Determinants of nonfarm earnings of farm-based husbands and wives in northern Ghana. Awudu Abdulai; Christopher L. Delgado.

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The nonfarm work participation decisions of married men and women in rural Northern Ghana were jointly and separately estimated for married couples through a bivariate probit, using recent survey data. Selectivity bias was corrected for in estimating wage offer and labor supply equations, using Heckman's procedure. Education, experience, infrastructure, distance to the capital, and population density, as well as interactions between education and infrastructure and between education and distance to the city, were found to be significantly related to the probability of nonfarm labor market participation, wages, and the amount of nonfarm labor performed, with significant differences by gender.

Key words: Africa, gender, infrastructure, nonfarm labor supply, wages.

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Finding part-time or part-year local nonfarm employment is vital for people living on small farms in zones with single agricultural seasons and relatively low agricultural productivity. Such employment provides vital income diversification and access to cash at key moments, especially in West Africa, where the risks of farming are high and rural credit markets are poorly developed (Reardon).

Much research on the rural nonfarm economy in Africa has been carried out in recent years. Previous studies have concentrated on the characteristics of microenterprises in rural areas (Liedholm, McPherson, and Chuta), quantifying the share of nonfarm in total income and employment to show the range of roles played by nonfarm activities in the household economy (Haggblade, Hazell, and Brown), or simulating farm-nonfarm growth linkages through calculation of growth multipliers, where rural enterprise growth is typically a demand-driven spin-off of agricultural growth (Delgado et al.).

Very few studies have considered empirically the factors that influence the decisions of rural farm households in sub-Saharan Africa to participate in nonfarm production and labor supply off-farm (Reardon). Fewer still have disaggregated these decisions at the intrahousehold level (Haddad, Hoddinot, and Alderman). This is in contrast to the plethora of empirical work on rural household time allocation in Asia and South America (e.g., Bardhan; Rosenzweig; Behrman and Wolf; Sahn and Alderman; Skoufias 1993, 1994).

Farm income and overall wealth are not well correlated in rural West Africa, unlike South Asia and many other areas of the developing world (Reardon). This is probably due to lesser constraints on access to land in West Africa and also to the relatively greater scarcity of high-yielding agricultural
technologies in Africa. This suggests that access to nonfarm income in West Africa may be a critical means to alleviate poverty in rural areas. Better understanding of the determinants of that access, which is very likely to be related to access to assets and information, is therefore critical to understanding why some households do better than others, and why men are more likely to be involved in nonfarm work than are women.

The contribution of the present article is to estimate jointly, for a sample of men and women married to each other and living on farms in a rural area of Northern Ghana, the nonindependent determinants of the decision of husbands and wives to participate in cash-income-oriented nonfarm work. The determinants of nonfarm earnings and hours worked for participating men and women were then estimated, controlling for sample selection bias.(1) The study area is especially appropriate for investigating these issues because of its relatively low level of economic development and the likelihood that most of the poverty reduction that took place between 1987 and 1992 in rural areas of Ghana was due to growth in the nonfarm sector (World Bank).

Economic Model

The time allocation model presented here is inspired by the economic theory of household behavior given in Strauss and in Skoufias (1994). It is specifically assumed that a household consists of one husband and one wife.(2) The number of children and demographic composition of the adult members is considered exogenous. Goods produced at home and purchased from the market are assumed to be perfect substitutes. Hence, persons are assumed to be indifferent to whether the goods and services they consume are produced at home or purchased in the market. Households in the model therefore allocate each of their members' time endowment among three main activities: nonfarm production, farm production, and leisure.

Given these specifications, the simplified household's utility is assumed to be a function of goods and services consumed, which include both consumption goods and leisure time:

\[
U = (Q, [L_{1}], [L_{2}]; [\Delta^{c}])
\]

where \( U \) is household utility function, which is assumed to be monotone increasing in its arguments, strictly concave, and to possess continuous second partial derivatives; \( Q \) is the set of consumption goods and services; and \([L_{1}]\) and \([L_{2}]\) represent male and female leisure hours. The vector \([\Delta^{c}]\) parameterizes the utility function and summarizes individual and household characteristics, such as demographic characteristics, human capital, and asset structure.

The household faces a time constraint, expressed as

\[
T = [T_{1}] + [T_{2}] + [L_{i}]
\]

where \( T \) is the total time available to the husband and wife, \([T_{i}]\) and \([T_{2}]\) are respectively time allocated by husbands \((i = 1)\) and wives \((i = 2)\) to farm and nonfarm production, and \([L_{i}]\) is considered the household leisure time of husband and wife. Since the optimal hours of nonfarm work might be zero in a given year, but not less, a nonnegativity constraint is imposed on participation in nonfarm work. That is, \([T_{i}] \geq 0\) for \( i = 1, 2 \).

