AGRICULTURAL PRODUCTIVITY AND OFF-FARM LABOR DECISIONS BY HEADS AND SPOUSES IN NICARAGUA: A SEMIPARAMETRIC ANALYSIS USING PANEL DATA

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1 Introduction

Lacking money to invest in their farms, and unable to produce enough income from agricultural activities to meet basic household needs, poor farmers are often forced to sell their labor in off-farm markets [35]. This income from off-farm employment can be a significant source of cash for purchased inputs and on-farm investments which can lead to improved yields and make farms more profitable [42,38,15]. For example, nonagricultural activities contribute up to 60% of total rural household income in Indonesia and Vietnam, and 50% in Nicaragua, the focus of this paper [52].

According to the World Bank, about 25% of adult females in rural areas worldwide work off-farm. Many societies that traditionally did not allow women to work off-farm are starting to liberalize this restriction [52]. The participation of women in labor markets is important and has a major role in agricultural development by enhancing their bargaining power and status, while improving the overall household's welfare [41]. Studies from the International Food Policy Research Institute [27] show that when female heads of households have the same level of education, experience, and farm inputs as men, their agricultural yields are 22% higher than those of their male counterparts. Moreover, it is widely recognized that women's education and their status within the household are key factors in reducing child malnutrition [27].

This paper investigates the participation of farm household heads and their spouses in nonfarm or off-farm activities in Nicaragua using a balanced panel data set for the years 1998, 2001, and 2005.[1] The literature covering nonfarm labor markets in less-developed countries is vast. There are two key features that distinguish this study from others: (1) the empirical strategy

[1] For this study, nonfarm and off-farm terms are used interchangeably to refer all labor activities except the ones which involve raising crops and livestock, fishing, and hunting.

addresses the well-known selectivity bias within a semiparametric approach and panel data; and (2) a special effort is made to analyze the marginal productivity MP_L (shadow wages) of on-farm labor activities separately for heads and spouses, following Jacoby [31] and Skoufias [48]. In our analysis, we quantify the impact of the on-farm MP_L on off-farm labor decisions.

Most studies in the literature that address off-farm work have focused on households in Africa and Asia; little attention has been given to Central America and to the use of panel data. Our goal is to further elucidate the relationship between agricultural activities and human capital, focusing specifically on farm household heads and their spouses in rural labor markets in Nicaragua. We make use of all three years (1998, 2001, and 2005) of the Nicaraguan Living Standard Measurement Surveys (LSMS), which to our knowledge has not yet been used in published studies. We find some evidence that in Nicaragua, development policies aimed at increasing agricultural productivity and empowering women can lead to poverty reduction more readily than urban-oriented policies, while also alleviating the pressure on natural resources.

The rest of this paper is organized as follows: section 2 reviews the literature to date, section 3 provides a brief description of the Nicaraguan rural sector and the data. Sections 4 and 5 present the econometric approach and the results, respectively, and we conclude with some reflections on the results.

2 Literature review

The literature covering nonfarm work in developing countries is quite rich, but there have been few detailed analyses differentiating labor decisions between heads of households and their spouses. Here we cover some of the major studies and findings related to this subject.

Studies of farmer participation in off-farm activities in rural Ghana, Uganda, and Zimbabwe suggest that not only do women earn less than men, but they also work more. In households where wives are more educated, their husbands have a higher probability of working in nonfarm activities. In addition, while off-farm labor is positively associated with population density and with higher education for males and females, it is negatively associated with age, land productivity, tenure security, and the cultivation of labor-intensive crops such as fruits and vegetables [1,11,32,37,38].

In China, rural social programs, which involve the economic and social participation of women through agricultural extension orientation, cultural activities and political meetings, increased the probability of female participation in the labor market [12]. This participation is positively correlated with women's education and household income, and negatively affected by family size. In Bulgaria, off-farm experience is positively associated with hours of nonfarm work for both men and women. Family size is also positively associated with off-farm work for men, but this association is negative for their wives. Bulgarian government subsidies granted to farmers seem to discourage off-farm labor for both husbands and wives [20].

There are few quantitative studies analyzing rural nonfarm income in Central America. Corral and Reardon [12] and Malchow-Moller and Svarer [36] examined rural nonfarm income in Nicaragua using only the 1998 LSMS data. They found that in areas with relatively high population density where households have access to electricity, water, and paved roads, 41% of farm household income comes from nonfarm activities. Younger and more educated individuals, as well as those who face land insecurity, are more likely to participate in off-farm labor than older, less educated individuals or farmers with secure title to their land .

The studies focusing on Central America provide useful insights but do not distinguish between the decisions made by heads of households and their spouses regarding their participation in off-farm labor. This study attempts to account for the factors that influence the decisions of both heads and their spouses to engage in off-farm employment and agricultural labor productivity.

3 The Nicaraguan Rural Sector and Data Used

After 43 years of military dictatorship by the Somoza Dynasty (1936–1979) and 10 years of civil war under the Sandinista political regime (1980–1990), the Nicaraguan rural sector exhibits a complex and challenging socioeconomic structure [26]. Approximately 43% of the total population of 5.8 million is rural, and 71% of the rural population lives as subsistence farmers, below the poverty line [17]. These farmers face distorted labor and credit markets and a highly unequal distribution of land ownership, and significant numbers are landless or nearly landless [19]. Most of Nicaragua's rural poor live in the vast dry central region, where natural resources are limited and the high population density has led to overexploitation of these resources [26].

As already indicated, the data used in this study are from the Living Standard Measurement Survey (LSMS), a nationwide household survey carried out mostly by the Nicaraguan Statistical Service (INIDE) with technical assistance from the World Bank for the years 1998, 2001, and 2005.[2] The LSMS covers a wide range of topics, such as household composition, health, education, income and expenditures, occupation, agricultural production, and credit and savings, and compiles the data at the national level. The Nicaraguan LSMS is very useful for research purposes, because it is designed to follow the same households and individuals over time.

In order to construct the data set used in this study the following criteria were used: (1) access to land (owned with or without title, borrowed, or rented) was not zero for at least two years of the survey; and (2) each household was represented by the same head and a spouse for all three years of the survey. Data for rural households that did not meet these criteria, along with a few outliers for land and income, were excluded. As a result, the final balanced panel for the study is made up by 559 households for each year, for a total of 1,677 observations. These 559 households represent 22%, 20%, and 14% of the total households—urban and rural—surveyed in 1998, 2001, and 2005, respectively. Table 1 shows the definitions for all variables used in the analysis, and Table 2 shows their means and standard deviations. All monetary values were converted from Córdoba (C$) to US real dollars (US$) using the official exchange rate deflated by the Consumer Price Index (CPI, 2005=100) for each year extracted from the World Development Indicators (WDI)[51].

