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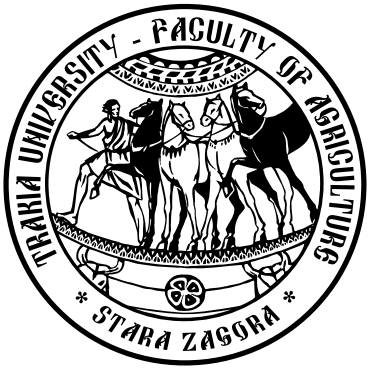


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# Effect of off-farm work on agricultural productivity: empirical evidence from northern Ghana

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***Abstract.*** *In recent years, there has been increasing recognition of the importance of income diversification to agrarian households in developing countries. Empirical evidence of the effect of farm household income diversification on agricultural productivity remains scanty and inconclusive. An important policy question concerns the effect that farmer participation in off-farm work has on agricultural productivity. This paper answers that question by examining the factors that explain the decision of farm household heads to work off-farm and how this impacts farm productivity using a sample of 300 rice producing households in northern Ghana. Endogenous switching regression model supported by a treatment effect model was used to empirically assess the effect of off-farm work on agricultural productivity. Results show that engagement in off-farm work has a robust and positive impact on rice productivity. Farmers' choice to work outside the farm thus contributed significantly to rice productivity of smallholders, confirming the role of income diversification in contributing to agricultural productivity of agrarian households.*

**Keywords:** off-farm work, endogenous switching regression, smallholder farmers, productivity, northern Ghana

## Introduction

There is increasing recognition of the important role that off-farm work plays in rural and agricultural development in developing countries like Ghana. The extant literature indicates that a high proportion of farm households and small-farm operators engage in off-farm waged employment in many developing countries as an additional source of household income. Also, the proportion of income from off-farm work in the total household income portfolio in developing countries is reportedly high (Davis et al., 2009). For example, the percentage of rural income derived from off-farm work in Africa, Asia, and Latin America is 42%, 32%, and 40%, respectively (Reardon et al., 1998). A study by de Janvry et al. (2005) in the Hubei province of China found that an estimated 36% of rural household income came from non-farm employment while Pfeiffer et al. (2009) found the proportion of household income from rural off-farm employment to be 33% in Mexico. In addition, Kilic et al. (2009) found the proportion of household income from rural non-farm employment to be 50% in Latin America and 35% in Africa. On a global level, the figure is estimated at 58%. As indicated by Chang and Wen (2011), participation in off-farm work is a persistent phenomenon, and reliance on off-farm work is expected to increase.

A number of studies have sought to explain the factors leading to the rise in off-farm activity among farm households, particularly in developing countries. Barrett et al. (2001) conceptualized the relationship between the farm and non-farm sectors in terms of pull and push factors. The idea is that there are certain factors pulling or pushing farm households to engage in off-farm work. An example of this is the limited landholding, which pushes farm households to work off-farm (van den Berg and Kumbi, 2006). Cunguara et al. (2011) also found that as a result of drought, households in Mozambique resorted to off-farm work as a coping strategy. Furthermore, a study by Mathenge and Tschirley (2015) indicated that Kenyan farmers work off-farm in order to overcome anticipated risks. Alasia et al. (2009) also view participation in off-farm work as a self-insurance mechanism aimed at increasing and stabilizing the household's income. Participation in off-farm work also enables farm households to reduce vulnerability (Seng, 2015) and stabilize consumption (Reardon et al., 1992). Lanjouw (1999) identified declining farm incomes and the need to mitigate production risks as factors leading to the rise in off-farm activity among farm households. Seng (2015), on the other hand, identified the head of household's age and educational attainment as well as landholding as factors determining participation in non-farm work in rural Cambodia.

Participation in off-farm work is also motivated by shifts in producer incentives and employment opportunities outside the farm. Farm households may view working off-farm as more desirable than working on-farm if the incentives for working outside the farm sector outweigh the benefits of working on the farm. An increase in the opportunities for employment outside the farm sector may therefore motivate farm households to seek employment outside farming.

On-farm and off-farm work play complementary roles with potential benefits to the farm sector in many developing countries. For example, it is not uncommon for farm households to invest income from off-farm work in farm operations and vice versa. Income from working outside the farm can facilitate the acquisition of farm inputs or the adoption of new

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technologies, while income from farming can be invested in commerce. Thus, backward and forward linkages exist between the two sectors in many developing countries.