The technology of farm production is represented by a twice differentiable, concave production function:
(3) \[ Y = Y([T_{11}], [T_{21}], [H_{11}], [H_{21}], X; [\Delta]^z, M, [\Omega]) \]

where \( Y \) is the output produced from the farm, \([T_{11}]\) and \([T_{21}]\) are respectively husband's and wife's labor allocated to farm production, \([H_{11}]\) and \([H_{21}]\) represent hired male and female labor, and \( X \) represents purchased nonlabor inputs. Vector \([\Delta]^c\) represents household characteristics affecting production decisions, \( M \) is a vector of fixed factors such as land, and \([\Omega]\) is a vector of fixed effects of sublocation, such as the state of infrastructure and population density.

The household also faces a budget constraint that states that expenditure on market goods, consumed or used as inputs in farm and household nonmarket production, cannot exceed family income (1):

(4) \[ PQ = \sum_{i=1}^{2} [W_{i2}][T_{i2}] + \frac{[P_y]Y - [P_x]X - [W_{11}][H_{11}] - [W_{21}][H_{21}] + R}{[\eta_i]} \]

where \( P \) is the price for the consumption good purchased in the market, and \([P_y]\) is the price for farm output. Quantity \([P_x]X\) is the outlay on purchased nonlabor farm inputs, \([W_{12}]\) and \([W_{22}]\) are the nonfarm wage rates of the male and female, respectively, and \([W_{i1}]\) is the wage paid to hired farm labor. Quantity \( R \) is nonlabor income such as land rent, nonfarm assets, and transfers received by the household.

The decision problem is to choose the quantity of consumption goods to purchase, the hours of husband's and wife's farm work and nonfarm work, and the quantity of purchased farm inputs so as to maximize household welfare. This can be restated formally as

(5) \[ L = U(Q, [L_{1}], [L_{2}]; [\Delta]^c, [\Omega]) \]

where \([\eta_i]\) is the Lagrangian multiplier associated with the inequality constraints on the work of each labor type and \([\psi]\) is the Lagrangian multiplier associated with the income inequality constraint. Maximization of this Lagrangian with respect to \( Q, [T_{i1}], [T_{i2}], [H_{i1}], \) and \( X \) yields the following first-first-order conditions for optimal choices by husband and wife, assuming participation in nonleisure activities:

(6) \[ \frac{[P_y]([\Delta]Y/[\Delta][T_{i1}])}{([\eta_i]/[\psi])} \geq [W_{i2}] \]

(7) \[ [P_y]([\Delta]Y/[\Delta][H_{i1}]) = [W_{i1}] \]

(8) \[ [P_y]([\Delta]Y/[\Delta]X) = [P_x] \].
Equation (6) gives conditions for optimal time allocation for the three activities. It implies that households equate the marginal values of an individual's leisure with that of farm work time, and that the result should be at least as great as the nonfarm wage. If \((\frac{\eta_i}{\psi}) - W_{i2} > 0\), then the marginal value of an individual's leisure time or farm work exceeds his or her nonfarm wage opportunities, and optimal hours of work are zero, i.e., \(T_{i2} = 0\). When \((\frac{\eta_i}{\psi}) - W_{i2} = 0\), then an individual's nonfarm wage offer equals the marginal value of his or her leisure or farm work time, and optimal hours of nonfarm work may be positive (Huffman). Equations (7) and (8) are the usual first-order conditions derived from profit maximization for hired labor and purchased nonlabor inputs. The assumptions concerning the utility and production functions ensure that second-order conditions are met.(3)

When husbands and wives allocate time to all three activities, equations (6), (7), and (8) can be solved to obtain the structural demand functions for husband and wife farm labor and leisure.

\[ \text{(9) [Mathematical Expression Omitted]} \]

\[ \text{(10) [Mathematical Expression Omitted]}. \]

The corresponding nonfarm labor supply function is then

\[ \text{(11) [Mathematical Expression Omitted]}, \]

where \[\text{[Mathematical Expression Omitted]}\]. The reservation wage for nonfarm work is the marginal value of the individual's time when all of it is allocated to farm labor and leisure. It is obtained from equation (11) by setting nonfarm hours worked equal to zero (i.e., \(T_{i2} = 0\)), and solving for \(W_{i2} = W_{i2}\). Suppressing the numeric subscripts for sectoral wages,

\[ \text{(12) [Mathematical Expression Omitted]}. \]

