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Rural Non-Farm Engagement and Agriculture Commercialization in Ghana: Complements or Competitors?

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Abstract

We used an endogenous switching probit and a generalized structural equation model (GSEM) to assess the effect of non-farm participation on householders' decisions to sell and on the level of commercialization of agricultural goods in Ghana. For this study, we used the Ghana Living Standards Survey for the years 2012-2013 and found that non-farm participation consistently increased both the probability of selling crops and quantities sold. We concluded that non-farm engagement by farmers boosts market participation and commercialization in Ghana, implying that non-farm engagement and agricultural commercialization are complementary. Developing the agricultural sector requires the government to create the conditions necessary to stimulate farmers' participation in non-farm activities.

JEL: D13; 012; Q13

Keywords: Non-farm participation, Market participation, Commercialization, Endogeneity, Ghana

SSRN Subjects: Agricultural and natural resource economics; Development economics; Econometric modeling in agricultural and natural resource economics; Microeconomics

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List of abbreviations

ATE	Average Treatment Effect
ATT	Average Treatment Effect on the Treated
ATU	Average Treatment Effect on the Untreated
GDP	Gross Domestic Product
GLSS	Ghana Living Standards Survey
GSEM	Generalized Structural Equation Model
GSS	Ghana Statistical Service
NFE	Non-Farm Engagement
OLS	Ordinary Least Squares
RNFE	Rural Non-Farm Economy
SEM	Structural Equation Model

I. Introduction

Ghana's economy is largely agrarian, and the business of agriculture is dominated by smallholder farmers who are predominantly rural dwellers (Ghana Statistical Service [GSS], 2014). The majority of the population in developing countries, in fact, is rural (International Fund for Agricultural Development, 2011; United Nations Conference on Trade and Development, 2015), and the predominant livelihood in such areas comes from farming. Efforts to lift rural farming households from poverty and set them upon the pathway of development has been narrowed to the promotion of agricultural development (Ellis & Biggs, 2001; Haggblade, 2007; United Nations Conference on Trade and Development, 2015). While this view is not entirely flawed, it is becoming obsolete in the advent of a fast-developing rural non-farm economy (RNFE) sector.

Most rural households engage in a range of economic activities beyond farming (United Nations Conference on Trade and Development, 2015). Some studies (e.g., de Janvry & Sadoulet, 2001; Buchenrieder et al., 2010) have attributed the growth of the RNFE to decreasing access to farmland and the need for diversification of risks. In addition, agricultural shocks emanating from poor yields due to climate change and decline in land fertility have also contributed to the rapid growth of the RNFE. These factors are summarized by the United Nations Conference on Trade and Development (2015) which employs the terminology of entrepreneurship by choice, entrepreneurship by necessity, and risk management. Other authors (see, e.g., Barrett, Reardon & Webb, 2001; Reardon et al., 2007) have coined the terms "demand-pull" and "distress-push" to describe the diversification of farm households into non-farm economic activities.

Given that the bulk of agriculture is dominated by small farms, the rising importance of the RNFE should be a major concern to policy makers, scholars, and development institutions. This is because, although the RNFE is usurping the role of agriculture, especially in the agenda of economic transformation of the rural economy, agriculture still remains important (United Nations Conference on Trade and Development, 2015).

In response to this, both farm and non-farm sectors have been the subject of attention and appear, for example, in empirical studies on the linkages between these two sectors. Studies on the links among non-farm activities, income inequality, poverty reduction, and

welfare include those of Reardon and Taylor (1996), Reardon et al. (1998), Mollers and Buchenrieder (2011), Senadza (2011), Dirven (2011), and Dzanku and Sarpong (2014), among others. The conclusions of these studies have not, however, been robust. Attempts to link non-farm activities to productivity, efficiency, and cost complementarity include the work of Anriquez and Daidone (2010), while a third class of studies links non-farm activities to expenditures on agricultural inputs and food security (Dedehouanou et al., 2016; Babatunde & Qaim, 2010; Smale et al., 2016, for example).

Despite these contributions, the farm/non-farm discourse is still evolving. One area that is surprisingly underdeveloped is an exploration of non-farm and farm linkages from the perspective of market participation and agricultural commercialization, despite the fact that market participation has been identified as one of the fulcrums for growth in poor rural households. For example, Yaro, Teye and Torvikey (2017) emphasized the importance of both wage employment and farming as livelihood-diversification strategies for farmers in Ghana. Interest in policy implications has increased as a result, even as a gap in the literature has emerged: connections between market participation and the non-farm sector have yet to be explored adequately.

Two notable contributions in this regard are the studies of Kan, Kimhi and Lerman (2006), and Tudor and Balint (2006), though both suffer from some weaknesses. Kan, Kimhi and Lerman (2006) concentrated solely on farmers who engaged in non-farm work while ignoring those who did not. Such a focus may have led to selection bias and may also have limited the policy application of their findings. Our study overcomes this by incorporating all farmers, whether engaged in on- or off-farm work, in our analysis. The Tudor and Balint study, meanwhile, explored the correlation between off-farm work and commercialization, neglecting causal effects.

The conclusion of at least part of the literature on the effects of non-farm engagement on productivity, efficiency, and agricultural investments/expenditures is implicitly weak: gains in agriculture lead to market participation. But this assumption may not be tenable. In contrast, our study aims to answer the following questions:

1. Does non-farm engagement by farm households promote selling of their farm output (market participation)?

2. How does non-farm engagement influence the quantity of product sold (level of commercialization)?

The answers to these questions have policy implications for Ghana and for developing economies as a whole. Though the agricultural sector is declining in importance in Ghana, its contribution to GDP and to employment should not be undervalued (GSS, 2018). Evidence of the relationship between non-farm engagement and market participation, together with information regarding levels of commercialization, are key microeconomic policy ingredients that can help shape sound, evidence-based policy in the ever-expanding farm/non-farm nexus.

Our study explores the relationship between the farm and non-farm sectors by examining decisions to sell and the quantity of product sold (level of commercialization), and it does so in a manner that is methodologically different from the studies of Kan, Kimhi and Lerman (2006) and Tudor and Balint (2006). Specifically, we estimated the effect of non-farm engagement on decisions to sell and on the level of commercialization in rural households. Notable empirical evidence in the farm/non-farm linkage in Ghana has been provided by Anríquez and Daidone (2010); Owusu, Abdulai and Abdul-Rahaman (2011); Senadza (2011); Dzanku and Sarpong (2014), and Osarfo, Senadza and Nketiah-Amponsah (2016). As noted earlier, however, none of these studies has placed these issues in the context we adopt in this study.

Analyzing the Ghana Living Standards Survey Round 6 (GLSS6) dataset, which was collected in 2012-2013, we estimated the effect of non-farm participation on decisions to sell using an endogenous switching probit. At the same time, we estimated the effect of non-farm participation on the quantity of product sold through a generalized structural equation model (GSEM). One significant result of these analyses is that non-farm participation increased the probability of selling agricultural products and, thus, the level of commercialization; in other words, non-farm participation complemented agricultural commercialization.

II. Literature Review

The farm household model employed by Singh, Squire and Strauss (1986) has largely been the theoretical underpinning for studies on the relationship between farm and non-farm sectors. The model posits that, given the skills present in a household, members allocate labor and other resources to the activities with the highest return (such as non-farm employment). Farm households' involvement in non-farm work is therefore dependent upon their human and physical capital (Woldehanna & Oskam, 2001; Van den Berg & Kumbi, 2006). In addition, farm households' engagement in non-farm work may be driven by "demand-pull" and "distress-push" (Barrett, Reardon & Webb, 2001; Reardon et al., 2007). Households may be pulled into non-farm work if that work provides a higher return to labor or capital and is less risky than on-farm work (Kilic et al., 2009); similarly, they may be pushed into non-farm work to overcome the shocks and risks of on-farm activities (such as poor yields, decline in land fertility, or loss of land) which may threaten their welfare and food security (Woldehanna & Oskam, 2001; Holden, Shiferraw & Pender, 2004).

Conceptually, the effect of non-farm activities on agricultural commercialization is explained through two main theories of impact: the liquidity-relaxing effect and the lost-labor effect (Reardon, Crawford & Kelly, 1994; Woldehanna, 2000; Woldehanna & Oskam, 2001; Babatunde, 2015). The liquidity-relaxing hypothesis posits that income from non-farm activities increases average household income, thereby easing households' capital and credit constraints and increasing capacity to purchase farm inputs, adopt new production technologies, and enhance farm productivity and efficiency. If non-farm income is spent on consumption and other non-farm investment rather than on farm inputs, however, farm productivity may suffer and non-farm work may become a competitor rather than a complement to commercialization (see Babatunde, 2015). The lost-labor-effect argument postulates that engagement in non-farm work places constraints on labor and other resources for farm operations. Expansion of non-farm employment thus means the transfer of labor out of farming and a drop in time spent on farming activities, which decrease farm productivity and efficiency, curtail the adoption of labor-intensive agricultural technology (Omiti et al., 2009) and, subsequently, reduce marketable surplus.

