as proxies for three binary choice indicators in both Y and u. If ε is standard normal, maximum likelihood methods provide consistent estimates of equation (17); the log-likelihood function is (Saha, *et al.* 1997):[4]

$$(18)\ \log L = -\frac{1}{2}\left[n*\ln(2\pi) + \sum_{i=1}^{n} \log(g(.)) + \sum_{i=1}^{n} \frac{(y-\beta' X - d_1\Phi_1(\hat{H}_1' X_1) - d_2\Phi_2(\hat{H}_2' X_2) - d_3\Phi(\hat{H}_3 X_3))}{g(.)} \right]$$

Data

The farm household data are from the 2001 Agricultural Resource Management Survey (ARMS), conducted by the National Agricultural Statistics Service (NASS) of the United States Department of Agriculture (USDA). By including data on the farm household (e.g. non-farm assets, non-farm income, demographics, etc.), the ARMS data provide the basis for assessing changes in the well being of farm households nationwide (Table 1). We limit our attention to the sample of farm households, excluding large corporate operations, etc. We also focus on crop farms; they contain the lion's share of CRP participation.

We also include data from additional sources. The economic characteristics of local areas, for example, are merged into our ARMS data set. These are county-level data from the Bureau of Economic Analysis income files in 2000, the Bureau of Economic Analysis employment files in 2000, the Bureau of Labor Statistics, and the 1990 Census of Population, STF-3 file. Since the

[4] The initial values are from the three-step method in Just and Pope (1979).

ARMS data lack information on land quality on the farm, variables representing land quality at the county level where the farm is located are used. We define land quality as the product of a variable for length of growing season and land capability class (i.e. Darwin and Ingram 2004).

Another factor affecting CRP participation is the Environmental Benefits Index (EBI), which in part determines the maximum price that can be paid for land offered into the CRP. Since an EBI index for land was not available for each farm, we use data from Jaroszewski (2000) to approximate an EBI for major agricultural regions based on the percentage of land in the various conservation practices currently enrolled in CRP.

Empirical Results

Our empirical specifications are guided by theoretical results from above and previous literature (e.g. Goodwin and Mishra 2004, El-Osta, *et al*. 2004, and Ahearn et al. 2006). Although our focus is to identify the effects of these three choices on farm household income, we do test the null hypothesis that the three decisions are independent and discuss briefly the important factors affecting the three decisions.

Tests for Interrelated Decisions

Based on the likelihood ratio test, we find substantial support for our joint decision model through a rejection of the null hypothesis that correlation coefficients between pairs of decisions are jointly equal to zero. Furthermore, CRP participation is positively correlated with off-farm work of the operator and spouse, and the coefficients are statistically significant.[5] The positive

[5] Full sample weights are used in the estimation to reflect appropriately the national characteristics of the crop farm households. However, this strategy does not account for any potential effect of the complex stratified sample design on the standard errors of the estimated coefficients. A delete-a-group jackknife procedure based on dividing the ARMS data into 15 nearly equal and mutually exclusive groups, with associated group (also called replicate) weights (Dubman 2000) has proven reliable for estimating variances of many financial statistics (most are linear functions of the data) in large samples, but much less is known about the performance in complex econometric models. It is not clear that the stratification scheme does not alter the likelihood functions beyond simple weights (Goodwin and Mishra 2006). They also argue that the appropriateness of applying the predefined jackknife replicate weights to a subsample of the ARMS data is unclear, and the numbers of observations in some of our subsamples is

correlation between the off-farm work by the operator and the spouse is consistent with those by Huffman and Lange (1989), Lim-Applegate, *et al*. (2002), and Ahearn, *et al*. (2006).

The Two Off-Farm Work Decisions

As in much of the existing literature (e.g. Sumner 1982; Benjamin and Guyomard 1994), our results (Table 2) continue to confirm that older farmers (OP_AGE) are more likely to work off the farm; results are similar for the spouse (SP_AGE). Although education (OP_ED_C; SP_ED_C) has a positive effect on the probability of participation in off-farm work for both, on-farm experience (OP_EXP; SP_EXP) has a negative effect. Farm operators raised on farms (RAISE_OP) are also less likely to work off the farm. These latter effects could reflect a strong preference for farm work and a farm lifestyle. The likelihood of the spouse working off the farm declines as the number of children under six years of age in the household rises (H_SIZE06). Since returns to off-farm labor are likely to be less variable than farm returns (e.g. Mishra, *et al*. 2002), the indication that the likelihood of off-farm participation is lower for farm operators willing to accept more risk (a negative coefficient on "RISK", a variable that increases as a farmer is willing to accept more risk) is consistent with risk averse behavior.