The geographical distribution of the farmers in the data set is as follows: 50% in the Central region; 30% in the Pacífico region; 19% in the Atlántico region; and only 1% in the region of Managua. Overall, the annual per capita Total Value of Farm Output (TVFO) generated from crop and livestock sales was low, but it rose from US $60 in 1998 to US $115 in 2005 (in real 2005 US dollars). The average land holding per capita was also low—2.7 manzanas (1.9 ha)—and did not vary significantly over the three years. During the 1998–2005 period, only 40% of the households in the data set held legal title to the land they farmed; 15% had access to credit and 26% to technical training. Also, around 85% (not shown) of husbands and spouses were

[2] The data can be accessed at no cost at: www.worldbank.org/lsms. We are grateful to the World Bank and the Instituto Nacional de Información de Desarollo (INIDE) (www.inide.gob.ni) in Nicaragua for making this data available.

self-employed, working without remuneration on their own land,[3] and concentrated their agricultural production on temporary crops, mostly maize, beans, sorghum, potatoes, and cassava. The cultivation of permanent crops such as mangoes, citrus fruits, bananas and coffee was also very common, and the sale of livestock was also an important contributor to farm income.

Both heads and spouses were relatively young (in their forties and thirties, respectively), and the level of education for both was generally low (3.3 years of schooling on average).[4] From 1998 to 2005 the participation of heads (95% are men) in off-farm activities (wage labor or self-employment) decreased from 14% to 11%, while the participation of their spouses increased from 13% to 19%. The yearly average contribution from nonfarm activities to total household income—38%— is substantial.[5] Our proxy for market wages (off-farm earnings) shows that if heads were making between US $20 and US $30 per week, their spouses did not make more than US $16 per week. For both men and women, the number of hours worked (off-farm) ranged from 38 to 54. Notice that the difference between worked hours for women and men is not large, but there is a higher discrepancy in wage rates. This may reflect the fact that women are often self-employed in low-wage activities, while men are employed more in the formal wage market [13].

4 Econometric Strategy

The econometric strategy followed in this paper consists of estimating separate off-farm labor supply equations for the head of household and the spouse. If the opportunity cost or reservation wage of working on the farm is greater than the real market wage that a person could earn off the farm, then it is expected that no labor would be supplied outside of the farm [1]. If the supply equations are estimated excluding those individuals that do not participate in the off-farm labor market and using Ordinary Least Squares (OLS) only on those who participate, then one would expect biased estimates because of self selection [22]. To correct for this selectivity bias problem,

[3] The rest are farmers who own land but are working as employees, whether formal or informal, on other farms.

[4] The LSMS asks for level of education according to categories such as no school, preschool, primary, secondary, technical school, and university. To convert these categories to years of schooling, we followed the grading scale used by Corral and Readon [13].

[5] The LSMSs collect detailed labor information for all individuals over five years old who had one or two jobs for the week before the survey. Out of 1,677 observations in our sample only 0.95% of heads and 1.2% of spouses had two off-farm jobs and 2% of heads and 0.35% of spouses had an agricultural job as primary and an off-farm job as secondary activity (for methodological details about the surveys see Basic Information Document [6]; Ficha Tecnica [18]; Informe de Metodologia y Operaciones [30]).

Tobit or Heckman procedures have been widely used to estimate labor supply models, particularly when cross-sectional data are used [9]. These methods are also likely to provide biased results if inadequate or weak instruments are used to isolate unobserved factors such as individual ability. However, if panel data are available, as in our case, and assuming that ability (e.g., managerial skills, motivation) is time-invariant, then it has been shown that traditional fixed-effects estimates can properly account for such unobserved heterogeneity [4].

In this paper we apply the approach proposed by Kyriazidou [25], who developed a panel data estimator that corrects for selectivity bias and also controls for other sources of bias that arise from time-invariant unobserved individual characteristics. Thus, consider the following econometric model:

$$y_{it} = d_{it} \cdot y_{it}^{*} = d_{it} \cdot (x_{it}^{*}\beta + \alpha_{i}^{*} + \varepsilon_{it}^{*}) = x_{it}\beta + \alpha_{i} + \varepsilon_{it}; \quad \mathrm{i} = 1,...,\mathrm{n}; \mathrm{t} = 1,...\mathrm{T}. \tag{6}$$

and

$$d_{it} = 1\{w_{it}\gamma + \eta_{i} + u_{it} \geq 0\}; \quad \mathrm{i} = 1,...,\mathrm{n}; \mathrm{t} = 1,...,\mathrm{T}. \tag{7}$$

where y_{it}^{*} is off-farm hours of labor supplied by individual i in period t; x_{it}^{*} is a vector of explanatory variables (e.g., individual and farm household characteristics); α_{it}^{*} is the time-invariant individual component; and ε_{it} is the residual term. Selectivity bias occurs because the latent term y_{it}^{*} in the participation equation (6) is observable only when the indicator variable $d_{it} \geq 0$, i.e., if a farm member is engaged only in nonfarm activities (equation 7). As in the two-step Heckman procedure, the vector of explanatory variables w_{it} in the selection equation (7) can be similar to or different from x_{it}^{*} [25]. The η_{it} variable is also a time-invariant individual component, and u_{it} is the residual term. The Greek letters in equations (6) and (7) are the parameters to be estimated. Following the traditional fixed-effects approach, the time-invariant individual components α_{i}^{*} and η_{i} and the error terms ε_{it} and u_{it} are allowed to be correlated with x_{it}^{*} and w_{it}, respectively.

Relying on the fixed-effects approach for panel data, the strategy is to estimate the supply of hours of off-farm labor (equation 6) by time-differencing pairs of observations where $d_{it} = d_{is} =$

1 for t≠s.[6] This method gets rid of the individual component α_i^* but not of the bias from sample selection. To account for the latter, consider a vector $\zeta_i = (w_{it}, w_{is}, x_{it}^*, x_{is}^*, \alpha_i, \eta_i)$ that includes all explanatory variables (observed and unobserved) from equations (7) and (8). Kyriazidou emphasizes that it is not necessary to assume that the conditional expectation $E(\varepsilon_{it}^* \mid d_{it}=1, d_{is}=1, \zeta_i)=0$ or that $E(\varepsilon_{it}^* \mid d_{it}=1, d_{is}=1, \zeta_i) = E(\varepsilon_{is}^* \mid d_{it}=1, d_{is}=1, \zeta_i)$. As a result, if both of these conditions do not hold, then for each time period the individual sample selection affecting λ_i depends on the vector ζ_i and on the joint conditional distribution of the error terms $(\varepsilon_{it}^*, u_{it}, u_{is})$. The sample selection effect can then be stated as:

$$\begin{aligned}\lambda_i &= E(\varepsilon_{it}^* \mid d_{it}=1, d_{is}=1, \zeta_i)\\ &= E(\varepsilon_{it}^* \mid u_{it} \le w_{it}\gamma + \eta_i, u_{is} \le w_{is}\gamma + \eta_i, \zeta_i)\\ &= \Lambda(w_{it}\gamma + \eta_i, w_{is}\gamma + \eta_i; F_{it}(\varepsilon_{it}^*, u_{it}, u_{is} \mid \zeta_i))\\ &= \Lambda_{it}(w_{it}\gamma + \eta_i, w_{is}\gamma + \eta_i, \zeta_i)\end{aligned} \qquad (8)$$