This paper hypothesized that non-farm engagement would affect agricultural

commercialization either by complementing or by competing with commercialization. We expected non-farm engagement to complement commercialization through liquidity-relaxing and market-network building. Income from non-farm engagement eases capital and credit constraints and gives households greater ability to invest in resources that enhance productivity, leading to increases in marketable surplus. Non-farm engagement also aids farmers in developing market networks that facilitate the sale of their products. Alternatively, we expected non-farm engagement to compete with commercialization through lost labor and lost time, and thus through decreases in production and in marketable surplus. The effect of non-farm engagement on agricultural commercialization therefore depends upon whether network creation and increased liquidity outweigh the time and labor lost to production.

A number of studies have concluded that such characteristics of households as education, ethnicity, skills, and gender; assets, financial and social capital; and physical infrastructure and information affect participation in non-farm work in important ways. For example, Ackah (2013) and Olugbire et al. (2012) identified land size, education, and gender as determinants of non-farm work. In a similar vein, Benedikter et al. (2013) observed that education, level of savings, prior work experience, and social capital were the main drivers of non-farm work, while Reardon (1997) identified location as significant in households' decisions to engage in non-farm activities.

A number of studies have investigated the linkage between on-farm and non-farm sectors. Abdullah et al. (2017) found that income from off-farm activities increased the probability of household participation in the market (commercialization) as did such other variables as household size, age, and gender. Woldehanna, Heckelei and Surry (2016), however, observed no effect of non-farm earning on market participation in Ethiopia. Chang, He and Saeliw (2017) reported that husbands' non-farm labor positively affected marketing while the reverse was observed for farm wives. Lerman (2004), in a comprehensive review of the factors that influenced agricultural commercialization among countries in transition from subsistence to commercialization, identified farm size, the presence of a farmers' union, and the availability of marketing services as crucial to farmers' decision to commercialize. Lerman argued that larger farm size meant greater output and, hence, an increase in marketable surplus. Kan, Kimhi and Lerman (2006) found that non-farm income negatively affected market participation, but Tudor and Balint (2006) observed a positive correlation between

off-farm employment and agricultural commercialization.

Other studies have focused on the effect of non-farm engagement on spending on agricultural inputs (see Bezu & Holden, 2008; Maertens, 2009; Babatunde, 2015; Dedehouanou et al., 2016; Smale et al., 2016); on the effect of non-farm labor on agricultural productivity, efficiency, and cost complementarity (see Woldehanna, 2002; Pfeiffer, López-Feldman & Taylor, 2009; Bezu, Barrett & Holden, 2012; Yang et al., 2016; Anang, 2017); and on the effect of non-farm engagement on income inequality, poverty reduction, consumption, and food security (see Canagarajah, Newman & Bhattamishra, 2001; Owusu, Abdulai & Abdul-Rahaman, 2011; Hoang, Pham & Ulubasoglu, 2014; Seng, 2016; Alemu & Adesina, 2017).

Our review revealed the limitations of comparative studies of non-farm and farm linkages from the perspective of market participation and agricultural commercialization (see also Woldehanna, Heckelei & Surry, 2016). The few studies in this area (i.e., Kan, Kimhi & Lerman, 2006; Tudor & Balint, 2006; Woldehanna, Heckelei & Surry, 2016) are either merely descriptive or concentrate only on farmers who participated in non-farm activities. This study departed from previous work by adopting generalized structural equation modeling framework, which allowed us to examine farmers who engaged in non-farm activities and those who did not while also correcting for potential endogeneity, censoring of the commercialization variable, and selection bias.

III. Econometric Specification and Estimation

The proportion of sales, mostly measured by the ratio of sales of household j, RS_j is fundamentally influenced by the marketable surplus generated by a farm household, a vector of transaction costs, and other determinants, as well as by a vector of basic household-specific characteristics, all of which are indicated by X. Thus, $RS_j = 0$ if the household decides not to sell. For a household that decides to sell, $RS_j > 0$. If a household sells all of its farm goods, however, $RS_j = 100$. The two extreme scenarios, $RS_j = 0$ and $RS_j = 100$, are similar to cases involving a censored dependent variable and an observed explanatory variable. We used

RS_j^{*} to indicate the continuous latent variable (without censoring). Given the objective of the study, controlling for X provided the foundation for an appropriate estimate of the effect of non-farm engagement, NFE on RS.

Based on this, an econometric model denoting the effect of NFE on RS can be specified as:

$$RS_j^{*} = X_j\beta + \theta NFE_j + \epsilon_j \quad (1)$$

and

$$RS_j^{**} = \begin{cases} RS_j & \text{if } RS_j^{*} > 0 \\ 0 & \text{if } RS_j^{*} \leq 0 \end{cases} \quad (2)$$

In the case in which NFE is a random process, either the Tobin (1958) model or the Tobit econometric specification is appropriate for estimating the treatment effect indicated by parameter θ. NFE is not a random decision, however. Smale et al. (2016) and Dedehouanou et al. (2016) noted the non-randomness of the decision of farm households to participate in the $RNFE$. For example, households that were closer to towns were more likely to have the opportunity to engage in non-farm activities and also to sell their farm goods. Households with greater financial capability could do similarly, more easily traveling to towns to engage in non-farm activities and sell farm goods. In addition to these, another set of factors exists that are unobservable in real life, and these can influence the decision to engage in non-farm activity and the proportion of sales. These factors generate selection bias and endogeneity. Thus, the econometric specification must consider two types of bias correction: censoring bias and selection bias. An appropriate way to treat these two problems jointly is to construct a generalized structural equation model (GSEM) (see, for instance, Skrondal & Rabe-Hesketh, 2004; Drukker, 2016).

Formally, we assumed that a household decides to participate in non-farm activity (i.e. $NFE = 1$) if:

$$Z_j\gamma + \xi_j > 0 \quad (3)$$

where Z_j is the set of the determinants of the NFE decision. We assumed that the error terms of eq. (1) and eq. (3) would follow normal distributions:

$$\epsilon_j \sim N(0, \sigma^2)$$
$$\xi_j \sim N(0, \tau^2)$$

and their correlations are given as:

$$corr(\epsilon, \xi) = \rho$$

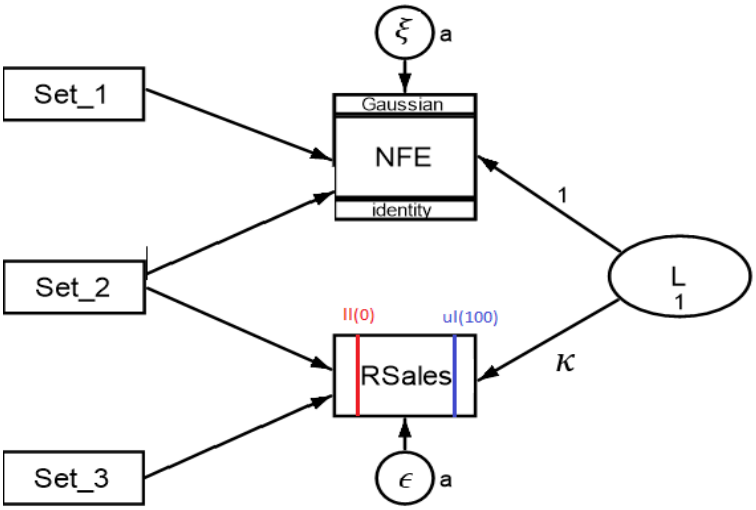
Under the SEM structure, the Heckman selection model was re-cast in the form of two equations: a linear regression (for the continuous outcome, RS) and a censored regression (for the selection equation, NFE). A latent variable, L_j, was added to both equations. The variance of the latent variable was set at one in both equations and at a coefficient of one in the selection equation, which left only coefficient κ to be estimated in the continuous-outcome equation. For identification, the variance from the censored regression was set as equal to that of the linear regression after updating left censoring ($RS_j^* = 0$) and right censoring ($RS_j^* = 100$). That is, $a = \sigma^2 = \tau^2$. The implications of this are the following:

1. The latent variable L_j synthesizes the unobservable factors. This permits the correlation between the two equations to be carried forward.
2. We call the estimated parameters in the GSEM formulation β^*, γ^*, and σ^{2*}. Let κ denote the coefficient on L_j in the continuous-outcome equation, then

$\beta = \beta^*$,
$\gamma = \gamma^*/\sqrt{\sigma^{2*} + 1}$,
$\sigma^2 = \sigma^{2*} + \kappa^2$
and
$\rho = \kappa/\sqrt{(\sigma^{2*} + \kappa^2) + (\sigma^{2*} + 1)}$

The summary of the GSEM model employed is presented in Figure 1.

Figure 1: The GSEM Model



As can be observed in Figure 1, the explanatory variables are subdivided into three sets; the first concerns only the selection model, while the third concerns only the outcome

model. The second set contains the observable factors that are used in the two models. The outcome variable, RS is censored at 0 and 100. The adjusted variance of the disturbance of the outcome model is constrained to be equal to that of the selection model (a). An estimate of this model was performed using the *gsem* command (in Stata 15.1).