The existing literature alludes to two main potential direct effects of income from off-farm work (Babatunde, 2015): the liquidity-relaxing effect, which supposes a potential increase in farm expenditure/investment, and the lost-labour effect, which supposes a potential allocation of labour away from the farm. Authors such as Ellis and Freeman (2004), de Janvry et al. (2005) and Stampini and Davis (2009) point to the liquidity-relaxing effect of income from off-farm work in different studies. Ellis and Freeman (2004) identified positive effects of off-farm income on land productivity, the hiring in of labour, and the acquisition of farm inputs while Oseni and Winters (2009) observed a greater use of hired labour and inorganic fertilizers among Nigerian farmers engaged in off-farm work. Similarly, Anriquez and Daidone (2010) found off-farm work to enhance investment in farm inputs among farmers in rural Ghana, while Maertens (2009) found off-farm employment to increase fertilizer use and cultivated areas in a study in Senegal. Pfeiffer et al. (2009), on the other hand, found off-farm employment to have a positive impact on the demand for farm inputs but a negative impact on output and use of household labour in production. An inverse relationship between the diversification of household income through working off-farm and farm investment is also reported by Ahituv and Kimhi (2002) and Davis et al. (2009).

From the foregoing, the potential direct effects of income from off-farm work have implications for agricultural productivity of smallholders. Diversification of the household's income sources may lead to either reallocation of time and labour away from farming, or it may relax its liquidity constraint thus enabling it to finance acquisition of farm inputs. The way farm households utilize income from off-farm work will determine whether off-farm income will translate directly into productivity growth at the farm level. Also, if participation in off-farm work places constraints on household labour availability for farm operations, this will adversely affect farm performance. Hence, income from off-farm work may not necessarily support on-farm investment, even though this is a common assumption regarding participation in off-farm activity. This assumption is based on the notion that smallholder farmers depend on agriculture as their main source of employment and are therefore expected to invest their extra income in farming. Authors such as Ellis and Freeman (2004), de Janvry et al. (2005), Stampini and Davis (2009) and Anriquez and Daidone (2010) have reported an increase in farm investment as a result of off-farm work. However, this view contrasts with Ahituv and Kimhi (2002) and Davis et al. (2009), who reported that income from off-farm work does not necessarily support on-farm investment.

As indicated by Babatunde (2015), the empirical literature provides contrasting evidence of the effects of off-farm employment on agricultural productivity and efficiency. For example, Kumbhakar et al. (1989) found the productivity of dairy farms in the USA to have a negative relationship with off-farm income. Yee et al. (2004) also reported a negative relationship between off-farm work and productivity in the south-eastern region of the United States. Similarly, Nasir and Hundie (2014) found a negative effect of off-farm employment on land productivity in southern Ethiopia. However, Gebregziabher et al. (2012a) as well as Woldehanna and Oskam (2001) found off-farm income to increase agricultural productivity by relieving farm households' credit constraints in northern Ethiopia. Similarly, Wang et al. (2011) found a positive effect of non-farm revenue on agricultural productivity in rural China. There is therefore no consensus regarding the effect on productivity when the household trades agicultural labor for income outside the farm sector. An important policy question however concerns the effect of off-farm work on smallholders' efficiency and productivity. This paper seeks to provide answers to this question by assessing the determinants of off-farm activity participation by smallholder rice farmers in Ghana and the effect off-farm work has on farmers' productivity level. The study also fills an important research gap due to the scarcity of studies on the effect of off-farm work on agricultural productivity of smallholder farmers in Ghana. To the best of the author's knowledge, this study is the first to assess the effect of off-farm activity participation on the productivity of smallholder rice producers in northern Ghana.

## Material and methods

*Conceptual framework for off-farm employment participation*

As reported by Jolliffe (2004), roughly 74% of Ghanaian farm households are involved in some form of off-farm work. Owusu et al. (2011) identified agro-processing, commerce, charcoal production, and seasonal migration as some of the off-farm income sources in rural Ghana. Other off-farm activities include gin brewing, basketry, and gathering firewood for sale.

Huffman (1991) provides a useful framework for analysing farm household labour allocation decisions. Owusu et al. (2011) used this framework in their study on off-farm work and food security among farm households in northern Ghana, on which the current study draws. According to the model, households allocate their time to specific activities that include off-farm work. The household's objective is to maximize its total utility, subject to certain constraints. The utility function that the household seeks to maximize is expressed as: $U = U(Q, H)$, where $Q$ is the household's consumption of goods and $H$ is leisure. This utility-maximizing behaviour is subject to time, budget, production, and non-negativity constraints (Owusu et al. 2011). The household's time constraint is given as: $T = L_1 + L_2 + H$, where $T$ represents the total household time endowment, $L_1$ is time allotted to farm work, $L_2$ is time allotted to off-farm work, and $H$ is leisure.