where Λ(•) is an unknown function and F(•) is an unknown joint conditional distribution. The sample selection term λ is now incorporated in expression (6) such that:

$$y_{it} = x_{it}\beta + \alpha_i + \lambda_{it} + v_{it} \qquad (9)$$

where v_{it} is a new error term that satisfies the condition $E(v_{it} \mid d_{it}=1, d_{is}=1, \zeta_i)=0$. The major feature of the Kyriazidou estimator is that for a given individual, the sample selection term in equation (9) will be the same in both periods (time-invariant) only if $w_{it}\gamma = w_{is}\gamma$. If this condition is satisfied, and assuming that the error terms $(\varepsilon_{it}^*, \varepsilon_{is}^*, u_{it}, u_{is})$ and $(\varepsilon_{is}^*, \varepsilon_{it}^*, u_{is}, u_{it})$ are identically distributed conditionally on the vector ζ_i, then $\lambda_{it} = \lambda_{is}$.[7] However, in applied work those pairs of observations— $w_{it}\hat{\gamma}_n$ and $w_{is}\hat{\gamma}_n$ in (7)—are not exactly equal. Thus, to implement the estimator, Kyriazidou suggests a two-step estimation procedure as follows:

Step 1. Get estimates for γ by using a conditional fixed-effects Logit model [3,14]; and

Step 2. Use the $\hat{\gamma}$ estimates to construct kernel weights, and estimate β in (6) by the traditional weighted ordinary least squares (WLS) method.

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6 We have a three-year panel, so the maximum number of differences is three.

7 For more details about this assumption and proofs, see Kyriazidou [25].

Thus, the Kyriazidou estimator (K) is given by:

$$\hat{\beta} = \left[\sum_{i=1}^{n} \hat{\varphi}_{in} (x_{it} - x_{is})'(x_{it} - x_{is}) d_{it} d_{is} \right]^{-1} \left[\sum_{i=n}^{n} \hat{\varphi}_{in} (x_{it} - x_{is})'(y_{it} - y_{is}) d_{it} d_{is} \right] \quad (10)$$

where

$$\hat{\varphi}_{in} = \frac{1}{b_n} \kappa \left(\frac{(w_{it} - w_{is})\hat{\gamma}_n}{b_n} \right) \quad \text{and}$$

where $\hat{\varphi}_{in}$ is a kernel weight that declines to zero as the difference $| w_{it}\gamma_n - w_{is}\gamma_n |$ increases, and b_n is the bandwidth that tends to zero as n→∞.

The Kyriazidou estimator assumes strict exogeneity of the explanatory variables, which might be a strong assumption. Charlier et al. [14] modified the Kyriazidou estimator for instances when endogeneity might be present giving rise to the Kyriazidou instrumental variable (K-IV) estimator, which is given by:

$$\hat{\beta} = \left[\sum_{i=1}^{n} \hat{\varphi}_{in} (\tilde{x}_{it} - \tilde{x}_{is})'(x_{it} - x_{is}) d_{it} d_{is} \right]^{-1} \left[\sum_{i=n}^{n} \hat{\varphi}_{in} (\tilde{x}_{it} - \tilde{x}_{is})'(y_{it} - y_{is}) d_{it} d_{is} \right] \quad (11)$$

where $\tilde{x} = (z_{it} - z_{is})$ is a vector of instruments.

To avoid problems of identification due to the nonparametric nature of the estimator, at least one variable in the selection equation (7) should be drawn from the participation equation (6) and from the vector of instruments [16,3].

5 Model Implementation and Results

5.1 Shadow Wages and Shadow Income

To estimate the off-farm labor supply, following our objectives, it is first necessary to derive shadow wages and shadow income for the farms. For this purpose, a Cobb-Douglas production function for the farm panel data set is estimated using the fixed-effects approach. As mentioned before, the main analytical advantage of the fixed effects method is to isolate some characteristics that are assumed to be time-invariant (e.g., managerial ability, soil characteristics) and that are also allowed to be correlated with the explanatory variables (e.g., education, input use) in the model.[8] The specification of the production function using Total Value of Farm Output (TVFO) as the dependent variable is:

TVFO = f(*LNLAND, LNPINPUTS, LNHLABOR, LNHRonHD, LNHRonSP, CREDIT, TITLE, TRAINING, RENTLAN, SONFARM5-15, SONFARM15-22, SONFARM22-31,DON_FARM5-15,DON_FARM15-22, DON_FARM22-31*, YEAR2, YEAR3) + *ERROR TERM* (12)

where all variables are defined in Table 1. Since the continuous variables are in logarithms, and to facilitate the computations, a 1 is added when 0 values are present.

The results of the fixed effect estimates as well as a simple pooled OLS estimation are displayed in Table 3.[9] Overall, both sets of estimates produced similar results, and the F statistic is significant at the 1% level in both cases; thus, the null hypothesis that all slope coefficients are equal to zero is rejected. A Hausman test was also performed between the fixed-effects and random effects specification (not shown) which favors the former at the 10% level.

The main results indicate that on-farm labor of the head (LNHRonHD) has a larger effect on agricultural production than that of the spouse (LNHRonSP). However, women might be allocating much of their time to domestic activities (e.g., cooking, cleaning, childcare) that are not included in the production function. Consequently, we should keep in mind that the estimates for the marginal agricultural productivity of women might be biased downwards. The parameters for other inputs used to explain the TVFO, such as LNLAND, LNPINPUTS, LNHLABOR, TITLE, TRAINING, and RENTLAND, show the expected signs, with statistically significant and positive coefficients. Like Jacoby [31] and Skoufias [48], we found the contribution of child labor of sons (SONFARM5-15) is not statistically significant.[10] However, households with at least one son between the ages of 15 and 22 (SONFARM15–22) exhibit a positive and significant effect on increase in TVFO. On the other hand, the on-farm labor of daughters between the ages of 5 and 15 (DONFARM5-15) has a negative effect on the TVFO, and its coefficient is significant in both fixed effects and pooled specifications.

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[8] López and Valdez [35] found no impact of levels of education on farm output for Honduras and El Salvador. They suggest that the major agricultural activities in Central America are operated under lower levels of technology and limited skills; consequently, additional schooling does not contribute much to higher levels of output.

[9] The within transformation is used to estimate the OLS fixed effects model [2].

[10] The minimum age for legal employment is typically fifteen years [7, 29].