This econometric procedure did not measure the effect of NFE on decisions to sell, however, which is a binary decision: either a farmer sold or did not. The mathematical representation of the link between market participation and NFE can be specified as:

$$MP_j = f(X_j, NFE_j) \quad (4)$$

where MP is market participation decision (which is a dummy equal to 1 if a household sold a particular crop and 0 otherwise). NFE and X are as defined before. Just as in the case above, the decision to engage in NFE and decisions to sell (MP) are potentially endogenous. Farm households may engage in non-farm activities to raise income for investments in farm activities that could lead to a production surplus and, thus, to participation in markets. Because these two decision processes may occur simultaneously, modelling them with univariate probit models would lead to biased and inconsistent estimates.

The user-written command *switch_probit,* introduced by Lokshin and Sajaia (2011), embraced, first, the potentially endogenous nature of MP and NFE and, second, the discrete nature of the outcome variable (i.e. MP). The model proposed a switch in the outcome (MP) based on treatment status (NFE) and implemented using full information maximum likelihood[1] to estimate binary selection and binary outcome simultaneously in order to yield consistent standard errors of the estimates.[2] After estimating the various parameters of the model, treatment effects (i.e. ATT, ATU, and ATE) of NFE on MP were derived.

[1] This is an estimation technique.

[2] The theoretical layout of the model is not described here but is neatly presented in Lokshin and Sajaia (2011).

IV. Data

Our study used the GLSS6 household-level dataset, collected by the GSS between October 2012 and October 2013. Using a questionnaire adapted from the World Bank's Living Standards Measurement Survey, the GLSS6 survey was intended to generate information on living conditions in Ghana by focusing on the household as the key socio-economic unit and by covering a stratified and nationally representative random sample of 16,772 households in 1,200 enumeration areas. Detailed information was collected on the demographic characteristics of households, including education, health, employment, migration and tourism, housing conditions, household agriculture, household expenditure, income and its components, and access to financial services, credit, and assets. Other modules administered in the survey were non-farm household enterprises, household access to financial services and governance, and peace and security. The GLSS6 presents comprehensive, reliable and up-to-date statistics that are useful in monitoring and evaluating the effects of development policies and programs on the living conditions of Ghanaians, and it has emerged as one of the richest and most important datasets on Ghana.

Disaggregating the entire sample (16,772), however, showed that large numbers of farmers were engaged in the cultivation of only five crops: cereals (maize, rice, and sorghum) and legumes (groundnut and beans), all of which were heavily cultivated in the 2012-2013 production season. In the sample, the farmers who cultivated these crops included: maize-4,437; groundnut-1,730; rice-1,157; beans-1,371; and sorghum-997. Our study therefore analyzed only these crops. The specific variables, their description and measurement are presented in Table 1.

Table 1: Description and measurement of variables

Variable	Description	Measurement
NFE	Engaged in non-farm activity	1 = if yes; 0 = otherwise
PART	Sold at least a crop	1 = if yes; 0 = otherwise
RS[a]	Commercialization index	Ratio of sales value to output value
HHAGE	Age of head of household	Years
AvHHAGE	Average age of household	Years
HHSEX	Male head of household	1 = if yes; 0 = otherwise
EDYEARS	Years of education of head	Years spent in school
HHLOC	Area of residence	1 = if rural; 0 = otherwise
REGION	Region of residence	Dummy for each region
HHSIZE	Household size	Number of people
OUT_PC[a]	Per capita output	Output in kg/household size
FSIZE[a]	Farm size	Hectare

PRICE_KG[a]	Average price	Ghana cedi/kilogram
CRED	Access to credit in the previous year	1 = if yes; 0 = otherwise
EXTCOMPL	Compliance with extension services	1 = if yes; 0 = otherwise
AWAGE	Agricultural wage	Ghana cedi
AEQS	Adult equivalent scale	Scale
ECOZN	Ecological zone	Dummy for each zone
COMMMKT	Market in community	1 = if yes; 0 = otherwise
MTRD	Navigable road to community	1 = if yes; 0 = otherwise
PTPASS	Public transport availability	1 = if yes; 0 = otherwise
RADIO	Ownership of radio	1 = if yes; 0 = otherwise
BANK_ACCT	Ownership of bank account	1 = if yes; 0 = otherwise

Note: [a] Represents aggregate variables for the five crops: maize, rice, groundnut, beans, and sorghum; sales and production are aggregates of the values of the individual crops, not their weights in kilograms; price/kg is calculated as the average of the price/kg for each crop.

In combining these into an aggregate dataset, we found that maize was the basic crop and, hence, that most households who cultivated groundnut, rice, beans, or sorghum also cultivated maize. Combining the various crop datasets would not yield a sample of 9,692 (i.e., the sum of all samples) but 4,915, and the final sample size in this study was 4,915 farmers.

V. Results and discussion

Our study set out to answer two questions: did non-farm engagement influence farmers' decisions to sell and what were farmers' levels of commercialization.

5.1 Characteristics of sample

Table 2 reports the descriptive statistics of the variables used in econometric estimates. Focusing attention on outcome and treatment variables for all crops, the results show that, overall, only 32.9% of farmers engaged in non-farm activities. Regarding decisions to sell, an average of 61.1% of farmers sold at least one crop: 60.3% of those engaged in non-farm activity did so as compared to 61.5% of those who did not engage in non-farm activity. In terms of the level of commercialization, an average of 28.2% of output was sold: those who engaged in non-farm activities sold 35.5% as against 24.7% for those who did not engage in non-farm activities. Thus, those who engaged in non-farm activities sold 10.8% more than those who did not engage in non-farm activities. These results confirm studies that indicate that the level of agricultural commercialization is low in Ghana (see International

Fund for Agricultural Development-International Food Policy Research Institute, 2011).

Regional maps of population density, crop output, and level of commercialization are presented in Figure 2. As shown in the first map, the Greater Accra, Ashanti, and Central regions, all of which are urbanized, are the most densely populated. The second map indicates that output is highest in the northern part of the country (Upper West, Northern, and Upper East regions) as well as in Greater Accra.

Table 2: Descriptive statistics of variables

	NFE Participants (n = 1616)		NFE non-participants (n = 3299)		Overall (n = 4915)	
Variable	Mean[a]	S.D.	Mean	S.D.	Mean	S.D.
Non-farm engagement	-	-	-	-	0.329	0.470
Sold crop	0.603	0.489	0.615	0.487	0.611	0.488
Commercialization index	35.49	34.64	24.72	25.20	28.23	29.05
Age of head of household	47.98	14.05	48.12	16.31	48.08	15.61
Average age of household	34.16	8.783	33.45	12.14	33.68	11.17
Male head of household	0.827	0.378	0.808	0.394	0.814	0.389
Years of education	5.607	4.454	4.005	4.217	4.526	4.360
Area of residence	0.968	0.175	0.976	0.153	0.974	0.160
Household size	5.877	3.081	4.882	2.977	5.205	3.046
Per capita output in kg	243.6	766.3	286.2	635.7	272.4	681.1
Farm size in hectares	1.609	2.742	2.046	14.40	1.904	11.94
Price/kg	4.322	3.777	4.162	3.754	4.214	3.762
Access to credit	0.101	0.302	0.101	0.302	0.101	0.302
Extension compliance	0.423	0.494	0.393	0.489	0.403	0.491
Agricultural wage	8.860	4.475	8.639	5.014	8.711	4.846
Adult equivalent scale	4.435	2.329	3.651	2.214	3.906	2.281
Market in community	0.280	0.449	0.296	0.456	0.290	0.454
Navigable road to community	0.469	0.499	0.790	0.408	0.685	0.464
Public transport availability	0.606	0.489	0.512	0.500	0.543	0.498
Ownership of radio	0.621	0.485	0.633	0.482	0.629	0.483
Ownership of bank account	0.329	0.470	0.194	0.395	0.238	0.426

Note: [a] connotes that for dummy variables, the means represent proportions; sampling weight is used.

Because maize was the dominant crop in our sample and was heavily cultivated in the north, this result is not surprising. Level of commercialization, a key outcome variable in our study, is shown in the third map. Interestingly but not surprising, commercialization is higher in the Greater Accra and Ashanti regions. The urbanized nature of these areas may mean that farmers there are motivated by higher prices to sell more of their output.