For both operator and spouse, the likelihood of participation in off-farm work declines with farm size (CROPSIZ1), and it is lower for vegetable or nursery operations (CROP456), the latter probably reflecting the opportunity cost of off-farm work for those producing high-value crops. The negative effects on the likelihood of participation of both net worth (NETWORT1) and participation in government programs (e.g. AMTA_A)[6] other than CRP may reflect wealth

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well below the limits at which the "…jackknife estimator faces structural problems in its application" (Dubman 2000, p.11). This inability to correct for sample design to estimate standard errors suggests that one must exercise caution in extending statistical inferences to the population.

[6]Production Flexibility Contract (PFC) payments, originally called Agricultural Market Transition Assistance (AMTA) payments, were initially designed to be "decoupled" from current production decisions. They are annual lump sum cash transfers announced in advance. However, at least in part because they are based on historical participation in commodity support programs, the jury is still out on whether they are pure transfers (e.g. Hennessy

or scale effects on off-farm labor supply (e.g. Goodwin and Mishra, 2004).[7] These effects are more pronounced for the operator. The negative effect of TENANCY (measured by the proportion of acreage owned) reflects a greater commitment to agricultural production (*ceteris paribus*). Finally, the strength of the local economy (measured by the proportion of jobs in manufacturing (MANUF)) increases the likelihood of off-farm work for both.

The CRP Participation Decision

The probability of participation in CRP increases with farm size (CROPSIZ1), but the probability of participation is lower for vegetable or nursery farms (CROP456), probably reflecting higher opportunity costs of removing land from high-value crop production (Table 2).

Environmental characteristics also matter for CRP participation. For instance, farm households located in areas where the EBI scores for land currently enrolled are high are more likely to participate in CRP, *ceteris paribus*. Further, participation in CRP rises (falls) as the proportion of land in the surrounding county is classified as high (LQH_96) (low) (LQL_96) quality. Thus, CRP participation may be higher in areas where land is well suited for agriculture. While this result offers guidance about types of areas where CRP participation is high or low, it offers little information about the quality of land actually enrolled. To draw specific conclusions about the quality of land in CRP, we would need farm-specific information.

Participation in CRP is related to the life-cycle of the farm operator. The likelihood of CRP participation increases with age (OP_AGE); as farmers get older, committing land to CRP may reduce labor requirements, and may help retain farmland assets for retirement, or for estate purposes. The positive correlation between farmers working off the farm and participation in

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1998).

[7]There is reason to think that receipt of decoupled payments is endogenous. Using tests by Smith and Blundell (1986) and Vella (1993), Chang (2006), in related research involving just CRP participation and the operator's off-farm work, found that decoupled payments (AMTA_A) are exogenous to the off-farm work decision.

CRP may reflect a desire to reduce operator labor requirements as land is taken out of production, and vice versa. The probability of CRP participation increases with farmer's education (OP_ED_C), perhaps indicating that investments in human capital increase participation in CRP.

As aversion to risk increases, we would expect the likelihood of participation in programs where payments are certain, such as CRP, to increase. This conclusion is supported by the negative sign on the variable "RISK" in Table 2 (e.g. high values for "RISK" are associated with farmers who prefer more risk). By allowing for decreasing absolute risk aversion (DARA), our theory is also consistent with the fact that decoupled payments, "AMTA_A", reduce the likelihood of CRP participation. By receiving decoupled payments rather than enrolling land in CRP, a farmer also retains program base acreages and the option to convert land to non-agricultural uses. Since commodity program-related loan deficiency payments (LDP_A) reduce farm income variability (particularly on the downside), these payments reduce risk averse farmers' concerns for allocating resources to programs, such as CRP.

Participation in state and local agriculturally-related programs also affects the likelihood for CRP participation. For example, if the farm is enrolled in a voluntary agricultural district, subject to a farmland preservation easement, or is located in an agricultural protection zone or an area zoned exclusively for agricultural use (the variable AGDIST), the farmer is less likely to participate in CRP. Farmers participate in these programs to maintain land in agricultural production in rapidly growing areas where there is competition for land for non-agricultural purposes. Consistent with Duke (2004), the likelihood of CRP participation falls as the proportion of population that is urban rises, reinforcing this explanation.

