Effect of non-farm work on agricultural productivity

Empirical evidence from northern Ghana

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Abstract: This paper investigates the factors influencing participation in non-farm work and the effect of participation on farmers' productivity, using survey data from 300 smallholder farm households in northern Ghana. The study employs an endogenous switching regression model to address selection into non-farm work, and a treatment effects model to measure the effect of participation on productivity. Factors determining participation in off-farm activity include the head of household's gender and years of formal education, the location of the farm, ownership of cattle, and the dependency ratio. Factors affecting productivity include gender, years of formal education, farm size, location of the farm, access to credit, herd ownership, and degree of specialization in rice production. Results from a treatment effects model indicate a positively significant effect of non-farm employment participation on farm productivity. Income diversification therefore remains an important livelihood strategy among smallholders, and earnings from off-farm work enable smallholders to improve their yields.

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1   Introduction

The farm economy literature on developing countries in the 1950s and 1960s regarded farm households as dependent on their own farming to meet their food security needs. If households were unable to generate enough food to meet their own requirements from the farm, they would engage in off-farm waged employment, or would send out migrants to work in the cities and send back remittances (Davis et al. 2009). However, new research findings show that rural non-farm employment currently comprises roughly 40–60% of rural incomes in Latin America, Asia, and Africa. Farm households may now be deciding to work off-farm for various reasons, including limited access to production inputs, better off-farm wages, declining farm wages, and the desire to mitigate production risks. The likelihood of engaging in off-farm work increases with the declining profitability of farming and the emergence of rural non-farm employment opportunities. In many developing countries, farm incomes are declining, and opportunities for non-farm work are emerging, especially in the cities. The decline in farm wages and emerging opportunities for work outside the farm sector can promote households' participation in rural non-farm work. As noted by Davis et al. (2009: 119), 'RNFE tends to be, in most countries, even much more important than migration and farm wage-labor income and often more important than cash cropping as a source of income and liquidity.'

The increasing importance of non-farm work (and decreasing importance of agriculture) to smallholder farm households is reported in some studies. For example, Mudhara (2010) reports that smallholder farm households in South Africa derive only a small fraction of their livelihoods directly from agriculture, with remittances, off-farm work, and government transfers providing the main source of livelihood.

The participation of farm households in off-farm work is a major decision that has implications for farm output and productivity in many developing countries. For example, investing the income from rural non-farm work in new production technologies and farm inputs may enhance the household's production efficiency and agricultural productivity. Income from off-farm work can also supplement on-farm income, thus contributing to household welfare and food security. However, when the income from non-farm sources is spent on non-farm activities (e.g. acquisition of household consumables, such as a new television set), productivity growth may not be realized. Thus the way farm households utilize income from rural non-farm employment is important for bringing about improved farm efficiency. Furthermore, if involvement in off-farm work places constraints on household labour for farm operations, then this will adversely affect farm performance.

Despite the important role of rural non-farm work in household welfare and food security, not much is known about its effect on farm performance, particularly with regard to the efficiency and productivity of smallholder agricultural production in Ghana. Much of the research on off-farm work in developing countries, including the little that relates to Ghana, has focused on the impact of working outside the farm on household welfare and food security (Owusu et al. 2011). What is unclear, particularly in the Ghanaian context, is the effect of off-farm work on the productivity of smallholder farmers, who are the main food producers in Ghana. Ascertaining the effect of off-farm work on farmers' productivity will help the formulation of policy to address some of the challenges of rural poverty and low agricultural productivity among smallholder farmers in Ghana and other developing countries. As indicated earlier, 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 will therefore invest their extra

income in farming. Authors such as de Janvry et al. (2005), Ellis and Freeman (2004), Anriquez and Daidone (2010), and Stampini and Davis (2009) have reported an increase in farm investment as a result of off-farm labour. However, this view contrasts with Ahituv and Kimhi (2002) and Davis et al. (2009), who suggest that income from off-farm work does not necessarily support on-farm investment.

The current study therefore empirically investigates the effect of non-farm work on the productivity of smallholder rice producers in northern Ghana, using household survey data collected in 2014. The rest the paper is structured as follows. Section 2 provides a brief literature review, followed in section 3 by an outline of the methodology used for the study. The methodology includes the conceptual framework, empirical models, and data. The results of the study are presented in section 4, with a discussion of the results in section 5. The conclusion and policy recommendations are presented in section 6.