From the estimates of the fixed effects model, the shadow wage for the head (HD) and spouse (SP) and the agricultural shadow income of households are calculated using the following expressions extracted from Jacoby [31] and Skoufias [48]:

A) **Agricultural Shadow Wage**: $\hat{W}_m = \hat{\beta}_{Houron_m}\left(\frac{TVFO}{Houron_m}\right)$ For m = HD,SP (13)

B) **Agricultural Shadow Income**: $\hat{I} = \widehat{TVFO} - \widehat{W}_{HD}(HRonHD) - \widehat{W}_{SP}(HRonSP) - \beta_{inputs}(inputs) - \beta_{Hiredlabor}(Hired)$ (14)

where the βs are the coefficients for the model in (12) and $\widehat{TVFO}$ is the predicted value of output for the i^{th} farm in the t^{th} time period. The use of predicted $\widehat{TVFO}$ instead of observed TVFO is based on the hypothesis that farmers face uncertainty primarily due to weather conditions [34].

5.2 Selection Equations and Kernel Weights

Before moving to the heart of the analysis, we needed to test if off-farm labor supply decisions between the heads of household and their spouses are jointly determined [1, 24]. In such cases, a bivariate Probit or Logit model provides estimates for the correlation between errors from the heads and spouses equations (rho). Here, four bivariate Probits were estimated, one for the three-year pooled set and then one for each year of the three survey years (1998, 2001, and 2005) separately.[11] The hypothesis that rho = 0 was not rejected for the four models; consequently, univariate Probit or Logit models were judged to be appropriate [24] and we proceeded to estimate individual selection and participation equations for heads of households and their spouses.[12]

Table 4 reports the results for the conditional fixed-effects Logit approach. For comparative purposes, the results of pooled Logit models are also shown. The dependent variable is equal to one if the individual worked off-farm in any of the three years surveyed and zero if

[11] The specification for the heads and spouses bivariate equation followed the same specification used for the pooled Logit presented in Table 5. Results are available upon request.

[12] Although the use of univariate dichotomous models simplifies the analysis, the hypothesis that heads' and spouses' decisions are made independently might not be realistic. This evidence in the literature is mixed. Abdulai and Delgado [1], and McCarthy and Sun [38] analyzed farmers in Ghana and rejected the null hypothesis that rho = 0; however, Huffman and Lange [24], analyzing U.S. farmers, and Matsche and Young [37], analyzing Zimbabwean farmers, did not reject this hypothesis.

he/she did not. In the fixed-effects Logit procedure, it should be clarified that only individuals who switched between working off-farm and not working off-farm are used in the estimation [4]. The results show that the coefficients for both methods—fixed effects and pooled—are similar, with the expected signs; however, more robust estimates are obtained from the pooled Logit estimation. This may reflect the fact that only 369 heads and 393 spouses switched their work status over the three years and were thus included in the fixed-effects Logit.

Our results corroborate the findings reported by Corral and Reardon [13] and Malchow-Moller and Svarer [36] for Nicaragua. We conclude that education and age play an important role in individuals' participation in nonfarm activities. More educated heads and spouses have a higher probability of pursuing nonfarm activities. The age and education effects are also somewhat correlated between partners. For example, as the education of the wife increases, the probability of her husband working off-farm becomes positive and significant. As heads get older, the participation of their spouses in nonfarm work decreases.

Land titling is an important issue in Nicaragua and thus is included in the analysis. The coefficient for this variable is negative in all four estimated equations but it is significant only in the pooled Logit for heads. As land security increases, the probability of working off-farm decreases for both partners. Malchow-Moller and Svarer [36], using instrumental variables for titling, report similar results for Nicaragua, and they argue that property rights not only create more incentives for on-farm investments but also absorb labor.

The coefficient for land farmed, although negative, as expected, is not statistically significant. The marginal effect of livestock ownership on nonfarm activities is small but has a significant and positive impact on nonfarm participation for spouses. Also, if any of the household members belong to local associations, the spouse has a higher probability of working off-farm. For the head, the parameter for this variable is not significant but has a negative sign. Finally, our measure of average efficiency (Agricultural and Livestock Sales divided by total expenditure on crop and livestock inputs, following Mishra and Goodwin [40]) suggests that as farm efficiency increases, the probability that heads and spouses will pursue nonfarm activities decreases.

As household size increases, the probability of heads and spouses working off-farm increases; but as long as there are children under five years of age in the household, it is less likely that heads will engage in nonfarm activities. For spouses, this variable is not statistically significant. Remittances of any origin are an important source of nonlabor income for Nicaragua and are considered here. The sign of this coefficient is negative, as expected, but it is not statistically significant.

The Nicaraguan rural sector is densely populated, with more than six individuals per household on average. We tried to capture how teenagers and adult children—males and females—who are living in the household and are also working either in on-farm or off-activities—might affect their parents' decisions to work in the off-farm market. The results are mixed and should be interpreted with caution because of potential endogeneity between the decisions of sons and daughters and those of their parents, an issue that is beyond the scope of this analysis.[13] The estimates suggest that for households that have at least one son between 5 and 31 years old working on-farm, there is a lower probability that the head of the household will work in nonfarm activities. On the other hand, if one son in this age bracket is working off-farm, then it is more likely that his parents will also work off-farm. Similar results were observed for the coefficients for daughters.

The next step is to calculate the kernel density weights required for the Kyriazidou estimator. These weights are calculated from the estimates of the conditional Logit fixed effects model for both the head and spouse equations. A Gaussian kernel was used and the choice of the bandwidth (.07 for the husband equation and .08 for the wife equation) is based on Silverman's Gaussian kernel rule [46]. Kyriazidou [25], Dustmann and Rochina-Barrachina [16], and Charlier et al. [14] used the plug-in procedure proposed by Horowitz [23]; however, as is the case with the findings reported by Askildsen et al. [3], the use of different bandwidths in our analysis had almost no effect on the final estimates.

5.3 Participation Equations

To avoid the simultaneity between labor supply and market wages, we used the instrumental variable (IV) approach calculated in a two-stage weighted least squares (2WLS) procedure [9]. First, the wage equations are estimated separately for heads and spouses, using the same Kyriazidou (K) estimator showed in equation (10). Then, off-farm labor supply equations are

[13] Similarly, for India, Skoufias [47] did not analyze work joint decisions among household members, and he also estimated separate functions for time allocated to market work, home production, school and leisure for male and female adults, and boys and girls.

estimated using the predicted wages generated from the first step and with market wages. The results for the wage equations for both head and spouse are given in Table 5. Education, experience—calculated as age minus years of schooling minus six [39]— and land were chosen as instruments. In both head and spouse functions, the coefficients for education and experience have the expected signs and are significant at the 10% level. Education is more important for the head, while experience is more relevant for spouses. The coefficient for land is positive and significant for heads, which might suggest that larger landowners might be exerting market power in determining nonfarm wages [1]. A Wu-Hausman test performed individually and jointly confirms that market wages for heads and spouses are indeed endogenous. The Sargan test for overidentifying restrictions [10] is also performed individually and jointly, and it confirms that the instruments employed are valid.