Empirical Results of the Farm Household Income Function

The estimated farm household income function is reported in Table 3, where the mean and variance functions are specified in linear and exponential forms, respectively. The effects of participation in CRP and/or off-farm work on farm household income are embodied in the coefficients associated with the estimated marginal probabilities of participating in CRP and off-farm work by the operator and spouse: PR_CRP, PR_OP, and PR_SP, respectively.[8] Household income rises with all three probabilities, although the statistically insignificant effect for the probability of off-farm work by the spouse may be because many spouses may work off the farm part time or primarily to gain access to health insurance, or to gain personal skills (Mishra, *et al.* 2002).

Since this variance function is based on a heteroskedastic error specification, it determines the extent to which the variability of household income across farm households is systematically related to farm and farm household characteristics, as well as the likelihood of participation in CRP or off farm work. Thus, all else equal, the variance in household income across farm households is systematically lower for those farm households which are more likely to participate in CRP or off-farm work (e.g. the negative coefficients on the variables PR_CRP, PR_OP, and PR_SP in the variance equation in Table 3). These results on off-farm work square with those by Mishra, *et al.* (2002) who suggest that off-farm income helps diversify sources of income. There is also less variability in household income among these farms with some off-farm income. This squares with the fact that income variability is higher among those farms where the spouse is a home maker (SP_HMAK).

The performance of the human capital variables seem consistent with the standard results found in the human capital and earnings literature (Low and Ormiston 1991). Operators retired from farming (OP_RET) have lower household incomes, but incomes are less variable. Average

[8] Based on a likelihood ratio test, we reject the null hypothesis that the coefficients on the predicted probabilities specified in both the mean and variance functions are all zero. These probabilities do affect the mean and variance in household income differently.

farm household income is lower where operators have more experience (OP_EXP), but there is also less variability in incomes across farms in this group. This former result squares with the fact that farmers with more experience are less likely to work off the farm or participate in CRP. However, while those farmers committed to farming may have somewhat lower average incomes, this latter result may speak to the value of farm experience in dealing effectively with the inherent variability of returns from farming. Furthermore, the characteristics of the spouses also affect household income. Household incomes increase with the spouses' educational levels (SP_ED_C), but incomes are more variable as the age of the spouse increases, all else equal.

Also consistent with expectation, larger farms (CROPSIZ1) or farmers owning a large share of farmland (TENANCY) have higher farm household income. However, this probably means that a larger share of household income comes from farm sources—thus explaining, at least in part, why both of these variables contribute to the variability in household income across farms in the group. Consistent with these findings is that income variability is somewhat higher for farms in areas where there is a high proportion of high quality land (LQH_96). While these may be productive soils, yields may be more responsive to weather at both extremes.

Farmers receiving (AMTA_A) payments also have higher average farm household incomes, which in part could be explained by the fact that decoupled payments are, in large measure, income transfers. Regardless of whether decoupled payments are pure transfers or have some modest effect on production decisions, it is not surprising that there is less variability in farm household among households receiving them. The financial status of the farm household also determines the farm household income. As the debt to asset ratio rises (DEBT_RAT) average farm income falls, but the variability of household income for farms with otherwise common characteristics falls, and the effect is significant.

From this discussion, it is evident that by controlling for the endogeneity of these three decisions, we are able to distinguish the *direct* effects of farm and household characteristics, other government programs, and local economic conditions on household income and its distribution from the *indirect* effects of these same factors through their effects on the probability of engaging in off-farm work or of participating in CRP. Information in Table 4 underscores the importance of these combined *indirect* effects.

The mean probabilities of participation in CRP and off-farm work differ substantially across the groups of farms, but they differ in predictable ways (Table 4). More important, any change in policy, etc. that affects substantially the probability of participation in CRP or off-farm work (even for non-participants) will affect household incomes for all groups, and variability of income across farms within a group. When combined, the indirect effects are substantial.

For example, after setting those factors that directly affect household income at the group means, the probability of the operator working off the farm accounts for anywhere from 22 percent of estimated farm household income (for the group where only the operator works off the farm) to 9 percent of mean income (for the group only participating in CRP). Similarly, by accounting for the probability of the operator working off the farm, the estimated standard deviation in income falls by between 11 percent and 27 percent among farms in the four groups of farms where the operator actually works off the farm. While it is important to document the size of these indirect effects, they are hardly surprising given the documented importance of income from non-farm sources.