2   Literature review

Among the challenges confronting Ghana and many developing countries are food insecurity and poverty (Owusu et al. 2011). Urban and rural poverty coexist in Ghana, but the incidence of rural poverty seems to be exacerbated by declining farm incomes, low agricultural productivity, and limited employment opportunities outside the farm sector. Rural farm households have therefore devised various means to overcome the challenges of poverty and food insecurity. Participating in off-farm employment activities and sending migrants to waged employment in the cities are some of the means adopted by rural households to obviate poverty and food insecurity.

There is a view that increasing food production as the means to tackle food insecurity in Africa may not be adequate; hence the need to promote rural non-farm employment to provide farmers with additional income (Gladwin et al. 2001). In many rural areas of sub-Saharan Africa, non-farm employment opportunities may be considered a possible solution to the vicious cycle of food insecurity. In light of the foregoing, it seems logical that attention to the generation of rural employment should be important in the fight against rural poverty and food insecurity in Africa.

Available evidence indicates that a high proportion of farm households and small-farm operators engage in non-farm waged employment in many developing countries as an additional source of household income. In addition, 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 reported as 42%, 32%, and 40% respectively (Reardon et al. 1998). Escobal (2001) found rural non-farm employment to constitute 51% of rural household income in Peru. A study conducted in the Hubei province of China by de Janvry et al. (2005) found an estimated 36% of rural household income to come from non-farm employment. The authors also found households that participated in non-farm employment to have higher incomes than households that did not participate in non-farm employment. Furthermore, the authors found participation in non-farm work to reduce income inequality. In a study of Mexican households, Pfeiffer et al. (2009) found the proportion of household income from rural non-farm employment to be 33%. In addition, Kilic et al. (2009) found the proportion of household income from rural non-farm employment to amount to 50% in Latin America and 35% in Africa. At the global level, the figure is estimated at 58%. As noted by Chang and Wen (2011), participation in off-farm work is a persistent phenomenon, and reliance on off-farm work is expected to increase. Participation in off-farm work is not a phenomenon restricted to farmers in developing countries. Bagi (1984), Fernandez-

Cornejo et al. (2007), and Kumbhakar et al. (1989) have reported participation in off-farm activity among farmers in developed countries such as the United States.

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. For example, 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. 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 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) indicates 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). The poverty reduction effect of engaging in off-farm work is recognized by Lanjouw and Lanjouw (2001) and Lanjouw and Shariff (2004). Off-farm work also enhances household consumption expenditure (Akaakohol and Aye 2014). Seng (2015) 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. The study showed that older farmers were more likely to work off-farm, and farmers with larger landholdings were less likely to engage in off-farm work. Household heads with better educations also have a higher propensity for working off the farm (Akaakohol and Aye 2014; Lanjouw and Shariff 2004).

Participation in off-farm work is also expected to be 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 waged 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 off the farm can facilitate the acquisition of farm inputs or the adoption of new 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 de Janvry et al. (2005), Ellis and Freeman (2004), Ruben and van den Berg (2001), and Stampini and Davis (2009) point to the liquidity-relaxing effect of income from off-farm work in different studies. These studies highlight the positive spillover effects of engaging in off-farm work on farm input among producers. 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. Furthermore, 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 of Senegalese farmers. Pfeiffer et al. (2009), on the other hand, found non-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).

Kumbhakar et al. (1989) found the productivity of dairy farms in the US 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 non-farm employment on land productivity in southern Ethiopia. However, Woldehanna and Oskam (2001), as well as Gebregziabher et al. (2012a), found off-farm income to increase agricultural productivity in northern Ethiopia. This was because off-farm income relieved farm households' credit constraints, thus enhancing expenditure on farm inputs. Similarly, Wang et al. (2011) found a positive effect of non-farm revenue on agricultural productivity in rural China.

As observed by Babatunde (2015), the empirical literature provides mixed evidence about the effects of non-farm employment on agricultural productivity and efficiency. The aim of this paper is therefore to empirically investigate the potential effects of participation in off-farm work on agricultural productivity. The current paper makes a significant contribution to the literature on the effect of non-farm work on smallholder farmers' agricultural productivity in view of the contrasting evidence provided so far by previous studies on the subject. To the best of my knowledge, the current study is the first to assess the effect of participation in non-farm activity on the productivity of Ghanaian smallholder rice farmers. The findings from the study will be helpful in informing policymakers on ways to improve agricultural productivity and rural livelihoods.

