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Abstract

In addition to farm work, most farm households in developed countries have at least one person working off-farm. The purpose of this paper is to examine if, and how, government payments, personal characteristics and household characteristics affect labor allocation of farm operators and their spouses, and the decisions to hire labor. We estimate an 8-regime multinomial logit model and a three equation multivariate probit model to quantify these impacts. Results indicate that age of household members is consistent with the life-cycle hypothesis on increasing then decreasing labor market par, and is positively associated with demand for hired labor. Hired farm labor and off farm activities increase with the operator education levels. As household size increases, a household member is more likely to work off the farm. Increasing net worth is found to have a positive impact on probability of spouses working on the farm as well as hired labor being used. Both coupled and decoupled payments increase demand for hired labor which is consistent both with farm expansion and reduced family labor time on the farm.

Keywords: government subsidies, government programs, time allocation, labor allocation, off-farm labor, farm labor, hired labor

JEL Codes: J22, Q12, Q18

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Introduction

There is a well-established literature documenting impacts of agricultural policies. Most studies have focused on the macro-impacts on markets for products and land (e.g., Lence, and Mishra, 2003), the environment, (e.g., Just and Antle, 1990) or farm structure and productivity (e.g., Huffman and Evenson, 2001; Ahearn, Yee, and Huffman, 2002; Ahearn, Yee, and Korb, 2005). There is also a vast literature on the effects of government studies on land and land values (e.g., Lence, and Mishra, 2003) and income (e.g., Dewbre, and Mishra, 2002.) More recently, as micro-level data have become increasingly available studies of the impact of farm program payments have narrowed to estimation at the farm household level examining relationships between government policy and farm incomes (e.g., Dewbre, and Mishra, 2002) and household labor allocation (El-Osta, Mishra, and Ahearn, 2004; Ahearn, El-Osta, and Dewbre, 2006).

The literature on labor allocation and government policy has shown that the receipt of government payments (depending on their nature and requirements) may cause households to work more or less on the farm, more or less off-farm, and enjoy more or less leisure time (e.g., El-Osta, Mishra, and Ahearn, 2004). In modern U.S. agriculture accounting for off-farm employment is of primary importance since most farm households have at least one member opting for off-farm employment (El-Osta, Mishra, and Ahearn, 2004) and the income from that employment is the dominant form of (permanent) income for households. The role of off-farm earnings in reducing income variability has also served as a stabilizing factor in slowing the exit of families from the farm population that was seen in the thirty years following World War II (Ahearn, El-Osta, and Dewbre.)

This article builds on previous empirical studies examining the effect of government payments on labor allocation (El-Osta, Mishra, and Ahearn, 2004; Ahearn, El-Osta, and Dewbre, 2006.) Extending these previous analyses, we consider the linkage between household labor allocation and hired labor demands by the farm business. Failure to model the entire labor regime of the household and farm business simultaneously presents serious potential for biased inference if household labor and hired labor are not perfectly substitutable due to specific human capital, monitoring costs, or the existence of required management input that can only be provided by household members. The rest of the paper is organized as follows: First, we present the standard theory of time allocation for the farm household followed by a brief literature review. Following this we report on the data used for the study and the econometric models to be estimated. Finally, we present the results and discussion from the empirical models, and offer conclusions and areas for further investigation.

Theory of Time Allocation

Farm households maximize their (joint) utility by deciding how to allocate their income to consumption and their time between farm work, off-farm work, and leisure. The inclusion of time follows from the "full" income concept of the household (Hallberg et al., 1991). A key factor to consider when allocating household time is the wage rate from the farm and off-farm sector, and the opportunity cost or implicit price of leisure. In the standard household model, when there is an increase in non-labor income, an individual will work less and enjoy more leisure because there is no change in the return from work. Reduction in time spend at work arises from the wealth effect associated with increased income. However, if for example there is an increase in the wage rate in the farm sector, ambiguity arises. On one hand, an individual may want to work more on-farm and less off-farm, because each farm work hour is paid more. On the other hand, an individual may want to work less on-farm and off-farm because they can get the same income by working less and have more time for leisure. Depending on which of these effects dominates the number of total work hours may increase, stay the same, or decrease (Ahearn, El-Osta, and Dewbre, 2006.)

The mathematical development here follows the organization and notation originally published in Hallberg et al. (1991.) The farm household is assumed to maximize the following household-utility function:

Maximize $U = U(Y, L^o, L^s, H^o, H^s, Z)$ (1)

Where superscripts o and s indicate "operator" and "spouse" respectively. Household utility depends on the inputs of goods purchased for direct or indirect consumption (Y), and of time allocated to leisure by the operator (L^o) and the spouse (L^s). Household utility also depends on the operator and the spouse's human capital variables (H^o, H^s) that are currently fixed but affect the efficiency of household production, e.g., schooling and experience of adults. The utility function also needs to take into account other household and area characteristics that might generate shifts in utility and demands, e.g., climate, number of children in the household, commuting distance to shopping, recreation, and schooling centers (Z.)