Table 6 reports the results for the off-farm labor supply equations, estimated separately for the heads of households (columns 2 and 4) and their spouses (columns 6 and 8) using the Kyriazidou estimator adjusting for endogeneity (K-IV) and without adjusting for the endogeneity (K). The dependent variable is the logarithm of weekly hours worked off-farm regressed on head and spouse characteristics plus farm characteristics and a set of control variables for sons and daughters working on- or off-farm. Overall, the F statistic is significant for each of the four models estimated at the 5% level or lower. A Hausman-type test (last row of Table 6) comparing the kernel weighted regression with the same regression without weights did not reject the null hypothesis of no selectivity for the four estimated equations.

Two of the main coefficients of interest—shadow wages and shadow income—exhibit the expected signs and are significant at the 5% and 1% levels, respectively.[14] The estimates clearly suggest that the impact of own-shadow wage is higher for the spouse than for the head. The negative signs for these coefficients imply that both the head and spouse allocate less labor to nonfarm activities as the opportunity cost for agricultural work goes up. The cross-shadow wage effect also suggests that when the shadow wage of the spouse goes up, heads reduce the hours worked off-farm. Similarly, for both equations estimated for spouses (K and K-IV), although the shadow wage for the head is negative, the coefficients are not statistically significant. Holding

[14] Jacoby [31] proposes a test for the validity of the perfect market assumption using shadow and market wages. The procedure is to regress $W_{shadowages} = \alpha + \beta W_{market} + \varepsilon$ and test the null hypothesis Ho: $\alpha = 0$ and $\beta=1$. We strongly rejected H_0, i.e., that the opportunity costs of heads of households and spouses are equal to their off-farm market wages. The results of this test are displayed in Table 7.

everything else constant, when shadow income goes up, heads work less in off-farm activities. In the equations for spouses, these coefficients are negative but not significant.

The shadow wage and shadow income approach to explain labor supply has been widely used and has produced mixed results. Jacoby [31], Skoufias [48], Barrett et al. [5], and Le [34] have all regressed hours of labor by aggregating on-farm, off-farm, and housework activities. Here we used observations for farmers who allocated hours to either on-farm or off-farm. It should be kept in mind that if either the head or the spouse or both worked off-farm continuously for the three years surveyed, then this implies that their household's agricultural MP_L is zero. In our sample, however, only two such cases were observed; and these observations were not discarded because their family shadow income was positive.

As described before, weekly earnings were used as a proxy for market wages taken as exogenous (K estimator) and endogenous (K-IV estimator) for both heads and spouses. For the heads, the coefficients for own-wage and cross-wage effects produced mixed results. The first result (column 2 in Table 6), which assumes that market wages are exogenous, suggests that when the off-farm wage of the household head increases, hours dedicated to off-farm labor also increase. On the other hand, under the instrumental variable method, the results suggest a backward-bending labor supply behavior for heads: if wages rise beyond a certain point, heads work less implying that the income effect dominates the substitution effect [44]. This backward bend occurs if the spouse's wages increase beyond a certain point, as well. For the spouse equations, the own-wage effect was positive but this parameter was significant only for the K estimator. The cross-wage effect was positive only for the K-IV estimator, suggesting that as the wage of heads increases, spouses increase their off-farm labor supply. Skoufias [47] found that in India, when male wages increase, there is a reduction of hours worked both in the market and at home, while hours allocated to leisure go up. On the other hand, as female wages increase, work at both the market and the home rises while leisure time goes down.

The educational level of spouses seems to have a positive and significant effect on total hours of off-farm work by heads of households, but the head's education does not have any effect on the spouse's off-farm work hours. In all four models estimated, age increases off-farm labor supply at a decreasing rate, as expected. In addition, livestock ownership, remittances, and the presence of children under five years old in the household are negatively correlated with off-farm work. More robust results for these variables were obtained under the IV estimation but only for the head equation.

A large set of control variables was used to verify how female and male teenagers and adult children who work on- or off-farm might affect the off-farm labor of heads and their spouses. The results for the head and spouse equations, instrumented or not, show that the estimates do not differ substantially; nevertheless, more robust results are observed for the K-IV estimation for heads. Overall, the signs of the coefficients are quite similar to those obtained in the selection equation.

In summary, if the household has at least one son or daughter between the ages of 5 and 31 working on-farm, the head of household works less in nonfarm activities. However, if there is at least one daughter between the ages of 15 and 22 working on-farm, the head of household will work more off-farm. Interestingly, the spouse equation captures more of the influence of children working if they are female. Again, these results should be interpreted with caution because as with the selection equations, simultaneity regarding to labor decisions between heads and spouses with their children was not considered, an issue left for future analysis.

6 Concluding Remarks

This paper contributes to the literature by focusing on off-farm labor supply in the rural sector of Nicaragua using panel data to undertake separate analyses for the household head and the spouse. For this purpose, we refined the empirical approach introduced by Jacoby [31] and Skoufias [48] to estimate shadow wages and shadow income. We also applied a semiparametric approach specific to panel data which eliminates biases not only from some of the key individual and farm time-invariant characteristics but also from sample selection. The sample selection problem is a key concern in the labor supply literature and thus needs to be carefully handled in applied wok.

Our main findings suggest that the shadow wages and shadow income of household heads and their spouses play a major role in the supply of labor to nonfarm activities. Specifically, when the marginal productivity of on farm agricultural work goes up, there is a reduction of hours allocated to nonfarm activities. This result lends support to the hypothesis that policy efforts designed to increase farm productivity and output growth among peasant farmers maybe more effective in alleviating rural poverty than urban-oriented development strategies. Although this hypothesis deserves further investigation, it might provide some evidence for the old idea formalized by Johnston and Mellor [33] that agricultural productivity growth is an essential component of any development strategy [52]. Moreover, within this strategy, recently there is increasing pressure on multilateral organizations as well as private foundations to provide more assistance to developing country agriculture particularly as we witness growing challenges in meeting the Millennium Development Goals [50].

Like other researchers in the field, we also found that education, age, remittances, household size, and sons and daughters working are related to off-farm labor supply, with significant differences between their effects on heads and spouses. Finally, we find that in a densely populated rural sector located in highly degraded areas, as is the case in Nicaragua and much of Central America, public support based on investments for agricultural research and extension should be seen as a means not only to promote productivity growth and poverty alleviation but also as a means to develop more environmentally sustainable production processes to improve the quality of life and livelihood for rural communities [43].