In contrast, the proportion of mean income accounted for by the probability of the spouse working off the farm is much smaller, ranging from only 1 percent to 3 percent across the nine groups. This might also be expected, but in percentage terms, the reduction in the standard deviation in income across farms within each group is much larger, ranging from a high of 24 percent and 25 percent for the two groups in which both the operator and spouse work off the farm, to a low of 9 percent for the two groups in which neither works off the farm.

Finally, although annual CRP payments are at most 1 percent to 2 percent of income to farm households from non-farm sources, the effect of the likelihood of participation in CRP for some sub-groups is substantially larger. For the four groups participating in CRP, the probability of participation accounts for from 31percent (group participating only in CRP) to 18 percent of estimated farm household income. For the four groups not participating in CRP, the estimated probabilities of participation in CRP account for only 4 percent to 10 percent of mean income. Since CRP payments are predictable over the length of the contracts, it is also not surprising that by accounting for the probability of CRP participation, the standard deviation in income falls between 22 percent and 27 percent among farms in the four groups participating in CRP.

Summary and Conclusions

In this paper, we develop an improved understanding of the interactions between the farm business and the farm household, particularly relative to decisions to participate in the Conservation Reserve Program (CRP), the largest U. S. agro-environmental program targeting land use. Importantly, we find that in order to explain participation in CRP, one must also account for the correlation between the decisions of farm operators and their spouses to work off the farm and the decision to participate in CRP. Moreover, by extending these results, we also demonstrate that these three decisions interact with socio-economic characteristics of the farm and farm household to affect the well-being of farm households, as measured by farm household income, and its variability among farm households with common characteristics.

Participating in CRP depends on characteristics of the farm, the farm operator (including age, experience, and risk attitudes), land quality, and local economic conditions. There are also differences in participation by major ERS production regions. Off-farm work decisions by the farm operator and spouse are related to many of these same factors, although the direction and magnitude of some of the effects are different. All three decisions are affected by participation in other Federal farm programs. Participation in CRP is affected by state and local programs for farmland retention, etc. Policy implications of these results are elaborated in the text.

It is not surprising that many of the same factors that affect the decisions to participate in CRP and to work off the farm also affect both farm household income and its variability compared with farm households in which the other farm and household characteristics are similar. After controlling for the endogeneity between these decisions and farm household income, we find that participation in CRP and off-farm work by both the operator and the spouse increase average household income, but they decrease the variability of household income across households with other similar characteristics. These results square with our expectations, since income from both CRP and off-farm work is likely to be less variable than income from farm sources, and they have important implications for farmers trying to adjust to a more market-oriented farm policy environment. In addition to increasing the program's environmental benefits, changes in agricultural policy that lead to increased participation in CRP are also likely to lead to important changes in the level and distribution of farm household income.

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Table 1: Summary Statistics for Farm and Farm Household Characteristics

Variable Names	Variable Definitions	Mean	St. Dev.
Dependent Variables			
OP	If the operator worked off the farm (=1); otherwise (=0)	0.52	0.50
CRP	If the household enrolled in CRP or CREP (=1); otherwise (=0)	0.23	0.42
SP	If the spouse worked off the farm (=1); otherwise (=0)	0.57	0.50
INCOME	Total principle household income ($1,000)	67.98	106.82
Operator and Spouse Characteristics			
OP_AGE	Age of the operator	55.51	13.16
OP_RET	If the operator was retired (=1), otherwise (=0)	0.12	0.32
OP_ED_C	Education of the operator (year)	13.01	2.45
OP_EXP	Years the operator has worked on farm job	24.45	14.95
RISK	Risk preference rating of the operator; =1 if risk averse, 10 if risk loving	4.45	2.41
RAISE_OP	If the operator was raised on the farm (=1); otherwise (=0)	0.78	0.41
SP_AGE	Age of the spouse	53.43	12.84
SP_ED_C	Education of the spouse (year)	13.35	2.09
SP_EXP	Years the spouse has worked on farm job	24.45	14.95
RAISE_SP	If the spouse was raised on the farm (=1); otherwise (=0)	0.57	0.50
SP_HMAK	If the spouse is a home maker (=1); otherwise (=0)	0.27	0.44
Farm and Household Characteristics			
CROP17	If a cash grain farm, (=1),otherwise (=0)	0.69	0.46
CROP456	If a vegetable, fruit, or nursery farm, (=1),otherwise (=0)	0.22	0.42
NETWORT1	Household net-worth value ($100,000)	4.72	16.24
DEBT_RAT	Ratio of total debt to total assets	0.13	0.22
NFASST1	Principle operator household non-farm assets ($10,000)	13.96	22.49
TENANCY	Ratio of owned acres over total operated acres	0.96	2.10
AMTA_A	Per acre AMTA payment	5.38	12.73
LDP_A	Per acre LDP payment	8.37	19.16
CROPSIZ1	Operated acres (divided by 1,000)	0.33	0.70
H_SIZE	Number of household members	2.84	1.24
H_SIZE06	Number of children younger than 6 years of age	0.14	0.48