The level of utility attainable is constrained at several levels. First consider the human time constraint. The available times of the operator and spouse are identified separately because endowed and acquired skills may be different. The allocation of operator's and spouse's time endowments is summarized by the following two equations, which provide all possible outlets for time use in either leisure, farm work, or off-farm work. Note that we assume the farm operator will have a strictly positive allocation of time to the farm business.

$T^o = L^o + OF^o + F^o, T^o > 0, L^o > 0, OF^o \geq 0, F^o > 0$ (2)

$T^s = L^s + OF^s + F^s, OF^s \geq 0, T^s > 0, L^s > 0, OF^s \geq 0, F^s \geq 0$ (3)

The farm household may receive annual income from the net return on the farming operation, off-farm earnings, and returns to non-farm assets. These receipts are spent on goods for direct or indirect household consumption. (Savings and investments are ignored here as means of simplifying the model.) The farm household is assumed to be competitive in farm output and input markets (i.e, individually they do no affect the prices that they pay for inputs or receive for outputs.) The budget constraint on household cash income is the following:

$p_y Y = p_f Y_f - r_f x_f + w^o{}' OF^o + w^s{}' OF^s + V$

(4)

The expenditures must equal the net farm household cash income. The expenditures are represented by $p_y Y$, Y being the consumption of goods and p_y being the price of the goods. The net farm household cash income is the summation of several components: the net farm income defined as revenue above variable costs ($p_f Y_f - r_f x_f$), the off-farm income ($w^o{}'OF^o + w^s{}'OF^s$) and the annual income of nonfarm assets and other non-labor returns to the farm (V). The net farm income equals the revenue, from the sales of Y_f at the price p_f, minus the cost of a quantity x_f of purchased farm inputs at the price r_f. The off farm income is based on the amount (OF^o) of operator off farm work at the wage rate net of direct cost of commuting ($w^o{}' = w^o - C^o(M^o)$), and the amount (OF^s) of spouse off farm work at the wage rate net of direct cost of commuting ($w^s{}' = w^s - C^s(M^s)$). C represents the commuting cost per hour worked and M represents the commuting distance. Finally, farm households generally have nonfarm assets, e.g., stocks, bonds, savings, etc., and annual income from these assets is represented by V.

The off-farm labor demand or wage offer equations facing the operator and the spouse are assumed to depend on their marketable human capital (H), local labor market characteristics (M) and job characteristics (Z_m.) Wage rates are assumed to be independent of hours worked to simplify the model. The market labor demand functions are summarized as:

W=w(H,M, Z_m) (5)

For simplicity, we assumed one aggregate farm output Y_f. The output is produced using operator's and spouse's farm time (F^o, F^s) and purchased inputs (x_f), including farmland services and labor hired from other households. The efficiency of farm production is assumed to depend on the human capital of the husband and wife (H^o, H^s), e.g., formal schooling, prior farming experience, public agricultural research and extension, and other exogenous farm-specific characteristics (Z_f), i.e., length of growing season, annual precipitation, and soil characteristics. The following concave production function represents the technology of farm production:

$$Y_f = F(F^o, F^s, x_f, H^o, H^s, Z_f), \partial Y^f / \partial F^o > 0,\ \partial Y_f / \partial F^s > 0,\ \partial Y_f / \partial x_f > 0 \qquad (6)$$

The production function (6) is substituted into the budget constraint (4) to obtain a farm technology-constrained measure of household net cash income:

$$p_y Y = p_f F(F^o, F^s, x_f, H^o, H^s, Z_f) - r_f x_f + w^o{}'OF^o + w^s{}'OF^s + V$$
(7)

The decision problem facing the household is now to simultaneously choose the quantity of consumption goods to purchase, the hours of operator and spouse on-farm and off-farm work, and the quantity of purchased farm inputs to maximize household welfare, i.e., maximizing the function ϕ:

$$\phi(x_f, F^o, F^s, OF^o, OF^s, L^o, L^s, Y; H^o, H^s, Z, p_f, Z_f, r_f, w^o, w^s, M^o, M^s, V, p_y,$$
$$H, M, Z_m, T^o, T^s)$$
$$= U(Y, L^o, L^s, H^o, H^s, Z) + \lambda_1 \begin{bmatrix} p_f F(F^o, F^s, x_f, H^o, H^s, Z_f) - r_f x_f \\ + \left(w^o - C^o(M^o)\right) OF^o + \left(w^s - C^s(M^s)\right) OF^s \\ + V - p_y Y \end{bmatrix} \quad (8)$$
$$+ \lambda_2 \left[T^o - L^o - OF^o - F^o\right] + \lambda_3 \left[T^s - L^s - OF^s - F^s\right]$$