The household faces a budget constraint on its cash income given by:

$$PQ = p_1 y_1 - w_1 L_1 + w_2 L_2 + R, \quad (1)$$

Where $P$ represents the price of goods bought by the household, $w_1$ is returns from on-farm work, $w_2$ is returns from off-farm work, $y_1$ is farm output, $p_1$ is the price of the household's farm output, and $R$ is non-labour income.

As indicated earlier, households allot their time between farm work, off-farm work, and leisure. The first-order condition for optimal time allocation for the three activities is as follows:

$$\partial U/\partial L_i = w_i \partial U/\partial Q - \partial U/\partial L = 0 \quad (2)$$

Rearranging (2), we can derive the returns to labour from on-farm and off-farm work as follows:

$$w_i = (\partial U/\partial L)/(\partial U/\partial Q) \quad (3)$$

The labour supply functions for on-farm and off-farm work, respectively, are given by equations (4) and (5):

$$L_1 = L_1 (w_1, w_2, p_1, p_2; Z) \quad (4)$$

$$L_2 = L_2 (w_1, w_2, p_1, p_2; R; Z) \quad (5)$$

Where $Z$ represents independent variables affecting the household's reservation and off-farm wages. If we denote the potential market wage by $w_i^m$ and the reservation wage by $w_i^r$, then $L_1 = 1$ if $w_i^m > w_i^r$, and $L_i = 0$ if $w_i^m \leq w_i^r$. Both the reservation and the potential market wages are not observable, but we observe the decision whether or not to participate in off-farm work. Such a decision can be analysed using a probit (or logit) model.

The reservation wage refers to the minimum wage at which an individual will consent to work. For engagement in off-farm work, it equals the marginal value of a person's time when it is all apportioned to farm and leisure (Owusu et al., 2011).

*Empirical models and data*

The study employs endogenous switching regression (ESR) to analyse the effect of off-farm work on smallholders' productivity. ESR is suitable for situations where we are interested in the effect of being in one of two different positions or regimes (e.g. participation versus non-participation) on a desired outcome. In this study, the two decision states or regimes are whether or not farm households engage in off-farm work, while the outcome of interest is agricultural productivity (measured as rice yield or rice output per area). Since the decision to participate in off-farm work is voluntary, farm households may self-select into off-farm wage activity, resulting in a biased sample and difficulty in determining causation. For example, participants in off-farm work may possess systematically different household attributes from non-participants as a result of self-selection. The use of ESR controls for observable as well as unobservable factors (e.g. ability) that might account for farmers' propensity to engage in off-farm work as well as farm performance. The problem of selection bias is therefore controlled using ESR.

The first step in the application of ESR is to estimate the determinants of off-farm activity participation using a probit model (see Lokshin and Sajaia, 2004), as follows:

$$L_i^* = \alpha Z_i + \mu_i, \quad (6)$$

$$L_i = 1 \text{ if } L_i^* > 1; 0 - \text{otherwise}, \quad (7)$$

Where $L_i^*$ is the latent dependent variable for participation in off-farm activity, which is observed through the choice to participate in off-farm work. The observed dichotomous choice to work off-farm is given by $L_i$, which is equal to 1 for participants and 0 for non-participants. $Z_i$ is a vector of farm and household characteristics affecting participation in off-farm work, $\alpha$ is a vector of unknown parameters, and $\mu_i$ is a random error term. The $Z_i$ variables include the head of household's gender, age, and years of formal education, the location of the farm, farm size, access to microcredit, herd ownership, degree of specialization in rice production, and dependency ratio. The degree of specialization in rice production is measured as the proportion of total landholding allocated to rice production.

The second step in implementing the ESR model is to derive separate productivity functions for the two farm groups. The productivity models are specified as follows:

$$\text{Participants: } Y_{1i} = \beta_1 X_{1i} + \varepsilon_{1i} \text{ if } L_i = 1 \quad (8)$$

$$\text{Non-participants: } Y_{2i} = \beta_2 X_{2i} + \varepsilon_{2i} \text{ if } L_i = 0 \quad (9)$$