Table 1 Variable Definitions

Farm Characteristics	
TVFO	Total value of farm output (crop and livestock sales) in dollars/year
LAND	Owned and rented land in manzanas
RENTLAND	1 if household rents land
TITLE	1 if the household has legal title to at least some of the land farmed
LIVT_ASSET	Livestock assets in dollars/year
PINPUTS	Total expenditure variable inputs in dollars/year (seeds, fertilizers, etc.)
HLABOR	Total expenditure on hired labor in dollars/year
CREDIT	1 if household receives credit for farm production
TRAINING	1 if household receives technical assistance
ORGANIZA	1 if household participates in farmer organizations
EFFICIENCY[a]	Agricultural and livestock Sales divided by total crop and livestock variable inputs
Household Characteristics	
HHSIZE	Number of household members
CHILD =< 5	1 if household has at least one child less than 5 years old
REMITTANCES	Remittances in dollars/year
Head and Spouse Characteristics	
Head	
AGEHD	Age
EDUCHD	Years of schooling
OFFHD	1 if works off-farm
WGoffHD	Weekly off farm wage in dollars
HRoffHD	Weekly hours worked off farm in dollars
HRonHD	Weekly hours worked on farm in dollars
Spouse	
AGESP	Age
EDUCSP	Years of schooling
OFFSP	1 if works off-farm
WGoffSP	Weekly off farm wage in dollars
HRoffSP	Weekly hours worked off farm in dollars
HRonSP	Weekly hours worked on farm in dollars
Young and Adult Children Working	
Son	
SonFARM 5 - 15	1 if at least one male child between 6 and 14 years old is working on farm
SonFARM 15 - 22	1 if at least one male child between 15 and 21 years old is working on farm
SonFARM 22 - 31	1 if at least one male child between 22 and 31 years old is working on farm
SoffFARM 5 - 15	1 if at least one male child between 6 and 14 years old is working off farm
SoffFARM 15 - 22	1 if at least one male child between 15 and 21 years old is working off farm
SoffFARM 22 - 31	1 if at least one male child between 22 and 31 years old is working off farm
Daughter	
DonFARM 5 - 15	1 if at least one female child between 6 and 14 years old is working on farm
DonFARM 15 - 22	1 if at least one female child between 15 and 21 years old is working on farm
DonFARM 22 - 31	1 if at least one female child between 22 and 31 years old is working on farm
DoffFARM 5 - 15	1 if at least one female child between 6 and 14 years old is working off farm
DoffFARM 15 - 22	1 if at least one female child between 15 and 21 years old is working off farm
DoffFARM 22 - 31	1 if at least one female child between 22 and 31 years old is working off farm
Geographic Characteristics	
MANAGUA	1 if resides in Managua region
PACIFICO	1 if resides in Pacífico region
CENTRAL	1 if resides in Central region
ATLANTICO	1 if resides in Atlántico region

[a] Indicator based on Mishra and Goodwin [47]

Table 2 Sample Statistics: Means and Standard Deviations by Year

	1998		2001		2005	
Farm Characteristics	Means	SD	Means	SD	Means	SD
TVFO[a]	60.03	194.93	82.39	415.97	115.48	241.85
LAND[a]	2.79	7.86	2.77	9.57	2.68	6.24
RENTLAND[a]	0.01	0.08	0.35	0.48	0.39	0.49
PINPUTS[a]	8.32	18.308	15.47	37.79	12.86	28.92
HLABOR[a]	3.44	20.81	0.299	2.26	0.50	1.86
LIVT_ASSET[a]	110.65	495.64	140.81	528.99	228.28	679.52
TITLE	0.40	0.49	0.43	0.49	0.47	0.50
CREDIT	0.17	0.38	0.10	0.30	0.26	0.44
TRAINING	0.15	0.35	0.12	0.32	0.06	0.24
ORGANIZA	0.07	0.25	0.06	0.24	0.26	0.44
EFFICIENCY	7.77	67.99	7.79	22.12	12.19	24.48
Household Characteristics						
HHSIZE	6.48	2.98	6.53	2.84	6.41	2.81
CHILD5 =<5	0.72	0.45	0.60	0.49	0.50	0.50
REMITTANCES[a]	1.83	9.25	13.63	51.24	2.38	7.57
Young and Adult Children Working						
Son						
SonFARM 5 - 15	0.28	0.45	0.17	0.38	0.15	0.36
SonFARM 15 - 22	0.19	0.39	0.28	0.45	0.30	0.46
SonFARM 22 - 31	0.09	0.28	0.11	0.32	0.14	0.34
SoffFARM 5 - 15	0.08	0.27	0.01	0.08	0.01	0.11
SoffFARM 15 - 22	0.05	0.22	0.04	0.19	0.03	0.16
SoffFARM 22 - 31	0.03	0.16	0.03	0.17	0.03	0.17
Daughter						
DonFARM 5 - 15	0.28	0.45	0.01	0.12	0.02	0.13
DonFARM 15 - 22	0.12	0.33	0.02	0.15	0.02	0.15
DonFARM 22 - 31	0.05	0.21	0.01	0.08	0.01	0.07
DoffFARM 5 - 15	0.08	0.27	0.01	0.11	0.01	0.12
DoffFARM 15 - 22	0.05	0.21	0.04	0.19	0.04	0.20
DoffFARM 22 - 31	0.02	0.15	0.05	0.21	0.04	0.20
Geographic Characteristics						
MANAGUA	0.01	0.12	0.01	0.12	0.02	0.13
PACIFICO	0.30	0.46	0.30	0.46	0.30	0.46
CENTRAL	0.50	0.50	0.50	0.50	0.50	0.50
ATLANTICO	0.19	0.39	0.19	0.39	0.19	0.39
Head Characteristics						
AGEHD	43.64	14.79	46.34	14.72	49.34	14.60
EDUCHD	3.30	3.40	3.47	3.40	3.48	3.59
OFFHD	0.14	0.35	0.13	0.34	0.11	0.31
WGoffHD	17.77	16.51	24.39	16.57	32.22	21.70
HRoffHD	46.41	18.16	45.72	19.63	54.03	17.25
HRonHD	33.66	15.48	38.62	18.33	41.65	15.05
Spouse Characteristics						
AGESP	35.76	15.72	38.74	15.66	44.11	13.71
EDUCSP	3.16	3.32	3.23	3.34	3.59	3.50
OFFSP	0.13	0.34	0.16	0.36	0.19	0.40
WGoffSP	11.48	9.69	16.18	10.51	16.98	16.46
HRoffSP	40.07	16.96	39.64	24.04	38.74	20.63
HRonSP	4.05	12.20	4.07	11.78	5.23	13.38