Using the Kuhn Tucker conditions, we can get the operator and the spouse off-farm labor-supply function:

$$OF^o = T^o - L^o - F^o = S_{OF^o}\left(w^o{}', r_f, p_f, p_y, I^*, H^o, Z_f, Z, T^o\right)$$
$$= S_{OF^o}\left(w^o{}', r_f, p_f, p_y, V, H^o, Z_f, Z, T^0\right) \quad (9)$$
$$OF^s = T^s - L^s - F^s = S_{OF^s}\left(w^s{}', r_f, p_f, p_y, I^*, H^s, Z_f, Z, T^s\right)$$
$$= S_{OF^s}\left(w^s{}', r_f, p_f, p_y, V, H^s, Z_f, Z, T^s\right) \quad (10)$$

In focusing on off-farm work decisions, an equation for the probability of an individual participating in off-farm work is of particular interest. In the agricultural household model, rational individuals are assumed to participate in off-farm work when their reservation wage (for farm and leisure time) is less than the off-farm wage rate offered in the market. The wage offer or off-farm labor demand function is equation (5). The reservation wage is defined as the marginal value of an individual's time when he/she allocates all of his/her time to farm and leisure time (and zero hours to off-farm work.) An equation for this relationship is obtained by taking equation (9) for the operator and (10) for the spouse, setting $OF^o = 0$ or $OF^s = 0$, and solving for $w^o{}' = w_R^o$ or $w^s{}' = w_R^s$:

$$w_R^0 = R(r_f, p_f, p_y, V, H^o, Z, Z_f, T^o) \quad (11)$$
$$w_R^s = R(r_f, p_f, p_y, V, H^s, Z, Z_f, T^s) \quad (12)$$

Let j=o,s and define D_j equal to 1 if $w_R^j < w^j{}'$ and equal to 0 if $w_R^j \geq w^j{}'$. Then,

$$\Pr(D_j = 1) = \Pr\left(w_R^j < w^j{}'\right) = \ell\left(r_f, p_f, p_y, V, H^s, H^o, Z, Z_f, H, M, Z_m, m, T^o, T^s\right) \quad (13)$$

Where Pr(.)=probability for an event to occur. Thus, the probability of an individual participating in off-farm work depends on all the exogenous variables that enter his/her reservation wage and off-farm wage equations. Estimates of these participation equations provide information about the marginal effects of exogenous variables on the probability of an individual participating in off-farm work.

For the topic of this paper, we are looking at government subsidies and their effect on labor allocation. On one hand, coupled payments refer to subsidies that require the landowner and/or producer to plant a specific commodity in order to receive the subsidy, with (in some cases) subsidy amounts received dependent on the quantity produced. For this reason, coupled payment should be associated with longer hours working on the farm because they will increase returns to farm time. On the other hand, decoupled payments do not require the landowner and/or producer to plant a specific commodity to receive the subsidy and decisions made by the producer cannot affect the level of receipt of these type of payments. This makes government payments similar to non-labor income and therefore should be correlated with less total work hours(on and/or off the farm) and more leirsure time (Ahearn, El-Osta, and Dewbre, 2006.) However, a greater consumption of leisure by the farm household may not translate into a lower agricultural supply because household labor may be substituted by hired labor (El-Osta, Mishra, and Ahearn, 2004). For this reason, we explicitly model hired labor jointly with household labor allocation.

Literature Review

El-Osta, Mishra, and Ahearn (2004) considered the impacts of the Agricultural Market Transition Act (AMTA)/Production Flexibility Contract (PFC) payments and other government payments on both farm and off-farm labor allocation. They did not include hired labor. They used a Tobit model with the independent variable being off-farm hours, an OLS model with the dependent variable being on-farm hours, and an additional OLS model with total work hours being the dependent variable. Several control variables were included and are similar to the ones in our study. In addition to the control variables in this paper, El-Osta, Mishra, and Ahearn (2004), control variables such as the unemployment rate and the employment in several sectors were included in their study. They used the same dataset as this paper but for the year 2001 while we look at the year 2003. They found that government payments tend to increase the hours operators work on their farm and decrease the hours they work off the farm. This conclusion was true for both the coupled and decoupled government payments. However, they remarked that these impacts on labor allocation are fairly small in magnitude.