Estimation

The econometric specification of the preceding model consists of nonfarm labor participation decision equations, wage rate equations, and labor supply equations estimated separately for husbands \((i = 1)\) and wives \((i = 2)\). If the potential market wage \([\text{[Mathematical Expression Omitted]}\) of an individual's nonfarm time is greater than the shadow value \([\text{[Mathematical Expression Omitted]}\) of farm time, a positive number of nonfarm hours will be observed for the individual. Following Huffman, the empirical reservation and nonfarm wage equations can be defined as

\[ \text{(13a) [Mathematical Expression Omitted]} \]

and

\[ \text{(13b) [Mathematical Expression Omitted]} \]

where the \([\text{c.sub.ij}]\) are exogenous explanatory variables such as personal, household, and sublocational characteristics of husbands and wives that influence their reservation and nonfarm wages; and \([\text{u.sub.ri}]\) and \([\text{u.sub.mi}]\) are random disturbance terms for the population of all farm husbands and wives. A nonfarm work participation indicator variable \((\text{[Mathematical Expression Omitted]})\) for individual \(i\) can be defined as
and

(14b) [Mathematical Expression Omitted].

Since \( u_{ri} \) and \( u_{mi} \) are random variables, the probability of participating in nonfarm work can then be specified as

(15) [Mathematical Expression Omitted]

where \( v_i = u_{ri} - u_{mi}, \Gamma_{C,i} = \Gamma_{2,i}C_{i2} - \Gamma_{1,i}C_{i1}, \) and \( F(\text{center dot}) \) is a cumulative distribution function for the random variable \( v. \)

The reduced-form nonfarm labor supply and wage functions can be specified as

(16a) \( T_i = \beta X_i + \epsilon_i i = 1, 2 \)

and

(16b) \( W_i = \alpha X_i + \mu_i i = 1, 2. \)

The vector \( X \) represents the independent variables specified on the right-hand side of equation (11); \( \Gamma, \beta, \) and \( \alpha \) are vectors of parameters to be estimated. The error terms \( u_i, \epsilon_i, \) and \( \mu_i \) are assumed to be joint-normally distributed with zero means and finite variances.

Applying OLS to the labor supply and wage equations in (16) to estimate the \( \beta \) and \( \alpha \) coefficients will yield biased parameter estimates, since they do not take into account the process generating the observed time allocation of farmers. A Lee-Heckman-type two-step process is therefore applied to correct for the possibility of bias due to sample selection (Maddala, pp. 278-83).

The model is estimated using an extension of the Heckman two-step procedure. The first step involves the estimation of the relationships in equation (15) using a bivariate probit model. This provides estimates of joint probabilities of participation for husbands and wives and estimates of \( \Gamma, \) and \( \rho \) (correlation between the errors). These estimates are then used to calculate the inverse Mills ratios \( (\Lambda) \), which can be treated as missing variables in equations (16a) and (16b). The inverse Mills ratios are then added to the wage and labor supply equations. This process yields the following equations, which may be estimated by OLS free of selection bias. The structural labor supply and wage functions take the form

(17a) [Mathematical Expression Omitted]

and

(17b) [Mathematical Expression Omitted]

where \( \Lambda_i = \Phi(\Gamma C)/\Phi(\Gamma C) \) if \( Z_i = 1, \) and \( \Lambda_i = \ldots \)
The participation decisions of couples given in equations (14a) and (14b) are assumed to be joint, within an optimizing household framework. Therefore the probability of a married individual participating in nonfarm work is affected by characteristics of the individual's spouse. Participation decisions are affected by random or unmeasured shocks to labor supply and demand; the correlation between the shocks (p) will be positive if the spouses are similarly affected by the shocks (Tockle and Huffman). The t-statistic on the parameter \( \rho \) is a Wald test of the hypothesis that p equals zero. Statistical significance of the correlation between the error terms in the two equations would imply that a full information maximum likelihood bivariate probit should be used, as opposed to univariate probit estimation (Greene).

**Data Description**

The gender-disaggregated data used in the present analysis were collected during 1992-93 in thirty-seven villages in four districts - Savelugu-Nanton, Tolon-Kumbungu, Gushiegu-Karaga, and Tamale - in Northern Ghana. A stratified random sample of sixty-four households were selected from each of the four districts to ensure representation of major land-holding categories, nonfarm participating and nonparticipating households, and isolated and centrally located households, as measured by distance from the regional capital, Tamale. Information from these households was gathered through interviews. The design and data collection was carried out under the supervision of one of the authors by trained enumerators speaking the local languages, using a pretested questionnaire. Additional survey data were obtained from the Northern Region Ministry of Agriculture and the Town and Country Planning Department, both in Tamale. The data covered information on farm and nonfarm activities, as well as demographic and locational characteristics. Information on farm activities included fertilizer applications and prices, human labor, farm size, crop output and prices, wages, capital assets, and livestock production. On cash-oriented nonfarm activities, information included weekly or monthly earnings and detailed time allocation information, input quantities and costs, and output quantities and prices.