Here, $Y_{1i}$ and $Y_{2i}$ are the dependent variables (log of rice yield) in the continuous productivity equation for participants and non-participants, respectively; $X_{1i}$ and $X_{2i}$ represent vectors of weakly exogenous variables, while $\beta_1$ and $\beta_2$ are vectors of parameters; and $\varepsilon_{1i}$ and $\varepsilon_{2i}$ are random disturbance terms. In order to address the sample selectivity bias, the ESR technique relies on joint normality of the error terms in the binary participation and continuous productivity equations. The error terms $u_i$, $\varepsilon_{1i}$ and $\varepsilon_{2i}$ are assumed to have a trivariate normal distribution with mean zero and covariance matrix, given as:

$$\operatorname{cov}(u_i, \varepsilon_i, \varepsilon_i) = \Omega = \begin{bmatrix} \sigma_u^2 & \sigma_{1u} & \sigma_{2u} \\ \sigma_{1u} & \sigma_1^2 & \sigma_{12} \\ \sigma_{2u} & \sigma_{12} & \sigma_2^2 \end{bmatrix} \quad (10)$$

Where $\sigma u^2$ represents the variance of the disturbance term $u_i$ in the probit participation (selection) model in equation (6); $\sigma_1^2$ and $\sigma_2^2$ represent variances of the disturbance terms in the productivity equations; $\sigma_{1u}$ is covariance of $u_i$ and $\varepsilon_{1i}$; $\sigma_{2u}$ is covariance of $u_i$ and $\varepsilon_{2i}$. It must be noted that the covariance between $\varepsilon_{1i}$ and $\varepsilon_{2i}$ is not defined, since $Y_{1i}$ and $Y_{2i}$ cannot be observed simultaneously.

According to Lokshin and Sajaia (2004), an efficient way to estimate ESR models is by full information maximum likelihood (FIML) estimation. This procedure simultaneously estimates the probit selection equation and the productivity equations to provide consistent standard errors. As noted by Lokshin and Sajaia (2004), the model is identified by construction through non-linearities. The FIML estimates of the parameters of the ESR model for this study were obtained using the Stata command movestay (Lokshin and Sajaia 2004).

To ensure that the model is properly identified, at least one independent variable in the first-stage probit participation regression is not included in the second-stage productivity regression (Maddala, 1983). A requirement for the selection instrument is that it must have a direct effect on the decision to participate in off-farm work but not on the outcome of interest (i.e. agricultural productivity). The study used dependency ratio as the selection instrument (or identification restriction) because it directly affects the decision to work off-farm but not agricultural productivity.

The study relied on data from a farm household survey covering 300 smallholders in northern Ghana. Northern

Ghana is considered the country's breadbasket because of the vast amount of agricultural land and the large volume of food produced in this area. The region is characterized by savannah vegetation and a short, unimodal rainfall regime. A multistage stratified random sampling technique was used to select the respondents. In the first stage, two of the regions comprising northern Ghana were purposively selected due to their high involvement in rice production. Next, the three major irrigation schemes in the study area were selected: the Vea and Tono Irrigation Schemes in the Upper East Region, and the Botanga Irrigation Scheme in the Northern Region. Five communities were then selected at random from the vicinity of each irrigation scheme. At the community level, farm households were stratified into irrigators and non-irrigators. Equal numbers of irrigators and non-irrigators were then selected from each community to give a total sample of 300 rice-producing farm households.

Table 1 provides the definitions and summary statistics for the sample. The mean productivity level indicates that yields are quite low among the respondents. The average farm size is less than one hectare, and years of formal education are low. The average head of household is at an active age for agricultural production. The sample contains fewer female heads of household. Roughly 45% of farmland is allocated to rice production. The dependency ratio is high at 85%.

Table 2 presents the descriptive statistics of the respondents according to their participation status in off-farm work.

**Table 1.** Definitions and summary statistics for the sample

| Variable | Description | Mean | Std. Dev. |
|---|---|---|---|
| Productivity | Output per area planted to rice | 790 | 741 |
| Farm size | Farm size in hectares | 0.86 | 0.68 |
| Gender | Dummy: equals 1 for male household head | 0.78 | 0.41 |
| Age | Age in years of the household head | 41.2 | 12.3 |
| Formal education | Years of formal education of household head | 3.93 | 5.35 |
| Specialization | Share of land allocated to rice | 45.4 | 25.1 |
| Cattle ownership | Dummy: equals 1 for cattle ownership | 0.34 | 0.47 |
| Region | Dummy: equals 1for Northern Region | 0.33 | 0.47 |
| Dependency ratio | Percentage of dependent household members | 0.85 | 0.83 |
| Access to credit | Dummy: equals 1 for credit users | 0.40 | 0.49 |