Ahearn, El-Osta, and Dewbre (2006) only focused on off-farm labor participation. They examined if, and how the recent change (the inclusion in the 1996 Federal Agriculture Improvement and Reform Act, FAIR, of the Production Flexibility Contract, PFC, Payments that are supposed to be somewhat decoupled) in the nature of government farm programs had affected the off-farm labor participation of farm operators. They used a bivariate probit model with the dependent variable looking at both operator and spouse off-farm labor. They examined if this variable was impacted by transition Payments (AMTA or PFC), marketing loan or loan deficiency payments (LDP), conservation reserve program payments (CRP), and marketing loan assistance and all other payments. They also included unemployment information from the Census Bureau. They also used data from the Agricultural Resource Management Survey (1996 and 1999 Cost and Returns Report Survey.) They included several control variables and additional dataset such as commuting zones from the Bureau of Economic Analysis and the Bureau of Labor Statistics. Their conclusion was that both the coupled and decoupled payments have a negative effect on off-farm labor participation. Their data also show that despite the effect of government payments, there is a "continuation of the long-term trend toward greater reliance on off-farm work of farm household."

Data

For consistency and because of availability of the data, we used the same dataset as previous studies (El-Osta, Mishra, and Ahearn, 2004; Ahearn, El-Osta, and Dewbre, 2006). However, a more recent year, 2003, is used here. The data are from the 2003 Cost and Returns Report version of the Agricultural Resource Management Survey (ARMS) (ERS web site). Since its inception in 1996, the ARMS is USDA's primary vehicle for collecting farm data on a wide range of issues about resource use, costs, farm financial conditions, and agricultural production. The ARMS has many versions with the Cost and Returns Report version offering the most data for the estimation of production costs and returns of agricultural commodities, and household farm and off-farm incomes.

The sample used in the analysis considers only those farm households[1] with married couples, with the operator working on the farm, producing some corn or soybeans[2]. Furthermore, the data is restricted to the Heartland region. The Heartland region includes portions of South Dakota, Nebraska, Iowa, Missouri, Illinois, Indiana, Ohio, and Minnesota (http://www.nass.usda.gov/mn/agstat05/p007012.pdf.) After placing these restrictions, our working sample included 2017 farms. No auxiliary dataset was used.

Descriptive Statistics

Explanatory variables used in both models include personal characteristics, family indicators, farm attributes and a location control variable. Personal characteristics include age and education of the operators, this same information for operator's spouse was not available. Data on operator's education provides information on the highest level of schooling which we translate to years of education using a value of 10 if the operator has been to high school but has not completed high school, the value of 12 for completed high school, 14 for some college, 16 for completed four year degree, and 18 for graduate school[3]. Other household attributes include the number of persons living in the household in 2003, and the non farm net worth for the household. Farm attributes include the farm net worth, the farm organization (whether or not the farm business is organized as a sole proprietorship.) Net worth represents the household equity and is used as a measure of wealth. Government payments are combined into decoupled (direct payments, conservation payments such as CRP) and coupled payments (loan deficiency payments, marketing loan gains, etc.)

Table 1 includes the summary of the definitions of explanatory variables and their sample means and standard deviation. Table 1 also includes some additional variables: labor allocation, farm and total household income. We consider all these variables to be predetermined although it may be argued that some of them are determined simultaneously with the labor regimes. Consequently, one should be cautious when making causal interpretations of the results.

[1] Non-family farms are not included.
[2] Harvested acres for corn or soybean must be greater than 0.
[3] The attribution of numerical values to levels of education follows from quantifying the typical years of education represented in matriculation and is constructed to conserve degrees of freedom. As has been noted by some reviewers of this work, this is a highly imperfect method of handling education as an explanatory variable that should be corrected.

Table 1 indicates that operators on average work on the farm more hours than their spouses but less off farm than their spouses. The average age of the operator is fairly high (about 52 years.) On average, respondents have completed high school and may even have a higher level of education. Most farms are sole or family proprietorship. Most households have a little bit over three members and have an off farm wealth considerably lower than their on farm wealth. On average, respondents received over $16,000 in government payments, with almost ¾ coming from decoupled payments.

Multinomial Logit Model

The first model used in this paper is based on Benjamin and Kimhi (2006) who created a discrete-choice model for labor decisions of farm couples in France by using a multinomial logit model. As all operators work on the farm, our multinomial logit model has eight choices, including all the permutations of three binary decisions: the spouse works on the farm, either the operator or the spouse works off-farm or not, and whether or not the farm uses hired labor. Table 2 shows the distribution of households in the sample according to the 8 regimes. About 53% of the operators' spouses worked on the farm. About 73% of the farms had a family member working in an off-farm job. Finally, about 38% of the farms used hired labor.