The nonfarm wage for wage employment was calculated by dividing weekly or monthly earnings by total hours worked, while that for self-employment was computed as nonfarm income, net of all nonlabor costs, including value of in-kind payments. The average hourly earnings were about 146 cedis for husbands and 119 cedis for wives. For both self-employed and wage workers, total nonfarm hours worked are calculated by summing the weekly hours worked in the nonfarm sector. In the present sample, there are no cases where individuals are self-employed and at the same time participated in wage employment. Approximately 59% of husbands and 68% of wives in the sample report positive hours of nonfarm work.

Factors that are specific to individuals include education, experience (proxied as an individual's age minus years of schooling minus six) in nonfarm work, age, age-squared to control for the nonlinear life cycle, number of children, household size, and nonlabor income. Age and age-squared represent
general experience that increases the marginal value of time in each activity. The level of education may indicate productivity potential, both on and off the farm (Behrman and Wolf). At constant wages, an improvement in the level of an individual's education can increase the probability of participation and time allocation in nonfarm work, if it increases his or her opportunity costs for staying at home. The number of children in the family less than six years of age and those above six were included to indicate the number of dependents, a factor very likely to influence participation of women in nonfarm work.

Wages were assumed to represent an exogenous evaluation of individual human capital stock. Since observed nonfarm wages in the study were derived by dividing earnings by hours worked, any errors in hours worked are inversely related to the wage rate estimated. Consequently, if observed wages are employed in the labor supply function, the estimated elasticity of labor supply with respect to wages will be biased toward minus one (Sahn and Alderman). Therefore, the widely applied approach of using predicted wages in the labor supply equation was followed (Rosenzweig, Skoufias 1994). Own wages have both a price effect and an income effect, so the expected sign is ambiguous. Cross-effects of wages of other family members also have income effects similar to own wages and substitution effects in nonwage household tasks.

Nonlabor income, measured as total cash income less net farm income and gross cash wages, salaries, and nonfarm income, was also included. If leisure is a normal good, higher nonlabor income could lead to an increase in quantity of leisure demanded at the expense of nonfarm work. An individual's district of residence may also be a determining factor in nonfarm work decisions and earnings, as it reflects, among other things, the district level average wage rate and the local labor market conditions. (9)

In noncompetitive labor markets, there is the tendency to ration jobs according to the status of the worker, with discrimination in earnings related to ethnicity, religion, or farm size (Bardhan, Rosenzweig). Farm size, measured as the number of acres of each household cultivated in the 1992 farming season, ethnicity, and religion were therefore included to examine their impacts on participation decisions and nonfarm earnings. Since persons of the Dagomba ethnic group constitute about 61% of the sample, a dummy variable taking the value of one if Dagomba and zero otherwise was constructed. Dummy variables for Muslims, Christians, and animists (traditional spiritual beliefs) were also included. Farmers also tend to consider the relative prices between farm and nonfarm products in their allocation of labor between the two activities. The ratio of a Stone's index of preplanting farmgate prices of the major crops cultivated by the household and a Stone's price index of nonfarm products was used as the terms of trade.

Local conditions were represented by population density, the state of infrastructure, and distance to the regional capital. Higher population density facilitates the attainment of minimum efficient scales of nonfarm production and service delivery, thereby promoting nonfarm activities and employment in the sector (Haggblade, Hazell and Brown). It may also limit the number of households able to survive from agriculture alone, thus inducing some into nonfarm work to supplement income. Declines in the cost of information and transport flows due to good infrastructure reduce transaction costs and improve the efficiency with which rural labor and financial markets channel inputs into activities yielding the highest returns. The variable for distance to the regional capital was used to proxy the transaction costs involved in searching for employment in the nonfarm sector, since areas closer to the regional capital offer the best employment opportunities. (10)

Identification of the selection effects of the earnings and labor supply equations was achieved through the inclusions of variables that do not enter the wage and labor supply equations themselves. In the
case of the earnings functions, these are a set of family background variables, such as number of children, number of adults, nonlabor income and the terms of trade between agriculture and nonagriculture, and an interaction term between farm size and the number of adults. The latter was included to identify effects arising from uneven land-labor ratios, since households with higher ratios may use nonfarm work as a means of equilibrating their allocations to the prevailing ratios. Since predicted male and female wages were used in the labor supply functions, identification also requires that there be at least one variable in the earnings function that does not appear in the labor supply function. The identifying restrictions for the nonfarm labor supplies are provided by the three district dummies and multiplicative interactions between distance and education, infrastructure and education, and the number of adults and farm size, respectively.