**Table 2.** Descriptive statistics of participants and non-participants in off-farm work

| Variable | Participants (n=128) | | Non-participants (n=172) | | Mean difference |
|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | |
| Productivity (kg/ha) | 812 | 925 | 774 | 568 | 38.0 |
| Farm size (ha) | 0.77 | 0.58 | 0.92 | 0.75 | -0.15 |
| Gender (1=male) | 0.69 | 0.47 | 0.85 | 0.35 | -0.16** |
| Age (years) | 40.0 | 11.1 | 42.1 | 13.1 | -2.10 |
| Formal education (Years) | 5.16 | 5.88 | 3.02 | 4.73 | 2.14** |
| Specialization (% rice land) | 44.2 | 23.0 | 46.2 | 26.6 | -2.00 |
| Cattle ownership (1=Yes) | 0.28 | 0.45 | 0.38 | 0.49 | -0.10 |
| Region (1=Northern) | 0.23 | 0.43 | 0.41 | 0.49 | -0.18** |
| Dependency ratio (%) | 0.88 | 0.87 | 0.82 | 0.79 | 0.06 |
| Access to credit (1=access) | 0.42 | 0.50 | 0.39 | 0.49 | 0.03 |

** indicate significant level at 1%

Participants in off-farm work reported higher rice productivity and had more years of formal education as well as higher dependency ratios. Non-participants in off-farm work were older and had larger farms but lower access to credit. Non-participants in off-farm work also had a higher degree of specialization in rice production. This shows that farmers with a higher degree of specialization in rice production are less likely to engage in off-farm work, other things being equal. The proportion of non-participants owning cattle was higher than that of participants. In addition, a lower proportion of the participants in off-farm work were male farmers. Hence, gender is likely to affect participation in off-farm work. In terms of regional distribution, 41% of the non-participants came from the Northern Region, as against 23% of the participants. Hence, participation in off-farm work is expected to be lower among respondents in the Northern Region.

## Results

*Determinants of participation in off-farm activity*

Table 3 presents the results of the off-farm participation model. The study showed that female farmers were more

likely to participate in off-farm income activity in the study area. Similarly, farm households with a higher dependency ratio were more likely to participate in off-farm work compared with households with a lower dependency ratio. In addition, farmers with more years of formal education had higher participation in off-farm employment compared with farmers with less formal education. Farmers located in the Upper East Region were also more likely to take part in off-farm work compared with those in the Northern Region, while households with cattle were less likely to engage in off-farm activity. The dependency ratio variable, which was included in the adoption model but not in the productivity model in order to identify the model (Abdulai and Huffman, 2014), had a positively significant effect on the decision to work off-farm.

**Table 3.** Determinants of smallholder farm households' participation in off-farm work

| Variable | Coefficient | Standard Error | *P*-value |
|---|---|---|---|
| Gender | -0.500* | 0.194 | 0.010 |
| Age | 0.127 | 0.260 | 0.626 |
| Education | 0.051** | 0.014 | 0.000 |
| Farm size | -0.138 | 0.162 | 0.394 |
| Farm size squared | 0.120 | 0.104 | 0.249 |
| Regional dummy | -0.469* | 0.203 | 0.021 |
| Access to credit | 0.151 | 0.158 | 0.337 |
| Herd ownership | -0.392* | 0.166 | 0.018 |
| Degree of specialization | -0.003 | 0.003 | 0.354 |
| Dependency ratio | 0.125* | 0.062 | 0.043 |
| Constant | -0.232 | 0.992 | 0.815 |
| Observations | 300 | - | - |

* indicate significant level at 5%; ** indicate significant level at 1%;

*Determinants of productivity*

The FIML estimates of the ESR of the determinants of farm productivity are presented in Table 4. The likelihood ratio test for joint independence of the three equations is statistically significant at 1% level. The covariance term for the adopters ($\rho_{\varepsilon 1u}$) is negative and statistically significant at 1% level, while the covariance term for the non-adopters is positive and statistically significant at 1% level.

**Table 4.** Full information maximum likelihood (FIML) estimates of the endogenous switching regression of the determinants of farm productivity