[a] In per capita terms

Table 3 Agricultural Production Function Estimates

Dependent Variable: LNTVFO	FIXED EFFECTS		POOLED OLS	
	Coeff	SE[a]	Coeff	SE[a]
Farm Characteristics				
LN LAND	0.2711***	(0.103)	0.218***	(0.055)
LN PINPUTS	0.4943***	(0.041)	0.553***	(0.034)
LN HLABOR	0.252***	(0.074)	0.333***	(0.056)
LNHRonHD	0.2519***	(0.048)	0.242***	(0.034)
LNHRonSP	0.1020	(0.067)	0.104**	(0.050)
CREDIT	0.219	(0.163)	0.203	(0.132)
TITLE	0.8414***	(0.166)	0.672***	(0.133)
TRAINING	0.4518**	(0.215)	0.374**	(0.176)
RENTLAND	0.6927***	(0.173)	0.498***	(0.144)
Young and Adult Children Working On-Farm				
Son				
SonFARM 5 - 15	0.0617	(0.15)	0.144	(0.129)
SonFARM 15 - 22	0.47***	(0.158)	0.407***	(0.121)
SonFARM 22 - 31	-0.093	(0.234)	-0.113	(0.180)
Daughter				
DonFARM 5 - 15	-0.513**	(0.227)	-0.352*	(0.203)
DonFARM 15 - 22	-0.143	(0.26)	0.245	(0.267)
DonFARM 22 - 31	-0.21	(0.41)	-0.339	(0.367)
Geographic Characteristics				
PACIFICO	-	-	0.46	(0.464)
CENTRAL	-	-	0.722	(0.461)
ATLANTICO	-	-	1.41***	(0.471)
DUMYEAR2	0.0063	(0.15)	0.185	(0.146)
DUMYEAR3	0.60***	(0.15)	0.784***	(0.152)
CONSTANT	0.324***	(0.24)	-0.53	(0.472)
Hausman $chi^2(17)$	26.05*			
N	1677		1677	
F	38.51***		98.46***	
R^2	0.4274		0.44	

* p<0.10; ** p<0.05; ***p<0.01.
[a] Robust standard errors

Table 4 Head and Spouse Participation Equations: Conditional Fixed Effects Logit and Pooled Logit

Dep Var: 1 if work off-farm	Head					Spouse				
	Fixed Effects			Pooled		Fixed Effects			Pooled	
	Coeff	SE[a]	ME[b]	Coeff	SE[a]	Coeff	SE[a]	ME[b]	Coeff	SE[a]
Head Characteristics										
EDUCHD	0.1524	(0.236)	.00313	0.286***	(0.070)	-0.181	(0.203)	-.00015	-0.013	(0.052)
AGEHD	0.1610**	(0.075)	.00328	0.139***	(0.052)	-0.021	(0.035)	-.000016	-0.0312***	(0.011)
AGEHD2	-0.0024**	(0.001)	-.00005	-0.0017***	(0.0006)	-	-		-	-
Spouse Characteristics										
EDUCSP	0.319*	(0.208)	.00672	0.1028*	(0.060)	0.322***	(0.127)	.00050	0.122***	(0.055)
AGESP	-0.0043	(0.030)	-.00009	-0.0065	(0.010)	0.201	(0.151)	.00015	0.146***	(0.035)
AGESP2	-	-		-	-	-0.0016	(0.001)	-1.2e-06	-0.0013***	(0.0004)
Farm Characteristics										
TITLE	-0.3480	(0.437)	-.00757	-0.7892***	(0.229)	-0.038	(0.412)	-.000011	-0.123	(0.169)
LAND	-0.0305	(0.027)	-.000622	-0.0061	(0.004)	0.0066	(0.008)	5.58e-06	-0.004	(0.004)
LIVT_ASSET	0.00021*	(0.0001)	4.3e-06	-0.00001	(0.0001)	-0.00003	(0.0001)	-2.3e-08	0.00002**	(0.0004)
TRAINING	0.864	(0.783)	.0128461	0.1414	(0.349)	0.169	(0.622)	.00014	0.21	(0.252)
ORGANIZATION	-0.2603	(0.631)	-.00549	-0.0911	(0.339)	0.8244*	(0.466)	.00051	0.50**	(0.223)
EFFICIENCY	-0.0611**	(0.024)	-.001273	-0.0466***	(0.016)	-0.032*	(0.015)	-.00002	-0.011**	(0.005)
Household Characteristics										
HHSIZE	0.279**	(0.130)	.00582	0.1069***	(0.041)	0.098	(0.090)	.000078	-0.10**	(0.041)
CHILD=< 5	-0.346	(0.458)	-.00650	-0.3912**	(0.210)	0.034	(0.385)	.000027	0.019	(0.184)
REMITTANCES	-0.0059	(0.004)	-.00012	-0.004	(0.002)	-0.0011	(0.0010)	-7.4e-07	-0.0008	(0.009)
Young and Adult Children Working										
Son										
SonFARM 5 - 15	-1.465**	(0.600)	-.05409	-1.0699***	(0.315)	-0.1303	(0.441)	-.00004	-0.108	(0.213)
SonFARM 15 - 22	-1.333**	(0.611)	-.0430	-0.7323***	(0.272)	0.0205	(0.445)	.00001	-0.383*	(0.205)
SonFARM 22 - 31	-2.53**	(1.105)	-.17458	-1.2399**	(0.550)	0.428	(0.623)	.000301	-0.0034	(0.280)
SoffFARM 5 - 15	1.541**	(0.699)	.01817	1.7503***	(0.356)	3.33***	(0.762)	.00095	3.002***	(0.389)
SoffFARM 15 - 22	5.209***	(1.514)	.03454	2.3947***	(0.393)	1.40**	(0.662)	.00065	1.12***	(0.355)
SoffFARM 22 - 31	0.639	(0.964)	.01031	0.459	(0.538)	2.14**	(0.991)	.00076	0.85*	0.476)
Daughter										
DonFARM 5 - 15	-2.744***	(0.988)	-.19790	-1.7359***	(0.456)	0.374	(0.563)	.00025	0.011	(0.299)
DonFARM 15 - 22	-2.6205	(3.063)	-.19953	-0.9602	(0.627)	1.473	(1.21)	.00064	0.404	(0.389)
DonFARM 22 - 31	-3.012	(2.293)	-.28778	-1.9425*	(1.165)	-0.657	(0.765)	-.00063	0.242	(0.597)
DoffFARM 5 - 15	1.904**	(1.003)	.0202	1.5008***	(0.356)	3.848***	(0.741)	.00103	3.11***	(0.386)
DoffFARM 15 - 22	1.009	(0.905)	.0143	0.5256	(0.383)	0.851	(1.055)	.00046	0.715**	(0.336)
DoffFARM 22 - 31	4.317	(2.981)	.02441	0.7439	(0.529)	0.283	(0.655)	.00020	0.036	(0.467)
Geographic Characteristics										
PACIFICO	-	-		-1.2149**	(0.608)	-	-		0.7736	0.698)
CENTRAL	-	-		-2.189***	(0.618)	-	-		0.786	0.691)
ATLANTICO	-	-		-1.520**	(0.636)	-	-		0.445	0.706)
DUM_YEAR2	0.226	(0.417)	.00482	-0.020	(0.272)	1.7438***	(0.511)	.00120	1.26***	0.2629)
DUM_YEAR3	0.6407	(0.610)	.01242	-0.15	(0.294)	1.958***	(0.637)	.00134	1.31***	0.2693)
CONSTANT	-	-		-3.027**	(1.221)	-	-		-5.51***	1.0637)
N	1,677			1,677		1,677			1,677	
Wald chi2(31)				199.85***					233.51***	
Wald chi2(28)	56.63***					69.10***				
Log likelihood	-73.071			-421.80		-92.11			-577.94	

* p<0.10; ** p<0.05; *** p<0.01.