Empirical Results

Participation in Nonfarm Work

Table 2 presents the results of the maximum likelihood bivariate probit estimates of the equations explaining the probability of participating in nonfarm work. The marginal effects of the regressors on the probability of participation in nonfarm work, which are calculated by multiplying the coefficient estimates by \( \Phi \) at the mean values of \( C \) (Maddala), are also reported as marginal probabilities in table 2. The estimate of \( p \) (correlation between the errors) that maximized the bivariate probit likelihood function was 0.36 and was significantly greater than zero at the 1% level. This suggests that the random disturbances in the nonfarm participation decisions of husbands and wives are affected in the same direction by random shocks and that their participation decisions are not statistically independent. Thus, inefficient parameter estimates may be obtained if the equations are estimated separately.

The log-likelihood ratio statistic was significant at the 1% level, suggesting that the independent variables taken together influence participation decisions. The McFadden (pseudo) \( R^2 \), an indication of goodness of fit, is 0.4 (Maddala). The results suggest that at younger ages an increase in age increases the probability of labor supply to the nonfarm sector with the maximum effect occurring at just over thirty-three years for husbands and at thirty years for wives. At older ages, the probability of participating in nonfarm work decreases as age increases.

A husband or wife who had more schooling had a significantly higher probability of engaging in nonfarm activities. This implies that additional schooling raises an individual's off-farm wage by more than it raises his or her reservation wage for farm and home activities. The marginal effect of a year of female schooling on the probability of participation was greater than that of male schooling (0.51 versus 0.30), a result consistent with findings based on U.S. data (Tockle and Huffman), suggesting that a year of schooling raises the difference between a woman's reservation and market wage relatively more than is the case for males. Additional schooling of the male did not significantly influence the participation of the females. For males, however, additional schooling of wives tends to decrease the probability of their participation in nonfarm work.

Nonlabor income lessened the likelihood of participating in nonfarm work for both males and females. The coefficients for the terms of trade variables in the equations for both husbands and wives had negative signs but were not significantly different from zero, suggesting that relative prices between the farm and nonfarm outputs did not significantly influence participation decisions of households in nonfarm work in the survey area. The presence of children had no significant effect on the
participation decision of women in nonfarm work. Adding a person to a household increases the probability of participation for males, suggesting that, at higher levels of family labor, extra effort is directed into nonfarm work instead of into the farm.

The results also suggest that well-developed infrastructure and population density had positive significant effects on the probability of nonfarm work. Infrastructure exerts [TABULAR DATA FOR TABLE 3 OMITTED] the highest marginal effect (0.69 for males and 0.78 for females) among the explanatory variables. The negative coefficient of the distance variable suggests that there are higher costs of nonfarm labor force participation for households living in more remote areas, as expected.

Multiplicative interaction terms were also included to measure the separate impacts of infrastructure and distance on the effect of schooling on participation in nonfarm work. Curiously, the results are uniformly positive, significant, and of similar orders of magnitude for husbands and wives. As expected, good infrastructure increases the positive impact of education on participation. However, while distance from the city decreases participation, ceteris paribus, it increases the positive effect of education on participation. Having a better education makes it even more likely that both husbands and wives will participate in nonfarm work in remote areas than it does for close-in areas, perhaps because more educated people who remain in remote areas do so mostly because they have found such work close to home.

Wage Functions

Table 3 presents results of the nonfarm wage equations. Since the two-step procedure employed in the analysis results in heteroskedastic residuals, White's formula was used to calculate the standard errors. The inverse Mills ratio (\(\Lambda\)) was significant for both husbands' and wives' wage equations, indicating that sample selection bias would have resulted if the wage equation had been estimated without taking into account the decision to participate in nonfarm work. For both males and females, experience and education variables were positive and significantly different from zero at the 5% level, with experience exhibiting diminishing marginal effects on the wage rate. The maximum effects for experience occur at forty-one years for males and at thirty-seven years for females.

The significant positive impact of education suggests that investment in human capital in the form of education has a significant private rate of return if the private nontime costs are not high (Behrman and Wolf). The wage equation indicates that a one-year increase in schooling causes a larger percentage increase in wives' wages than in husbands' wages, 6.9% versus 4.9%. Additional experience, however, seems to be more important for men than for women. In the survey area, males engaged in nonfarm work are frequently involved in employment where experience may be more important than formal education, such as metal work, equipment repair, and driving. Women with more education are more likely to be in salaried or government jobs such as nursing, teaching, and office work, where returns to education are quite high. The relative magnitudes found here are consistent with results reported in other studies for other countries (Tockle and Huffman).