| Variables | Participants (n=128) | | | Non-participants (n=172) | | |
|---|---|---|---|---|---|---|
| | Coefficient | S.E. | P-value | Coefficient | S.E. | P-value |
| Gender | 1.091** | 0.304 | 0.000 | 0.361 | 0.195 | 0.064 |
| Age | 0.047 | 0.413 | 0.909 | 0.266 | 0.219 | 0.226 |
| Education | -0.077** | 0.022 | 0.000 | 0.011 | 0.015 | 0.476 |
| Farm size | -0.466 | 0.251 | 0.064 | -0.639** | 0.153 | 0.000 |
| Farm size squared | 0.003 | 0.171 | 0.987 | 0.243** | 0.091 | 0.007 |
| Regional dummy | 0.996** | 0.325 | 0.002 | 0.321 | 0.175 | 0.067 |
| Access to microcredit | -0.048 | 0.244 | 0.844 | 0.289* | 0.138 | 0.037 |
| Herd ownership | 0.833** | 0.267 | 0.002 | 0.099 | 0.142 | 0.488 |
| Degree of specialization | 0.022** | 0.006 | 0.000 | 0.007** | 0.003 | 0.009 |
| Constant | 5.648** | 1.549 | 0.000 | 5.081** | 0.874 | 0.000 |
| ln $\sigma_{\varepsilon 1u}$ | 0.426** | 0.096 | 0.000 | - | - | - |
| $\rho_{\varepsilon 1u}$ | -0.951** | 0.030 | 0.000 | - | - | - |
| ln $\sigma_{\varepsilon 2u}$ | - | - | - | -0.075 | 0.099 | 0.451 |
| $\rho_{\varepsilon 2u}$ | - | - | - | 0.845** | 0.092 | 0.000 |
| LR test of indep. eqns. | 13.05** | | | | | |
| Log likelihood | -547.9 | | | | | |

Note: The dependent variable is the natural log of yield, defined as output per area. The selection equation reported in Table 3 and outcome equations above were jointly estimated using FIML.
* indicate significant level at 5%; ** indicate significant level at 1%.

According to the results, the productivity of participants in off-farm work is affected by the head of household's gender and years of formal education, farm location, herd ownership, and the degree of specialization in rice production. The results show that the productivity of participants increased when the household was headed by a male farmer, was located in the Northern Region, possessed cattle, and specialized more in rice production, but decreased with the number of years of formal education. For the non-participants in off-farm work, productivity was affected by farm size, access to microcredit and degree of specialization in rice production. The productivity of non-participants in off-farm work increased when the household had access to credit, was located in the Northern Region, and specialized more in rice production, but decreased with farm size.

The results reveal that access to credit affects the productivity of non-participants in off-farm work, but not the productivity of participants. The study also indicates an inverse relationship between farm size and productivity. Furthermore, the study shows that length of formal education is positively associated with participation in off-farm work but negatively related to productivity. Finally, herd ownership enhances the productivity of participants, but has no effect on the productivity of non-participants in off-farm work while the degree of specialization in rice production had the same productivity effect on both participants and non-participants.

*Estimation of average treatment effect of off-farm work on productivity*

Table 5 presents the results of the average treatment effect of participation in off-farm activity on the farm households' agricultural productivity. To ensure robustness in the estimation, different estimation procedures were used. The results indicate that participation in off-farm work increases rice productivity by an amount ranging between 175.4 kg/ha and 218.5 kg/ha.

**Table 5.** Estimates of the average treatment effect of nonfarm work on productivity

| Treatment effect estimation method | Coefficient | Robust S.E. | *P*-value |
|---|---|---|---|
| Nearest-neighbour matching | 218.5* | 97.2 | 0.025 |
| Regression adjustment | 175.4 | 90.5 | 0.053 |
| Inverse-probability weighting | 190.5* | 88.6 | 0.031 |
| Inverse-probability-weighted regression adjustment | 175.4 | 90.5 | 0.053 |

* indicate significant level at 5%

## Discussion

*Participation in off-farm work*

Women in many rural areas play critical roles in the home, augmenting the household income through petty trading and other income activities. Due to their entrepreneurial abilities, women are more likely to engage in off-farm activities, in consonance with the findings of this study. This result accords with Man and Sadiya (2009), who found male paddy farmers in Malaysia to be less likely to engage in off-farm work. However, the result is at variance with Matshe and Young (2004), who found lower female participation in the off-farm labour market in Zimbabwe. Corral and Reardon (2001) also reported higher male participation in non-farm waged employment in Nicaragua, although non-farm self-employment was found to be lower for males.

Households with higher dependency ratios tend to have more family obligations and higher expenditure, other things being equal. Consequently, households with more dependents are more likely to participate in off-farm work to supplement their income from farming. This finding of the study is consistent with Man and Sadiya (2009), who found that Malaysian paddy farmers' likelihood of engaging in off-farm work increased as the number of dependents increased. Rahman (2013) also established the dependency ratio to positively influence the decision to work in the service sector in Bangladesh. On the other hand, Owusu et al. (2011) found that females' participation in non-farm employment in northern Ghana was influenced negatively by the dependency ratio. However, the authors found a non-significant positive effect of the dependency ratio on males' participation in non-farm employment.