Figure 2: A Map Showing Key Variables

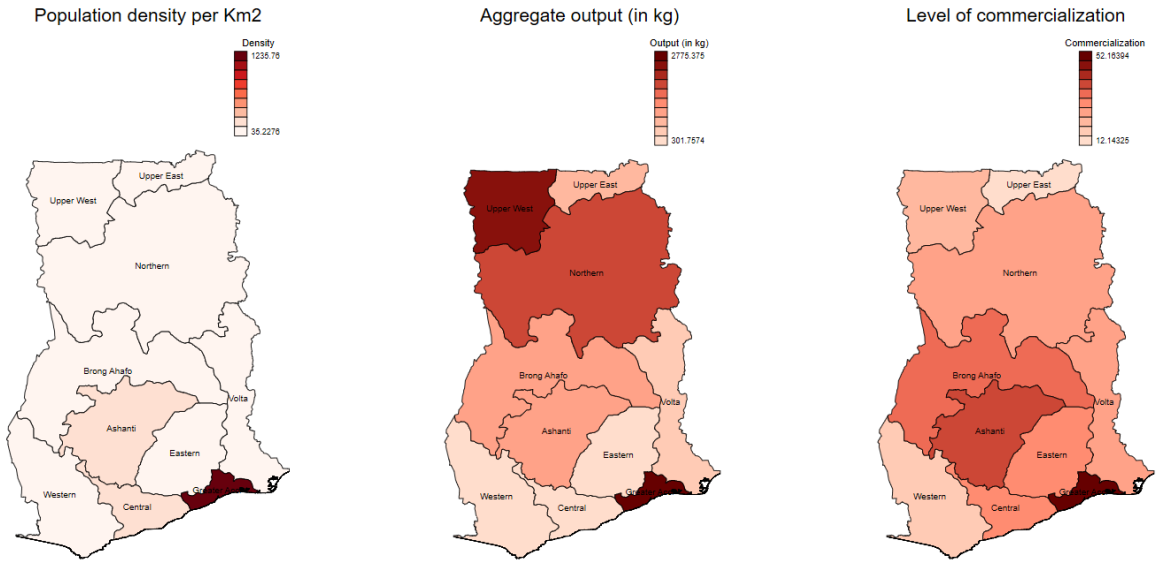
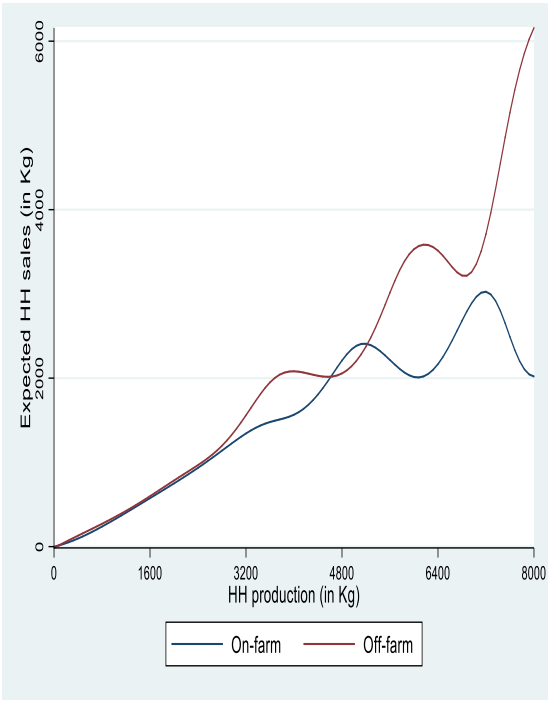
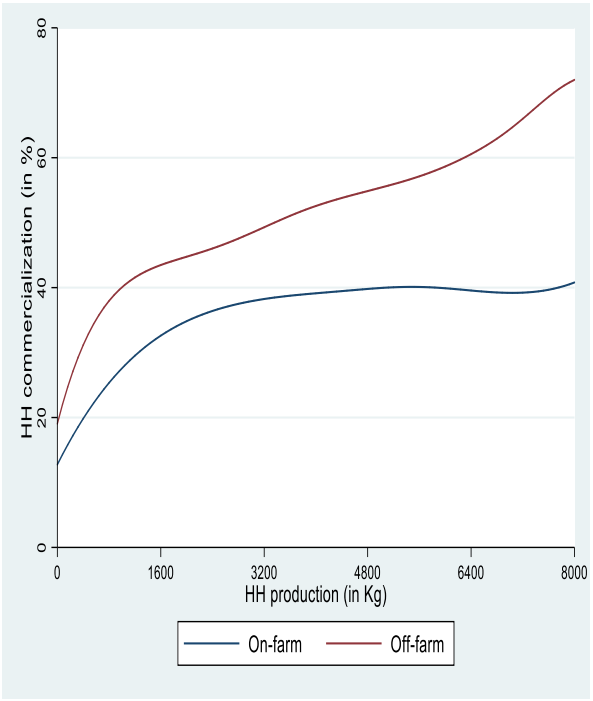


Figure 3 presents some non-parametric descriptive statistics of expected sales and levels of production.[3] Generally, the figure indicates that the proportions sold in quantities (kg) and values (Ghana cedi) are increasing functions of the quantity produced. The non-farm group has higher sales as compared to their counterparts, however, especially in the case of farmers with large productions.

Figure 3: Non-Parametric Descriptive Statistics



Expected sales (in kg) and production (in kg)



Expected sales (in %) and production (in kg)

[3] For this non-parametric regression, we used the locally linear estimation technique with the Stata DASP package.

5.2 Effect of Non-Farm Engagement on Market Participation

Table 3 presents the underlying estimates of the switch_probit endogenous regression model, which involved the determinants of non-farm engagement and market participation. As an additional robustness check, estimates for individual crops are presented in Table A1 (in the Appendix).

The results show that average age of household, years of education, household size, price/kg, public transport availability, and ownership of bank accounts increased the probability of engaging in non-farm activities while agricultural wages reduced that probability. Generally, these estimates meet a priori expectations. For example, the positive estimate of household size implied that households with larger sizes were more likely to engage in non-farm activities because they required more financial resources to meet basic household expenditures. In addition, households with bank accounts were more likely to engage in non-farm activities. Given that most financial services are concentrated in urban areas in Ghana, this observation could imply that opening bank accounts in these urban centers made it easier for account owners to have access to non-farm activities. Moreover, an increase in the level of education of the head of households increased the probability of non-farm activities because some level of education is a pre-requisite for securing jobs outside farming.

Table 3: Determinants of Non-Farm Activity and Decisions to Sell

Variable	NFE	Decisions to Sell	
		Participants	Non-Participants
Basic household characteristics:			
Age of head of household	-0.002	-0.001	-0.006***
Average age of household	0.004**	-0.000	-0.002
Male head of household	-0.046	-0.223*	0.266***
Years of education	0.036***	0.014	-0.019***
Area of residence	-0.251**	0.220	0.065
Region (base: Upper West):			
- Western	-0.452***	0.477**	0.857***
- Central	0.027	5.158***	0.652
- Greater Accra	0.183*	0.655***	0.548***
- Volta	0.126	0.691***	0.434***
- Eastern	-0.142	0.370**	0.869***
- Ashanti	-0.069	0.503**	0.555***
- Brong Ahafo	0.095	0.667**	0.415**
- Northern	-0.040	-0.617**	-0.284
- Upper East	0.569***	0.774***	0.228
Production determinants:			
Household size	0.083***	0.176**	0.022

Farm size in hectares	-0.011*	0.114***	0.120***
Price/kg	0.021***	0.051***	0.023***
Access to credit	0.046	0.627	1.856***
Extension compliance		0.125	0.221***
Agricultural wage	-0.011**	-0.009	0.010*
Ecological zone (base: Coastal):			
- Forest	-0.057	0.198	0.016
- Savannah	-0.408***	0.422*	0.451***
Needs determinants:			
Adult equivalent scale		-0.173*	-0.076
Other sales determinants:			
Market in community		-0.126	-0.351***
Navigable road to community		2.616***	0.432***
Public transport availability	0.183***	-0.031	0.074
Ownership of radio	-0.035	0.139	0.164***
Ownership of bank account	0.268***		
Constant	-0.802***	-2.364***	-1.144***
Observations	4915		
Wald chi2	497.33***		
Log Pseudo lik.	-5256.342		
Rho		0.203	-0.389
Wald test	5.33*		

Source: GLSS6 Data; * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Further, because an increase in agricultural wages decreased the probability that a household would engage in non-farm activities, an increase in agricultural wage apparently motivated farmers to stay on-farm. A key motivation for non-farm engagement is a desire to supplement meagre agriculture earnings, particularly in developing countries.

The determinants of the market participation of participants and non-participants in non-farm activities indicated that except gender, which has a differential effect, farm size price/kg and navigable road in the community simultaneously positively determined the two regimes. These estimates are also generally consistent with expectations. For example, an increase in output per capita increases the likelihood of selling because it provides an opportunity to generate marketable surplus to enter markets. Also, higher prices increase the probability that a household will consider entering the market because a high-price signal provides an incentive to generate marketable surplus. The infrastructure variable (navigable road) further shows that reducing transaction costs in agricultural marketing increases the probability of selling.

From estimates of the determinants of non-farm engagement and market participation, the treatment effects of non-farm engagements on market participation were

predicted; these results are presented in Table 4.

Table 4: Estimates of the Effect of Non-Farm Engagement on Market Participation

Effect	All crops	Individual crops[4]		
		Maize	Groundnut	Rice
ATT	0.244	0.283	-0.250	-0.200
	(0.258)	(0.394)	(0.548)	(0.248)
ATU	0.139	0.304	0.340	0.602
	(0.266)	(0.388)	(0.371)	(0.198)
ATE	0.169	0.299	0.115	0.235
	(0.280)	(0.416)	(0.436)	(0.231)

Note: Figures in parentheses are standard deviations.