Table 3 presents the mean for the entire sample and each of the regimes (t-test results are available upon request to the authors.) Table 3 also includes some additional variables: labor allocation, farm and total household income that are not included in the multinomial logit model. Most variables vary across regimes. The excluded labor regime is regime 0, in which neither the operator nor the spouse work off-farm, the spouse does not work on the farm, and no hired labor is employed on the farm. Each marginal effect effect we report therefore represents the effect of an explanatory variable on the probability of the farm family to choose a particular regime over the alternative to choose regime 0.

Empirical Results

The results from the multinomial logit estimation of regime choice are presented in table 4. The McFadden R squared for the estimation is 0.1213, a level of explanatory power consistent with other estimates using cross-section data. The excluded labor regime is regime 0 in which no household member works off the farm, the spouse does not work on the farm and there is no hired labor. Each coefficient therefore represents the effect of an explanatory variable on the tendency of the farm family to choose a particular regime over the alternative of regime 0. Alternatively, one can think of each coefficient as the difference between the coefficients of a particular explanatory variable in the linearized indirect utility functions of a particular regime and of regime 0.

One-tailed t-tests are used to evaluate whether coefficients significantly differ from zero. All explanatory variables have a statistically significant coefficient in at least one of the regression equations across regimes. Marginal effects are the partial derivatives of the event probability with respect to the independent variables of the model. These are reported in Table 5 and we note that there are far fewer marginal effects that are significantly different from zero, and all but one of these occur in the equation for regime five where the spouse does not work on the farm, no household member works off the farm, and the farm uses hired labor. This regime differs from the omitted case only in the use of hired labor so analyzing these results offers some insight into the effects of government payments on labor regimes of these households that rely exclusively on the farm business for their employment. Both of the government payment variables included in the regression indicate small increases in the probability of hiring labor as the level of government payments increase from either source. These effects are of the same magnitude and are likely indicative of the proclivity for farm households solely engaged in farming to use increased earnings to expand farm production or productivity.

In general the econometric results are disappointing in terms of significance of the results, but analysis of the marginal effects across regimes offers some insights into thinking about labor regime choices on farm households and what we might expect with improved results from better data. In only one case do the signs on the marginal effects between decoupled and coupled payments differ for the same regime equation. Regime six which differs from the omitted regime only in off-farm participation, indicates that decoupled payments increase the probability of off-farm work, while coupled payments decrease the probability. This is intuitive since decoupled programs do not depend on farm production and may even free the farm operator or spouse to pursue off-farm work with marginal time. Coupled payments on the other hand decrease the probability of off-farm work since receipt of the payments is oriented to the level of production.

Similarly, for a variable like household size, we see that in increased household size makes it more likely that the spouse works on the farm. The flexibility of farm work time and proximity to children drives the choice to adopt one of these labor regimes in cases where household size is large. Returning to the choice to include hired farm labor and the impact of government payments, we see that in regimes two and five both types of government payment levels tend to increase the choice of these regimes while in regimes four and seven the probability is reduced relative to the omitted regime. In comparing these cases, the key difference is whether a household member works off-farm or not. In regimes two and five which are more likely to be chosen with increased government payments, no one in the household works off the farm. The cases of regime four and seven have negative marginal effects and feature a household member working off-farm. Thus, we can consider government payments (of any form) related to farming to tend to reduce off-farm employment for farm households.

As the previous discussion indicates, the large number of regimes makes for cumbersome interpretations of the marginal effects. To facilitate this, we aggregate the effects as in Benjamin et al. (2006), computing the marginal effects of the three regime criteria (spouse works on the farm, household member works off-farm, farm uses hired labor) for each variable, by adding up the marginal effects on the four categories in which the relevant criteria obtains the value 1. These are reported in table 6 and discussed below.

The results reported in Table 6 for combined marginal impact are all quite small in magnitude. This is particularly true for variables of interest such as the relative impact of farm versus non-farm net-worth and the level of coupled and decoupled payments received by the household. Household characteristics such as the operator's age and education have larger marginal effects, but in some cases are difficult to interpret. For example, the effect negative linear term and positive quadratic term in age-squared for both cases of the spouse working on-farm and a household member working off-farm, indicate that spouse farm work and off-farm work decrease to some critical age of the operator at which point these forms of participation increase again. These results contradict typical expectations and likely result from the increased prevalence of multi-operator farm businesses. This increase in multi-operator farms and the intergenerational management of the farm is difficult to deal with in cross-section but should be addressed in further work.