The variable representing farm size was positive but not significant, indicating that large landowners are not able to exert market power to obtain higher nonfarm wages in the nonfarm sector, once other factors are controlled for. This is in line with findings reported by Rosenzweig for India and Sahn and Alderman for Sri Lanka. Similarly, ethnicity and religion did not appear to have significant impacts on earnings in the study area, indicating that there is neither discrimination in favor of the dominant Dagomba ethnic group nor in favor of the Muslim majority in the study area. The district of residence also appears to influence the earnings of both males and females. The fixed effects coefficients for districts in table 3 suggest small but significant wage differences among the districts for both men and
women, especially with regard to Tolon district. This may indicate some segmentation of the rural labor market by region (Sahn and Alderman).

The coefficients for population density were positive and significant for both males and females, a result that contrasts with expectations, as put forth by Benjamin, that population pressure has a negative effect on wages. It is, however, in line with the notion that higher population density stimulates development of the nonfarm service sector, increasing the demand for labor, and exerting an upward pressure on wages (Haggblade, Hazell and Brown). Males and females residing in localities with well-developed infrastructure earn 6.1% and 6.8% higher wage rates than their counterparts, respectively, in localities with poorly developed infrastructure. The effects of distance are negative and significant in both equations, suggesting that individuals who live closer to the regional capital were more likely to earn higher wages than those who lived farther away.

The multiplicative interaction terms between infrastructure and education and distance and education, included to examine the marginal impact of infrastructure on the private rate of return to education, were positive and significant for both males and females, suggesting that the private rate of return to schooling is increased when the infrastructure is better developed. The increases in the private rate of return to an extra year's education resulting from infrastructural improvement were 3.2% for males and 4.2% for females. Poor infrastructure is usually associated with low demand for laborers and low household income, leading to reduced demand for education through the labor market (Behrman).(14) The multiplicative interaction term for distance and education is also positive and significant for both husbands and wives, but the gap between men and women in this respect is not significant. The relative private returns to education are even higher in remote areas than in close-in ones, suggesting that the wage gap between educational groups is smaller where the density of educated people is higher.

Labor Supply Functions

Table 4 presents the results for the labor supply equations. The inverse Mill ratios ([Lambda].sub.i) were significant for both males and females. The male and female wage rates used in labor supply functions were predicted wages estimated deleting the district dummies, DIST(*)EDUC and INFRA (*)EDUC, from the wage equations. The Wald test statistics for the joint significance of these five variables in the wage equation, distributed as [Chi].sup.2](5), are 16.38 and 17.82 for males and females, respectively.(15)

Both male and female own-wage effects were positive and significant, suggesting that higher wages lead to substitution effects that are greater than the opposing income effects, leading to increased labor supply to nonfarm employment - an upward sloping labor supply, supportive of the utility maximization hypothesis. While the positive response concurs with findings by Jacoby using Peruvian data, it contrasts with Rosenzweig's findings with Indian data. The own-wage elasticities for males and females are, respectively, 0.32 and [TABULAR DATA FOR TABLE 4 OMITTED] 0.66, suggesting that females are more responsive to changes in the marginal returns to their labor than are males.16

The estimated male wage effect on female labor supply was negative and significant. A 10% increase in the wage rate of husbands is associated with a 2.1% reduction in the number of days worked by wives, presumably due in part to the reallocation of time by wives from nonfarm to farm production and non-income-generating personal matters such as funerals and weddings. The cross-wage effect for females was positive, but not significant, indicating that husbands as a group do not reduce their labor supply, even when wives as a group earn more from nonfarm activities. The negative effect of higher
male wages on female labor supply suggests that male and female leisure are gross substitutes in terms of utility. The significance of the cross-wage effects is consistent with family utility maximization and confirms that studies that restrict such cross-wage effects to be zero may yield estimates that are subject to specification error (Skoufias 1994). Nonlabor income also had a negative influence on the nonfarm labor supply of both males and females. The tendency for wives to lower nonfarm labor supply in response to increases in nonlabor income was much higher than that of males (elasticity of 0.23 versus 0.13). This was probably due to the fact that males are traditionally more likely to remain in nonfarm work over time than are married women in the study zone.