The results in Table 4 indicate that the estimated ATT for all crops and maize was positive, implying that non-farm engagement increased the probability of market participation. Specifically, market participation increased by 24.4% and 28.3% respectively for all crops and for maize farmers who engaged in non-farm work. On the other hand, the estimated ATT for groundnut and rice was negative, implying that non-farm engagement of farmers reduced the probability of participation in the market. In terms of the magnitude of effect, market participation decreased by 25.0% and 20.0% respectively for groundnut and rice farmers who engaged in non-farm activities, which may indicate a reallocation of labor among different crops where more maize was produced and sold in contrast to groundnut and rice, when NFE increased. This could also imply the income effect of NFE, which would have reduced the need to sell groundnut and rice in cases in which they had been sold largely to cover expenses.

The ATU estimates (from non-participants in non-farm activities) confirm the ATT that non-farm engagement did increase the probability of selling crops. As Table 4 suggests, ATE estimates were consistently positive for all crops. Thus, non-farm engagement increased the probability of market participation. Specifically, market participation increased by 16.9%, 29.9%, 11.5%, and 23.5% respectively for all crops, maize, groundnuts, and rice. This supports the liquidity-relaxing-effect hypothesis, which asserts that non-farm work could provide additional liquidity for farm investment and increase output and marketable surplus (Woldehanna, 2000), but contradicts Kan, Kimhi and Lerman (2006), who observed a negative effect of non-farm engagement on market participation in Georgia.

[4] Estimates for beans and sorghum could not be obtained because of inadequate sample.

5.3 Effect of Non-Farm Engagement on Agricultural Commercialization

Table 5 presents the parameters of the GSEM (Figure 1), which show the determinants of non-farm engagement and level of commercialization and, fundamentally, the effect of NFE on commercialization. Before estimating the baseline model (GSEM), we estimated the model with ordinary least squares (OLS) and then with a Tobit. The results of OLS and Tobit are shown in the second and third columns, respectively. The results of GSEM are in the fourth and fifth columns. The first part of the GSEM results presents the determinants of commercialization while the second part presents the determinants of non-farm engagement. The estimates of the OLS, the Tobit, and the GSEM models reveal the extent and the nature of the different biases, as well as the importance of correcting them.

We focused on the parameters of the estimated baseline model. First, we found that the coefficient of quantity produced was positive and statistically significant, implying that an increase in output led to an increase in marketable surplus and hence in the quantity of product sold. Second, the coefficient of the adult equivalent scale (which is a measure of household needs) showed a negative impact on commercialization. Thus, the greater were the needs of the household in a form of consumption, the lower was the quantity of product sold. The effects of most of the other determinants were as expected. Household size, for example, exerted a significant and positive effect on the level of commercialization because members of a household largely served as a source of farm labor. An increase in household size meant an increase in labor and, consequently, an increase in output. Increase in output resulted in an increase in marketable surplus and, hence, in the level of commercialization.

We also found that the level of commercialization was positively affected when households complied with the instructions of extension officers (experts who teach farmers best practices for land preparation, sowing, weeding, and harvesting, among other skills) and had access to credit, implying that farm investment could generate an increase in output and, hence, an increase in quantity of product sold. Access to information through radio ownership also had a positive impact on the level of commercialization because it provided a means to receive information regarding markets, pricing, best farming practices, and weather, among other subjects. Better information could increase levels of commercialization.

Table 5 shows that the treatment effect of NFE on commercialization was positive and

statistically significant in all three models. This implies that NFE increased the quantity of output sold. Specifically, engagement in non-farm activities increased the quantity of product sold by 10.9%, 13.3%, and 15.5%, respectively, in the OLS, Tobit and GSEM models.

Table 5: Agricultural Product Sales and Non-Farm Activity

Variable	Simple OLS	Tobit (Left Cens. (0) & Right Cen. (100))	GSEM: Full model	
			RS	NFE
Non-farm engagement	**10.85*** **	**13.28*** **	**15.48*** **	
***Basic household characteristics*:**				
Age of head of household	-0.091***	-0.146***	-0.145***	-0.029
Average age of household	-0.011	-0.011	-0.014	0.131***
Male head of household	2.574**	5.868***	5.933***	-2.186
Years of education	-0.215*	-0.380**	-0.417**	1.108***
Area of residence	1.536	2.070	2.161	-2.710
Region (base: Upper West):				
- Western	8.150***	4.336	4.730	-11.26***
- Central	14.96***	19.26***	20.10***	-25.40***
- Greater Accra	29.00***	36.40***	36.87***	-13.52*
- Volta	13.68***	16.96***	17.24***	-8.090***
- Eastern	16.59***	21.42***	21.71***	-7.905***
- Ashanti	19.67***	25.09***	25.65***	-16.01***
- Brong Ahafo	13.52***	17.01***	17.54***	-15.06***
- Northern	4.478***	6.527***	6.889***	-10.33***
- Upper East	-5.782***	-17.18***	-16.82***	-11.15***
Production determinants:				
Household size	1.066	2.356*	2.291	1.904***
Per capita output in kg	0.005***	0.008***	0.008***	
Farm size in hectares	-0.006	0.016	0.017	-0.120
Price/kg	0.236**	0.576***	0.574***	0.078
Access to credit	38.17***	52.01***	51.98***	0.737
Extension compliance	5.950***	10.01***	10.01***	
Agricultural wage	-0.055	-0.055	-0.044	-0.310**
Ecological zone (base: Coastal):				
- Forest	-8.418***	-11.51***	-11.78***	7.775***
- Savannah	-8.652***	-12.31***	-12.49***	5.043**
Needs determinants:				
Adult equivalent scale	-1.466	-3.268*	-3.263*	
Other sale determinants:				
Market in community	1.915*	1.818	1.815	
Public transport availability	1.441	2.824*	2.662*	4.955***
Ownership of radio	4.546***	6.803***	6.872***	-2.058*
Ownership of bank account	0.918	1.700	1.451	7.173***
Latent			-29.40***	1
Constant	8.772**	-9.040	-9.600	-16.30***
Observations	4915	4915	4915	4915
R^2	0.303			
Pseudo R^2			0.103	
σ^2		1357.2**	493.9***	

τ^2	493.9***

Source: GLSS6 Data; * p<0.10, ** p<0.05, *** p<0.010

These models show different results in terms of magnitude and indicate that there is a progressive downward bias from the OLS to the GSEM estimates. This bias type is expected. First, the OLS presents a downward bias with respect to the Tobit because farmers who sold no product had zero levels of sales. Because the OLS cannot correct for this massing-up at zero, the level of sales for the entire sample is underestimated. The Tobit can correct this censoring issue, however, and so results in higher estimates. The Tobit also reflects a downward bias with respect to the GSEM because, although it adjusts zeros to correct for censoring, it is unable to deal with selection and endogeneity biases, leading to underestimates in this case. Because the GSEM corrects both these two problems and censoring, the estimate of the effect is higher. Therefore, without controlling for any of these problems (OLS model) and controlling for only censoring (Tobit model), the effect of NFE is understated.

Indeed, the on-farm group showed relatively greater crop outputs (in part because they had more land). If this group participated in non-farm activity, the impact of the quantity of product sold on average would be high. The corrected effect, thus, is the 15.5% given by the GSEM, which controls for selection bias and endogeneity as well as censoring of the commercialization variable. This means that farmers who engaged in NFE sold 15.5% more output than their counterparts who did not engage in NFE. These observations confirm the assertion that non-farm engagement positively impacts commercialization and can, in fact, be seen as a complement to it.

The positive impact of NFE on commercialization may be attributed to a number of factors. First, income from non-farm activities may be invested in modern technology as well as in the expansion of cultivated land and (see Babatunde, 2015; Smale et al., 2016; Dedehouanou et al., 2016) or may otherwise be directed back into crop production. Increased production produces marketable surplus, confirming the liquidity-relaxing theory, according to which income from non-farm engagement eases household capital and credit constraints and thereby increases investment in farm inputs. Second, the engagement of farmers in non-farm activities stimulates the creation of market networks and facilitates the selling of products. Non-farm participation, for example, may provide farmers with

information on market dynamics that may make them comparatively better equipped to engage with the market.

As a robustness check, we also estimated the effect of NFE using individual crops. The results, presented in Table A2 (in the Appendix), indicate that the treatment effect of NFE on maize and groundnut was all positive and confirmed that the effect of NFE on commercialization was monotonically positive.