As the number of members in the household increases, as expected, off farm work is more likely, and hired labor is less likely. We find that the operator's spouse is more likely to work on the farm. As discussed previously, these households likely forego off-farm work for the flexibility to match with the family needs. As expected, the higher the non farm net worth, the more likely the operator's spouse will not work on the farm, and nobody will work off the farm. We also find that hired labor is less likely since the wealth level is unrelated to the farm business. The impact of government payments contradict the expectations offered in the literature review. In sum, both coupled and decoupled payments decrease the likelihood for the spouse to work on the farm, and increase the likelihood that a household member works off the farm. The differing signs for hired labor are in accord with expectations. Decoupled payments should not affect production and may actually reduce it, which makes it less likely for the farm to hire labor. The opposite being true for coupled payments. However, we should note that these results are not significant and are combinations of several marginal effects.

Multivariate Probit Model

The disappointing results of the multinomial logit results lead us to try a second specification. The second model used in this paper is a multivariate probit following Kimhi (1994) who created a discrete-choice model for labor decisions of farm couples. Our allocation model includes three equations. The dependent variables are binary choices on spouse work on the farm, household member off-farm work, and the use of hired labor consistent with our prior specification.

While Benjamin and Kimhi (2006) argue effectively for the multinomial logit approach, the multivariate probit offers some advantages for this stage of our analysis. First, the multivariate probit model allows correlation between the residuals for the three choices, giving us a direct measure of cross-equation correlation Second, since our data favor combining off-farm work choices of both the spouse and operator into a single choice the multinomial regime model may be overly sensitive to this restriction since the combination reduces the regimes by one-half (from sixteen to eight). In comparison, we are just omitting one equation in the multivariate problem. Third, in light of the unexpected results of the multinomial model with the government payments variables, we feel compelled to test our dataset a second time with a different model.

The results of a three equation multivariate probit model are presented in Table 7. In comparison with the multinomial results, the results that change the most are the ones for the equation on hired labor. We discuss below only the results that are significant. Operator age and operator age squared do not have the expected effect on work off farm. This may suggest that early on, the farm owners need to work outside to finance the growth of the farm. As the farm and the operator ages, this becomes less needed and therefore less likely up to a certain age where it starts increasing again, maybe because the farm has reached a point where things are done more efficiently, less labor is needed and can be used on off farm activities. As the operators' education increases, somebody is more likely to work off the farm because of the increased off farm well paid job opportunities, and therefore labor is hired to compensate. These results confirm the uncombined multinomial results that are also significant.

Farms that are in sole proprietorship are more likely to have the spouse working on the farm and to hire labor, the latter is also found to be significant in the uncombined multinomial model. As household gets larger, somebody is more likely to work off the farm to support the large family. The combined multinomial results suggest this but are not significant. As the farm net worth increases, spouses are more likely to work on the farm, somebody is more likely to work off the farm (which was not expected), and hiring labor is more likely. More farm net worth may be an image of mature farms, where the operator may have on off-farm activities and delegate some of the responsibilities to the spouse and some labor to hired help.

Our results on government payment are insignificant. The results for spouse work on farm and hired labor confirm the results of earlier papers. The latter result is also found in the non combined multinomial results and is significant. Indeed, government payments should make the farming business more profitable (higher on farm wage), the spouse is more likely to be involved and labor can be hired as well to run better the business or grow it. However, we do find the same results as in the multinomial model for off farm work: both types of payments make it more likely for somebody to work off the farm but the coefficients have a small magnitude. This suggests that the increased hired labor and spouse on farm labor, liberates some time for somebody to have on off farm job.

The cross-equation correlation coefficients indicate that there is a significant relationship between decisions for the spouse to work on-farm and the use of hired labor. The positive sign suggests that spouse on farm work and hired labor are complementary (the presence of one increases the probability of the other),which is not consistent with a priori expectations.

Discussion and Conclusion

This study attempts to outline the role of operator's spouse in on farm labor, the relationships between use of hired labor and spouse's on farm labor, and the involvement in off farm job by estimating jointly spouse on farm work, off farm work, and hired labor decisions. In 2003, in our dataset, about 53% of the operators' spouses worked on the farm. About 73% of the farms had at least the operator or the operator's spouse working off the farm. Finally, about 38% of the farms used hired labor.