Table 1: Summary Statistics (con't)

Variable Names	Variable Definitions	Mean	St. Dev.
Environmental Characteristics			
LQH_96	Index of high quality land of 1996	0.33	0.25
LQL_96	Index of low quality land of 1996	0.23	0.19
EQIP	If participate in EQIP (=1), otherwise(=0)	0.0032	0.0566
EBI	Environmental benefit index	61.59	3.93
Location and Local Economic Conditions			
URBAN	Percent of labor market area's population living in urban areas	56.51	21.86
MANUF	LMA's employment in manufacturing (%), lagged one year	13.78	6.89
TRADE	LMA's employment in wholesale and retail trade (%), lagged one year	20.30	2.34
AGDIST	If participates in local agricultural preservation program (=1); otherwise (=0)	0.04	0.20
REGN1	If located in Heartland (=1); otherwise (=0)	0.29	0.45
REGN3	If located in Northern Great Plains (=1); otherwise (=0)	0.07	0.25
REGN567	If located in Eastern Uplands, Southern Seaboard, or Fruitful Rim (=1); otherwise (=0)	0.30	0.46
REGN9	If located in Mississippi Portal (=1); otherwise (=0)	0.05	0.22

Note: Data are for crop farms and are from the 2001 ARMS Survey.

Variables are weighted by the full sample weights; sample size is 2,102.

Table 2: Trivariate Probit Model Estimation

Variable[a]	Coefficient	St. Dev.	t-value
	For OP Choice Equation		
Constant	-3.67	0.70	-5.26
OP_AGE	0.24	0.02	11.72
OP_AGESQ	-2.59	0.18	-14.18
OP_ED_C	0.06	0.01	4.39
OP_EXP	-0.05	0.01	-5.29
OP_EXPSQ	0.00	0.00	4.24
H_SIZE	0.00	0.03	-0.06
CROPSIZ1	-0.55	0.03	-17.43
RAISE_OP	-0.47	0.10	-4.56
MANUF	0.01	0.01	2.53
TRADE	-0.04	0.01	-3.04
AMTA_A	-0.01	0.00	-2.85
LDP_A	0.00	0.00	-1.07
RISK	-0.03	0.01	-1.70
NETWORT1	-0.01	0.00	-2.07
SP_HMAK	0.49	0.08	5.98
CROP456	-0.88	0.10	-8.91
REGN3	0.04	0.15	0.27
REGN567	-0.16	0.08	-2.04
TENANCY	-0.04	0.03	-1.60
	For CRP Choice Equation		
Constant	-5.70	1.48	-3.85
OP_AGE	0.03	0.00	9.57
OP_ED_C	0.08	0.02	4.85
LQH_96	0.54	0.23	2.35
LQL_96	-0.96	0.34	-2.79
EQIP	1.11	0.40	2.77
AGDIST	-1.18	0.26	-4.55
EBI	0.06	0.02	2.49
AMTA_A	-0.03	0.00	-5.92
LDP_A	-0.01	0.00	-5.24
RISK	-0.06	0.02	-3.14
CROP456	-1.96	0.26	-7.48
CROPSIZ1	0.23	0.04	5.56
REGN1	0.19	0.11	1.68
REGN567	-0.30	0.15	-2.03
REGN9	1.31	0.27	4.77
URBAN	-0.01	0.00	-7.45

Table 2: Trivariate Probit Model Estimation (con't)