5.4 Heterogeneous Effects of Non-Farm Engagement on Agricultural Commercialization

Our study also assessed whether the heterogeneous effects of NFE on commercialization existed across ecological zones and examined the interaction of ecological zones and household localities. These results appear in Table 6, which includes only the outcome (commercialization) part of the GSEM.[5]

Table 6: Agricultural Product Sales and Off-Farm Activity by Ecological Zones and Locality

Variable	Ecological zone			Interaction of ecological zone and locality			
	EZ 1	EZ 2	EZ 3	EZL 1	EZL 2	EZL 3	EZL 4
Non-farm engagement	21.12***	20.57***	7.97***	21.07***	9.47***	10.49***	20.55***
Basic household characteristics:							
Age of head of household	-0.052	-0.047	-0.215***	-0.063	-0.271***	-0.220***	-0.056
Average age of household	0.025	-0.027	0.015	-0.033	0.081	-0.009	-0.027
Male head of household	6.635**	5.756**	1.060	5.411*	5.392	1.073	5.895**
Years of education	-0.499*	-0.464*		-0.515*	-0.0511	-0.353	-0.436
Area of residence	-3.998	-1.057	5.136		7.144		-1.704
Region (base: Upper West):							
- Western	-12.55**	-9.817*		-10.12*			2.161
- Central	4.053	4.659		4.016			16.53*
- Greater Accra		24.69***		24.60***			36.48***
- Volta	1.555	-0.540	15.00***	0.407		15.93***	12.05
- Eastern	2.530	3.089		2.979			15.20
- Ashanti	7.544*	7.256*		7.296*			19.27*
- Brong Ahafo			15.17***			17.54***	11.25
- Northern			6.030***			6.560***	-1.861
- Upper East			-15.17***			-12.74***	-67.38***
Production determinants:							
Household size	1.470	1.374	2.344	1.402	3.239**	2.025	1.329
Per capita output in kg	0.008***	0.008***	0.007**	0.008***	0.008***	0.007***	0.008***

[5] Due to low sample of households from the coastal zone (263), estimation did not achieve convergence. We thus incorporated the sample into the forest sample to create a third sample (EZ 2) alongside the forest (EZ 1) and savannah (EZ 3) samples.

Farm size in hectares	2.203**	2.031*	0.002	1.990*	0.013	-0.001	1.760**
Price/kg	0.284	0.969**	0.391**	0.951**	0.161	0.433**	0.964**
Access to credit	54.47***	53.16***	39.22***	52.85***	45.51***	39.43***	52.89***
Extension compliance	14.90***	15.51***	5.482***	15.35***	4.752***	5.632***	15.03***
Agricultural wage	-0.361	-0.308	0.327	-0.318	1.287***	0.360	-0.303
Needs determinants:							
Adult equivalent scale	-3.156	-3.192	-2.480	-3.253	-3.185	-2.112	-3.084
Other sales determinants:							
Market in community	7.471**	9.255***	-4.713**	9.225***	-5.573***	-6.201***	9.699***
Public transport availability	-0.887	0.983	5.843***	0.877	9.538***	6.257***	0.716
Ownership of radio	12.29***	11.45***	1.899	11.64***	2.173	1.928	11.26***
Ownership of bank account	1.252	2.00	0.154	1.636	2.758	-0.029	2.100
Latent	-28.37***	-29.40***	11.34	-30.02***	-21.67	-27.10***	-29.63***
Constant	-5.840	-9.664	-1.187	-8.881	-12.20*	4.135	-20.45*
Observations	1555	1818	3097	1774	3141	3012	1903
σ^2	609.3***	560.2***	1069.7	523.8***	807.3	465.9***	526.8***

Source: GLSS6 Data; * p<0.10, ** p<0.05, *** p<0.010; EZ 1 is forest; EZ 2 is forest/coastal; EZ 3 is savannah; EZL 1 is the interaction of forest/coastal and rural; EZL 2 is the interaction of savannah and rural; EZL 3 is the interaction of forest/coastal and urban; EZL 4 is the interaction of savannah and urban.

The results show that households in the forest ecological zone sold more (21.1%) than did those in both the forest and coastal zones (20.6%) and savannah zone (7.97%). This finding confirms the observation from the third map in Figure 2, which shows high commercialization in southern Ghana (forest and coastal ecological zones) as compared to northern Ghana (savannah). As noted, higher prices in the south provided a greater incentive to households to sell. With respect to the interaction of ecological zone and locality, the results indicate that households in rural areas of forest/coastal zone sold more (21.1%) than did rural households in the savannah zone (9.5%), whereas households in urban areas in the savannah zone sold more (20.6%) than did urban households in the forest/coastal zone (10.5%). The implication of these observations is that the effect of NFE on commercialization was highly heterogeneous across ecological zones and locality and thus calls for caution in the design and implementation of agricultural policies geared towards enhancing commercialization.

VI. Conclusion and Policy Implications

Our study analyzed, on the one hand, the impact of non-farm participation on households' decisions to sell five crops—maize, beans, groundnut, rice, and sorghum— (i.e. market participation) and, on the other, the quantity of product sold (level of commercialization) by farmers who decided to sell their crops. An endogenous switching probit ("*switch_probit*") was used to estimate the determinants of non-farm engagement and market participation, and the effects of non-farm engagement on market participation were evaluated on the basis of parameter estimates. The generalized structural equation model (GSEM) was used to estimate the determinants of non-farm engagement and level of commercialization as well as the treatment effect of non-farm engagement on commercialization.

Three key findings emerge from our analyses. First, non-farm participation consistently increased the probability of selling crops as indicated by the ATE. Second, non-farm participation increased the quantity of product sold. Third, commercialization varied markedly across ecological zones and locality. The conclusion of this study is that non-farm engagement by farmers encouraged market participation and level of commercialization in Ghana. Thus, non-farm engagement and commercialization are complements. From a policy standpoint, this conclusion points to two issues. First, in the quest to develop agriculture from a subsistence level to a commercialized sector, stakeholders, primarily the government of Ghana, should rethink the implementation of existing agricultural policies. Most government policy documents acknowledge the importance of commercialization and of non-farm engagement, but agricultural policies to increase both are often implemented on parallel tracks. To achieve maximum impact, these policies should be revised to tackle commercialization and non-farm work simultaneously.

The government's flagship programs, for example, *Planting for Food and Jobs* (2017-2022) and the Medium Term Agriculture Sector Investment Plan (METASIP) III (2018-2021), tend to concentrate on increasing productivity, production, and commercialization but do nothing to encourage non-farm work. We recommend that the government begin promoting non-farm work in the implementation of these policies by broadening farmers' access to financial capital, education, and infrastructure. Second, in the formulation of new policies, the

government should be guided by this evidence of complementarity. Specifically, we recommend that the *One District, One Factory (1D1F)* development agenda currently under consideration be used as an opportunity to provide farm households with opportunities for non-farm work.

Another approach that would maximize the impact of agricultural policies would be a policy design that responded to the localities and ecological zones of farm households. Thus, adaptive-centered policies should be encouraged in Ghana. Given the promotion of decentralization, this should not be far-fetched. Lastly, the implementation of these measures would strongly enhance commercialization, a key policy objective of METASIP III.

References

Abdullah, Rabbi, F., Ahamad, R., Ali, S., Chandio, A. A., Ahmad, W., Llyas, A., and Din, I. U. (2017). Determinants of Commercialization and Its Impact on the Welfare of Smallholder Rice Farmers by Using Heckman Two-Stage Approach. Journal of the Saudi Society of Agricultural Sciences. http://dx.doi.org/10.1016/j.jssas.2017.06.001.

Ackah, C. (2013). Non-Farm Employment and Incomes in Rural Ghana. Journal of International Development 25(3): 325-39.

Alemu, A. E., and Adesina, J. O. (2017). In Search of Rural Entrepreneurship: Non-Farm Household Enterprises (NFES) As Instruments of Rural Transformation in Ethiopia. *African Development Review* 29(2): 259-271.

Anang, B. T. (2017). Effect of Non-Farm Work on Agricultural Productivity: Empirical Evidence from Northern Ghana. WIDER Working Paper, No. 2017/38. Helsinki: UNU-WIDER. Available at: https://www.wider.unu.edu/publication/effect-non-farm-work-agricultural-productivity

Anriquez, G., and Daidone, S. (2010). Linkages between the Farm and Non-Farm Sectors at the Household Level in Rural Ghana: A Consistent Stochastic Distance Function Approach. *Agricultural Economics* 41(1): 51-66.

Babatunde, R. O. (2015). On-Farm and Off-Farm Works: Complement or Substitute? Evidence from Nigeria. Maastricht School of Management Working Paper 2015/02. Ilorin: University of Ilorin, Department of Agricultural Economics and Farm Management.

Babatunde, R. O., and Qaim, M. (2010). Impact of Off-Farm Income on Food Security and Nutrition In Nigeria. *Food Policy* 35: 303-311.

Barrett, C. B., Reardon, T., and Webb, P. (2001). Non-Farm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics and Policy Implications. *Food Policy* 26(4): 315-331.

Benedikter, S., Waibel, G. l, Birtel, S., and Tran, B. T. (2013). Local Entrepreneurship in Viet Nam's Rural Transformation: A Case Study from the Mekong Delta. Bonn: Centre for Development Research (ZEF), Can Tho City Institute for Socio-Economic Development Studies (CIDS), Southern Institute of Social Sciences (SISS).

Bezu, S., and Holden, S. (2008). Can Food-For-Work Encourage Agricultural Production? *Food Policy* 33(6): 541-549.

Bezu, S., Barrett, C. B., and Holden, S. T. (2012). Does the Nonfarm Economy Offer Pathways For Upward Mobility? Evidence from a Panel Data Study in Ethiopia. *World Development* 40(8): 1634-1646.