3 Materials and methods

3.1 Conceptual framework for non-farm employment participation

As reported by Jolliffe (2004), roughly 74% of Ghanaian farm households are involved in some form of non-farm work. Owusu et al. (2011) identified agro-processing, commerce, charcoal production, and seasonal migration as some of the non-farm income sources in rural Ghana. Other non-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 non-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:

$$PQ = p_1 y_1 - w_1 L_1 + w_2 L_2 + R \qquad [1]$$

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:

$$\partial U / \partial L_i = w_i \partial U / \partial Q - \partial U / \partial L = 0 \qquad [2]$$

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

$$w_i = (\partial U / \partial L) / (\partial U / \partial Q) \qquad [3]$$

The labour supply functions for on-farm and off-farm work respectively are given by equations [4] and [5]:

$$L_1 = L_1(w_1, w_2, p_1, p_2; Z) \qquad [4]$$

$$L_2 = L_2(w_1, w_2, p_1, p_2, R; Z) \qquad [5]$$

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[1] by w_i^r, then $L_i = 1$ if $w_i^m > w_i^r$, and $L_i = 0$ if $w_i^m \leq w_i^r$. Both the reservation and 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.

3.2 Empirical models and data

The study employs endogenous switching regression (ESR) to analyse the effect of non-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 non-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 non-farm wage activity, resulting in a biased sample and difficulty in determining causation. For example, participants in non-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

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[1] 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).

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 non-farm activity participation using a probit model (see Lokshin and Sajaia 2004), as follows:

$$L_i^* = \alpha Z_i + \mu_i \qquad\qquad [6]$$

$$L_i = \begin{cases} 1 & if \ L_i^* > 1 \\ 0 & otherwise \end{cases} \qquad\qquad [7]$$

where L_i^* is the latent dependent variable for participation in non-farm activity, which is observed through the choice to participate in non-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, α is a vector of unknown parameters, and μ_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:

Participants: $\qquad\qquad Y_{1i} = \beta_1 X_{1i} + \varepsilon_{1i} \qquad\qquad$ if $\qquad\qquad L_i = 1 \qquad [8]$

Non-participants: $\qquad Y_{2i} = \beta_2 X_{2i} + \varepsilon_{2i} \qquad\qquad$ if $\qquad\qquad L_i = 0 \qquad [9]$

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 β_1 and β_2 are vectors of parameters; and ε_{1i} and ε_{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, ε_{1i}, and ε_{2i} are assumed to have a trivariate normal distribution with mean zero and covariance matrix, given as:

$$\text{cov}(u_i, e_{1i}, e_{2i}) = W = \begin{bmatrix} S_u^2 & S_{1u} & S_{2u} \\ S_{1u} & S_1^2 & S_{12} \\ S_{2u} & S_{12} & S_2^2 \end{bmatrix} \qquad\qquad [10]$$

where σ_u^2 represents the variance of the disturbance term u_i in the probit participation (selection) model in equation [6]; σ_1^2 and S_2^2 represent variances of the disturbance terms in the productivity

equations; σ_{1u} is covariance of u_i and ε_{1i}; S_{2u} is covariance of u_i and ε_{2i}. It must be noted that the covariance between ε_{1i} and ε_{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 non-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 comprises the Northern, Upper East and Upper West Regions, which together produced 66.7% of total rice output in Ghana in 2010 (Angelucci et al. 2013). 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 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

Source: author's computation.

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

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

*Significant at the 10% level.

**Significant at the 1% level.

Source: author's computation.

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.

4 Results

4.1 Determinants of participation in non-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 non-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 non-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 non-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		

*Significant at 5% level.

**Significant at 1% level.

Source: author's computation.

4.2   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 the 1% level. The covariance term for the adopters ($\rho_{\varepsilon_1 u}$) is negative and statistically significant at the 1% level, while the covariance term for the non-adopters is positive and statistically significant at the 1% level.

Table 4: Full information maximum likelihood estimates of the endogenous switching regression of the determinants of farm productivity

Variables	Participants (*n* = 128)			Non-participants (*n* = 172)		
	Coefficient	SE	*P*-value	Coefficient	SE	*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
$\ln \sigma_{\varepsilon_1 u}$	0.426***	0.096	0.000			
$\rho_{\varepsilon_1 u}$	− 0.951***	0.030	0.000			
$\ln \sigma_{\varepsilon_2 u}$				− 0.075	0.099	0.451
$\rho_{\varepsilon_2 u}$				0.845***	0.092	0.000
LR test of indep. eqns	13.05***					
Log likelihood	− 547.9					

*Significant at 10% level.