Education enhances the value of human capital and opens up more opportunities for rural people to engage in income-earning activities. Educated farmers are therefore expected to have a higher participation in off-farm work, since they are more likely to find jobs outside the farm sector compared with uneducated farmers. This result agrees with Seng (2015), who found that the years of formal education of the household head enhanced participation in non-farm work in rural Cambodia. Abdulai and CroleRees (2001) also established higher participation in off-farm work among households with educated heads compared with households with illiterate heads. Similar result was obtained by Owusu et al. (2011) in their study on non-farm work and food security in northern Ghana. As indicated by Ferreira and Lanjouw (2001), years of formal education make household members more employable.

The lower participation of herd owners in off-farm work might indicate a lower likelihood of wealthier households to engage in off-farm work, since herd ownership is an indication of wealth in many rural communities in Ghana. This result contrasts with Owusu et al. (2011), who found cattle ownership to have a positive and significant effect on males' participation in non-farm employment in northern Ghana but a non-significant positive effect on females' participation in

non-farm employment. Beyene (2008), on the other hand, showed that herd size positively influenced women's participation in off-farm work in Ethiopia but did not influence males' participation.

The higher participation of farmers in the Upper East Region in off-farm work, compared with their counterparts in the Northern Region, suggests that regional variations account for farmers' participation in off-farm work. The Upper East Region is further from the national capital and has a higher population density than the Northern Region. Hence, land for arable crop production may be scarcer in the Upper East Region compared with the Northern Region. These factors may account for the higher income diversification among farm households in the Upper East Region.

*Determinants of productivity*

The likelihood ratio test for joint independence of the three equations indicates that the equations are dependent. The covariance terms ($\sigma_{\varepsilon 1u}$ and $\sigma_{\varepsilon 2u}$) are non-zero, indicating that the model shows endogenous switching (Maddala, 1986). This therefore justifies the use of the ESR model. The significance of the correlation between $\varepsilon_1$ and $\mu$ ($\rho_{\varepsilon 1u}$) indicates the presence of self-selection in participation in off-farm activity. The result implies that participation in off-farm work may not produce the same effect on non-participants, if they decide to participate (Lokshin and Sajaia, 2004). Since the coefficient $\rho_{\varepsilon 1u}$ is negative and significantly different from zero, the model indicates that participants in off-farm work have higher productivity than a random household from the sample. The negative sign of $\rho_{\varepsilon 1u}$ can also be interpreted to mean a positive selection bias so that participants enjoy above-average productivity levels (yields) once they take part in off-farm work. The model satisfies the necessary conditions for consistency since $\rho_{\varepsilon 2u} > \rho_{\varepsilon 1u}$, suggesting that participants achieve higher yields than would be the case if they did not participate (Lokshin and Sajaia, 2004; Trost, 1981). On the other hand, the positive and significant value of $\rho_{\varepsilon 2u}$ (correlation between $\varepsilon_2$ and $\mu$) indicates that non-participants enjoy above-average productivity levels when they do not take part in off-farm work. Thus farm households' decisions to participate in off-farm work are based on comparative advantage (Maddala, 1983; Rao and Qaim, 2011). The findings concur with Barrett et al. (2004), Abdulai and Binder (2006) and Abdulai and Huffman (2014).

The findings point to an inverse relationship between farm size and productivity. This supports the almost stylized fact of an inverse relationship between farm size and productivity. Even though some researchers (e.g. Cornia, 1985; Yee et al., 2004) have found a positive relationship between farm size and productivity, authors such as Larson et al. (2012) and Thapa (2007) established productivity to decrease with farm size. Since smallholders are mainly resource-poor and largely rely on their own resources for production, it is anticipated that they would be severely constrained in managing very large farms. It is expected that farmers' managerial abilities are related to their education and access to extension services and information, which are lacking in most rural communities. Hence, most smallholders are likely to be less productive on larger farms, other things being equal. Productivity decreased at an increasing rate for the non-participants, while for the participants, the quadratic term of the farm size variable had a non-significant positive effect on productivity. The result accords with Abdulai and Huffman (2014), who reported a negatively significant influence of farm size on rice yield among non-adopters of soil and water conservation technology in Ghana but not among adopters.

An important implication of the current study is that education tends to draw labour away from the farm sector, thereby reducing productivity at the farm level. This is shown by the positive effect of education on participation in off-farm activity and the opposite effect on the productivity of participants. Hence, there is a labour-loss effect associated with additional years of formal education, due to its positive effect on participation in off-farm activity. On the other hand, education does not influence the productivity of non-participants. The education variable has a non-significant positive effect on the productivity of farm households that do not engage in off-farm work. This result is at variance with Abdulai and Huffman (2014), who established a positively significant influence of education on rice yield among both adopters and non-adopters of soil and water conservation technology in four districts in the Northern Region of Ghana.