[a] Robust standard errors

[b] Marginal Effects

Table 5 Head and Spouse Off-Farm Wage Equations: Kyriazidou Estimates

Dep Var: Weekly off-Farm wage	Head		Spouse	
	Coeff	SE[a]	Coeff	SE[a]
EDUCHD	1.595*	(0.875)	-	-
EXPERHD	1.83**	(0.671)	-	-
EXPERHD2	-0.023***	(0.008)	-	-
EDUCSP	-	-	1.691*	(1.03)
EXPERSP	-	-	0.391*	(0.235)
EXPERSP2	-	-	-0.010**	(0.0052)
LAND	0.137**	(0.07)	-0.018	(0.020)
HHSIZE	0.21	(0.542)	0.10	(0.426)
LIVT_ASSET	-0.0013*	(0.001)	-0.0002	(0.0003)
CONSTANT	1.324	(1.63)	4.91***	(1.529)
N	211		271	
F	2.99**		2.03*	
R^2	0.119		0.036	

* p<0.10; ** p<0.05; *** p<0.01

[a]Standard Errors in parenthesis

Table 6 Head and Spouse Off-Farm Labor Supply Equations: Kyriazidou Estimates

Dep Var: Logarithm of weekly hours worked off-Farm	Head				Spouse			
	K		K-IV		K		K-IV	
	Coeff	SE[a]	Coeff	SE[a]	Coeff	SE[a]	Coeff	SE[a]
Head Characteristics								
WGoffHD	0.0716***	(0.0106)	-0.077***	(0.027)	0.00035	(0.0052)	0.0346**	(0.0122)
SHAWAGEHD	-0.0032	(0.0173)	-1.267**	(0.531)	-0.046	(0.3223)	-0.049	(0.3141)
AGEHD	0.0142	(0.0510)	0.018	(0.0589)	-0.0210	(0.0148)	-0.0111	(0.0142)
AGEHD2	0.00002	(0.0005)	-0.0002	(0.0006)	-	-	-	-
EDUCHD					0.0939	(0.0716)	0.116	(0.0846)
Spouse Characteristics								
WGoffSP	-0.0264***	(0.0045)	0.081**	(0.033)	0.0268***	(0.0065)	0.0028	(0.0241)
SHAWAGESP	-1.142***	(0.4099)	-1.926***	(0.569)	-3.922***	(0.4755)	-4.306***	(0.4986)
AGESP	-0.0117*	(0.0090)	-0.013	(0.0134)	0.0767**	(0.0346)	0.0837**	(0.0370)
AGESP2	-	-	-	-	-0.0013*	(0.0007)	-0.0015**	(0.0007)
EDUCSP	0.233**	(0.1007)	0.394***	(0.117)				
Household and Farm Characteristics								
SHADOW INCOME	-0.291**	(0.1270)	-0.325***	(0.187)	-0.0835	(0.1818)	-0.156	(0.1971)
HHSIZE	0.0469	(0.0608)	0.124**	(0.072)	-0.0355	(0.0566)	-0.0285	(0.0600)
CHILD=< 5	-0.123	(0.1909)	-0.741***	(0.247)	-0.2678	(0.1973)	-0.364*	(0.2135)
REMITTANCES	0.00021	(0.0002)	0.0004	(0.0003)	-0.0003	(0.0002)	-0.0002*	(0.0002)
LIVT_ASSET	-0.000012	(0.0001)	-0.0002**	(0.0002)	-0.00002	(0.0000)	-0.00007**	(0.0000)
Young and Adult Children Working								
Son								
SonFARM 5 - 15	-0.619***	(0.2416)	-0.682**	(0.314)	-0.0006	(0.2051)	-0.104	(0.2126)
SonFARM 15 - 22	0.0633	(0.2063)	-0.015	(0.276)	-0.2954	(0.2095)	-0.355*	(0.2273)
SonFARM 22 - 31	-0.323	(0.2445)	-0.380	(0.343)	0.2521	(0.3374)	0.178	(0.3399)
SoffFARM 5 - 15	1.142***	(0.3013)	1.134***	(0.384)	0.0795	(0.3216)	0.095	(0.3438)
SoffFARM 15 - 22	0.302	(0.3916)	1.48***	(0.471)	0.4357	(0.3375)	0.415	(0.3613)
SoffFARM 22 - 31	0.0617	(0.4619)	-0.0422	(0.651)	0.699	(0.7860)	0.969	(0.8396)
Daughter								
DonFARM 5 - 15	-0.3502	(0.2666)	-0.757**	(0.339)	-0.077	(0.2457)	0.0415	(0.2512)
DonFARM 15 - 22	0.9716**	(0.4496)	0.764*	(0.491)	-0.4713	(0.7095)	-0.741	(0.6715)
DonFARM 22 - 31	-2.987	(0.5015)	-2.932***	(0.538)	0.396	(0.4830)	0.203	(0.5438)
DoffFARM 5 - 15	1.063***	(0.3275)	0.492*	(0.329)	0.4539*	(0.2758)	0.608**	(0.2620)
DoffFARM 15 - 22	0.733**	(0.2982)	0.896**	(0.322)	0.1352	(0.3370)	0.504	(0.3068)
DoffFARM 22 - 31	0.666	(0.5126)	0.253	(0.458)	0.58**	(0.4021)	1.02**	(0.4085)
CONSTANT	-0.222	(0.1502)	-0.3285*	(0.193)	0.3165	(0.1677)	0.374**	(0.1701)
N	211		211		271		271	
F	65.88**		20.12***		9.22***		8.79***	
R^2	0.67		0.41		0.52		0.48	
Hausman Test (Chi2(25))	4.97		3.38		8.52		13.81	

p<0.10; ** p<0.05; *** p<0.01

[a]Standard Errors in parenthesis

Table 7 Test of the Equality of Estimated Marginal Product and Market Wages for Heads and Spouses: Kyriazidou Estimates.

Dep Var: SHADOW_WAGE	Heads		Spouses	
	K[a]	K-IV[a]	K[a]	K-IV[a]
WAGEOFF	-.00068	.00165	.0122	-.00114
	(0.00013)	(0.00126)	(0.0105)	(0.0044)
CONSTANT	-.00256	-.0039	1.0454	.0225
	(0.0152)	(0.0167)	(0.271)	(0.0171)
N	211	211	271	271
R^2	0.0047	0.0036	0.0033	0.0003
F(2,209)[b]	3.4e+07***	5.4e+05***		
F(2,269)[b]			4,844.96***	27,579.71***

*** p<0.01

† Standard errors in parentheses

[b] Test under the null hypothesis: H_0: $\alpha=0$ and $\beta=1$

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