**Significant at 5% level.

***Significant at 1% level.

The dependent variable is the natural log of yield, defined as output per area. The selection equation reported in Table 1 and the outcome equations above were jointly estimated using full information maximum likelihood.

Source: author's computation.

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 size, 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 and farm size. For the non-participants in off-farm work, productivity was affected by the gender of the household head, farm size, location of the farm, and degree of specialization in rice production. The productivity of non-participants in off-farm work increased when the household was headed by a male, 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.

Factors that had the same productivity effects on participants and non-participants were the gender of the household head, farm size, location of the farm, and degree of specialization in rice production.

4.3   Estimation of average treatment effect of non-farm work on productivity

Table 5 presents the results of the average treatment effect of participation in non-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 175.4kg/ha and 218.5kg/ha.

Table 5: Estimates of the average treatment effect of non-farm work on productivity

Treatment effect estimation method	Coefficient	Robust SE	P-value
Nearest-neighbour matching (NNMATCH)	218.5**	97.2	0.025
Regression adjustment (RA)	175.4*	90.5	0.053
Inverse-probability weighting (IPW)	190.5**	88.6	0.031
Inverse-probability-weighted regression adjustment (IPWRA)	175.4*	90.5	0.053

* Significant at 10% level.

** Significant at 5% level.

Source: author's computation.

5   Discussion

5.1   Participation in non-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 non-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 non-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 found 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 non-farm work, since they are more likely to find jobs outside the farm sector compared with uneducated farmers. This result accords with Seng (2015), who found that the head of household's years of formal education enhanced participation in non-farm work in rural Cambodia. Abdulai and CroleRees (2001) also found higher participation in off-farm work among households with educated heads compared with households with illiterate heads. This result of this study also accords with Ahituv and Kimhi (2002), Corral and Reardon (2001), Ferreira and Lanjouw (2001), Matshe and Young (2004), and Owusu et al. (2011). As indicated by Ferreira and Lanjouw (2001), years of formal education make household members more employable.

The lower participation of herd owners in non-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 non-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.

5.2 Determinants of productivity

The likelihood ratio test for joint independence of the three equations indicates that the equations are dependent. The covariance terms ($\sigma_{\varepsilon_1 u}$ and $\sigma_{\varepsilon_2 u}$) 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 ε_1 and μ ($\rho_{\varepsilon_1 u}$) indicates the presence of self-selection in participation in non-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 $\rho_{\varepsilon_1 u}$ 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 $\rho_{\varepsilon_1 u}$ 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.[2] On the other hand, the positive and significant value of $r_{\varepsilon_2 u}$ (correlation between ε_2 and μ) 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 the comparative advantage (Fuglie and Bosh 1995; Maddala 1983; Rao and Qaim 2011). Similar results have been obtained by Abdulai and Binder (2006), Abdulai and Huffman (2014), and Barrett et al. (2004).

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), Sen (1962, 1966), and Thapa (2007) have found 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. This result of the study 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 of the study is at variance with Abdulai and Huffman (2014), who reported 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 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-

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[2] The model satisfies the necessary conditions for consistency since $\rho_{\varepsilon_2 u} > \rho_{\varepsilon_1 u}$, suggesting that participants achieve higher yields than would be the case if they did not participate (Lokshin and Sajaia 2004; Trost 1981).

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). Anang et al. (2015) also noted that 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 male farmers to be more productive in production due to their greater access to productive resources. The results further indicate that productivity is influenced by the 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.

5.3 Average treatment effect of non-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 non-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.

6 Conclusion and policy recommendations

The study examined the effect of participation in non-farm activity on agricultural productivity among smallholder rice farmers in northern Ghana. Self-selection into non-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, household 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 for participants and non-participants in off-farm work alike was influenced by the gender of the head of household, farm size, farm location, and degree of specialization in rice production. These factors should therefore be taken into account when strategizing how to enhance the productivity of smallholder farmers in northern Ghana. Herd ownership and the number of years of formal education affected the productivity of participants in off-farm work, while access to credit was significant in its effect on the 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. The study therefore concludes 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.

The following policy recommendations emerge from the study to improve rice productivity in Ghana. First, the results indicate that as farmers specialize in the production of rice they become more productive. Thus productivity can be enhanced by encouraging farmers to specialize more in the cultivation of rice. Second, rice productivity can be enhanced by making agricultural credit available to farmers. This is because credit is significant in its effect on productivity. Even though the effect of credit on the participants' productivity was not significant, its effect on non-participants, as well as results from other studies, indicates that expanding access to credit is likely to bring about improvements in rice productivity.

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