Personal characteristics also had significant effects on the labor supply functions. Both husbands and wives performed more nonfarm labor as they aged, but at a decreasing rate. Maximum effects occur at thirty-eight years for males and at thirty-six years for females. Labor supply of husbands was positively and significantly affected by both their own education and that of their spouse. The same was true for wives. An increase in the number of years of schooling increased the nonfarm labor supply of wives more than husbands, with an estimated elasticity (not shown) of wives' labor supply of 0.33 with respect to education, versus 0.18 for husbands. The significant positive own-education effects conformed to the findings of Collier and Lal in East Africa, where farmers with education were found to be better positioned to mobilize capital through nonfarm work.

The presence of children had no significant effect on labor supply to nonfarm work of husbands and wives in the study area, concurring with findings of other studies in rural areas in developing countries that support the view that nonfarm work and child-rearing are not necessarily competing activities in those countries (Rosenzweig, Sahn and Alderman, Skoufias 1994). In places such as the survey zone, members of the extended family take care of children in the absence of the parents. The coefficient for the household size variable, which is a measure of the non-nuclearity of the household, was positive and significantly different from zero.

Well-developed infrastructure and high population densities were also associated with high levels of nonfarm work of both males and females. This fits with the view that decreases in the costs of information and transportation that stem from improvements in infrastructure improve both the incentives and opportunities for farm-based rural labor to participate in nonfarm work.(17)

Conclusions and Policy Implications

This article has investigated the impacts of personal, household, and locational characteristics on the jointly determined earnings and time allocation decisions of rural married couples in Northern Ghana. Participation decisions of wives and husbands toward nonfarm work are shown to be nonindependent of one another, at least in the sense that wives' choices to become involved in the nonfarm economy are in part stimulated by the relative lack of nonfarm cash income of their husbands, although the reverse was not found.

Results support the view that wives' participation in nonfarm work is relatively more sensitive to the lack of household cash than is the case for husbands. Although the the analysis here cannot fully substantiate the point, the pattern of dependency of women's participation on their husbands' participation is consistent with the view that women's nonfarm work in the study zone is more of a residual than is the case for men. This suggests that women's income strategies, more than men's, may be significantly motivated by coping behavior to deal with shortfalls in the household's ability to secure necessities when needed. Food safety net policies, therefore, should pay special attention to the factors that permit increased participation in nonfarm work by women, since they would then build on existing behavioral patterns in addressing food security.
The results also reveal that human capital, as embodied in education and experience, is essential in increasing nonfarm earnings and time allocation of rural families and to diversify the rural economy out of agriculture. A one-year increase in schooling was found to increase the wage rate of women by 6.9% and that of men by 4.9%. Furthermore, a 10% increase in years of schooling increased women's labor supply to nonfarm activities by 6.6%, compared to 3.2% for men. Investments in education and infrastructure are not only significant for the development of the rural nonfarm sector, but in particular are crucial in Northern Ghana for improving the welfare of women. The disaggregation between men and women suggests that increased targeting of schooling to women may increase the impact of policy interventions on nonfarm employment. Schooling, in particular, has a higher marginal impact on women's participation and nonfarm income levels than it does on men's.

Locational characteristics were found to be especially important in explaining nonfarm work. In particular, the state of infrastructure and population density were found to influence positively and significantly the earnings and time allocation of rural farm-based husbands and wives in nonfarm work. Husbands and wives residing in localities with well-developed infrastructure earned 6.1% and 6.8% higher nonfarm wages, respectively, than their counterparts in localities with poorly developed infrastructure.

Tests based on interaction terms suggest that the greatest gains in nonfarm earnings overall and for married women in particular come where infrastructure and education are combined. On top of the evidence of 5% to 7% marginal returns to education and infrastructure in isolation, increases in the private rates of return to an extra year of education from improvements in infrastructure were 3.2% for males and 4.2% for females. This direct evidence of the high private returns to education and infrastructure suggests that local authorities in Ghana may have more scope for financing at least part of these services from user fees or taxes than is currently done, permitting broader coverage than is currently possible.

The results showing higher private returns to infrastructure and education in more densely settled areas, and higher nonfarm wages in those areas, are consistent with the view, ceteris paribus, that increasing population density is key to the development of robust nonfarm economies. Higher population densities cut overheads and transaction costs of nonfarm activities and also concentrate demand for nonfarm items, many of which - such as services - are nontradables. This suggests that overall returns would be higher from concentrating investments in rural nonfarm enterprises in the more densely settled pockets, rather than spreading resources more thinly, as regional equity or political considerations might dictate.