Variable[a]	Coefficient	Std. Dev.	t-value
	For SP Choice Equation		
Constant	-2.84	0.73	-3.89
SP_AGE	0.13	0.03	4.67
SP_AGESQ	0.00	0.00	-6.92
SP_ED_C	0.16	0.02	9.02
SP_EXP	-0.01	0.00	-1.88
H_SIZE	-0.10	0.03	-2.99
H_SIZE06	-0.26	0.09	-2.90
CROPSIZ1	-0.14	0.05	-2.60
RAISE_SP	0.14	0.07	1.94
MANUF	0.02	0.01	2.69
AMTA_A	0.00	0.00	-1.24
LDP_A	0.00	0.00	-0.39
NETWORT1	0.00	0.00	-0.99
CROP456	-0.88	0.09	-9.45
REGN3	0.14	0.17	0.86
REGN567	0.12	0.08	1.64
	Correlation Coefficients		
RHO(OP,CRP)	0.17	0.05	3.16
RHO(OP,SP)	0.25	0.05	5.28
RHO(CRP,SP)	0.12	0.06	2.00
Log-likelihood	-2792.44		
LR Test*	53.86		

[a] Variables are defined in Table 1.

[b] The null hypothesis is: RHO(OP,CRP) = RHO(OP,SP)= RHO(CRP,SP) = 0.

The critical value is: $x^2_{0.95,3}$ =7.8.

Table 3: Estimated Stochastic Household Income Function

Variable[a]	Coefficient	St. Dev.	t-value
		Mean Function	
Constant	0.24	20.07	0.01
OP_RET	-14.78	4.30	-3.44
OP_EXP	-0.28	0.15	-1.93
SP_AGE	-0.07	0.23	-0.32
SP_ED_C	4.29	0.83	5.16
CROPSIZ1	7.39	2.99	2.47
TENANCY	10.60	2.40	4.42
CROP17	-5.14	4.43	-1.16
AMTA_A	0.35	0.08	4.20
DEBT_RAT	-5.85	8.56	-0.68
URBAN	0.16	0.08	1.99
TRADE	-1.02	0.64	-1.58
REGN567	6.93	4.26	1.63
PR_CRP	24.29	9.29	2.62
PR_OP	18.40	9.95	1.85
PR_SP	2.89	12.59	0.23
		Variance Function	
Constant	3.29	0.51	6.44
OP_RET	-1.02	0.14	-7.04
OP_EXP	-0.02	0.00	-5.75
SP_AGE	0.02	0.00	4.61
SP_HMAK	0.33	0.08	4.44
CROPSIZ1	0.18	0.03	6.30
TENANCY	0.20	0.02	10.28
AMTA_A	-0.01	0.00	-5.14
DEBT_RAT	0.22	0.06	3.74
NFASST1	0.02	0.00	18.68
LQH_96	0.26	0.15	1.79
URBAN	0.01	0.00	4.31
REGN567	0.17	0.08	2.13
PR_CRP	-1.18	0.20	-5.78
PR_OP	-0.28	0.20	-1.42
PR_SP	-0.59	0.20	-2.90
$\sigma = 6.64$	Log L = -13,646[b]	LR Test = 531	$x^2_{0.95,6}=12.6$

[a]Variables defined in Table 1; PR_CRP, PR_OP,PR_SP predicted probabilities of choices.

[b]The null hypothesis of the LR test is: PR_CRP=PR_OP=PR_SP= 0.

Table 4: Effects of Participation in CRP and Off-farm Work on Total Household Income and its Distribution

	Farm Household Income ($1,000)		Mean Probability of Participation in:			% of Mean and Standard Deviation in Farm Household Income Accounted for by the Probabilities of Participation in:					
						CRP		OP Off-Farm Work		SP Off-Farm Work	
Group[a]	Mean	Std. Dev.	CRP	OP Off-Farm	SP Off-Farm	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
ALL	62.4	55.3									
(1,1,1)	72.5	45.4	0.46	0.72	0.73	18	-24	18	-11	3	-24
(1,1,0)	69.7	54.9	0.54	0.60	0.49	23	-27	16	-9	2	-15
(1,0,1)	55.4	38.8	0.43	0.35	0.49	23	-22	12	-5	3	-16
(1,0,0)	54.5	42.4	0.53	0.26	0.28	31	-27	9	-4	1	-9
(0,1,1)	68.6	53.0	0.16	0.70	0.76	6	-9	19	-10	3	-25
(0,1,0)	59.3	70.1	0.10	0.71	0.53	4	-6	22	-10	3	-17
(0,0,1)	65.6	50.6	0.15	0.44	0.68	6	-8	12	-6	3	-22
(0,0,0)	51.5	66.8	0.18	0.27	0.28	10	-10	10	-4	2	-9

[a]A "1" indicates that farms participate in CRP, the operator works off the farm, and the spouse works off the farm, respectively.

[b]These contributions are calculated with all other variables at the group means.

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