Our results are on average small in magnitude in both models. As the age of the operator increases, the farm is also more likely to hire labor, ceteris paribus, to compensate for the decreased physical performance of the operator (non combined multinomial result). The age of the operator has a convex effect on off-farm work suggesting that as the operator ages, off farm work becomes less needed to finance the growth off the farm up to a certain age when they start increasing their off farm activity again maybe because of farm labor efficiency gains (multivariate result). This same convex effect is found with spouse work on farm, suggesting that maybe spouse work on farm can be a substitute of operator work on farm if we assume that the operator is the one doing the off farm activity (non combined multinomial result). More education seems to be a proxy for better confidence and management of hired labor and opportunities for well paid off farm job, making the farm more likely to hire labor and have somebody with an off farm activity (non combined multinomial result and multivariate result. Farms that are in sole proprietorship are more likely to have the spouse working on the farm (multivariate result) and to hire labor (non combined multivariate and multinomial results) since there are not many owners/partners that can provide labor. As household gets larger, somebody is more likely to work off the farm to support the large family (multivariate result). As the farm net worth increases, spouses are more likely to work on the farm, somebody is more likely to work off the farm (which was not expected), and hiring labor is more likely (multivariate results). Both coupled and decoupled payments increase the chance to hire labor (non combined multinomial model) which is an extension to what previous studies have found.

This analysis represents a novel addition by estimating jointly spouse on farm labor, off farm labor, and hired labor. Most of the previous literature did not look at all of these three effects and were not looking at joint estimation. Future improvements to this work should focus on the issues highlighted in the discussion of results. Additional influences on the choice of labor regimes such as demand for leisure time, health benefits, and other consumption side issues represent important extensions that would improve explanatory power of the model.

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Table 1. Definitions, Means, and Standard Deviations of the Entire Sample

Variable	Description	Unit	Mean	Standard Deviation
OPHRS	Operator hours on farm	hours	2217.19	57.48
SPHRS	Spouse hours on farm	hours	443.81	13.11
OFFOPHRS	Operator hours off farm	hours	728.87	59.95
OFFSPHRS	Spouse hours off farm	hours	1091.31	29.75
HIRED	Hired labor expense	$	4858.15	464.39
AGE	Age of the operator	years	52.48	0.73
AGE^2	Age of the operator squared	years	2914.47	78.38
EDUC	Operator education	years	13.11	0.09
FARMORG	Organization: 1= Sole proprietor, 0=Not a sole proprietor	0/1	0.87	0.01
HH_SIZE	Household size	persons	3.22	0.06
NFNW	Non Farm Net Worth	$/1000	138.47	11.93
FNW	Farm Net Worth	$/1000	764.8	21.92
GP12	Decoupled Payments	$/1000	11.82	0.58
GP34	Coupled Payments	$/1000	4.59	0.30

Source: Agricultural Resource Management Survey (2003)

Table 2: Definitions and Frequencies of Labor Regimes

Regime	Spouse On-Farm	Household Off-Farm	Hired Labor	Frequency
0	no	no	no	10%
1	yes	no	no	6%
2	yes	no	yes	7%
3	yes	yes	no	22%
4	yes	yes	yes	17%
5	no	no	yes	3%
6	no	yes	no	24%
7	no	yes	yes	10%

Source: Agricultural Resource Management Survey (2003)

Table 3. Means of Key Variables across Regimes

	Regimes								
	all	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Operator hours on farm	2217.19	1968.72	2497.08	3136.41	1905.48	2574.55	2266.88	1844.84	2514.85
Spouse hours on farm	443.81	0.00	1409.47	1353.34	555.26	750.20	0.00	0.00	0.00
Operator hours off farm	728.87	0.00	0.00	0.00	1293.47	703.35	0.00	1087.26	634.29
Spouse hours off farm	1091.31	0.00	0.00	0.00	1451.69	1389.40	0.00	1533.69	1640.52
Hired labor expense	4858.15	0.00	0.00	19147.62	0.00	9618.25	19671.23	0.00	11049.64
Farm household income	29467.74	27693.97	19258.98	63219.78	18566.39	40836.96	43152.49	25268.45	23050.15
Total household income	73575.78	53573.16	35055.57	78003.26	65833.46	86369.89	63266.06	89267.25	75984.90
Age of the operator	52.48	62.84	61.58	54.73	47.70	50.76	64.57	49.63	51.35
Age of the operator squared	2914.47	4173.88	3920.32	3145.76	2404.00	2656.94	4430.39	2582.08	2752.78
Education of the operator	13.11	12.18	12.45	12.80	13.06	13.56	12.92	13.30	13.60
Farm organization	0.87	0.84	0.94	0.82	0.96	0.87	0.66	0.86	0.79
Household size	3.22	2.82	2.69	3.17	3.47	3.33	2.91	3.25	3.24
Non Farm Net Worth	138.47	133.29	170.60	163.45	88.82	150.12	204.22	154.27	135.68
Farm Net Worth	764.80	924.76	1024.74	1303.91	587.29	799.86	1093.87	543.92	786.50
Decoupled Payments	11.82	8.06	12.72	21.80	7.67	15.10	18.23	8.71	16.05
Coupled Payments	4.59	2.77	5.44	8.99	3.65	6.22	4.91	2.92	5.61