The view that nonprice factors such as education, infrastructure, and population density drive effective participation in rural nonfarm employment in Northern Ghana is strengthened by the finding that the relative price ratio between farm and nonfarm output - which varied significantly across study locations - was not a significant factor in explaining participation in nonfarm work. It seems unlikely in the study area that improved agricultural incentives would decrease diversification into nonfarm work. On the contrary, higher agricultural incomes would most likely stimulate higher participation in nonfarm work and higher nonfarm earnings, especially in the more densely settled zones that are also better served by infrastructure. The latter zones are likely to be the areas where efforts to promote rural diversification into nonfarm employment will succeed most.

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1 An earlier paper investigated household decisions to participate in nonfarm work in Northern Ghana. Unlike the present article, it assumed independent decision making by husbands and wives, did not explicitly test for selectivity bias, and did not investigate the determinants of nonfarm earnings (Abdulai and Delgado).

2 The results below are estimated using only monogamous households. The random survey included fourteen polygamous households, or 5.4% of the sample. The model given here is only suitable for monogamous households, yet results are similar to those where the first wives of polygamous households were included.

3 As pointed out by an anonymous reviewer, migrant remittances should be included with nonfarm earnings when dealing with nonfarm participation decisions of rural households in developing countries. This is due to the fact that remittances from migrants may result from conscious family decisions to maximize income for a given level of risk by sending some family members to areas in which wages are higher, or perhaps to spread income risk to sources that are not well correlated with farm income (Reardon). Information on income from migrant labor was, however, not collected, as emigrants were absent during the time of the survey. The results of this omission may not be serious however. The motivations for seeking to diversify farm household income sources into local (dealt with here) and non-local (migratory) income are different. A simple correlation coefficient between the shares of local and non-local nonfarm income from twenty-eight independent farm household surveys across Africa was 0.17 and insignificant at the 10% level (Delgado).

4 Besides the fourteen polygamous households discussed in footnote 2, a further fourteen households fell out of the analysis because of incomplete information, leading to a final sample of 228 households.

5 A fourteen-day recall period was used. Data are available upon request.

6 We did not separate the consideration of nonfarm self-employment from nonfarm wage employment, similar to the approach of Furtan, Van Kooten, and Thompson, and Olfert. Taylor, and Stabler.

7 The prevailing exchange rate during the survey was about 400 cedis to a U.S. dollar, implying hourly earnings of about 37[cents] and 30 [cents] for husbands and wives, respectively.

8 While 42% of husbands who participated in nonfarm work were engaged in wage employment, about 39% of wives who participated were in wage employment.

9 Since district-level dummies, which to some extent capture district differentials in the wage rates for hired agricultural labor, were employed in the analysis, district-level wage rates were not included in the estimation.

10 The infrastructure variable was constructed by apportioning weights to the viability of using roads to neighboring markets (0.5), the availability of good drinking water facilities (0.3), and the size of the market in the village in which the household is located (0.2), transforming the discrete composite
variable into a dummy variable, with 0.5 as the cut-off point. A value of true was used for any location with an index equal to or greater than 0.5, and zero otherwise. Sensitivity analyses altering the cut-off point showed no significant differences.

11 In cases where a firm is a household venture common to husband and wife, the spouse's human capital characteristics could affect the profitability of the firm, resulting in problems with human capital characteristics of spouses as identifying variables. The sample under study, however, contained no such cases.

12 All specifications were estimated using the econometric software package LIMDEP, version 7.

13 Using a Lagrange multiplier test suggested by Greene also suggested that the participation decisions are not independent.

14 A test of the null hypothesis that the coefficients of POPDEN, INFRA, and DISTAN are jointly equal to zero is rejected for both males and females. The sample value of the Wald statistic distributed as $\chi^2$ is 11.72 for males and 12.58 for females, with a critical value of 11.30 at the 1% significance level. Thus, for both males and females, individual characteristics alone do not capture differences in wage rates across individuals.

15 Both were significant at the 1% level, suggesting that the instruments do enter the first-stage estimation and are appropriate instruments (Staiger and Stock). A Wu-Hausman test suggested that the instruments can be treated as exogenous variables. A test of overidentification restrictions to ascertain whether the instruments meet minimal exogeneity conditions is calculated as the sample size times the $R^2$ from a regression of the residuals from the first-stage regression on the exogenous variables and the instruments (Newey). It suggested, at the 5% level, that the instruments employed were valid.

16 All marginal effects are computed as $\left[\frac{\partial E(y)}{\partial x} \right|$ (Greene, pp. 954-55) and used to calculate elasticities given in text.

17 Components of the infrastructure index such as rural roads and electrification contribute directly to providing increased opportunities to farm-based people; in the study area, good drinking water - another component of the index - proxies other key variables that are not specifically included, such as the proximity of telephones and schools.

References