The results of the study also revealed an important role of the wealth status in agricultural productivity among smallholders in the study area. In the current study, herd ownership was used as a proxy for wealth status, because it is usually wealthier households that own cattle in many rural communities. As expected, participation in off-farm work was lower for herd owners, suggesting that wealthier households participated less in off-farm work. The positive and significant effect of cattle ownership on the productivity of participants indicates the important role of cattle as draught animals in smallholder farming. Cattle ownership had no effect on the productivity of non-participants in off-farm work, suggesting that wealthier non-participants may be using more improved technology, such as machinery, in production.

Another important implication of this study is that the impact of credit on farm productivity seems to depend on the household's income diversification. Access to credit is considered an important determinant of productivity growth (Reyes et al., 2012). Access to credit allows optimal input use, resulting in a positive impact on agricultural productivity. Accordingly, there are several attempts by both governmental and non-governmental organizations to increase smallholders' access to agricultural credit. The current study indicates that access to credit enhances the productivity of non-participants in off-farm work but has a non-significant negative effect on the productivity of participants. The result could mean that non-participants in off-farm work utilize credit more efficiently in farming. The result is consistent with other studies, such as Abdulai and Huffman (2014), who found a positively significant influence of credit on rice yield among both adopters and non-adopters of soil and water conservation technology in the Northern Region of Ghana. Furthermore, Reyes et al. (2012) identified access to credit as one of the factors influencing farm productivity and rural development in Chile.

In line with a priori expectations, the degree of specialization in rice production had a positive effect on farmers' levels of productivity. This result accords with the economic theory that specialization leads to higher productivity. The study also supports the findings of other researchers that show that male farmers are more productive in production due to their greater access to productive resources. The results further indicate that productivity of participants in off-farm work is influenced by geographical location of the farm, with producers in the Northern Region having higher productivity than their counterparts in the Upper East Region. As noted by Gebregziabher et al. (2012b), biophysical and environmental factors may influence farmers' efficiency and productivity. Finally, the age of the household head had no significant effect on the productivity of farm households. This result accords with Abdulai and Huffman's (2014) study involving rice-producing households in Northern Ghana.

*Average treatment effect of off-farm work on productivity*

This study highlights income diversification as an important livelihood strategy among farm households, with a positive effect on agricultural productivity. Results from the ESR diagnostic coefficients as well as the treatment effects model reveal a positive association between off-farm work and agricultural productivity. Hence, this study does not seem to indicate a lost-labour effect from off-farm work. On the other hand, the study seems to support the notion of a liquidity-relaxing effect of off-farm work on agricultural productivity. In other words, participation in off-farm work might enable farmers to earn wages in order to finance agricultural production, e.g. the purchase of seeds and hiring of labour. The results of the treatment effects model are robust and justifiable from the different methodologies employed in the estimation. The findings accord with Wang et al. (2011), who found a positive effect of non-farm revenue on agricultural land productivity in rural China. Woldehanna and Oskam (2001) also found off-farm income to increase agricultural productivity in northern Ethiopia.

## Conclusion

The study examined the effect of participation in off-farm activity on agricultural productivity among smallholder rice farmers in northern Ghana. Self-selection into off-farm work was addressed using an endogenous switching regression framework. Results of a probit analysis found the head of household's gender and years of formal education, herd ownership, the dependency ratio, and the geographical location of the farm household to be significant factors influencing the decision to participate in off-farm work. According to the ESR results, farm productivity of both participants and non-participants in off-farm work was influenced by degree of specialization in rice production. Gender, herd ownership, years of formal education and location of the farm affected the productivity of participants in off-farm work, while farm size and access to credit were significant in their effect on productivity of non-participants. Results from a treatment effects model showed that participation in off-farm work had a positive effect on farmers' levels of productivity. Generally, the results obtained showed that income diversification is an important livelihood strategy among smallholders, and that earning an income from working off-farm enables smallholders to improve their yields. This paper makes a significant contribution to the literature by confirming the direction of effect of off-farm work on agricultural productivity of smallholder farmers in the light of contrasting evidence provided by previous studies on the subject. The findings from the study can be used as a guide policy-making on strategies to improve agricultural productivity and rural development in Ghana and other developing countries.

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## Conflict of interest

The author declares no conflict of interest.

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