Source: Agricultural Resource Management Survey (2003)

Table 4. Multinomial Logit Estimates by Household Labor Regime

	Regime Estimates						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Age of the operator	***-0.2085***	0.0865	-0.0995	-0.0286	***0.1886***	***-0.3362***	0.0264
Age of the operator squared	***0.0024***	-0.0001	0.0012	0.0000	***-0.0019***	***0.0038***	-0.0005
Education of the operator	***-0.3426***	***-0.3064***	***-0.2522***	***-0.1096***	-0.0188	-0.1428	-0.0761
Farm organization	-0.1986	***1.3231***	0.4045	***1.4508***	***0.6054***	***-0.9334***	0.2283
Household size	0.1462	0.1080	0.1279	-0.0630	0.0197	***0.3875***	***-0.1158***
Non Farm Net Worth	0.0000	0.0005	0.0003	-0.0006	0.0004	0.0006	***0.0007***
Farm Net Worth	***0.0007***	***0.0004***	***0.0006***	-0.0001	0.0000	*0.0006*	***-0.0005***
Decoupled Payments	***-0.0382***	-0.0046	***0.0058***	***-0.0435***	-0.0029	0.0070	***-0.0315***
Coupled Payments	***-0.0338***	0.0067	0.0097	-0.0130	***0.0069***	-0.0139	***-0.0298***

Source: Authors' estimates. Highlighted results differ from zero at the ten percent confidence level.

Table 5. Multinomial Logit Marginal Effects by Household Labor Regime

	Regime Estimates						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Age of the operator	-0.0251	0.0040	-0.0070	0.0089	***0.0237***	-0.0185	0.0062
Age of the operator squared	0.0003	0.0000	0.0001	-0.0002	***-0.0002***	0.0002	-0.0001
Education of the operator	-0.0315	-0.0057	-0.0169	0.0123	***0.0135***	0.0006	***0.0062***
Farm organization	-0.1150	0.0346	0.0076	0.1839	***0.0260***	-0.0827	-0.0089
Household size	0.0161	0.0016	0.0117	0.0117	-0.0055	0.0207	-0.0137
Non Farm Net Worth	0.0000	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000
Farm Net Worth	0.0001	0.0000	0.0001	-0.0001	0.0000	0.0000	-0.0001
Decoupled Payments	-0.0035	0.0003	0.0042	-0.0040	***0.0009***	0.0014	-0.0011
Coupled Payments	-0.0044	0.0005	0.0035	-0.0002	***0.0013***	-0.0003	-0.0014

Source: Authors' estimates. Highlighted results differ from zero at the ten percent confidence level.

Table 6. Combined Marginal Effects for the Multinomial Logit Model

	Spouse: On-Farm	Household: Off-Farm	Hired Labor
Age of the operator	-0.01919	-0.01037	0.04279
Age squared	0.00021	0.00005	-0.00052
Operator Educ.	-0.04172	0.00227	0.02633
Farm organization	0.11112	0.09985	0.23562
Household size	0.04105	0.03042	-0.00594
Non Farm Net Worth	-0.00007	-0.00000	-0.00005
Farm Net Worth	0.00008	-0.00002	-0.00013
Decoupled Payments	-0.00305	0.00049	-0.00397
Coupled Payments	-0.00055	0.00155	0.00016

Source: Authors' estimates.

Table 7. Multivariate Probit Estimates

	Spouse: On-Farm		Household: Off-Farm		Hired Labor	
Age of the operator	0.0028		0.0009	***	0.0016	
Age squared	0.0000		0.0000	***	0.0000	
Operator Educ.	0.0008		0.0015	***	0.0015	*
Farm organization	0.0161	***	0.0312		0.0171	*
Household size	0.0029		0.0021	***	0.0031	
Non Farm Net Worth	0.0000		0.0000		0.0000	
Farm Net Worth	0.0000	***	0.0000	***	0.0000	**
Decoupled Payments	0.0000		0.0000		0.0004	
Coupled Payments	0.0001		0.0000		0.0001	
Rho.SPHRS1.OFFHRS1	0.0050					
Rho.SPHRS1.hired1	0.0027	***				
Rho.OFFHRS1.hired1	0.0031					

Source: Authors' estimates.

Notes:*, **, ***: statistically significant at the 10%, 5%, and 1% or lower level, respectively.