Buchenrieder, G., Traikova, D., Möllers, J., and Dufhues, T. (2010). Putting All The Eggs in One Basket? Diversification Strategies in Rural Europe. Keynote. 118th EAAE Seminar on "Rural Development: Governance, Policy Design and Delivery" from August 25-27, 2010. University of Ljubljana, Ljubljana, SL, IAMO, and the Slovene Association of Agricultural Economists (DAES).

Canagarajah, S., Newman, C., and Bhattamishra, R. (2001). Non-farm Income, Gender, and Inequality: Evidence from Rural Ghana and Uganda. *Food Policy* 26(4): 405-420.

Chang, H., He, J., and Saeliw, K. (2017). The Role of Off-Farm Labor Participation Decisions of Married Farm Couples on Farm Direct Marketing in Taiwan. *The Developing Economies* 55(1): 3-22.

De Janvry, A., and Sadoulet, E. (2001). Income Strategies among Rural Households in Mexico: The Role of Off-Farm Activities. *World Development* 29(3): 467-480.

Dedehouanou, S. F. A., Ousseini, A., Harouna, A. L., and Maimounata, J. (2016). Spillovers from Off-Farm Self-Employment Opportunities in Rural Niger. Partnership for Economic Policy (PEP) Working Paper 2016-08.

Dirven, M. (2011). Non-Farm Rural Employment and Rural Poverty Reduction: What We Know in Latin America in 2010. Paper presented at the IFAD Conference on New Directions for Smallholder Agriculture 24-25 January, 2011.

Drukker, D. M. (2016). A Generalized Regression-Adjustment Estimator for Average Treatment Effects from Panel Data. *Stata Journal* 16: 826-836.

Dzanku, F. M., and Sarpong, D. B. (2014). Household-Level Farm/Non-Farm Linkages and Household Welfare Implications. AFRINT 3: Ghana Micro Report, Accra, Ghana.

Ellis, F., and Biggs, S. (2001). Evolving Themes in Rural Development 1950s-2000s. *Development Policy Review* 19(4): 437-448.

Ghana Statistical Service (GSS) (2014). Ghana Living Standards Survey Report of the Sixth Round. Accra, Ghana, (GLSS6).

Ghana Statistical Service (GSS) (2018). Provisional 2017 Annual Gross Domestic Product. Accra, Ghana.

Haggblade, S. (2007). Alternative Perceptions of the Rural Non-Farm Economy. In S. Haggblade, P.B.R. Hazell, and T. Reardon (Eds.). *Transforming the Rural Non-Farm Economy: Opportunities and Threats in the Developing World*. Baltimore: Johns Hopkins University Press, 25-54.

Hoang, T. X, Pham, C. S., and Ulubasoglu, M. A. (2014). Non-Farm Activity, Household Expenditure, and Poverty Reduction in Rural Vietnam: 2002-2008. *World Development* 64: 554-568.

Holden, S., Shiferraw, B., and Pender, J. (2004). Non-Farm Income, Household Welfare, and Sustainable Land Management in a Less Favoured Area in Ethiopian Highlands. *Food Policy* 29: 369-392

International Fund for Agricultural Development (IFAD) (2011). *Rural Poverty Report. New Realities, New Challenges: New Opportunities for Tomorrow's Generation*. Rome, Italy: Quintily.

International Fund for Agricultural Development-International Food Policy Research Institute (IFAD-IFPRI) (2011). Agricultural Commercialization in northern Ghana. Innovative Policies on Increasing Access to markets for High-Value Commodities and Climate Change Mitigation. IFAD-IFPRI Partnership Newsletter. Available at: http://ifadifpri.wordpress.com.

Kan, I., Kimhi, A., and Lerman, Z. (2006). Farm Output, Non-Farm Income, and Commercialization in Rural Georgia. *eJADE: electronic Journal of Agricultural and Development Economics* 3(2): 276-286.

Kilic, T., Carletto, C., Miluka, J., and Savastano, S. (2009). Rural Non-Farm Income and Its Impact on Agriculture: Evidence From Albania. *Agricultural Economics* 40: 139-60.

Lerman, Z. (2004). Policies and Institutions for Commercialization of Subsistence Farms in Transition Countries. *Journal of Asian Economics* 15(3), 461-479.

Lokshin, M., and Sajaia, Z. (2011). Impact of Interventions on Discrete Outcomes: Maximum Likelihood Estimation of the Binary Choice Models with Binary Endogenous Regressors. *The Stata Journal* 11(3): 368-385.

Maertens, M. (2009). Horticulture Exports, Agro-Industrialization and Farm-Nonfarm Linkages with the Small Farm Sector: Evidence from Senegal. *Agricultural Economics* 40: 219-29.

Mollers, J., and Buchenrieder, G. (2011). Effects of Rural Non-Farm Employment on Household Welfare and Income Distribution of Small Farms in Croatia. *Quarterly Journal of International Agriculture* 50(23): 217-235.

Olugbire, O. O., Falusi, A. O., Adeoti, A. I., and Oyekale, A. S. (2012). Determinants of Non-Farm Income Diversification among Rural Households in Nigeria. *Journal of American Science* 8(1): 77-82.

Omiti, J. M., Otieno, D. J., Nyanamba, T. O., and McCullough, E. (2009). Factors Influencing The Intensity Of Market Participation By Smallholder Farmers: A Case Study of Rural and Peri-Urban Areas of Kenya. *African Journal of Agricultural and Resource Economics* 3(1): 57-82.

Osarfo, D., Senadza, B., and Nketiah-Amponsah, E. (2016). The Impact of Non-Farm Activities on Rural Farm Household Income and Food Security in the Upper East and Upper West Regions of Ghana. *Theoretical Economics Letters* 6: 388-400.

Owusu, V., Abdulai, A., and Abdul-Rahaman, S. (2011). Non-Farm Work and Food Security among Farm Households in Northern Ghana. *Food Policy* 36: 108-118.

Pfeiffer, L., López-Feldman, A., and Taylor, J. E. (2009). Is Off-Farm Income Reforming the Farm? Evidence From Mexico. *Agricultural Economics* 40(2): 125-38.

Reardon, T. (1997). Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labor Market in Africa. *World Development* 25(5): 735-747.

Reardon, T., and Taylor, J. E. (1996). Agroclimatic Shock, Income Inequality and Poverty: Evidence From Burkina Faso. *World Development* 24(5): 901-914.

Reardon, T., Berdegué, J., Barrett, C. B., and Stamoulis, K. (2007). Household Income Diversification into Rural Non-Farm Activities. In S. Haggblade, P.B.R. Hazell, and T. Reardon (Eds.). *Transforming the Rural Non-Farm Economy: Opportunities and Threats in the Developing World.* Baltimore: Johns Hopkins University Press, 55-79.

Reardon, T., Crawford, E., and Kelly, V. (1994). Link between Non-Farm Income and Farm Investment in African Households: Adding the Capital Market Perspective. *American Journal of Agricultural Economics* 76: 1172-1176.

Reardon, T., Stamoulis, K., Balisacan, A., Cruz, M. E., Berdegue, J., and Banks, B. (1998). Rural Non-Farm income in Developing Countries. In R. Tucker (Ed.). *The State of Food and Agriculture 1998*. Rome, Italy: FAO, FAO Agriculture Series No. 31.

Senadza, B. (2011). Does Non-Farm Income Improve or Worsen Income Inequality? Evidence from Rural Ghana. *African Review of Economics and Finance* 2(2): 104-121.

Seng, K. (2016). The Effects of Market Participation on Farm Households' Food Security in Cambodia: An Endogenous Switching Approach. MPRA paper no. 69669. Available at: https://mpra.ub.uni-muenchen.de/69669/.

Singh, I., Squire, L., and Strauss, J. (1986). *Agricultural Household Models*. Baltimore: Johns Hopkins University Press.

Skrondal, A., and Rabe-Hesketh, S. (2004). Generalized Latent Variable Modeling: Multilevel, Longitudinal, and Structural Equation Models. Boca Raton, FL: Chapman & Hall/CRC.

Smale, M., Kusunose, Y, Mathenge, M. K., and Alia, D. (2016). Destination or Distraction? Querying the Linkage between Off-Farm Work and Food Crop Investments in Kenya. *Journal of African Economies* 25(3): 388-417.

Tobin, J. (1958). Estimation of Relationships for Limited Dependent Variables. *Econometrica* 26: 24-36.

Tudor, M., and Balint, B. (2006). Off-Farm Employment and Agricultural Sales: Evidence from Romania. *Post-Communist Economies* 18(2): 243-260.

United Nations Conference on Trade and Development (UNCTAD) (2015). *The Least Developed Countries Report 2015: Transforming Rural Economies*. New York and Geneva: The United Nations.

Van den Berg, M., and Kumbi, G. E. (2006). Poverty and the Rural Non-Farm Economy in Oromia, Ethiopia. *Agricultural Economics* 35: 469-475.

Woldehanna, T. (2000). Economic Analysis and Policy Implication of Farm and Off-Farm Employment: A Case Study in the Tigray Region of Northern Ethiopia. Published PhD Dissertation, Agricultural Economics and Rural Policy Group, Wageningen University. Available at: http://library.wur.nl/WebQuery/wurpubs/67022.

Woldehanna, T. (2002). Rural Farm/Non-Farm Income Linkages in Northern Ethiopia. In B. Davis, T. Reardon, K. Stamoulis and P. Winters (Eds.). *Promoting Farm/Non-Farm Linkages for Rural Development: Case Studies from Africa and Latin America*. Rome, Italy: FAO, 121-144.

Woldehanna, T., and Oskam, A. (2001). Off-Farm Employment and Income Inequality: The Implication for Poverty Reduction Strategy. *Ethiopian Journal of Economics* 4: 41–57.

Woldehanna, T., Heckelei, T., and Surry, Y. (2016). Effect of Off-Farm Income on Smallholder Commercialization: Panel Evidence from Rural Households in Ethiopia. *Agricultural Economics* 48(2): 207-218.

Yang, J., Wang, H., Jin, S., Chen, K., Riedinger, J., and Peng, C. (2016). Migration, Local Off-Farm Employment and Agricultural Production Efficiency: Evidence from China. *Journal of Productivity Analysis* 45(3): 247-259.

Yaro, J. A., Teye, J. K., and Torvikey, G. D. (2017). Agricultural Commercialization Models, Agrarian Dynamics and Local Development in Ghana. *The Journal of Peasant Studies* 44(3): 538-554.

Appendix

Table A1: Switch_Probit Estimates of Determinants of Non-Farm Engagement and Participation

Variable	NFE	Decisions to sell maize		NFE	Decisions to sell groundnut		NFE	Decisions to sell rice	
		PART	Non-PART		PART	Non-PART		PART	Non-PART
Basic household characteristics:									
Age of head of household	-0.002*	-0.003	-0.005***	-0.003	-0.001	-0.004	-0.005*	0.003	-0.007*
Average age of household	0.004**	0.006	-0.000	0.006*	-0.003	0.002	0.003	-0.011*	-0.007
Male head of household	-0.002	-0.109	0.242***	-0.133	0.192	0.109	-0.059	0.101	0.008
Years of education	0.033***	0.022	-0.023***	0.013	-0.015	-0.010	0.019*	-0.020	0.013
Area of residence	-0.323***	-0.000	-0.020	0.042	0.375*	0.269	-0.215	0.571**	0.551
Region (base: Upper West):									
- Western	-0.482***	5.497***	0.892***				-0.707	1.695**	5.485***
- Central	-0.259	0.017	0.576				6.043***	6.317***	
- Greater Accra	0.211*	6.075***	0.375**				-0.594	2.063***	5.748***
- Volta	0.180	6.031***	0.329**				-1.280*	-3.294	5.370***
- Eastern	-0.123	5.368***	0.792***				-0.288	2.038***	4.457***
- Ashanti	-0.043	5.748***	0.396**				-0.563	2.572***	5.369***
- Brong Ahafo	0.167	5.670***	0.132				-0.442	2.900***	5.879***
- Northern	0.012	5.087***	-0.026				-0.777*	2.402***	5.173***
- Upper East	0.697***	5.540***	-0.193				-0.094	1.946***	5.532***
Production determinants:									
Household size	0.092***	0.037	-0.071	0.089***	-0.044	0.015	0.083***	0.183**	-0.055
Farm size in hectares	-0.046***	0.035	0.214***	-0.001	0.217***	0.012	0.223***	0.077	0.207
Price/kg	0.018	0.025	-0.033*	-0.013	0.035**	0.030	0.013	-0.079*	-0.111*
Access to credit	0.030	13.444***	7.201***	-0.011	0.011	0.027	0.275*	-0.082	-0.249
Extension compliance		0.229*	0.200***					-0.088	-0.041
Agricultural wage	-0.010**	-0.027	0.014**	-0.021*	0.002	0.027	-0.021	0.186***	0.106
Ecological zone (base: Coastal):									
- Forest	-0.068	6.228	-0.001	-0.356	0.563	-0.452			
- Savannah	-0.421***	6.046***	0.195	-0.080	0.114	-0.134			

Needs determinants:									
Adult equivalent scale		0.028	0.043		-0.022	0.060		-0.335***	0.147
Other sales determinants:									
Market in community		-0.640***	-0.295***		2.129***	-7.220***		-0.341***	-0.216
Navigable road to community		20.222***	0.331***					-0.009	0.200
Public transport availability	0.189***	-0.830***	-0.015	0.187***	-0.235***	-0.062	0.150*	0.068	0.113
Ownership of radio	-0.012	0.035	0.127***	-0.077	0.136*	0.127	-0.085	0.005	-0.067
Ownership of bank account	0.286***			0.233**			0.130		
Constant	-0.767***	-13.729	-1.000***	-0.712*	0.130	6.365	0.022	-2.260***	-6.301
Observation	4437			1730			1157		
Wald chi2	467.21***			114.07***			2530.5***		
Log Pseudo lik.	-4483.26			-1552.84			-1313.36		
Rho		0.658	-0.619		-1.00	0.613		-0.951	0.508
Wald test	12.78***			3.13			8.90**		

Source: GLSS6 Data; * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table A2: Determinants of Non-Farm Engagement and Commercialization

	Maize				Groundnut			
	Simple		GSEM: Full model		Simple		GSEM: Full model	
Variable	OLS	Tobit	RS	NFE	OLS	Tobit	RS	NFE
Non-farm engagement	11.78***	14.96***	16.75***		7.778***	10.74***	13.08***	
Basic household characteristics:								
Age of head of household	-0.085***	-0.172***	-0.172***	-0.0251	-0.035	-0.053	-0.051	-0.069
Average age of household	-0.006	0.001	-0.002	0.129**	-0.089	-0.118	-0.125	0.196**
Male head of household	2.103	6.069**	6.105**	-1.896	6.835***	11.74***	11.94***	-4.961*
Years of education	-0.131	-0.326	-0.354	1.257***	-0.289	-0.432	-0.448	0.381
Area of residence	-1.246	-3.272	-3.156	-5.093	8.548*	15.03**	14.99**	0.996
Region (base: Upper West):								
- Western	8.282***	13.58**	13.95**	-15.69***	9.706			
- Central	15.34***	30.32***	31.05***	-33.19***	25.63***			
- Greater Accra	27.55***	48.67***	49.20***	-23.63**				
- Volta	11.51***	22.98***	23.24***	-11.07***	14.23***			

- Eastern	16.11***	30.77***	31.02***	-10.34***	5.172			
- Ashanti	18.87***	34.14***	34.63***	-20.97***	0.421			
- Brong Ahafo	12.50***	23.11***	23.57***	-19.58***	-2.275			
- Northern	0.060	3.499	3.791	-12.72***	4.015**			
- Upper East	1.659	2.213	2.554	-15.53***	-4.004**			
Production determinants:								
Household size	-0.455	-0.496	-0.552	2.427***	0.667	1.419	1.357	1.442***
Per capita output in kg	0.003	0.006	0.006		0.010**	0.012**	0.012**	
Farm size in hectares	1.660***	2.963***	2.980***	-0.770	0.212	0.240	0.235	0.103
Price/kg	-0.704**	-1.405**	-1.408**	0.112	-0.353	-0.494	-0.461	-0.794**
Access to credit	40.98***	58.96***	58.93***	1.137	18.72***	24.22***	24.21***	0.534
Extension compliance	6.175***	11.64***	11.63***		25.62***	39.41***	39.40***	
Agricultural wage	-0.068	-0.000	0.008	-0.357**	0.491***	0.669**	0.686**	-0.402
Ecological zone (base: Coastal):								
- Forest	-1.690	-1.776	-2.016	10.51***	7.928	13.22*	13.16*	1.212
- Savannah	-2.735	-4.336	-4.507	7.103**	-3.052	-4.038	-3.735	-7.619**
Needs determinants:								
Adult equivalent scale	0.090	-0.147	-0.143		0.313	-0.210	-0.208	
Other sales determinants:								
Market in community	2.079*	1.634	1.630		-7.401***	-12.20***	-12.20***	
Public transport availability	0.705	1.702	1.565	6.321***	9.304***	12.17***	12.02***	3.507**
Ownership of radio	6.217***	9.917***	9.968***	-2.289	-2.887*	-4.656**	-4.645**	-0.171
Ownership of bank account	0.882	2.100	1.893	9.016***	0.658	-0.192	-0.556	8.137***
Latent			-29.34***	1			-27.21***	1
Constant	6.774*	-21.71***	-22.21***	-17.71***	2.536	-22.42**	-22.97**	-14.36**
Observations	4437	4437	4437	4437	1730	1730	1730	1730
R^2	0.360				0.397			
Pseudo R^2			0.129				0.065	
σ^2		1600.7***	740.3***			1103.4***	363.9***	
τ^2				740.3***				363.9***

Source: GLSS6 Data; * p<0.10, ** p<0.05, *** p<0.010